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Variation in the Mortality of the Population of the Southern Regions of Ukraine

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Abstract

The article presents the results of analysis of statistical data of the National Statistics Service of Ukraine on the southern regions population. The focus area includes Zaporizhzhia, Kherson, Mykolaiv and Odesa oblasts' (regions), which are located in the steppe zone and adjusted to the Black and Azov Seas coast. The results indicate the development of negative demographic processes. In spite of the share of the population of urban areas of these regions is growing, at least since 2010, both rural and urban population has been declining. The main reason for population decline is the predominance of high mortality rate (higher than 15 per 1000 inhabitants) over birth rate. The main cause of death is diseases of the circulatory system (over 60% of deaths). In the country, the share of deaths from diseases of blood circulation from the total number of deaths decreased by 6% during in 2010-2021, but in absolute numbers, mortality from this factor is growing, especially a sharp increase was observed in 2020 and 2021. The share of deaths from respiratory diseases is relatively small (less than 3%), the mortality rate caused by these diseases remained virtually unchanged during 2010 - 2019, but since 2020 the sharp increase has been observed. These changes coincided with the spread of the SARS-CoV-2 pandemic, and apparently has a direct relationship to this factor. Since 2010, the proportion of deaths caused by neoplasms (the second leading cause of death) in the country has decreased by 2%, but the mortality rate remains virtually unchanged in all southern regions. At the same time, mortality caused by neoplasms in Zaporizhzhia is about 20% higher than in other regions. Non-monotonic is the dynamics of mortality rates caused by digestive apparatus diseases. In 2010, it was the highest in Mykolayiv and Odesa regions, but over time there was a slow decline. Kherson and especially Zaporizhzhia had lower mortality rates caused by digestive apparatus diseases in 2010, but they increased and almost equaled the rates of Odessa and Mykolayiv regions in 2021. The smallest share in all southern regions are deaths caused by the certain infectious and parasitic diseases (up to 1% of total death number), and the positive tendency to reduce mortality rate caused by this factor is registered from 2010 till 2021 in the country and in all regions.

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Introduction

Since the first half of the 1990s, Ukraine's population has been declining. One of the main reasons is the predominance of mortality over the birth rate. The World Population Review portal informs [1] that Ukraine ranks second in the world in terms of mortality (15.2 per 1,000 inhabitants, 2020) following to Bulgaria with the rate of 15.4. As of 2020, the World Bank estimates give even more disappointing figures for Ukraine - 16 deaths per thousand inhabitants per year (estimation for Bulgaria is 18 deaths per 1,000 inhabitants) [2]. At the same time, the official source providing the demographic data for Ukraine is the State Statistics Service and its data are used by international agencies for their estimates. According to the State Statistics Service, the total mortality rate in 2020 was 15.9 people per 1,000 inhabitants, however the figures for the rural population (18.1) were significantly higher than for the urban population (14.8) [3].

There are several reasons for such a high mortality rate in Ukraine, but the main ones are the following. The declining birth rate over the last thirty years is causing a gradual aging of the country's population. In 2020, the percentage of young people under the age of 18 (18.1%) was significantly lower than the percentage of the elderly (over 60) (23.9%) [3], and this factor negatively affects mortality. In addition, a significant factor influencing mortality is the state of the health care system in the country - the country lacks highly qualified specialists in the field of health care, especially in rural areas. The technological level of medical services and the provision of medicines to medical institutions remain unsatisfactory. At the same time, against such a negative background, at least from 2000 to 2013, mortality in the country decreased, and life expectancy increased, which confirms the analysis of estimates of the State Statistics Service [4, 5]. Since 2013, both processes have slowed down, and since 2019 negative trends have emerged. The reasons for such demographic changes are primarily related to the deep socio-political transformations in the country and the aggression of the Russian Federation, as a result of which hostilities in Eastern Ukraine are going on since 2014.

