

THE SITUATION IN THE FIGHT AGAINST THE PANDEMIC IN UKRAINE JUST BEFORE THE WAR WAS IMPROVING

Mariia SKULYSH¹, Antoni WILIŃSKI^{2*}, Artur KOZŁOWSKI³

¹Department of Information And Communication Technologies And Systems, National Technical University of Ukraine «Igor Sikorsky KPI» Kyiv, Ukraine; mskulysh@gmail.com, ORCID:0000-0002-5141-1382

²Department of Computer Science, WSB Merito University in Gdansk, Poland;
Antoni.Wilinski@gdansk.merito.pl, ORCID: 0000-0002-2817-9095

³Department of Law and Administration, WSB Merito University in Gdansk, Poland;
Artur.Kozlowski@gdansk.merito.pl, ORCID: 0000-0002-5359-192X

* Corresponding author

Purpose: The aim of the article is to compare the efficiency of pandemic management in two conflicting countries - Russia and Ukraine. The thesis about the superiority of Russia over Ukraine in terms of many social and economic factors seemed obvious. Reality measured with logically defined data contradicts this thesis. The use of statistical data ended on the day the war began.

Design/methodology/approach: Each of the two considered countries was treated as an administrative structure divided into regions (oblasts). It was assumed that the quality of regional management by the central authority should be assessed on the basis of fair and equal treatment of all regions. This assessment was made for two statistical factors - the number of deaths and the number of vaccinations, whose distribution in the country was assessed according to the Gini index.

Findings: Just before the war broke out – in February 2021, indicators of efficient pandemic management in the regions were better for Ukraine than for Russia. Ukraine recovered from the pandemic faster. This is a rather unexpected result. The article justifies the historical background of the centuries-old social and political relations between Russia and Ukraine, also using the position of Poland in these relations.

Research limitations/implications: The presented research, together with its methodology, can be repeated for any administrative structure (state, group of countries), regions, cities, etc. An obvious requirement for conducting such research is the availability of reliable data on deaths and vaccinations.

Practical implications: The method can be used to assess the efficiency of pandemic management at any administrative level (states, regions, groups of cities, etc.).

Originality/value: An important novelty and the result of the research is the discovery of the Ukrainian organizational advantage in the fight against the pandemic just before the outbreak of the war.

Keywords: Ukraine's war with Russia, COVID-19, vaccinations, pandemic deaths, pandemic management.

Category of the paper: Research paper.

1. Introduction

At the beginning of the article, let us recall a few statistical data characterizing the pandemic situation in Ukraine from the very beginning of the pandemic - numbers, facts, and dates. In Ukraine, the Covid-19 coronavirus infection was first diagnosed on March 3, 2020, in Chernivtsi. On March 13, the first death due to a coronavirus infection was recorded. We should remember that the first in-the-world prediction of the day of one million cases was provided by Koczkodaj et al., 2020 but it was only restricted to the beginning phase of the pandemic.

From March 12, 2020, by order of the Cabinet of Ministers, a quarantine was established on the entire territory of Ukraine. Trade establishments were closed, except for grocery stores, pharmacies, gas stations and banks. Metro lines in Kyiv, Kharkiv, and Dnipro have also been suspended, and intercity and interregional road, rail, and air services have been suspended. The quarantine lasted until May 22, 2020. It should be noted that these measures were taken to prevent the spread of the coronavirus disease. Because as of March 16, 2022, only 16 people were infected in Ukraine. The measures taken had the expected effect, it allowed to avoid the first peak of infection, which occurred in the spring of 2020 and was observed in many European countries. During the quarantine period of spring 2020 in Ukraine, a gradual increase in the number of new cases was observed, the value did not exceed 580 new cases per day ([https://index.minfin.com.ua/...](https://index.minfin.com.ua/)).

Nevertheless, in the future, there were new outbreaks of infections. Thus, in the pre-war period, four surges were observed in Ukraine:

- The first peak came on November 28, 2020, when 16,585 people fell ill in one day.
- The second surge came on April 2, 2021, when 20,003 people fell ill in one day.
- The third peak came in November 2021, when 28,477 people fell ill on November 4, 2021.
- The fourth peak occurred immediately before the war, on February 4, 45,022 new cases were detected (<https://phc.org.ua/>).

However, due to a successful population vaccination campaign in late 2021, the death toll during the fourth-largest wave did not greatly exceed the peak of the first wave. Thus, the maximum values of the dead during four outbreaks of infection with the coronavirus disease were:

- 297 people died on December 11, 2020;
- 486 people died on April 7, 2021;
- 861 people died on November 9, 2021;
- 322 people died on February 16, 2022.

These and other figures led us to the idea of analyzing the effectiveness of the management of the pandemic in Ukraine before the start of the war (<https://moz.gov.ua/>).

The main purpose of this paper is to try to prove the thesis that just before the war, Ukraine as a homogeneous and effectively governed state had progress in combating pandemics. It took appropriate steps to reduce differences in the state of pandemic risk between regions (oblasts). These are significantly positive developments, as there are three oblasts within the country already affected by the 2014 war - Crimea, Donetsk and Luhansk. The latter two were partially excluded from Ukrainian jurisdiction in an attempt to break away from the mother state, cooperating with the later aggressor - Russia. Despite this, pandemic data were obtained for both of these separatist regions. It did not succeed for Crimea, which is entirely under Russian control and was omitted from this research. Statistical research aimed at checking the homogeneity of infections in the country for diagnostic purposes and the homogeneity of organizational efforts measured by the vaccination rate is, according to the authors, extremely logical. Striving for fair treatment of all one's society in democratic countries should be an obvious principle of exercising power.

The article considers only factors related to the pandemic and assesses the efficiency of the state. In doing so, it was assumed that the most relevant and measurable factors in assessing the effectiveness of the fight against the pandemic would be the number of deaths and the number of vaccinations per population. Consideration of the number of new infections, widely regarded as the most important factor in the spread of a pandemic due to its indeterminacy, was dropped. The testing capabilities and laws governing the obligation and circumstances of reporting infection were and are different in each country. Asymptomatic passing of infection often left no statistical trace of the disease.

Considering the pandemic situation in Ukraine before Russia's aggression, i.e., by 24.02.2022, one can see that compared to the aggressor, covid statistics are quite similar. The hypothesis of a significant developmental, cultural or technological lag in Ukraine cannot be considered valid.

Ukraine's cultural heritage has a tradition dating back more than a thousand years, originating in the autonomous Principality of Rus, and in its long history it has developed its cultural code enriched by cultural patterns drawn from various geographic directions. Modern times have been heavily influenced by the Russian domination of the country (1795-1991), which lasted about two centuries, including its continuation of the Soviet domination of the country. It followed the collapse of the Polish, Ukrainian, Lithuanian and lands of present-day Belarus - the Polish-Lithuanian Commonwealth - as a result of the Partitions (1772-1795) and the incorporation of Ukrainian lands into the Russian Tsarist Empire. This meant that after nearly four centuries the Polish-Lithuanian Commonwealth ceased to exist as a state, and in Ukraine, western cultural patterns began to be replaced by the Russian partitioner with a system of state organization imposed by force. However, the cultural heritage of the former ROP in terms of spiritual culture and national myths continued to be cultivated until the rise of

nationalism (Snyder, 2009) and the great geopolitical changes resulting from the two world wars.

