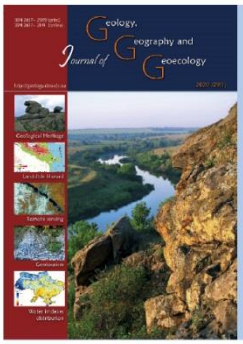

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The regional nosogeographical analysis and factors affecting population respiratory morbidity (on example of the Sumy region, Ukraine)

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Abstract. The article is devoted to consideration of the spatial-temporal structure of the primary morbidity and prevalence of the respiratory organs diseases among the population of the Sumy region. The article based on the data of annual statistical reports of medical institutions of Sumy region, which are subordinate to the Ministry of Public Health of Ukraine. The article used the methods of factor and correlation analysis, as well as methods of mathematical-statistical analysis, and ranking. The authors analyzed the spatial-temporal structure of respiratory organs pathology among the population and revealed the territorial differences and the dynamics of respiratory morbidity of the population. Nosogeographic assessment of territory of the Sumy region, which was carried out according to the integral respiratory diseases morbidity index (IMI), shows that today the highest values of IMI are obtained by analyzing the incidence rate in Putyvl' (1.01), Krasnopillia (1.02), Konotop (1.11), Buryn' (1.32) districts and in the city of Sumy (1.15). These are the districts where the incidence rate of respiratory diseases among the population has increased most of all during the study period. Low values of IMI are noted in Lypova Dolyna (0.63), Seredyna Buda (0.71), Velyka Pysarivka (0.72) and Nedryhailiv (0.79) districts. The higher is the IMI value, the worse the health level of the population. The average index storage respiratory diseases (ISD) in the Sumy region in 2017 was 1.27, with polarization ISD value in some areas from 1.19 in Shostka, 1.22 in Konotop, 1.23 in Yampil' and Trostianets regions to 1.39 in Lebedyn, 1.42 in Romny and 1.61 in the Seredyna Buda districts. This indicates the predomination of chronic forms of diseases over acute ones and can be explained by the influence of environmental and socio-economic factors. It also points to the need to increase of attention of both the regional and state components of the health care system. Besides that, the issues of providing financial and human resources for the health care system in districts with high incidence rates of respiratory pathology require attention. The study of the primary morbidity and the prevalence of respiratory diseases trends is a prerequisite for the development of preventive measures in the Sumy region. They are also needed to assess the quality of medical care for residents who have the pulmonary diseases. The factor analysis results are confirmed the importance of environmental and technogenic factors in formation of the indicators of primary morbidity and prevalence of respiratory diseases among the residents of the Sumy region.

Key words: respiratory diseases, primary morbidity, diseases prevalence, nosology, morbidity factors, nosogeographic assessment, medical and environmental research, Sumy region.

Регіональний нозогеографічний аналіз пульмонологічної захворюваності населення та пошук факторів, що її зумовлюють (на прикладі Сумської області, Україна)

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Анотація. Стаття присвячена розгляду просторово-часової структури первинної захворюваності та поширеності хвороб органів дихання серед населення Сумської області. Авторами виконана загальна нозогеографічна оцінка території регіону за цією групою нозологій й виділені фактори, що визначають рівень захворюваності на них. Отримані результати ґрунтуються на даних щорічних статистичних звітів медичних установ Сумської області, які підпорядковуються Міністерству охорони здоров'я України. У статті використано методи факторного і кореляційного аналізу, а також інші математико-статистичні методи і прийоми. У результаті аналізу просторово-часової структури поширення патологій органів дихання серед населення виявлено територіальні відмінності пульмонологічної захворюваності та з'ясовано динаміку рівнів захворюваності населення

на хвороби органів дихання. Проведена нозогеографічна оцінка території Сумської області, здійснена за показником інтегрального індексу захворюваності населення на хвороби органів дихання, свідчить, що сьогодні найвищі показники його показники отримані при аналізі захворюваності мешканців Путивльського (1,01), Краснопільського (1,02), Конотопського (1,11), Буринського (1,32) районів та м. Суми (1,15). Це ті райони, де показники захворюваності населення на хвороби органів дихання найбільше зросли за досліджуваний період. інтегрального індексу захворюваності відмічаються у Липоводолинському (0,63), Середино-Будському (0,71), Великописарівському (0,72) та Недригайлівському (0,79) районах. Чим вищий показник інтегрального індексу захворюваності населення на хвороби органів дихання, тим рівень здоров'я населення гірший. Середнє значення індексу накопичення пульмонологічних хвороб у Сумській області в 2017 р. становило 1,27 при поляризації цього показника в окремих районах від 1,19 у Шосткинському, 1,22 у Конотопському, 1,23 у Ямпільському та Тростянецькому районах до 1,39 у Лебединському, 1,42 у Роменському та 1,61 у Середино-Будському районах, що свідчить про переважання хронічних форм захворювань над гострими та може пояснюватися впливом екологічних та соціально-економічних чинників та рівнем медичного обслуговування.. Результати факторного аналізу підтверджують важливість екологічних і техногенних факторів у формуванні показників первинної захворюваності і поширеності хвороб органів дихання серед жителів Сумської області. Натомість показник забезпеченості населення регіону лікарями-пульмонологами характеризує розвиток системи охорони здоров'я, а не рівень здоров'я населення.

Ключові слова: хвороби органів дихання, первинна захворюваність, поширеність захворювань, нозологія, фактори захворюваності, нозогеографічна оцінка, медико-екологічне дослідження, Сумська область.

Introduction. Respiratory diseases are occupying a leading position among the diseases of the world's population in terms of prevalence as well as by percentage in the structure of death causes – through of them the 1/6 of all deaths in the world is occurring. Diseases of the respiratory system not only lead to premature death, but also often cause to disability of the able-bodied population, which is an additional social and financial burden for many countries. WHO estimates (Chronic, 2019) that 64 million people have chronic obstructive pulmonary diseases (COPD). In the European Union countries 600 thousand people die each year from pulmonary diseases only. Pathologies of this group are occupying the third place among the causes of death, after cardiovascular and oncological diseases.

According to modern interpretation, a respiratory pathology combines the diseases of infectious, allergic, immunological, and hereditary origin. In addition to these factors, some chronic diseases of respiratory organs as well as cancer pathologies of their, are associated with environmental, occupational and other harmful factors, and the etiology of some diseases has not yet been determined, therefore they are interpreted as idiopathic (Yakovenko, 2017).

In Ukraine, as in the world at large, respiratory diseases are also one of the most common pathologies of the population. According to the results of 2016, diseases of this nosological class in Ukraine were on second place in the structure of the prevalence of diseases (33952.9 cases per 100 thousand of people) after cardiovascular diseases, and in terms of primary incidence – on first place (28.445 case per 100 thousand people) (Dudina, 2015; Shevchenko, 1997). Residents of Sumy region, where respiratory diseases are very common and inferior only to diseases of the cardiovascular system (Kornus, 2018), are not an exception. This makes the study of regional disproportions of the pulmonary morbidity as important and relevant. The relevance of the study is also emphasized by the rapid rates of the respiratory diseases prevalence.