Changes in the demographics at the national level hide the regional features related to industrial development, economic specialization, the state of the environment (first of all, the pollution level), as well as the mental attitudes, values and behavioral practices of the population. Therefore, the regional differences and features of the manifestation and changes in the demographic indicators of the local population (in particular, mortality) are typical for Ukraine and for other countries [13-15]. Mortality rates are influenced by social status, economic activity and natural living conditions of the population, and they vary significantly in different regions of the country. In particular, the physical-geographical and climatic conditions of the southern, eastern, central, western and northern regions of Ukraine have significant differences [6,7]. Thus, the climate of the southern regions is temperate-continental with subtropical features, with mild winters, relatively long springs and warm long, often very hot, summers and long warm autumns. The average annual temperature in the region was ~ 10 ± 1°C, and the annual amount of precipitations was 400-500 mm / year for the last 120 years [7]. These climatic conditions differ significantly from the climatic conditions of the northern and western regions, where the average annual temperature is several degrees lower and precipitation is significantly higher (~ 700 mm per year). Natural and climatic conditions to some extent affect living conditions, morbidity, and hence the demographic characteristics of the local population [11, 12].

This article is an attempt to characterize the regional features and changes in the mortality rate of the coastal southern regions of Ukraine over the past 10 years. The analysis of the causes of death was limited to five classes of diseases that directly or indirectly depend on the state of the environment. Some of them represent the main cases of the mortality rate. The selected regions include Zaporizhzhia, Kherson, Mykolaiv and Odesa, adjacent to the Azov and Black Seas and located in the same natural and climatic zone.

Data and methods

Data for analysing regional mortality patterns and tendencies were sourced mainly from the State Statistic Service of Ukraine. National deaths and population estimates for the period from 2010 to 2021 were obtained from statistical reports [3,4] and open data sets [8]. These data enabled the calculation of mortality tables for selected regions of the country. Regional and county total mortality data were used at the disaggregate level - by urban and rural population as well as by selected diseases as a death causes. The paper analyzes the magnitude and dynamics of mortality rates caused by diseases that are directly or indirectly related to the environment and that cause the highest mortality. Such a limited list includes diseases that according to the International Classification of Diseases ICD-10 [9] belong to I. Certain infectious and parasitic diseases (A00-B99), II. Neoplasms C00-D48, IX. Diseases of the circulatory system (I00-I99), X. Diseases of the respiratory system (J00-J99) and XI. Diseases of the digestive system (K00-K93).

The data processed according to standard methods of statistical analysis.

Results and discussions

According to the State Statistics Service of Ukraine [8], the population of Ukraine as of January 1, 2022 was 41,167.3 people, of whom 69.6% lived in cities. Estimates of the population of the southern regions are presented in the Table 1. As it follows from these data, the population of each region is declining, which reflects the overall demographic picture in the country. Despite the decline of both urban and rural populations, the percentage of the population living in the cities of each region is growing **(Table 1)**. This indicates that the reduction of the rural population is also due to migration to urban areas.

The largest share of urban population is recorded in the Zaporizhzhia region (about 77.5%), which is characterized by a developed industrial and energy complex. The smallest share of the population lives in the cities of the Kherson region (approximately 61.4%), where agricultural production is well developed. At the same time, the difference of these indicators is very small in the Odesa (67.2%) and Mykolaiv (68.7%) regions.

Table 1: Estimation of present population in Zaporizhzhia, Kherson, Mykolaiv and Odes regions during 2010-2021 (data as of January 1).