The end of World War I resurrected the hope of rebuilding its own, already national state. This was fostered by the expulsion of Russia from its ethnic borders by the armies of the Central Powers. De facto, under German protection, the foundations of nation-states were being formed, but their defeat in the West opened up competition for self-determination for the peoples of this part of the continent. While Poland managed to defend its independence in the war against the Soviet army, Ukraine, although separated as a Soviet Republic, was incorporated into the Land of the Rades and subordinated to Moscow.

Communist ideology, making the promise of revolutionary change of the system after the overthrow of the tsarism, remained a conglomeration of empty slogans and platitudes without confirmation in reality. The permanent transition period, characterized by the struggle against the omnipresent enemies of the people, was marked by the perfection of the system of surveillance and repression in all areas of social life (Pipes, 2008). Russian historian Lev Gumilev points to the leading role of the civilizational pattern, different from the European because Asian, which determined the formation of Soviet statehood (Gumilev, 1996). Attention is drawn to the superiority of the Soviet system over the tsarist one that preceded it in terms of both broader and deeper state control over the individual, who, moreover, was denied subjectivity in favour of an imaginary communist community (Kucharzewski, 1990). While russification and conversions to Orthodoxy were made under the tsars, the Soviet project involved comprehensive social engineering leading to the creation of a new Soviet man, living in a Soviet state and functioning in a communist economy. The inculcation of a collectivist mentality was linked to indiscriminate violence. Among the societies subjected to the Soviets, Ukrainians were the most massively and severely affected. Notable in its tragic consequences was Stalin's deliberately induced Holodomor (artificially caused famine - 1932-1933), which was intended to break the moral backbone of Ukrainian society and facilitate the creation of *hominum sovieticorum* (Heller, 1988). The clash of ideas with the realities of creating a new system was aptly described by H. Carrère D'Encausse in exposing both Lenin's pre-revolutionary intentions and presenting the later unificationist efforts to eliminate the differences in the lives of individual national groups and give them a common form (Carrère d'Encausse, 1992).

Stalin's ethnic cleansing and World War II took a strong toll on the cultural identity of Ukrainians. In the post-Stalin era, they joined in the reconstruction of their still-Soviet republic and gradually incorporated alongside Russians in the administration of the country. Brammer's "matryoshka nationalism" characterized the Soviet authorities' acquiescence in the coexistence of individual nationalities within a great nation as specific to Soviet nationalism (Brammer, 1993). This enabled, in his view, the birth of nationality movements.

Working from the grassroots and drawing on the rich Ukrainian tradition was a pillar of the revival of the Ukrainian intelligentsia and the expansion of the spirit of national tradition in the broader masses of society. Ukrainian elites had developed enough to attempt to govern the country independently after the dissolution of the USSR in December 1991. The political transition was not easy, and was characterized by social conflicts, the rapid formation of an influential and mutually belligerent oligarchy, a high rate of corruption, and fierce disputes over establishing the azimuth of political and economic integration along the east (Russia) - west (rapprochement with the European Union) axis. These tensions culminated internally, albeit with a behind-the-scenes destructive role of Russia, with the Orange Revolution (2004) or the pro-European Maidan (2013/2014), and externally with Russia's war against Ukraine marked so far by two stages - the annexation of Crimea and the occupation of part of Donbas from March 2014, followed by a further escalation of the already full-scale war from February 24, 2022.

The aforementioned events constitute a list of the most important and not exclusive factors determining the institutional and social conditions of the modern Ukrainian state and society oriented clearly towards Western patterns (Kozlovsky, Yankiv 2021). In the comparative dimension concerning the recent and still aspiring to such a role - the hegemon Russia, it is worth pointing to the recognized indicators reflecting the cultural and institutional characteristics of the compared countries. For this purpose, we used the representation of the dimensions of culture by G. Hofstede, indicators of the extent of freedom of political systems regularly measured by the Freedom House Organization, Perception Corruption Index, and basic economic and quality of life indicators (tab. 1).

Table 1.

Country comparison in dimensions of cultures by G. Hofstede

Dimension of culture	Russia	Ukraine	Poland
Power distance	93	92	68
Individualism	39	25	60
Masculinity	36	27	64
Uncertainty avoidance	95	95	93
Long term orientation	81	86	38
Indulgence	20	14	29

Source: own elaboration based on Geert Hofstede's cultures dimensions <https://www.hofstede-insights.com/fi/product/compare-countries/>, 8.10.2022.

Hofstede's dimensions of culture do not fully describe the cultural differences between Ukrainians and Russians, but nevertheless, provide a basis for pointing out certain distinctions. Hofstede sees Ukrainians as a more collectivist society than Russians, while in the other direction, they are far from the more individualistic Poles. Differences in the masculinity dimension of the culture are similarly perceived. The low-scoring dimension here represents societies' attitudes toward caring for others and quality of life. "Ukrainians, both in the workplace and when meeting a stranger, tend to understate their achievements, contributions or abilities. They speak modestly about themselves, and scientists, researchers or doctors are most

often expected to have a very modest standard of living. Dominant behaviour may be accepted when it comes from the boss but is not valued among peers" (<https://www.hofstede-insights.com/country-comparison/ukraine/>) A similar description applies to Russians, with the difference in results indicating a greater concern for neighbours among Ukrainians.

The similarity between Ukraine and Russia is shown by the level of corruption in both countries, Tab. 2, which is an un-"cured" post-Soviet legacy. It was the high level of corruption that was cited as the main obstacle to real modernization in Ukraine before the war with Russia.

Table 2.

Corruption Perception Index value in Transparency International organization's indicators in 2012, 2017, 2022

	2012	2017	2022
Russia	28	29	29
Ukraine	26	30	32
Poland	58	60	56

Legend: 0 means highly corrupt and 100 means very clean.

Source: <https://www.transparency.org/>, 8.10.2022.

While the indicators of cultural differences inadequately describe the differences that exist between Ukraine and Russia, already the reference to the institutional level and the outcome data of the scope of freedom of the political system and the scope of freedom of the Internet indicate the differences between the studied countries with an indication of a broader scope of freedom in Ukraine (tab. 3.)

Table 3.

The scope of freedom of the political system of Russia, Ukraine and Poland in the indicators of the Freedom House Organization in 2017 and 2022

	Global Freedom Score max 100		Internet Freedom Score max 100		Political Rights max 40		Civil Liberties max 60		Democracy Percentage max 100		Democracy Score max 7		Democracy Sstatus		Freedom in the World Status	
	2017	2022	2017	2022	2017	2022	2017	2022	2017	2022	2017	2022	2017	2022	2017	2022
Russia	19	19	30	30	5	5	15	15	7,14	5,36	1,43	1,32	CAR	CAR	Not Free	Not Free
Ukraine	61	61	62	62	25	26	36	35	39,88	39,29	3,39	3,36	THR	THR	Partly Free	Partly Free
Poland	81	81	na	na	37	34	52	47	73,81	58,93	5,43	4,54	SCD	SCD	Free	Free

Legend: SCD - Semi-Consolidated Democracy; THR - Transitional or Hybrid Regime; CAR - Consolidated Authoritarian Regime.

Source: own elaboration based on Nations in transit and Freedom of the World by Freedom house Organization, <https://freedomhouse.org/>, 8.10.2022.

Despite several dysfunctional burdens on state institutions carried over from the Soviet era, the Ukrainian state has gradually and noticeably raised the scope of civil liberties and democratic transparency. And although it is not a state without flaws such as, above all, continued oligarchization and corruption, it was already clearly more efficient than the state of the former hegemon.