Review of previous researches. Regional differences in the incidence of the Ukrainian population by various diseases, including respiratory diseases, were considered in the works of various geographers. Most of them were relied on the classical works by V. Shevchenko about the medical-geographical analysis of the territory of Ukraine (the experience of foreign scientists is summarized in the monograph (Mayer, 2010), for example, (Shevchenko, 1997). Among the new ones, it is worth noting the scientific research by R. Molikevich, who investigated the peculiarities of population morbidity of the Kherson region for a wide range of nosologies (Molikevych, 2016). An analysis of the morbidity of population of the Chergihiv region is presented in the reaearch of T. Shovkun (Shovkun, 2012). Medical-geographical studies of the Ternopil region were conducted by I. Demianchuk (Demianchuk, 2017).

A certain part of the scientific works is devoted to clarifying the influence of environmental factors on the structure and level of morbidity formation (medical ecology). So, I. Mezentseva determined the coefficients of the relationship between the total chemical pollution of various components of the urban environment and the population morbidity of the Volyn region (Mezentseva, 2008). V. Gutsulyak & K. Nakonechnyi were engaged a medical and environmental analysis of Chernivtsi region's landscapes and medical-ecological assessment of the settlement geosystems of this region (Hutsuliak, 2010).

The third group of publications consists the works devoted to the geography of the medical

care sphere. Among of them are the studies of Kh. Podvirna, which examined the geospatial organization of the population health care of the Lviv region (Podvirna, 2010) and I. Martusenko, who studied the characteristics of the medical complex organization and the population health status of the Vinnitsa region (Martusenko, 2005).

Regarding the Sumy region, all of the above issues were considered in general form in numerous works by O. Kornus with co-authors, which found their generalization in the monograph (Kornus, 2015). However, diseases of the respiratory system, as such, which occupy the first place in the structure of the primary population morbidity, require more detailed study, as well as the search for the causes that cause of it. This is what determined the aim of our article. **The aim of the article** is to perform the nosogeographical assessment of the Sumy region's territory based on the analysis of the spatial and temporal structure of the respiratory diseases prevalence and the primary morbidity of inhabitants of the Sumy region, as well as to establish the factors defining the level of respiratory morbidity.

Material and research methods. The observation covers the period from 2005 to 2017. 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. The structure of the following major respiratory diseases was investigated in the space-time aspect: 1) acute pharyngitis and acute tonsillitis; 2) acute laryngitis and tracheitis; 3) pneumonias); 4) allergic rhinitis; 5) chronic rhinitis, nasopharyngitis and pharyngitis; 6) chronic diseases of tonsils and adenoids; 7) chronic laryngitis and laryngotracheitis; 8) chronic obstructive pulmonary diseases; 9) bronchial asthma; 10) other respiratory diseases.

To establish the factors influencing on respiratory diseases prevalence, a methods of factor and correlation analysis were applied. The latter provided for the determination of the correlations between the prevalence of diseases and the environmental and socio-economic indicators, as well as the number of doctors providing specialized medical care. As a result of the analysis, 680 paired Pearson correlation coefficients were obtained between the socio-economic indicators and factors characterizing the environment quality, on the one hand, and the primary morbidity of Sumy region inhabitants and the respiratory diseases prevalence belonging to the above mentioned ten nosological groups, on the other hand. From the resulting correlation array, there are 37 pairs for which the correlation is significant at the level of ≤0.05 and 10 pairs for which the correlation is significant at the level of ≤0.01 were identified, that is; those where the connections between the correlated parameters are the closest and most reliable. Thus, out of all correlation array, only 47 (6.9 %) correlation coefficients are statistically significant.

To carry out a nosogeographic assessment of territory of the Sumy region, the indicators of the diseases prevalence and the population primary morbidity were used. Nosogeographical assessment we understanding as selection and systematization of administrative-territorial units, differing from each other by the structure of nosologies, prevalenting among inhabitants. This assessment was carried out in several stages. At the first stage, the average value of both estimated indicators for the period 2005-2017 was calculated for each respiratory disease by administrative units of the Sumy region. After that, the normalized health indicators *(HI)* of the population (Demianchuk, 2017) were calculated for all nosologies in the administrative districts by the formula

$$HI = \frac{\bar{x}}{P_n} \qquad (1),$$

where: $\bar{x}$ – average value of the nosology indicator (average value of the j-th indicator in the n-th administrative district); – the value of the normative nosology indicator (average regional value of the j-th indicator).

At the final stage, the calculation of the integral morbidity index *(IMI)* of the population by respiratory diseases for each of administrative districts of the region was carried out by formula:

$$IMI = \frac{1}{n}\sum_{i=1}^{n} HI \qquad (2),$$

where: n – the number of nosologies taken for analysis; *HI* – normalized health indicator of the n-th administrative district.

Many nosological forms are diagnosed in a launched state, therefore they are difficult to cure that quite often lead to mortality. Take into account this fact an important moment of the nosogeographical evaluation of territory is the determination of the level of diseases accumulation. It is believed (Demianchuk, 2017) that the indicator of diseases accumulation, in addition to assessing the actual morbidity, provides an opportunity to analyze the level of preventive work, to assess the quality of primary diseases diagnosis and the medical services availability. One such index is the index storage diseases *(ISD)* – the ratio between prevalence of diseases and primary morbidity. Higher values of this index indicating, first of all,

the predomination of chronic forms of diseases over acute ones in a some region, and also indicate a better level of medical care for the population as well as the favorable influence of other social factors on the diseases course (Demianchuk, 2017).

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

Results and discussion. As of January 1, 2018 in Sumy region the primary morbidity by respiratory diseases was 22,070.29 cases per 100 thousand people, and the prevalence of diseases was 28,054.31 cases per 100 thousand of inhabitants. During 2005-2017, there is an increase both primary morbidity (by 15.04 %) and the prevalence of respiratory diseases (by 14.42 %). The city of Sumy, Konotop and Bilopillia districts have the highest rates of both primary morbidity and prevalence of disease. The lowest prevalence of respiratory pathologies in 2017 was recorded in Lebedyn, Hlukhiv, Nedryhailiv and Lypova Dolyna districts, and the primary incidence – in the Lebedyn, Hlukhiv, Nedryhailiv and Seredyna Buda districts.

During the study period, the primary incidence and respiratory diseases prevalence among the population were decreased in three administrative units only – Krasnopillia (by 12.26 % and 7.99 %, respectively), Okhtyrka (by 7.61 and 3.08 %) districts and Sumy city (by 7.67 % and 3.94 %). And for most districts of Sumy region, the growth of primary incidence and prevalence of this group of nosologies was characteristic, which was most noticeable in four districts – Shostka (primary incidence increased by 66.06 % and prevalence by 52.04 %), Konotop (86.37 % and 56.96 %), Seredyna Buda (1.8 times and 68.36 %), Putyvl' (76.28 % and 69.42 % respectively).