	Zaporizhzhia		Kherson		Mykolaiv		Odesa	
	Population, total	Urban, %	Population, total	Urban, %	Population, total	Urban, %	Population, total	Urban, %
2010	1 811 664	76,8	1 093 431	61,1	1 189 516	67,7	2 391 022	66,7
2011	1 801 315	76,9	1 088 237	61,2	1 183 282	67,7	2 388 670	66,8
2012	1 791 668	77	1 083 367	61,1	1 178 223	67,7	2 388 297	66,8
2013	1 785 243	77,1	1 078 232	61,2	1 173 481	67,8	2 395 160	66,9
2014	1 775 833	77,1	1 072 567	61,2	1 168 372	67,9	2 396 493	66,9
2015	1 765 926	77,1	1 067 876	61,2	1 164 342	68,1	2 396 442	66,9
2016	1 753 642	77,2	1 062 356	61,2	1 158 207	68,3	2 390 289	66,8
2017	1 739 488	77,2	1 055 649	61,2	1 150 126	68,3	2 386 516	66,9
2018	1 723 171	77,3	1 046 981	61,3	1 141 324	68,3	2 383 075	66,9
2019	1 705 836	77,3	1 037 640	61,3	1 131 096	68,4	2 380 308	67
2020	1 687 401	77,4	1 027 913	61,4	1 119 862	68,6	2 377 230	67,2
2021	1 666 515	77,5	1 016 707	61,4	1 108 394	68,7	2 368 107	67,2

The mortality rates of the population of the southern regions are relatively high, and obviously this factor is the key to the declining population. The average values of the total mortality of Zaporizhzhia (16.3 ± 1.8 per 1,000 inh.), Kherson (15.7 ± 1.5 per 1,000 inh.) and Mykolaiv (15.5 ± 1.3 per 1,000 inh.) regions are higher than the national average (15.1 ± 1.1 per 1,000 inh.) for the period 2010-2021 **(Figure 1)**. At the same time, only the Odessa region has indicators lower than the national average and the indicators of other southern regions (14.6 ± 1.1 per 1,000 inh.).

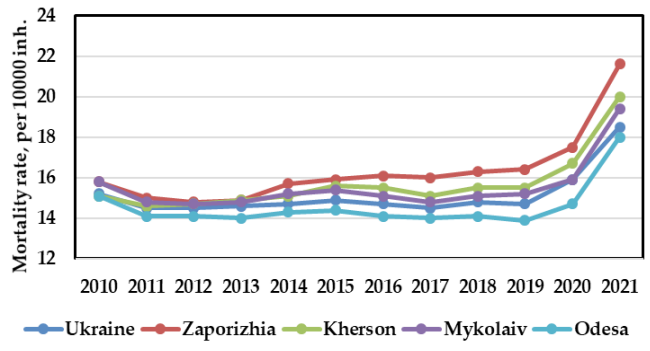

Figure 1: Annual all-cause mortality rate of total population of Ukraine, as well as the Zaporizhzhia, Kherson, Mykolaiv and Odesa Regions during 2010-2021.

The certain patterns and trends have been registered in the dynamics of the death numbers among the present urban and rural population. The first feature is that in 2010 the rural mortality rate in all regions was higher than the urban mortality rate, but during 10 years the situation has changed significantly and the urban mortality rate has exceeded the rural mortality rate in all southern regions, except in the Zaporizhzhia region, where the mortality rate remains high (19.1 ± 1.2 per 1000 inh.) **(Figures 2,3)**. In general, the average annual mortality rate of the rural population of the Kherson (15.4 ± 0.8 per 1000 inh.), Mykolayiv (17.0 ± 0.8 per 1000 inh.) and Odessa (16.4 ± 1.0 per 1000 inh.) regions is lower than the national average (17.9 ± 0.7 per 1000 inh.) **(Figure 3)**. At the same time, the mortality of the population of the Zaporizhzhia region is the highest among considered areas.