A comparison of the population of the Russian state, as well as the total wealth of its citizens, falls decisively in Russia's favour. This largest state in the world is more than three times more populous than its neighbour and with an annual aggregate GDP nearly seven times larger, although per capita is already only three times larger. This is undoubtedly influenced by the magnitude of the unequal distribution of wealth, as reflected by the Gini index indicating a greater concentration of wealth among wealthy Russians than its dispersion among Ukrainians (tab. 4).

Table 4.

Pre-covid social and economic data for Russia and Ukraine as of 2019

	Population total	GDP current US\$ millions	GDP per capita current US\$	Gini Index 0-100	Human Capital Index 0-1 (2018 & 2020)	People using safely managed sanitation services (% of population)
Russia	143 446 060	1 069,0	11 536,3	37,7	0,7	61
Ukraine	44 386 203	153,9	3 661,5	26,6	0,6	72

Source: own elaboration based on World Bank data, <https://data.worldbank.org/>, 9.10.2022.

In the comparative analysis of the level of civilizational development of the two countries from the perspective of the health and well-being of the two societies, at least two indicators systematically studied by the World Bank deserve attention, namely the Human Capital Index (HCI), which is responsible for predicting the life expectancy of a born child to the age of 18, taking into account the risk of poor health and the degree of education in the inhabited country. This index reflects the improvements in current health and education outcomes that shape the productivity of the next generation of workers. It can also be complemented by the People using safely managed sanitation services indicator, i.e. reflecting the quality and availability of hygienic living conditions in households. While the HCI index minimally ranks the quality of life of Russian residents higher, the opposite is true from the perspective of hygienic conditions. In summary, the two countries differ in terms of economics and quality of life, with an apparent advantage for the wealthy in Russia over Ukrainian society. However, when we compare the broader masses of society the indication is in favor of the Ukrainian state, which before Russia's full escalation of the war provided better living conditions for its residents.

Ukraine here before the attack was a country not particularly distinguished negatively among the countries with which it borders.

2. Comparison with neighbouring countries

Ukraine borders 7 countries and all of them, along with Ukraine, are included in the diagram in Figure 1. The figure shows the number of pandemic-related deaths in each country per million inhabitants.

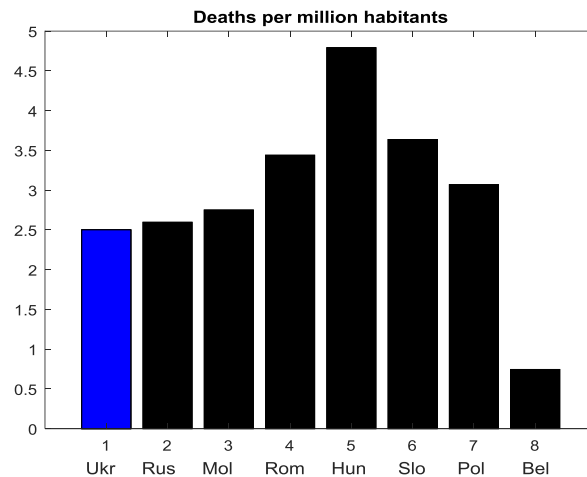


Figure 1. Number of deaths related to the COVID-19 pandemic as of 24.02.2022 in Ukraine and neighbouring countries per million inhabitants.

Source: CSSE JHU Baltimore, USA; <https://coronavirus.jhu.edu/map.html>.

The diagram shows that Ukraine was among the countries that stood out positively according to this criterion. It was in second place in the group of these countries behind Belarus. The next diagram, Figure 2, compares these countries according to the criterion of vaccinations performed, also based on data published by the CSSE of Johns Hopkins University (<https://coronavirus.jhu.edu/map.html>).

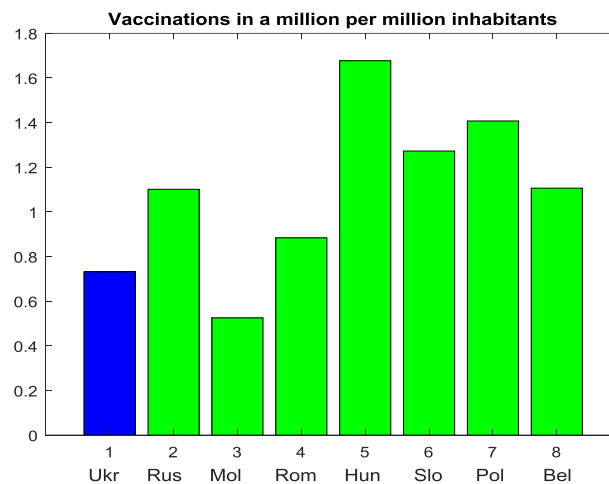


Figure 2. The number of all vaccinations performed in million related to population.

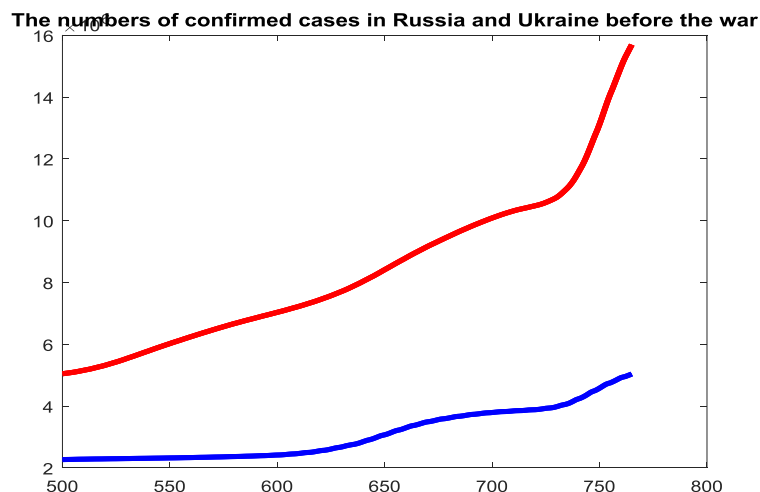
Source: <https://coronavirus.jhu.edu/map.html>.

In Figure 2, the opposite of Figure 1, the higher the bar, the better. This is because it is all about public health and the highest possible vaccination rate of the population. Ukraine does not fare well in this ranking, only Moldova is worse. The manufacturer of the vaccine may not be irrelevant here. According to (<https://www.euractiv.pl/...>), the proposal to vaccinate with Russian Sputnik V benefited Hungary and Slovakia, which for this reason found it easier to achieve a high vaccination rate (<https://www.euractiv.pl/...>, 29.03.2021). Without referring to the political aspects, however, the fact is the lower vaccination rate of Ukrainian society here before the war.

Is it possible, therefore, to put forward a thesis on organizational negligence in Ukraine in the area of fighting the pandemic?

How does Ukraine in general compare with Russia in statistical terms?

For example, on the issue of differential susceptibility to SARS-CoV-2 virus infection in the two countries compared in this article, the following statistical arguments can be made (based on data from the CSSE JHU (<https://coronavirus.jhu.edu/map.html>) widely considered by the scientific world to be reliable and supported). The first, shown in Fig. 3, is a comparison of the absolute number of confirmed infections in Russia and Ukraine.