According to medical statistics, chronic obstructive pulmonary diseases (COPD) were the most common pulmonary diseases in the Sumy region in 2017. According to WHO, (Chronic, 2019) COPD is a collective term, but not a single disease. It is used to describe all chronic respiratory diseases that limit airflow to lungs. Terms such as «chronic bronchitis» and «emphysema» are no longer used and are now included into the diagnosis COPD. Among administrative districts, the highest of this pathology prevalence are observed among the inhabitants of Velyka Pysarivka (1,842.93 cases per 100,000 people), Konotop (1,844.74), Lebedyn (1,979.03) and Putyvl' (3,228.39 cases per 100 thousand of people) districts. The inhabitants of Shostka (1,054.87) and Trostianets districts (1,158.53 cases per 100 thousand people) are suffer from COPD at least of all.

As for primary morbidity by COPD, according to the results of 2017, Buryn' (141.87 cases per 100 thousand people), Velyka Pysarivka (146.6), Okhtyrka (172.74) and Putyvl' (421.73 cases per 100 thousand people) districts are the leaders on this indicator. The number of cases of bronchitis, emphysema and other chronic obstructive pulmonary diseases, reported for the first time in 2017, was lowest among the inhabitants of Romny (35.71) and Seredyna Buda (36.45 cases per 100 thousand people) districts.

It is also worth noting a decrease of the prevalence of this group of pathologies among the inhabitants of all districts of the Sumy region, except Putyvl', where this indicator for 2005-2017 was grow by 18.35 %. In the six districts of the region, the prevalence of these diseases is reduced by more than 50 %; in Yampil' (by 66.21 %), Romny (by 60.42 %), Seredyna Buda (by 59.81 %), Konotop (by 58.03 %), Shostka (by 56.87 %) and Okhtyrka (on 51,82 %) districts. The primary respiratory nosologies are also decrease in most administrative-territorial units of the region (11 out of 19). Among the districts where there is an increase of the primary morbidity by COPD, Putyvl' district is again stands out. For the Putyvl' district inhabitants this indicator has more than doubled.

Acute pharyngitis and tonsillitis are in second place in the structure of respiratory diseases of the Sumy region residents. These are infectious diseases developing on the background of acute respiratory viral diseases. Complications from them can cause an acute rheumatic fever, which in 40-60 % of cases leads to irreversible autoimmune damage of heart valves and the development of chronic rheumatic heart disease (Masheiko, 2017). For the years 2005-2017 in the region only in four administrative-territorial units there was a decrease of the prevalence of acute pharyngitis and tonsillitis: in Buryn' (by 17.78 %), Bilopillia (by 16.64 %), Konotop (by 3.21 %) districts and in the city of Sumy (by 12.69 %).

However, in most areas there are an increase of prevalence of these nosologies. The prevalence of acute pharyngitis and tonsillitis among the inhabitants of Putyvl' district increased by 10 times (from 422.32 to 4,224.53 cases per 100 thousand people), and among residents of Seredyna Buda district – almost by 20 times (from 115.23 to 2,205.48 cases per 100 thousand inhabitants). For these two districts, there are also a high growth rate of primary morbidity, which in Putyvl' district during 2005-2017 has increased by 4 times. Therefore, here, as well as among the residents of Yampil' and Trostianets districts, the highest rates of primary morbidity and prevalence of this group of nosologies were observed.

The decrease of the population primary morbidity by acute pharyngitis and acute tonsillitis during the above mentioned observation period was recorded only in Buryn' (by 7.36 %), Bilopillia (by 13.7 %), Konotop (by 21.51 %), Lebedyn (by 16,01 %) districts and in the city of Sumy (by 22.1 %). In Sumy, as well as Lypova Dolyna, Romny and Shostka districts, the lowest indicators of the primary morbidity of their inhabitants were recorded.

Chronic diseases of the tonsils and adenoids are occupying the third place in the structure of respiratory diseases of the Sumy region population. Most often children are falling ill by these. The reasons that contribute to the development of this diseases group including inflammatory diseases of the upper respiratory tract, infectious diseases (measles, diphtheria, influenza, etc.). In this case, what happens is a lesion of the nasal mucosa and tonsils, which leads to a violation of nasal breathing. In 2017, the chronic diseases of the tonsils and adenoids were most common among the inhabitants of Bilopillia (1,034.75 cases per 100,000 people), Lypova Dolyna (1,039.11), Putyvl' (1,265.18) and Buryn' (2,245.55) districts, and the lowest prevalence rates were recorded in Velyka Pysarivka (387.43) and Hlukhiv (392.95 case per 100 thousand inhabitants) districts. During 2005–2017, in eight districts of the region there was a decrease of the prevalence of these diseases, especially noticeable among the residents of Krasnopillia (by 77.17 %) and Hlukhiv (by 55.10 %) districts. At the same time among the inhabitants of Putyvl' district the diseases of tonsils and adenoids were almost doubled, and in Lypova Dolyna district were increased almost by 8 times.

The highest rates of newly registered cases of chronic diseases of the tonsils and adenoids were observed in Shostka (400.58), Yampil' (436.42), Putyvl' (596.23) districts and in the city of Sumy (453.92 case per 100 thousand inhabitants). In 2017, least of all these nosologies were distributed among the residents of Nedryhailiv (12.33), Lebedyn (30.65) and Velyka Pysarivka (68.06 case per 100 thousand people) districts. According to the dynamics of primary population morbidity of the region by nosologies of this group, then in nine districts there are positive trends to its reduction. It was especially noticeable among the residents of Nedryhailiv (by 95.86 %), Krasnopillia (by 86.53 %), Lebedyn (by 79.85 %) and Velyka Pysarivka (by 68.74 %) districts. In other administrative units, on the contrary, an increase of primary morbidity is observed: Romny (2 times increase), Lypova Dolyna (almost 4 times increase), Seredyna Buda (6.5 times increase) and especially in Putyvl' (more than 12 times increase) districts.

Theoccurrenceofrespiratorydiseasesisassociated with many factors, including environmental, natural, genetic, socio-economic, and others. Environmental or technological factors (dustiness and gas pollution of atmospheric air, the excess of safe concentrations a chemical elements in the environment, water and food products pollution) cause mainly infectious-inflammatory diseases (bronchitis, pneumonia), as well as allergic reactions that can develop to bronchial asthma. For example, it is estimated that indoor air pollution is responsible for 2.7 % of diseases globally (the 8th most important risk factor for pathologies occurrence) and 1.5–2 million deaths annually. As separate factor is the effect of mold fungi, which is a source of allergens and may increase the risk of asthmatic problems by 30-50 % (Zdorove, 2014). The effect of suspended particles, gases, vapors or smoke in the workplace causes 15 % of all cases of the respiratory tract cancer in men and 5 % in women and 15-20 % of all asthma cases (are known about 350-400 different agents causing occupational bronchial asthma) and COPD among adults (Zdorove, 2014).