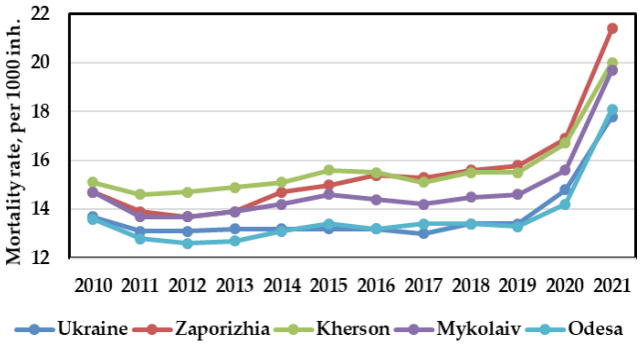

Figure 2: Annual all-cause mortality rate of urban population of Ukraine, as well as the Zaporizhzhia, Kherson, Mykolaiv and Odesa Regions during 2010-2021. Average mortality rate for the period 2010-2021: Ukraine -15,1±1,4; Zaporizhzhia -15,5±2,1; Kherson-15,7±1,5; Mykolaiv-14,8±1,5; Odesa-13,6±1,5 per 10^3inh.

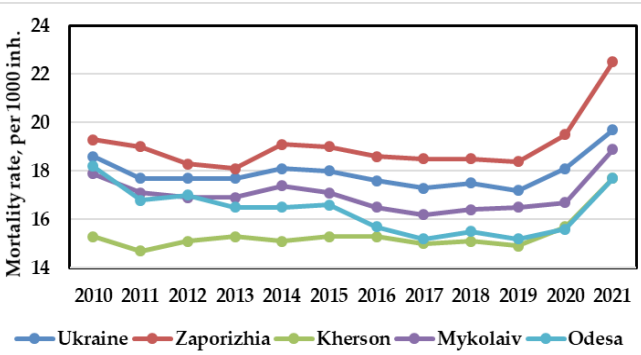

Figure 3: Annual all-cause mortality rate of rural population of Ukraine, as well as the Zaporizhzhia, Kherson, Mykolaiv and Odesa Regions during 2010-2021. Average mortality rate for the period 2010-2021: Ukraine-17,9 ± 0,7; Zaporizhzhia-19,1±1,2; Kherson – 15,4 ± 0,8; Mykolaiv-17,0 ± 0,8; Odesa-16,4 ± 1,0per 10^3inh.

Another pattern can be traced in the dynamics of mortality. Until 2019, there are slight changes in the overall mortality of the current population and mortality in urban and rural areas, but after 2019 a sharp increase in the number of deaths among both groups in the southern regions and in the country as a whole is observed. Taking into account the SARS-CoV-2 pandemic, which has spread rapidly across the country since the first quarter of 2020 [6], it can be assumed that the pandemic has the significant impact on the mortality rate in the country.

Looking at these data, regional varieties of the dynamics and trends of one of the main demographic parameters can be traced. Among the main factors influencing this indicator are lifestyle, employment, level of health care, natural characteristics of the place of residence and the region as a whole, and some others. These factors may provoke illness or disability, which ultimately leads to death.

Diseases that largely depend on the state and the factors of the natural, social and industrial environment include respiratory diseases (J00-J98), digestive diseases (K00-K92), neoplasms (C00-D48), and diseases of the circulatory system. (I00-I99). These diseases, as well as some others, including external causes of morbidity and mortality, are main causes of the largest number of people died. Some infectious and parasitic diseases (A00-B99) are also caused by the environment, but the proportion of deaths from these diseases is relatively small (up to 1%) and has been declining for at least the last 10 years **(Figure 4)**.

Analysis of statistical data on the mortality of the population of the southern regions indicates that the causes of mortality also show certain patterns. The main cause of death in the region, in the whole country and in the vast majority of other countries are diseases of the circulatory system[16] **(Figure 4)**. In 2010, these diseases caused more than 66.6% of deaths in Ukraine, although in 2021 this share decreased to 60.1% **(Figure 4)**. Mortality from malignant neoplasms was 12.7% in 2010 and decreased to 10.4% in 2021. Mortality rates from digestive diseases and certain infectious and parasitic diseases also decreased during the study period, although mortality from the latter diseases is a small percentage. And only the share of deaths from respiratory diseases increased by about 1%.