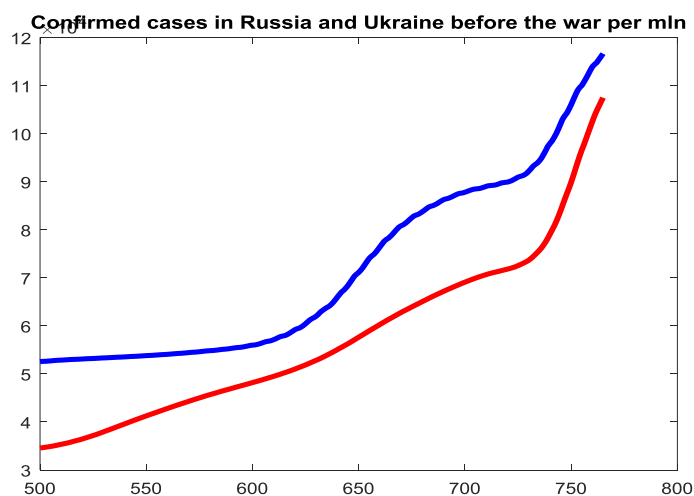


On the abscissa axis the number of days from the beginning of registration of COVID-19 statistics to the start of the war. On the ordinate axis, the number of confirmed cases in millions.

Figure 3. Number of infections of confirmed COVID-19 cases in Russia (upper) and Ukraine in the period until the start of the war on 24.02.2022.

Of course, Russia as a country with several times the population also has more confirmed infections. Is it in proportion to the population?

Figure 4 shows the same statistics converted to population.

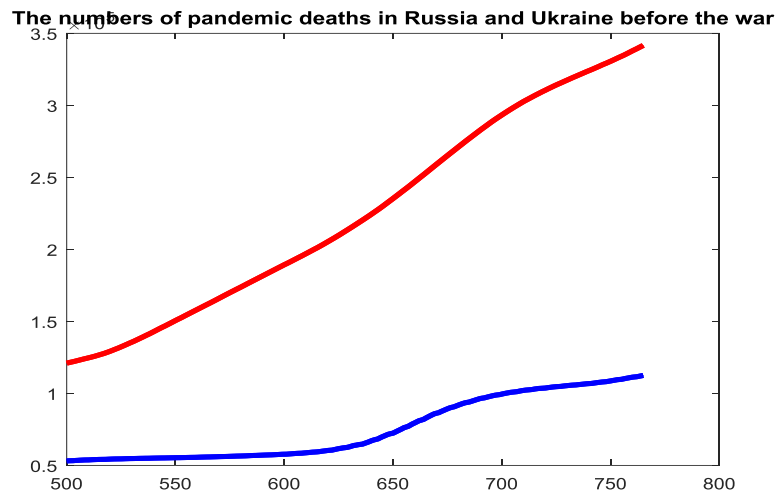


On the abscissa axis the number of days since the beginning of registration up to start of the war. On the ordinate axis, the number of confirmed cases in tens of thousands.

Figure 4. Number of confirmed cases of infection per population in Russia (lower) and Ukraine in the period until the start of the war on 24.02.2022.

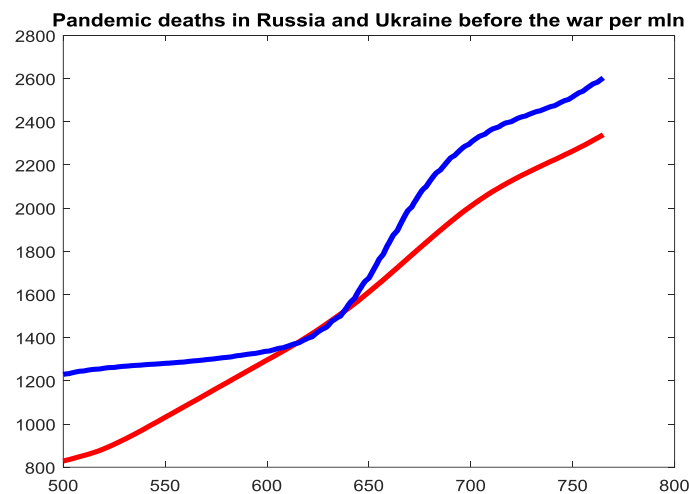
The graph of Fig. 4 already shows a worse situation for Ukraine than for Russia, although in general, the curves are not very far apart. Pearson's correlation coefficient for the observed curves is 0.9784.

A comparison of the number of deaths in Russia and Ukraine in the period before the start of the war may be of similar social significance. Figure 5 shows them in absolute numbers in Figure 6, after normalizing by dividing these values by the population.



On the abscissa axis, the number of days since the start of recording statistics. On the ordinate axis, the number of deaths in the hundreds of thousands.

Figure 5. The number of deaths remaining due to the pandemic in Russia (upper) and Ukraine (lower) until the start of the invasion by Russia.



On the abscissa axis, the number of days of the beginning of listing until the outbreak of war. On the ordinate axis, the number of deaths per million inhabitants.

Figure 6. The number of deaths remaining related to the pandemic in Russia (lower) and Ukraine (upper) per population, until the start of the invasion by Russia.

In Figures 4 and 6 we already see a worse pandemic situation for Ukraine than for Russia, but the difference is not critical. An important question could be raised here, whether the situation in Ukraine was improving, but the war prevented the observation of this trend, or vice

versa - the war hid the growing crisis due to the pandemic. To clarify this question, a criterion for managing the distribution of vaccinations among the regions was put forward.

With the outbreak of the war on 24 Feb 2022, the CSSE institute stopped noting all statistical data on Ukraine.

A method for measuring the degree of uniformity of vaccination in Ukraine's regions.

Referring to comparisons of Ukraine with other neighbouring countries more than with Russia itself, one could ask whether the not-so-good pandemic vaccination situation is changing and in what direction. The experience of many countries shows that one of the most important aspects of good pandemic management is the uniformity of vaccine distribution between regions (Arti, Wilinski, 2021; Chotikapanich, 2008, Gastwirth, 1972).

Let's make the following assumption at the outset of the method - if the distribution of vaccines in a country is moving in the direction of reducing the disparities between regions, this indicates good pandemic management.

The following regions (oblasts) of Ukraine were taken into account:

- Vinnytsia Oblast.
- Volyn Oblast.
- Dnipropetrovsk Oblast.
- Donetsk Oblast.
- Zhytomyr Oblast.
- Zakarpattia Oblast.
- Zaporizhzhia Oblast.
- Ivano-Frankivsk Oblast.
- Kyiv Oblast.
- Kirovohrad Oblast.
- Luhansk Oblast.
- Lviv Oblast.
- Mykolaiv Oblast.
- Odesa Oblast.
- Poltava Oblast.
- Rivne Oblast.
- Sumy Oblast.
- Ternopil Oblast.
- Kharkiv Oblast.
- Kherson Oblast.
- Khmelnytskyi Oblast.
- Cherkasy Oblast.
- Chernivtsi Oblast.
- Chernihiv Oblast.
- Kyiv (Municipality).

So let there be given a certain target territory T , here, Ukraine, which can be conventionally divided into N disjoint smaller territories T_i and making up the target territory T (for Ukraine $N = 25$ oblasts):

For all T_i belonging to T , the sum of T_i equals T , $T = \{T_1, T_2, \dots, T_N\}$ (1)

Each i -th territory has three features P_i , V_i and D_i :

where:

P_i – population in millions living in the territory in 2022 before the start of the war;

D_i – the cumulative number of deaths from SARS-CoV-2 by the start of the war;

V_i – the number of vaccinations with the last dose in the i -th oblast by the same date.