Atmospheric pollution in the Sumy region occurs because of emissions into the atmosphere from stationary and mobile sources of pollution, transboundary transfer of pollutants and the ability of atmosphere to self-purification. The presence and nature of stationary pollution sources are determined by the development in the region a mining and chemical industries, engineering, food industry and other sectors of the economy that emit the pollutants. At the end of 2015, there are 936 industrial enterprises that emitted the pollutants into the atmospheric air operated in the region (Kornus, 2017).

The results of many medical-ecological studies are show that there is close links between pollution of surface layer of the atmosphere and the population health in time and in space (Kornus, 2015). For example, in (Hutsuliak, 2010), which concerns to medical and ecological assessment of the Chernivtsi region was found that the most vulnerable human organs are organs of direct exposure (the respiratory organs). In the same paper was received extremely high correlation coefficients ($r = 0.9$) between air pollution and disease of children by bronchial asthma, as well as the dependence of mortality due to respiratory diseases from overall emissions of air pollutants. Our results partially confirm these conclusions (Fig. 1), although the correlation coefficients values that we obtained are significantly lower. As can be seen from Fig. 1, there is so close relationship between the prevalence of bronchial asthma ($r = 0.468$, $p < 0.038$)

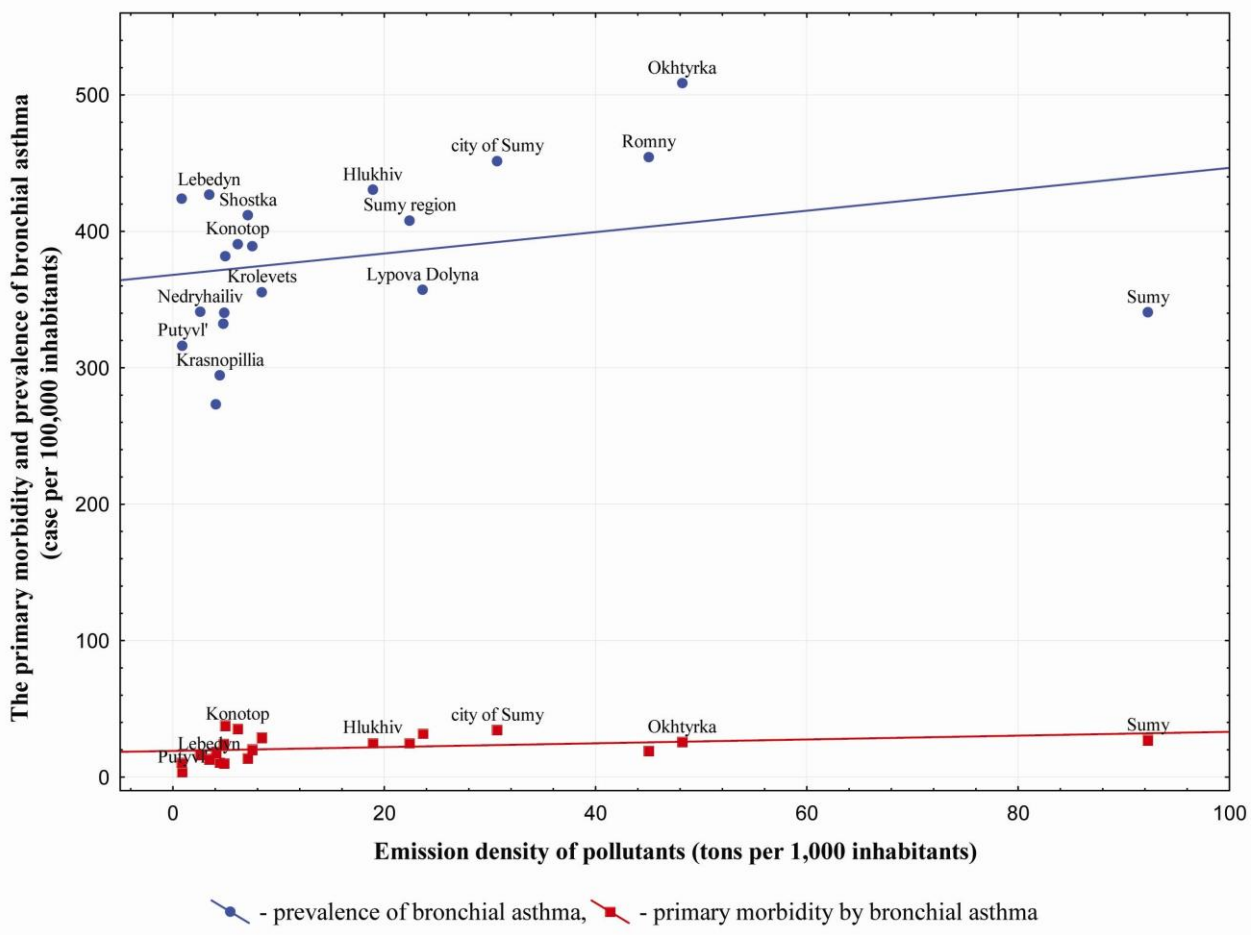

Fig. 1. The relationship between the primary morbidity and prevalence of bronchial asthma and the emission density of pollutants into atmospheric air of the Sumy region (Source: Own edition)

as well the primary incidence by this nosology ($r = 0.547$, $p < 0.002$) and the amount of pollutant emissions into the atmospheric air.

In general, the prevalence of bronchial asthma is very indicative in this regard – this indicator closely correlates with many ingredients polluting the air. However, the closest and with a high degree of reliability are the relationships between the prevalence of bronchial asthma and emissions of Nitrogen dioxide ($r = 0.629$, $p < 0.01$), Sulfur dioxide ($r = 0.715$, $p < 0.01$), as well emissions of Methane ($r = 0.495$, $p < 0.05$) and Non-Methane volatile organic compounds ($r = 0.487$, $p < 0.05$) (Fig. 2).

With the density of pollutants emissions into the air both in all terms and in terms of individual pollutants, especially SO_2, C and CO_2, are closely correlates with the prevalence of pulmonary diseases, including allergic and chronic rhinitis, nasopharyngitis, pharyngitis and the primary morbidity of the population of administrative units of the Sumy region by these pathologies.

Both the primary incidence ($r = 0.609$, $p < 0.01$) and the general prevalence ($r = 0.648$, $p < 0.01$) of respiratory diseases at all (Fig. 3) are related to the density of SO_2 emissions. A somewhat less significant, but noticeable, is the relationship is between the emission of CO into the atmosphere and the primary incidence ($r = 0.585$, $p < 0.01$) and the prevalence ($r = 0.482$, $p < 0.05$) of chronic rhinitis, nasopharyngitis and pharyngitis (Fig. 4), as well as the prevalence of bronchial asthma among residents of the Sumy region ($r = 0.523$, $p < 0.01$), the relationship of which with the quality of atmospheric air has already been mentioned above.