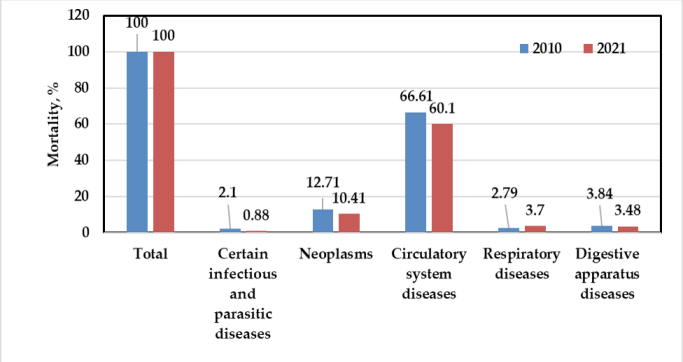

Figure 4: Total mortality caused by selected diseases in Ukraine in 2010 and 2021.

The dynamics of the mortality caused by the selected environmentally dependent diseases is featured by regional specific. The mortality rate caused by diseases of blood circulation demonstrates non-monotonic dynamics throughout the analysing period **(Figure 5)**. Since 2010, mortality in the southern regions was lower than the national average, but after 2013 these figures were almost the same as the national average and increased significantly from 2019 for the population of Kherson and Odessa regions. Since 2013, the mortality rates for Mykolayiv and Zaporizhzhia regions have also been increasing, which significantly exceed the figures of neighboring regions. A sharp increase in mortality caused by diseases of blood circulation was recorded in 2020-2021 in the country and in all southern regions.

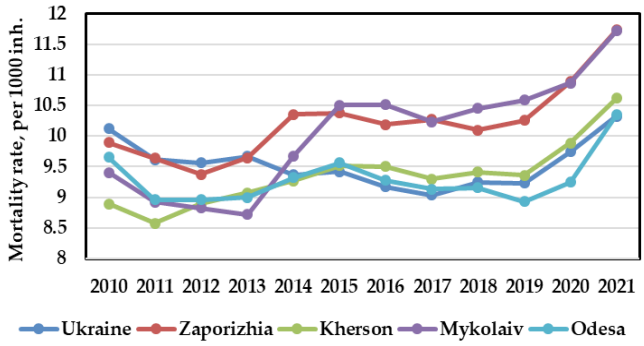

Figure 5: Annual mortality rate caused by diseases of blood circulation of present population of Ukraine, as well as the Zaporizhzhia, Kherson, Mykolaiv and Odesa Regions during 2010-2021.

Figure 6 presents the dynamics of mortality rate caused by neoplasms. As can be seen, the mortality caused by this factor is the highest in the Zaporozhzhia region and averages 25.7±0.07 deaths per 10^4 inhabitants during 2010-2021, while for the same period in the Kherson (19.6 ± 0.6), Mykolaiv (18.8 ± 0.7), Odessa (20.0 ± 0.6) regions and in the country as a whole (18.9 ± 0.7) the figures of the mortality rates are close and fluctuate slightly (18-20 deaths per 10^4 inhabitants) without significant increase or decrease.

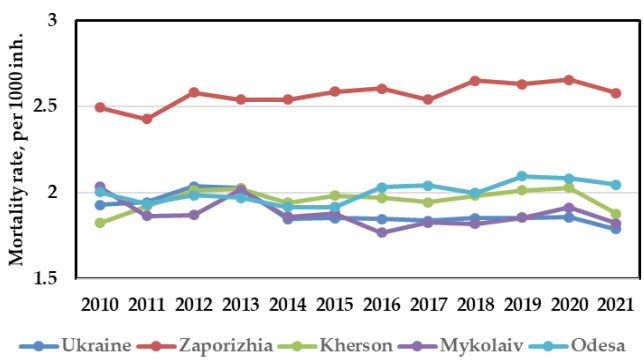

Figure 6: Annual mortality rate caused by neoplasms of present population of Ukraine, as well as the Zaporizhzhia, Kherson, Mykolaiv and Odesa Regions during 2010-2021.