Let's enter the variable - the number of deaths per million population living in the i -th region of a country T_i as:

$$d_i = D_i/P_i, i = 1, 2, \dots, N \quad (2)$$

Whereby P_i should be expressed in millions of inhabitants. Similarly for vaccinations:

$$v_i = V_i/P_i, i = 1, 2, \dots, N \quad (3)$$

In further considerations, the integer variable M_i of the number of one-million population granules in the i -th region T_i will be useful, which can be determined after rounding:

$$M_i = \text{round}(P_i), i = 1, 2, \dots, N \quad (4)$$

The idea of determining the inequality of the distribution of infections and deaths in a country will be reduced to the Lorentz curve model known in economics as the income distribution function of a society. It allows us to determine what percentage of the population earns income above or below a certain level (Gastwirth, 1972).

For the purposes of this model, let's imagine that the entire population of a country is divided into one-millionth granules. Suppose we have two classes of such granules. One represents the amount of deaths in a region and the other represents the amount of vaccination in that region. The granules of each class differ from each other by some characteristic - the number of deaths per million or the number of vaccinations per million population. Therefore, in each T_i - this territory will be associated with two types of granules - granules equal in terms of d_i and other granules equal in terms of v_i . If the granules, separately for each type, are sorted from those with the lowest d_i value starting to those with the highest d_i values, they will form a stepped curve. The lengths of the horizontal segments of such a curve will correspond to the population of each T_i region and the step changes on the ordinate axis will correspond to changes in the d_i characteristic - the number of deaths per million. The integral of such a stepped curve is called a Lorentz curve. It will be a broken curve with the characteristics of the income curve already mentioned in economics. In an identical way, we can construct a Lorentz curve for vaccinations.

Formally, the Lorentz curve can be explained using the following pseudocode proposed by Wilinski, Arti and Kupracz 2022:

```

k = 0; % index of one-million granules
for i = 1: N %oblasts from 1 to N
for j = 1: Mi % Mi - the numer of the granules in i-th oblast
k = k+1;
zk = Li % feature of k-th granula – e.g. number of deaths or vaccinations;
end for j
end for i.

```

The result of the execution of these loops is a vector z_k , $k = 1, 2, \dots, K$ granules of different sizes, approximately as many as there are millions of population in a country (sum P_i). Let's denote the length of the vector z_k as K .

$$K = \text{sum} (M_i) \quad (5)$$

Now let's arrange these one-million population granules according to their L_i values, in ascending order

$$Z_s = \text{sort} (z_k), \text{Ascend} \quad (6)$$

Let's then calculate the integral of the above curve according to the formula:

$$Z_c(k) = \text{sum} (1:k) z_s \text{ for } k = 1, 2, \dots, K \quad (7)$$

In order to normalize this curve, let's determine the sum of all the z_s as $Z = \text{sum} (1:K) z_c$

$$Z_n(k) = Z_c(k)/Z \quad (8)$$

We also place the normalized variable $kn=k/K$ on the abscissa axis. In this way we move along the demographic resources of a country express them in the form of a number belonging to $[0,1]$.

We will calculate the Lorentz curves according to Gastwirth (1972) and the resulting Gini coefficients to determine the uniformity of the number of deaths in Ukrainian regions and then according to the same rules to calculate the uniformity of vaccination.

3. Studies of the distribution of deaths and vaccinations for different oblasts

The study aims to verify the trend of the death rate and the vaccination rate in Ukraine based on measurements taken at two relatively distant moments in time - in September 2021 and February 2022, just before the war.

The assumptions are as follows - if the Gini index for deaths and vaccinations decreases, it will mean a more even distribution of both characteristics across the country, which will be a desirable phenomenon.

Table 5 shows for all regions of Ukraine data measured at two points in time - in September 2021 and February 2022 just before the start of the war.

Table 5.
Data for each oblast in the fight against the pandemic

Oblast	Population [thousand]	Deaths Sep 21	Deaths Feb 22	Vaccin Sep 21[thous]	Vaccin Feb 22[thous]
	1	2	3	4	5
Vinnitsia	1512	1726	3394	157916	563413
Volyn	1022	1206	2278	70691	318654
Dnipropetrovsk	3100	4676	9199	321025	1339792
Donetsk, for territory under Ukraine's control (18718 km ²)	4063	2479	5357	146571	610434
Zhytomyr	1181	1828	3392	123166	441253
Zakarpattia	1245	1612	2596	83889	305466
Zaporizhzhia	1641	2484	5605	123325	575310
Ivano-Frankivsk	1353	2120	3313	90852	407485
Kyiv	1795	2797	4861	256220	832728
Kirovohrad	906	874	1662	76750	309237
Luhansk, for territory under Ukraine's control (18 306 km ²)	2105	1012	2292	66286	281699
Lviv	2480	3720	6282	237520	970015
Mykolaiv	1093	1885	3417	113455	394356
Odessa	2353	3081	5769	187370	822623
Poltava	1354	1885	3989	186610	609441
Rivne	1143	1217	2416	85104	402574
Sumy Oblast	1037	1355	3033	111173	425891
Ternopil Oblast	1023	1223	2268	86641	353312
Kharkiv Oblast	2602	3687	6641	233724	1047899
Kherson Oblast	1003	1216	2788	98975	362509
Khmelnyskyi Oblast	1231	1926	3532	114578	435505
Cherkasy Oblast	1162	1334	2812	146517	487376
Chernivtsi Oblast	891	1843	3173	68279	283919
Chernihiv Oblast	961	1366	2621	106200	381363
Kyiv (Municipality)	2953	5281	8687	610506	1833499

Using data on deaths (col. 3, tab. 5) and vaccinations (col. 4, tab. 5), at the first time point under study – Sept. 2021 with the population in each oblast (col. 2, tab. 5). Gini coefficients were calculated for the two variables under consideration.

The Gini coefficients for the two distributions are shown in Fig. 7.

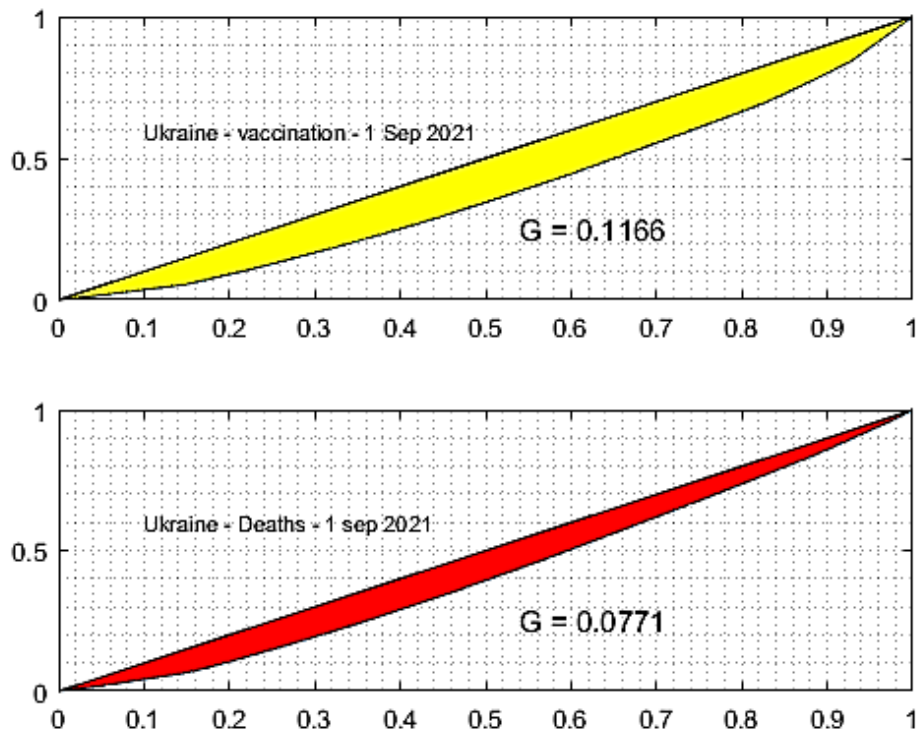


Figure 7. Lorenz curves and Gini coefficients for pandemic deaths and vaccination in Ukraine in September 2021. Gini coefficients are determined by the filled-in fields - for vaccination at the top and for deaths at the bottom.