The technogenic factor also can cause other professional diseases – allergic rhinitis of office workers, carboconiosis of miners, aluminosis of metallurgists, and pneumoconiosis of electric welders. The accumulation in the air Carbon oxides, Sulfur, Nitrogen, Formaldehyde, industrial dust (and with it compounds of heavy metals, surfactants and other pollutants) leads to disruption of the function of the surfactant in lungs, enzymes in tissues of the respiratory organs, that resulting to autoallergic conditions (bronchial asthma, obstructive bronchitis, respiratory allergies) development (Chronic, 2019).

Natural factors are divided into abiotic (cosmic, geo- and heliofactors) and biotic (for example,

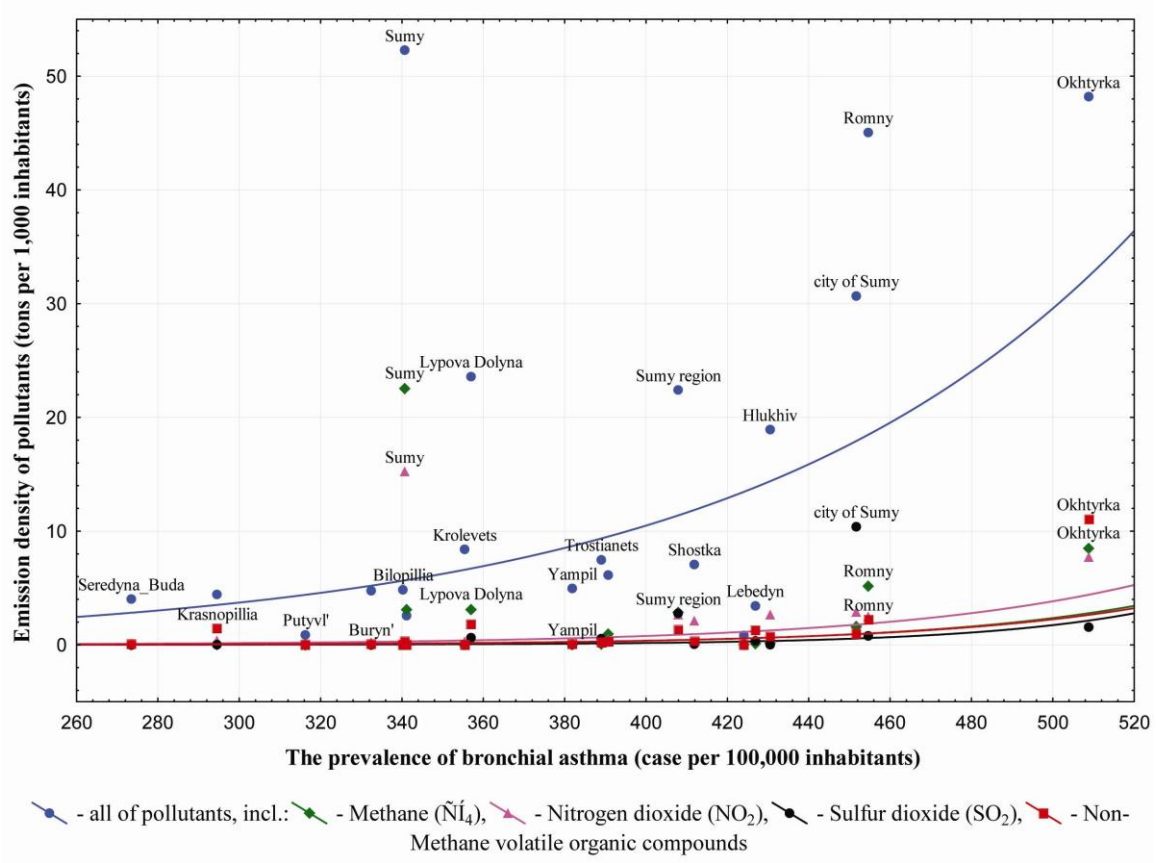

Fig. 2. The relationship between the prevalence of bronchial asthma and the emission density of some pollutants into atmospheric air of the Sumy region

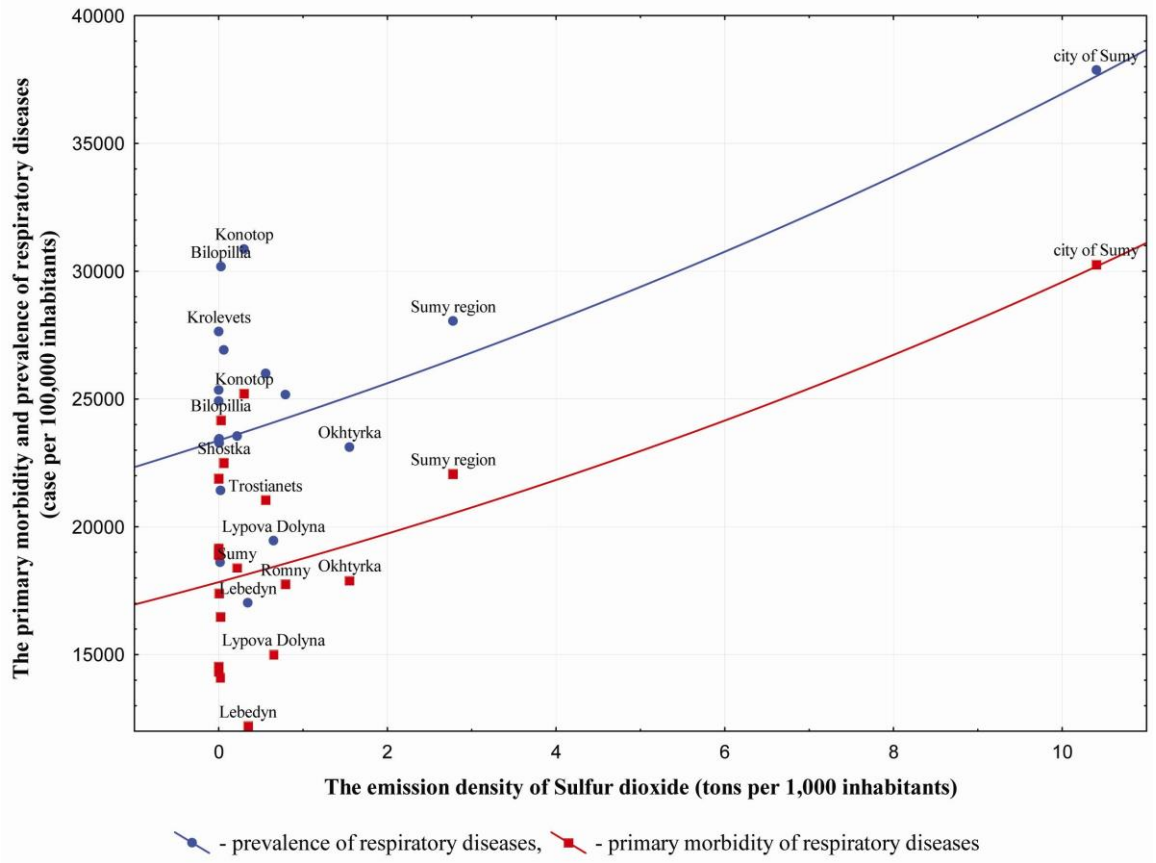

Fig. 3. The relationship between the primary morbidity and prevalence of respiratory diseases and the emission density of Sulfur dioxide (Source: Own edition)