Positive dynamics can be traced on the **Figure 7** showing the mortality rates caused by certain infectious and parasitic diseases during the study period. This class includes data on the mortality caused by tuberculosis (A15-A19), viral hepatitis (B15-B19), human immunodeficiency virus (B20-B24) and some other diseases. The Figure 7 data show that in 2010 the mortality caused by these diseases in the Mykolayiv (5.48 per 10^4 inh.) and Odessa (5.72 per 10^4 inh.) regions was almost twice as high as the average mortality in the country (3.19 per 10^4 inh.), Kherson (3.63 per 10^4 inh.) and Zaporizhzhia (3.03 per 10^4 inh.) regions, the numerical values of which almost coinside in 2021. At the same time, the mortality rate caused by these diseases in the Odessa region is still significantly higher than similar indicators in neighboring regions.

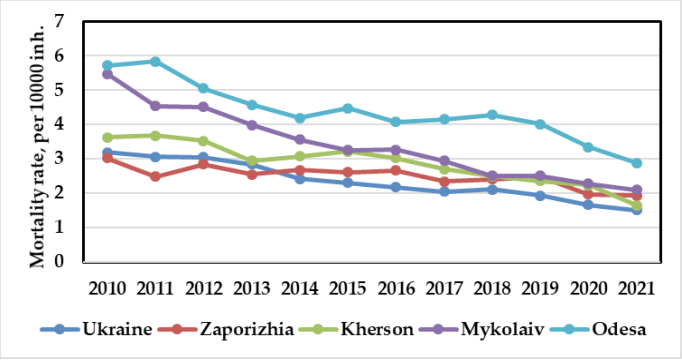

Figure 7: Annual mortality rate caused by certain infectious and parasitic diseases of present population of Ukraine, as well as the Zaporizhzhia, Kherson, Mykolaiv and Odesa Regions during 2010-2021.

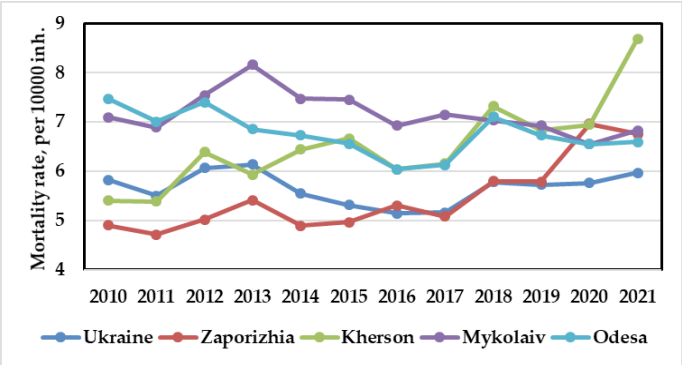

Figure 8: Annual mortality rate caused by digestive apparatus diseases of present population of Ukraine, as well as the Zaporizhzhia, Kherson, Mykolaiv and Odesa Regions during 2010-2021.

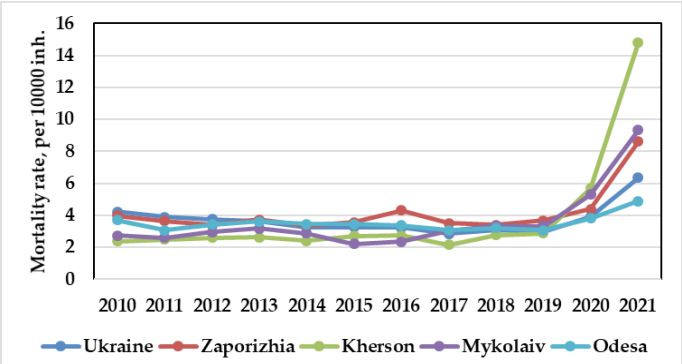

Figure 9: Annual mortality rate caused by respiratory diseases of present population of Ukraine, as well as the Zaporizhzhia, Kherson, Mykolaiv and Odesa Regions during 2010-2021.