After performing operations according to the described pseudo-code, it is possible to determine the Lorenz curve which in Figure 7 is represented by an arched broken curve bounding the field from below (in both parts of the figure). If we denote the area under the Lorenz curve as A , the Gini coefficient is the area G expressed as a part (percentage) of the lower triangle of the normalized graph.

$$G = 0.5 - A \quad (9)$$

In the above formula, 0.5 is the area of the lower triangle in the normalized square 1×1 . The diagonal of this square would be the Lorenz curve for an idealized completely uniform distribution of the trait under study.

For the distribution of deaths in the regions of Ukraine according to the methodology described above obtained:

$$GD = 0.0771.$$

And for the distribution of vaccinations:

$$GV = 0.1166.$$

The results can be assessed as a fairly even distribution of both deaths and vaccinations across the country. The world as a whole, for example, has a Gini index for deaths of five times higher, about 0.38 (Wilinski, Bach-Dabrowska, 2022). This implies a great natural "injustice" in the distribution of deaths, globally.

Within the framework of the present study, the task was to check whether the Gini coefficients for deaths and vaccinations for Ukraine change over time, and what is the direction of these changes.

The results on the distribution of deaths and vaccinations by region were collected on February 7, 2022, and so a dozen days before Russia's aggression.

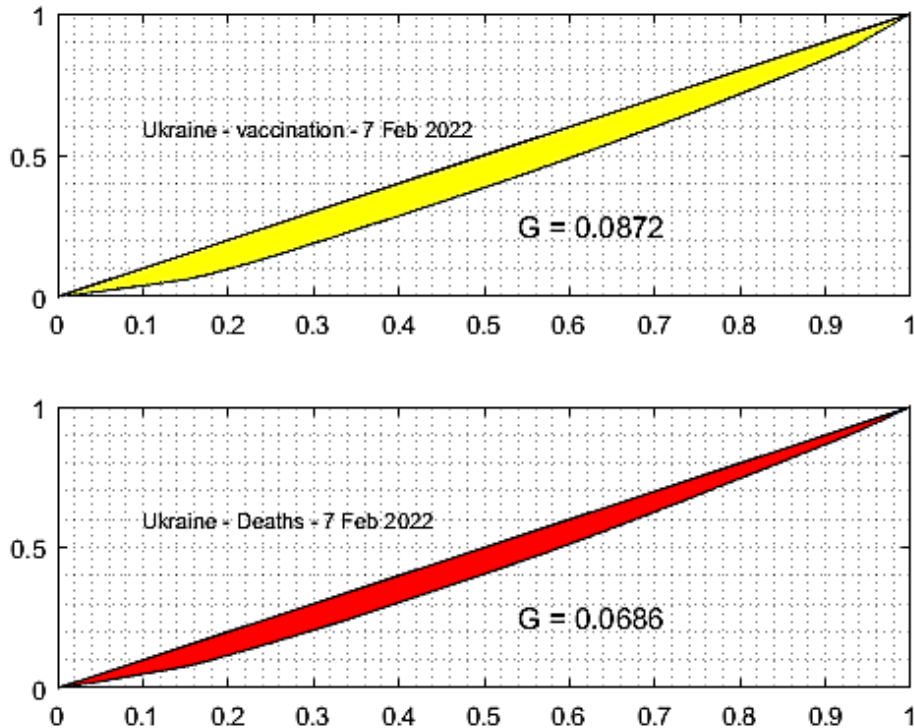


Figure 8. Gini indices for Ukraine calculated a few months after the first observation. Now just before the outbreak of war in February 2022.

The results of these calculations are shown in Fig. 8. The most important conclusion of comparing the graphs in Fig. 7 and Fig. 8 is the conundrum of decreasing Gini coefficients for both factors considered - deaths and vaccinations.

For comparison, we calculated the Gini index for vaccination statistics in the Russian regions as of February 2022. We analyzed the data presented on the website and selected vaccination statistics by region plus or minus as of February 11, 2022. The collected statistics are presented in Table 6.

Table 6.

Data on the population and number of vaccinations in Russia to assess the uniformity of the distribution across the country

NN	Region name	Population vector for each oblast (1x83) in thousand	Vector of the number of vaccinations in region around the 11th of February 2022	NN	Region name	Population vector for each oblast (1x83) in thousand	Vector of the number of vaccinations in region around the 11th of February 2022
1	Republic of Adygea	468,34	220000	43	Murmansk region	724,452	357000
2	Altai Republic	221,559	132839	44	Nenets Autonomous Okrug	44,54	23954
3	Altai region	2268,179	1338386	45	Nizhny Novgorod Region	3144,25	2008478
4	Amur region	772,525	454358	46	Novgorod region	586,129	302504
5	Arkhangelsk region (with NAO)	1114,322	539447	47	Novosibirsk region	2780,29	1716327
6	Astrakhan region	989,43	474366	48	Omsk region	1879,55	1225240
7	Republic of Bashkortostan	4001,678	3085430	49	Orenburg region	1924,58	881700
8	Belgorod region	1531,917	1083531	50	Oryol Region	714,094	406841
9	Bryansk region	1168,771	681533	51	Penza region	1274,06	871023
10	The Republic of Buryatia	982,629	504347	52	Perm region	2556,85	1173000
11	Vladimir region	1323,659	667654	53	Primorsky Krai	1863,01	1109310
12	Volgograd region	2449,781	1700000	54	Pskov region	613,356	296297
13	Vologodskaya Oblast	1139,499	527000	55	Rostov region	4153,76	2079790
14	Voronezh region	2287,678	1519100	56	Ryazan Oblast	1085,15	668975
15	The Republic of Dagestan	3153,857	1446504	57	Samara Region	3131,72	1750000
16	Jewish Autonomous Region	153,831	66802	58	St. Petersburg	5377,5	3285000
17	Zabaykalsky Krai	1043,467	727207	59	Saratov region	2360,96	1538814
18	Ivanovo region	976,918	541938	60	The Republic of Sakha (Yakutia)	992,115	650917
19	The Republic of Ingushetia	524,058	308756	61	Sakhalin region	484,177	242056
20	Irkutsk region	2357,134	1373868	62	Sverdlovsk region	4264,34	2309000
21	Kabardino-Balkarian Republic	870,487	286000	63	Republic of the North Ossetia - Alania"	688,124	269115
22	Kaliningrad region	1027,678	510900	64	Smolensk region	909,856	534809
23	Republic of Kalmykia	267,756	156915	65	Stavropol region	2780,2	1543167
24	Kaluga region	1012,844	531119	66	Tambov Region	980,984	536363

Cont. table 6.