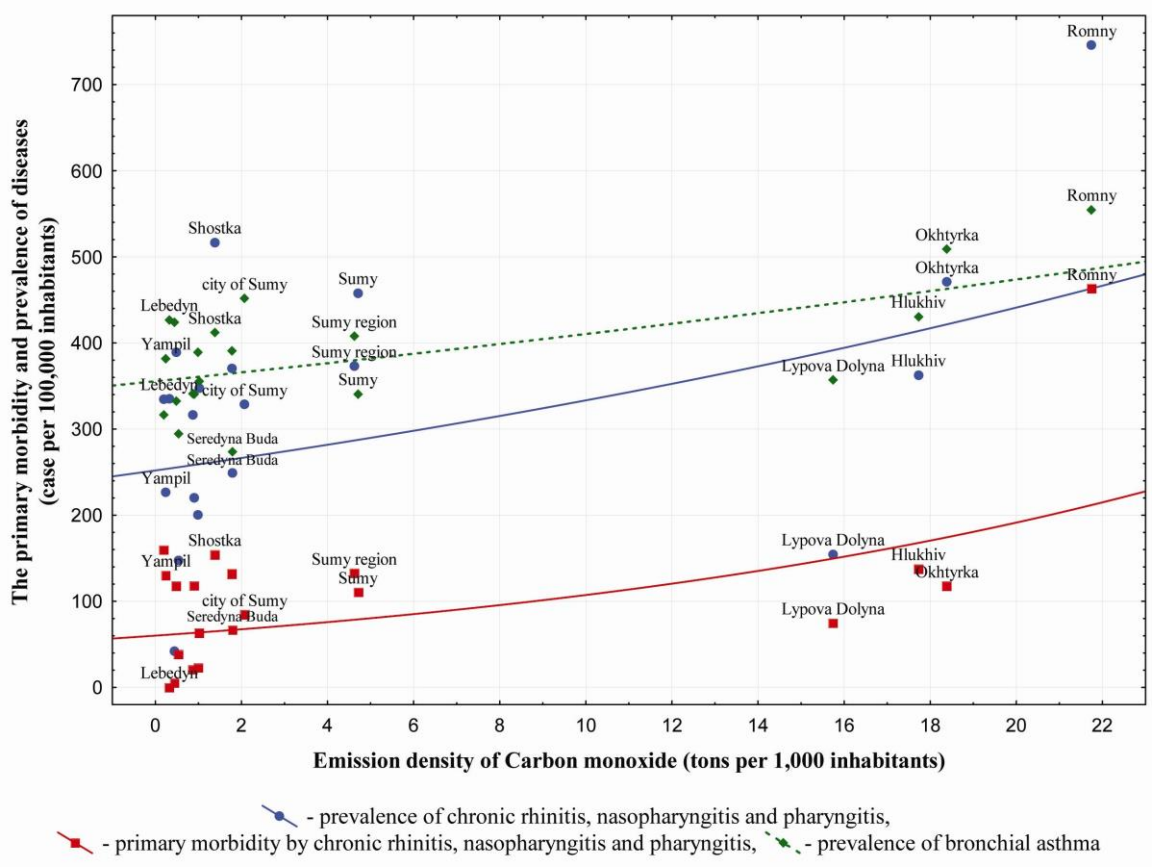

Fig. 4. The relationship between the primary morbidity and prevalence of some respiratory diseases and the emission density of Carbon monoxide in the Sumy region (Source: Own edition)

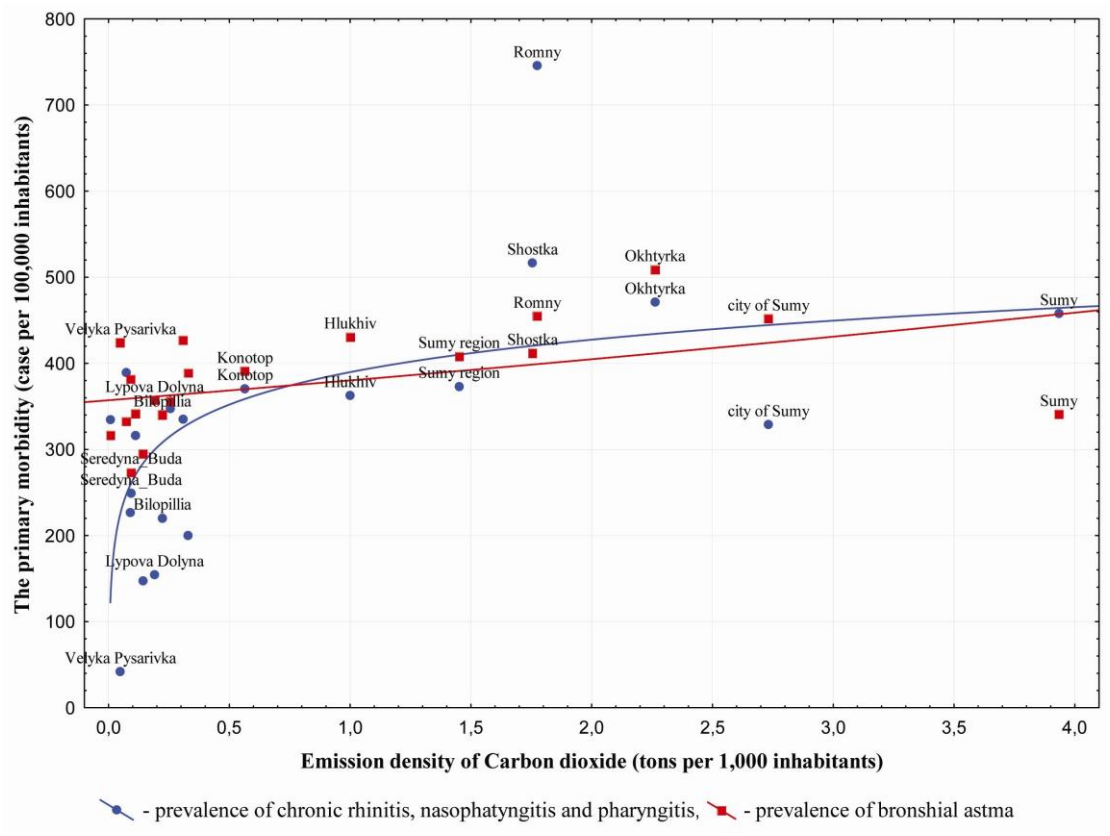

Fig. 5. The relationship between the prevalence of some respiratory diseases and the emission density of Carbon dioxide in the Sumy region (Source: Own edition)

bacteria and viruses). The latter cause the appearance of bronchitis, pneumonias, tonsillitis and pharyngitis, rhinitis, etc. Climatic and meteorological factors (humidity of air, atmospheric pressure, temperature) can lead to development of various inflammations of respiratory organs, exacerbations of chronic obstructive pulmonary disease, pneumonia, influenza and the like. The consequences of forest fires (Buts, 2018), geological factors, in particular the emission of Radon from the bowels of the Earth, can also provoke some diseases. For example, a Radon ejection is the second most important (after smoking) cause of lung cancer.