Nonmonotonic changes are observed in the time dependences of mortality rates caused by digestive apparatus diseases **(Figure 8)**. Again, as in the previous case, the mortality rate from digestive apparatus diseases in 2010 was significantly higher in Mykolayiv (7.10 per 10^4 inh.) and Odessa (7.47 per 10^4 inh.) regions, however over time it was observed slow decline. The Zaporizhzhia region had the lowest mortality rate from this factor in 2010 (4.91 per 10^4 inh.), but they were almost equal to those of the Odessa and Mykolayiv regions in 2021. In general, mortality rate caused by digestive apparatus diseases in the Kherson region increases non-monotonically. The Statistics Service registered a sharp increase of the mortality in Kherson region in 2021, which currently has no adequate explanation. At the same time, the mortality rates caused by this factor in the country as a whole were mostly lower than in the southern regions with a trend close to 0 for the entire analysis period.

Finally, the mortality rate from respiratory diseases in all studied regions and in the country as a whole remains almost at the same level from 2010 to 2019 (average values of 2.9 - 3.7 per 10^4 inh.), but in 2020 and especially in 2021 there was a sharp increase. The maximum growth (by five times) is observed in 2021 in the Kherson region **(Figure 9)**.

According to the presented data, in the initial year of analysis (2010), the mortality of the rural population of the Zaporizhzhia, Kherson, Mykolaiv and Odesa regions was higher than the mortality of the urban population. Differences in the demographic indicators of urban and rural populations are well known, but in this case, there are certain features. As we can see, by 2021, population mortality of all territories was increasing. However, the mortality of the urban population exceeded the mortality of the rural population in all regions except Zaporizhzhia. This patern differs significantly from the dynamics that reflect the overall mortality in other countries, in particular, in USA and its individual regions. The mortality of both geographies in the United States, first, is declining, and second, the mortality of rural areas remains significantly higher than the mortality of urban agglomerations in all regions [17]. Obviously, the reason is the differences in the health status due to inequalities in health services, socioeconomic characteristics, environmental exposures, etc. in each country, but these differences still need to be identified and analyzed.

If we consider mortality by the main causes, for the population of Zaporizhzhia, Kherson, Mykolaiv and Odesa Regions only indicators of mortality caused by certain infectious and parasitic diseases show a clear downward trend **(Figure 7)**. The same trend is observed for the population of the whole country. Other diseases considered either do not cause significant changes during 2010-2021 (as observed in the case of neoplasms, **Figure 6**), or show non-monotonic dynamics (digestive apparatus diseases, **Figure 8**), or increase in the mortality, especially expressed in 2020-2021 (diseases of blood circulation, **Figure 5**; respiratory diseases, **Figure 9**). The increase in mortality caused by the latter two factors may be triggered by the spread of Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and its associated symptoms, named coronavirus disease 2019 (COVID-19). According to the State Statistics Service of Ukraine, in 2020 and 2021 in the country COVID-19 was recognized as cause of the death of 20,583 and 85,975 people, respectively, which is 3.34% and 11.98% of the total number of deaths [18, 19]. It is known that SARS-CoV-2 predominantly affects the lung, but it can also affect other organs such as the brain, heart, and gastrointestinal system [20]. Patients with comorbidities such as cardiovascular disease, cancer, and some others become more vulnerable to COVID-19, resulting in severe disease and additional mortality [21]. The dynamics of mortality of the population of the country and the southern regions caused by tumors and diseases of the digestive system (Figures 6 & 8) do not show a significant increase in deaths in 2020 and 2021, and in this aspect it looks atypical. This fact requires further research and analysis.