25	Kamchatka Krai	312,704	153448	67	Republic of Tatarstan	3886,4	2591000
26	Karachay-Cherkess Republic	464,219	230933	68	Tver region	1230,19	735111
27	Republic of Karelia	603,067	292753	69	Tyva Republic	332,609	675887
28	Kemerovo region	2604,272	1250100	70	The Republic of Khakassia	528,338	773000
29	Kirov region	1234,78	785297	71	Tomsk region	1068,3	150047
30	Komi Republic	803,477	491198	72	Tula region	1432,57	1176975
31	Kostroma region	620,776	309791	73	Tyumen region without Khanty-Mansi Autonomous Okrug and YaNAO	1552,15	700156
32	Krasnodar region	5687,378	3069826	74	Udmurt republic	1484,46	767350
33	Krasnoyarsk region	2849,169	1362709	75	Ulyanovsk region	1203,97	721436
34	Kurgan region	805,51	469005	76	Khabarovsk region	1298,98	324617
35	Kursk region	1083,584	573000	77	Khanty-Mansiysk Autonomous Okrug - Yugra	1702,24	881700
36	Leningrad region	1911,586	961517	78	Chelyabinsk region	3418,61	1902405
37	Lipetsk region	1113,68	638486	79	Chechen Republic	1516,39	722000
38	Magadan Region	137,767	85858	80	Chuvash Republic	1198,43	704373
39	Mari El Republic	671,455	430301	81	Chukotka Autonomous Okrug	50,04	32892
40	The Republic of Mordovia	770,673	482000	82	Yamalo-Nenets Autonomous Okrug	552,117	274000
41	Moscow	12635,466	6199585	83	Yaroslavl region	1227,38	646000
42	Moscow region	7768,878	4417160				

The calculation of the Gini index and the construction of the Lorenz curve was carried out according to the formulas given above. The result of calculating these indicators on the database of vaccination in the regions of Russia as of mid-February 2022, before the war, is presented in Fig. 9.

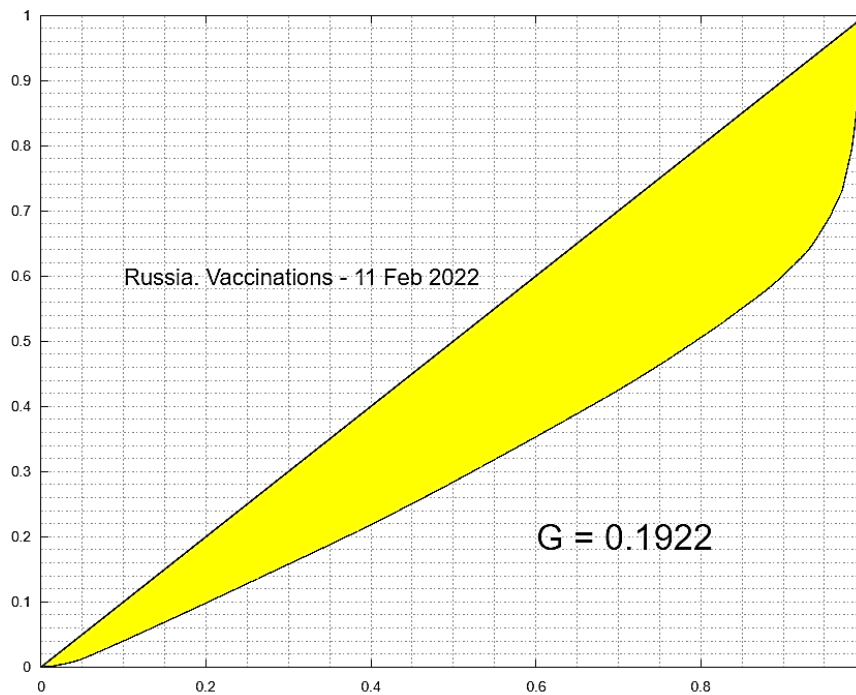


Figure 9. Gini indices for Russia calculated just before the outbreak of war in February 2022.

As can be seen from Fig. 9 the situation with vaccination in the Russian regions in the pre-war period remained quite difficult. The value of the Gini index as of February 2022, $G = 0.1922$, is worse than in Ukraine at the beginning of September 2021, when this indicator was equal to $G = 0.1166$. According to the estimate of the Gini coefficient in February, the situation with the distribution of vaccination on the territory of Ukraine ($G = 0.0872$) was 2.2 times better than in the corresponding period in Russia ($G = 0.1922$).

4. Peculiarities of the vaccination process in Ukraine

The attitude of ordinary Ukrainians towards vaccination gradually changed. If at the beginning of the pandemic in 2020, due to a lack of understanding of the vaccine mechanisms action and elementary fears of the new, a large part of Ukrainians were afraid of the so-called "chipping" with a vaccine, or something like that, various fables spread among the population. Thus, in December 2020, a survey was conducted by the Kharkiv Institute of Social Research on behalf of the Laboratory of Public Interest Journalism with the support of the International Renaissance Foundation. The survey was conducted from December 13 to 23, 2020 using the Computer-Assisted Personal Interviews (CAPI) method. 1,500 face-to-face interviews were conducted using a random sample in settlements of different sizes, representing 5 macro-regions of Ukraine (East, West, South, North, Center) ([https://khisr.kharkov.ua/...](https://khisr.kharkov.ua/)). The study showed that some months before starting vaccination, 40% of Ukrainians were ready to be vaccinated against the coronavirus. Those who are not ready were more - 47%, and 13% of

Ukrainians were undecided. According to this study, 50.6% of respondents among those who did not plan to be vaccinated expressed fears for their health, fearing that vaccination would cause an allergy or exacerbation of the chronic disease, as the main reasons for refusing vaccination. 43.5% of respondents believed that an effective vaccine could not be developed so quickly, therefore they thought that it would not protect against infection and would be dangerous.

But over time, the situation changed, the UNICEF study: Most Ukrainians are ready to be vaccinated against COVID-19 ([https://www.unicef.org/ukraine/...](https://www.unicef.org/ukraine/)) which was conducted in April 2021, showed that most of the respondents had already made up their minds, so 62% of the respondents agreed to vaccination, 34% of the population were against vaccination, and only 3% hesitated in making a decision. In this way, the attitude to vaccination changed from December 2020 to April 2021. Vaccination was started in February 2021.

In connection with the vaccine shortage at the beginning of the public vaccination campaign, on December 24, 2020, the Ministry of Health of Ukraine, by order N 3018/2022 (<https://ips.ligazakon.net/document/MOZ32580>) determined priority population groups for vaccination among them:

1. medical workers, including persons who directly participate in measures to combat the coronavirus disease COVID-19;
2. social workers;
3. persons living in institutions providing long-term care and support and employees of such institutions;
4. elderly people (60 years and older), including people with concomitant diseases who are at risk of developing complications and death due to the disease of the coronavirus disease; the following priorities were defined in this group, starting with people over 80 years of age (the highest priority), and further dividing into cohorts 79-75 years, 74-70 years, 69-65 years, 64-60 years;
5. military personnel who are participating in the Joint Forces Operation;
6. employees of critically important state security structures, including the State Emergency Service of Ukraine, the National Police of Ukraine, the National Guard of Ukraine, the Security Service of Ukraine, the State Border Guard Service of Ukraine, servicemen of the Armed Forces of Ukraine, the Ministry of Internal Affairs of Ukraine;
7. teachers and other workers in the field of education;
8. adults (aged 18 to 59 years; from 16 years old) with concomitant diseases who are in the risk group for the development of complications and the onset of death in connection with the disease of the coronavirus disease COVID-19;
9. people who are in places of restraint and/or detention centres and employees of the places.