The prevalence rates of chronic rhinitis, nasopharyngitis and pharyngitis ($r = 0.581$, $p < 0.01$) and the prevalence of bronchial asthma ($r = 0.453$, $p < 0.05$) are correlate quite clearly with the emissions density of CO_2 (Fig. 5).

Important in the emergence and development of respiratory diseases is a socio-economic factor, which includes working conditions, population density, intellectual and cultural level of society development, bad habits (tobacco smoking, alcohol abuse, drug use, poor quality nutrition), conflicts, etc. It should be noted that this factor may exceed others. For example, smoking is the main cause of many lung diseases (tobacco smoke contains more than 4,000 chemicals, many of which are toxic and carcinogenic). It is estimated (Zdorove, 2014) that during the 20th century, 100 million people in world at large were died from smoking and this number will increase to 1 billion over the 21st century. In the EU, lung cancer kills more people than any other cancers (it accounts for about 20 % of all cancer deaths). Passive smoking also belongs to the important causes of respiratory diseases. More than 600 thousand people in world at large, who do not use tobacco products, die each year as a result of passive smoking (Zdorovie, 2014). More than 250 chemicals affecting the human body because of passive smoking are known as toxic or carcinogenic and can causing lung cancer, cough, obstructive and other pulmonary diseases.

Our research has established a fairly close and reliable relationship between the population density and the primary incidence by respiratory diseases of the Sumy region inhabitants ($r = 0.623$, $p < 0.01$), and the prevalence ($r = 0.660$, $p < 0.01$) of these diseases (Fig. 6).

The influence of socio-economic factors assessed through the search of correlations between the primary incidence or prevalence of diseases and the value of GDP per capita, the level of employment, incomes of the population, etc. In this context, we have found a relationship between the level of socio-economic development of administrative units of the Sumy region, calculated according to the method (Kornus, 2007) and the primary incidence ($r = 0.648$, $p < 0.01$) of their inhabitants by respiratory diseases and prevalence ($r = 0.678$, $p < 0.01$) of these diseases (Fig. 7).

As separate factor is the level of health care – the quality of medical services, their availability as well the availability of preventive measures and the availability of the appropriate profile doctors, places in hospitals. Usually, when the first clinical signs of these nosologies are appear, patients turn to family doctors or therapists, and when the diagnosis is confirmed, they are referred for examination or treatment to pulmonologists. To clarify the possibilities of overcoming the consequences of respiratory organs morbidity, it is important to analyze medical assistance for the population of the Sumy region. According to medical statistics, as of January 1, 2018, in the Sumy region pulmonological medical care for patients was provided by 13 pulmonologists, two of them are working in cities of Konotop and Okhtyrka. The remaining specialists are working in the regional center.

It should be noted there are no reliable links between morbidity or mortality rates from respiratory diseases and the staffing level by family doctors as well availability of pulmonologists. Therefore, the number of doctors or hospital beds is an indicator of assessing the availability of medical care, but not the state of public health. A big number of hospital beds do not mean at all that the health of the population in such regions is better than in those where their number is lower. This opinion is supported the results of studies by O. Krasnova (Krasnova, 2014), according to which an increase of number of a hospital beds is no way affects neither the prevalence of diseases, nor the primary morbidity.

Also to factors that determine the development and prevalence of respiratory diseases included the genetic factor, which is closely related to the state of environment and exposure of teratogenic factors (alcohol, drugs, smoking, industrial poisons, medicaments, food additives, etc.), which act during the time of embryogenesis and disturbing the development of tissues and organs. This can provoke severe pathological phenomena or lead to chromosomal and genetic mutations. In some people, an increased risk of lung diseases developing may be associated with a genetic predisposition inherited from the parents. Hereditary diseases are including congenital bronchiectasis, primary pulmonary hypertension, familial pulmonary emphysema, pulmonary alveolar microlithiasis, tracheobronchomegaly (Mounier-Kuhn Syn-

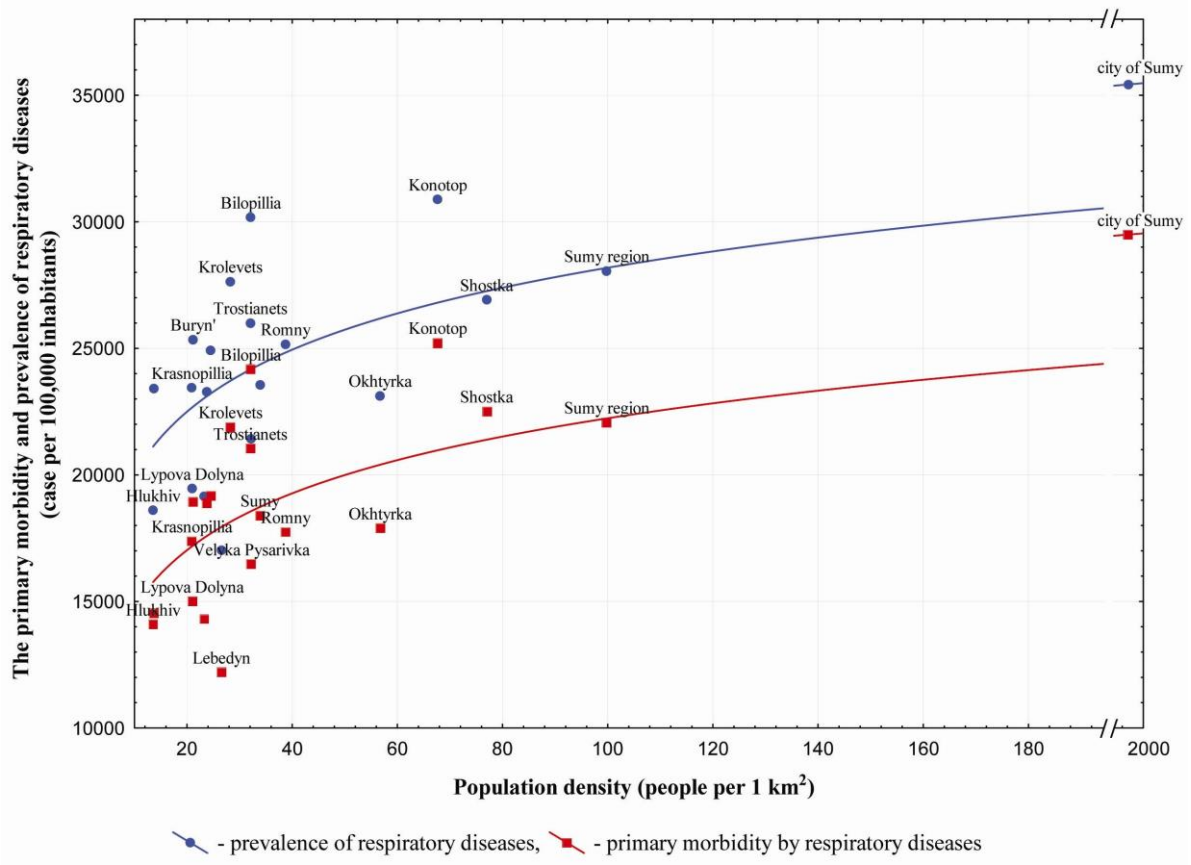

Fig. 6. Dependence the primary morbidity and prevalence of respiratory diseases among the population of the Sumy region from the population density (Source: Own edition)