In general, overall mortality is increasing in the southern regions and in the country **(Figure 1-3)**. At the same time, life expectancy is also increasing [5], which indicates certain positive changes in living conditions and behavior of the population. However, the southern regions are characterized by

the lowest levels of life expectancy compared to other regions of the country [5].

Of particular note are the increased mortality rates caused by neoplasms in Zaporizhzhia, which is a sad leader in this indicator in the country. Determining the factor influencing this disease and its consequences, obviously, will allow to find effective means of its mitigation.

Conclusions

The results of the analysis of some statistical data concerning the population of the southern regions of Ukraine (Zaporizhzhia, Kherson, Mykolaiv and Odesa) presented in this article indicate the development of negative demographic processes: at least since 2010 the population of these regions is slowly but steadily declining. The population of both urban and rural areas is declining. The main reason for population decline is the predominance of mortality over birth rate and migration processes. The growing share of the urban population indicates that the rural population is migrating to cities, not the other way around.

The main cause of death is diseases of the circulatory system (over 60% of deaths). In the country, the share of deaths caused by blood circulation diseases from the total number of deaths in 2010-2021 decreased by 6%, but in absolute terms, mortality caused by this factor is growing, especially a sharp increase is observed in 2020 and 2021. The worst indicators are registered in the Mykolayiv and Zaporizhzhia regions.

Neoplasms are the second leading cause of death. Over the past 10 years, the proportion of deaths caused by tumors in the country has decreased by 2%, but in all southern regions there are no significant changes. Mortality in the Zaporizhzhia region caused by tumors is about 20% higher than in other regions.

Non-monotonic is the dynamics of mortality rates caused by digestive apparatus diseases. The mortality rate from digestive apparatus diseases in 2010 was the highest in Mykolayiv and Odesa regions, but over time there was a slow decline. Kherson and especially Zaporizhzhia regions had lower mortality rates caused by this factor in 2010, but they increased and were practically equal to the rates of the Odessa and Mykolayiv regions in 2021.

The smallest share in all southern regions are deaths caused by certain infectious and parasitic diseases (up to 1%), while in all regions there is a tendency to reduce mortality from this factor.

The share of deaths caused by respiratory diseases is relatively small both in the country and in the regions of observation (less than 3%), the mortality rate remained virtually unchanged during 2010 - 2019, but in 2020 and 2021 there was a sharp increase of this indicator, more pronounced than increase of the mortality caused by diseases of blood circulation. This coincided with the spread of the SARS-CoV-2 pandemic, and apparently has a direct relationship to this factor.

Further statistical observations would be important to fully determine the causes of high mortality and the peculiarities of the dynamics of the mortality rate of the southern regions population. Unfortunately, at present (June 2022) this is impossible: the troops of the Russian Federation have occupied part of the Kherson, Mykolaiv and Zaporizhzhia regions, where heavy hostilities are going on. The Odessa region is under constant missile and artillery fire by Russian troops. A large part of the population moved to other regions of Ukraine or left country. The medical care system in the occupied territories has been destroyed, and in the territories under the control of the Government of Ukraine, it is working hard due to the large number of wounded military and civilian. The future of the southern regions and the population remains uncertain and poorly predicted. This situation will certainly significantly change the picture of demographic indicators of the southern regions and their relationship with the corresponding indicators of other regions of the country. At the same time, the established features and patterns of mortality of the population of the Zaporizhzhia, Kherson, Mykolaiv and Odesa regions have not only historical value, but can also be used to restore and improve health care systems after the liberation of these regions and peace in Ukraine.

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Ethical statement

The data for analysis were obtained from open sources (database of the State Statistic Service of Ukraine) and consent from data owner was not required. The manuscript is based on original research and currently not being considered for publication elsewhere.

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