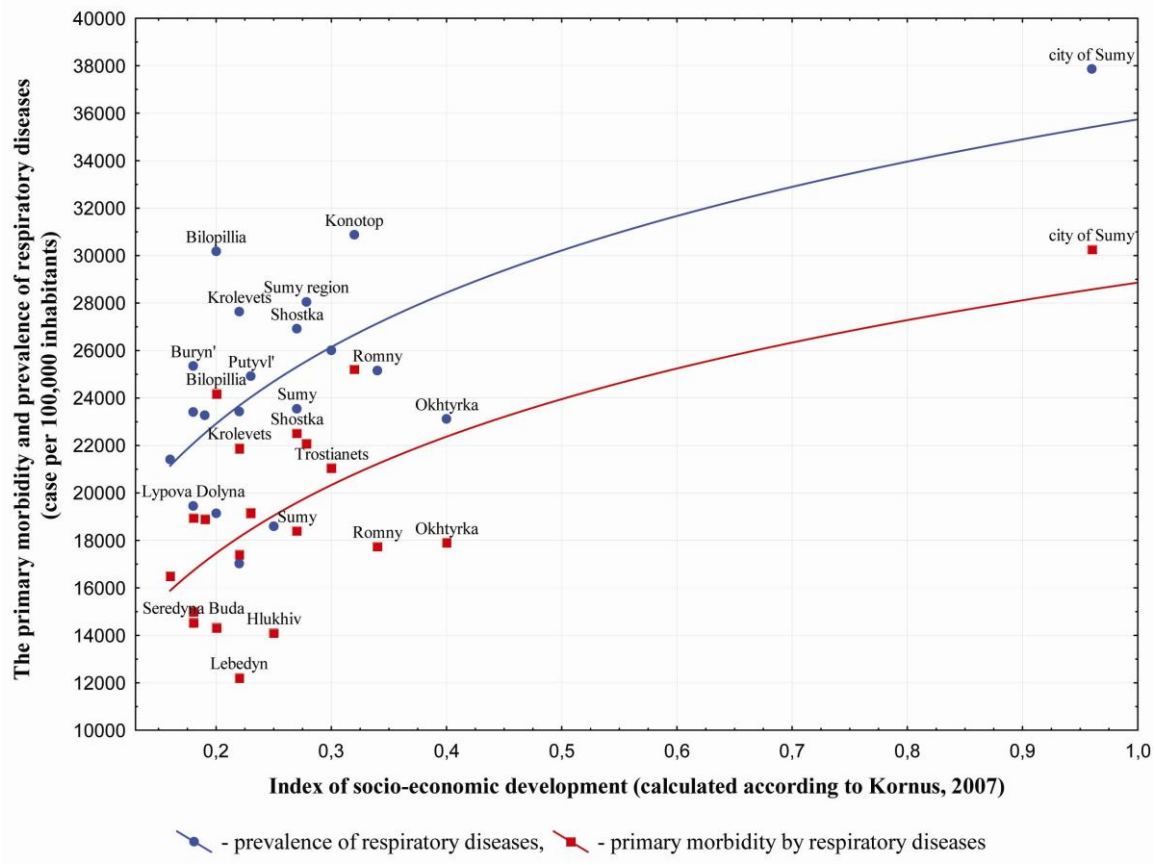

Fig. 7. Dependence the primary morbidity and prevalence of respiratory diseases among the population of the Sumy region from the level of socio-economic development of administrative-territorial units of the Sumy region (Source: Own edition)

drome), congenital bronchomalacia, immotile ciliary syndrome, Kartagener's syndrome (Novikov, 2007). The development of mucoviscidosis (cystic fibrosis) is associated with more than 1000 different mutations of the CFTR gene. COPD is develops in only about 20 % of smokers, which suggests a significant role of genetic factors for the development of this disease (Zdorove, 2014).

Conclusions. Analysis of the spatial and temporal structure of diseases of the respiratory organs of residents of the Sumy region made it possible to establish the territorial differences and the dynamics of the population morbidity and predict further scenarios of their development. During 2005-2017, there is an increase of the primary morbidity of the population as well as the prevalence of pulmonary diseases among inhabitants of the Sumy region. The leaders in terms of the primary morbidity and the prevalence of respiratory diseases among the population are city of Sumy and Konotop and Bilopillia districts.

Nosogeographic assessment of territory of the Sumy region, which was carried out according to the integral respiratory diseases morbidity index *(IMI)*, shows that today the highest values of *IMI* are obtained by analyzing the incidence rate in Putyvl' (1.01), Krasnopillia (1.02), Konotop (1.11), Buryn' (1.32) districts and in the city of Sumy (1.15). These are the districts where the incidence rate of respiratory diseases among the population has increased most of all during the study period. Low values of *IMI* are noted in Lypova Dolyna (0.63), Seredyna Buda (0.71), Velyka Pysarivka (0.72) and Nedryhailiv (0.79) districts. The higher is the *IMI* value, the worse the health level of the population.

The average index storage respiratory diseases *(ISD)* in the Sumy region in 2017 was 1.27, with polarization *ISD* value in some areas from 1.19 in Shostka, 1.22 in Konotop, 1.23 in Yampil' and Trostianets regions to 1.39 in Lebedyn, 1.42 in Romny and 1.61 in the Seredyna Buda districts. This indicates the predomination of chronic forms of diseases over acute ones and can be explained by the influence of environmental and socio-economic factors. It also points to the need to increase of attention of both the regional and state components of the health care system. Besides that, the issues of providing financial and human resources for the health care system in districts with high incidence rates of respiratory pathology require attention. The study of the primary morbidity and the prevalence of respiratory diseases trends is a prerequisite for the development of preventive measures in the Sumy region. They are also needed to assess the quality of medical care for residents who have the pulmonary diseases.

The factor analysis results are confirmed the importance of environmental and technogenic factors in formation of primary morbidity and prevalence of respiratory diseases among the residents of the Sumy region. However, the indicator of the provision of region's population by doctors characterizes the development of health care system, but not the level of population's health. Among the environmental and socio-economic factors, the closest and most reliable is the correlation between emissions of Sulfur dioxide and the prevalence of asthma ($r = 0.715$, $p < 0.01$), the level of socio-economic development and the prevalence of respiratory diseases ($r = 0.678$, $p < 0.01$), and between the prevalence of these diseases and population density ($r = 0.660$, $p < 0.01$).

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