These population groups were planned for vaccination in the first place. However, already in April 2021, an opportunity arose and vaccination for the elderly (60+ years) was announced. All adults over the age of 18 who expressed a desire to be vaccinated receive such a possibility from July 21, 2021 ([https://www.ukrinform.ua/rubric-society/...](https://www.ukrinform.ua/rubric-society/)).

Everybody can get vaccinated at the nearest vaccination point, a mass vaccination centre, the enterprises could also be ordered a mobile brigade if there were more than 50 employees. Vaccinations were carried out based on 3,127 vaccination offices, in more than 200 vaccination centres and by the forces of more than 800 mobile brigades. It was possible to sign up for vaccination by calling the registration desk of the vaccination centre or mass vaccination contact centres, and a live queue was formed at vaccination centres.

The third wave of Covid'19 in Ukraine occurred in October-November 2021, it turned out to be the most severe in terms of the number of deaths. Based on forecasts on the eve of the third surge, the Cabinet of Ministers of Ukraine introduced stricter measures. 23 September 2021, the Cabinet of Ministers of Ukraine will amend Resolution No. 1236 on establishing quarantine and introducing restrictive anti-epidemic measures ([https://zakon.rada.gov.ua/...](https://zakon.rada.gov.ua/)).

The changes to the so-called "quarantine decree" contained two key innovations.

The first is the introduction of yellow and green internal COVID-19 certificates. Yellow ones become available to those who have received one dose of the vaccine against the coronavirus disease, and green ones - those who have completed the course of immunization. In addition, certificates soon began to include the entire history of "interaction" with COVID-19, in particular, information on whether a person has already been sick.

The second key change to the Decree concerns the holding of mass events, the operation of entertainment facilities, catering and cultural facilities, and sports centres. Since then, the owners of establishments and organizers of events have been checking the presence of all event participants, users, visitors, and the organizers (employees) themselves, with documents that would confirm receipt of vaccination against COVID-19 or the absence of a person with a coronavirus disease. In our opinion, it was this Resolution that caused the vaccination peak, which fell at the end of October 2021. The dynamics of vaccination in the period from the beginning of vaccination to the beginning of the war can be seen in Fig. 10. The average weekly number of new vaccines, all vaccinations for the blue line and the first vaccinations for the red line were chosen.

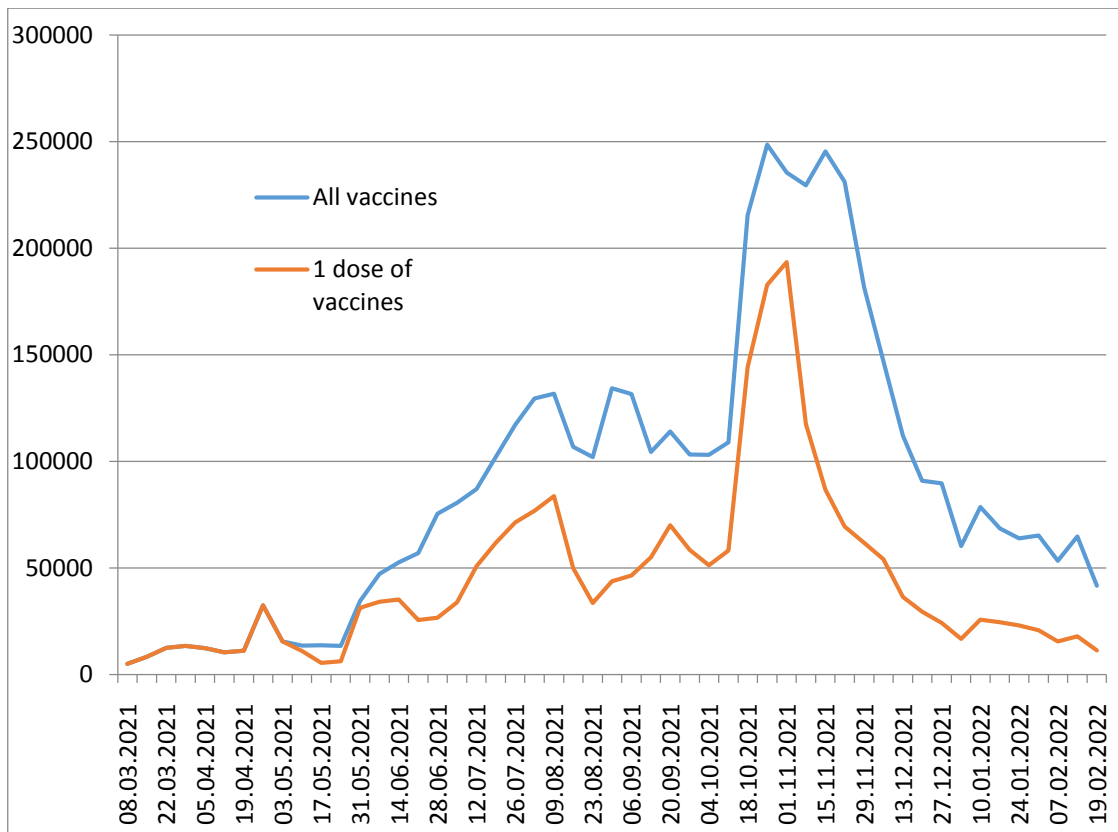


Figure 10. Vaccination dynamic is shown by the average weekly number of new vaccines.

Another tool of influence on unvaccinated persons was the offer of a monetary reward for vaccination.

As you know, in some countries, for additional motivation to get vaccinated, government bodies offer money for vaccination. Such measures have been adopted in some countries for selected population groups. Thus, in Greece, the youth receives a monetary reward. Seniors aged 60 and over receive vaccination rewards in Latvia, Georgia, and Moscow (Russia). All citizens who were vaccinated in Ukraine, Serbia, Mongolia and New York (USA) also can receive a monetary reward ([https://www.slovoidilo.ua/...](https://www.slovoidilo.ua/)).

In Ukraine, on November 15, 2021, a special support program was announced for citizens who completed a full vaccination course ([https://itc.ua/news/...](https://itc.ua/news/)).

The program started on December 19, 2021, and will continue for a year until December 18, 2022. This program also works during wartime. Every citizen over the age of 14 has the opportunity to receive 1,000 hryvnias on an electronic bank card, the reward can be ordered through the Diya application. Diya is a digital platform developed by the Ministry of Digital Transformation of Ukraine to provide various public services to citizens of Ukraine, including storing personal digital documents.

A feature of the use of money received from vaccination was the limitation of the services that can be bought with this money. In this way, state regulation and support of enterprises that were most affected by knockdowns during the Covid-19 pandemic took place.

5. Conclusion

The research conducted allows one to draw a rather unexpected conclusion, at least for those not closely observing the realities of Ukraine. Ukraine handled the pandemic well. It will be rather justifiable to assume that, had it not been for the war, Ukraine was heading in the right direction in the fight against the pandemic by reducing the inequality of vaccination distribution and recording a decreasing variation between regions in the number of deaths following the pandemic.

The article analyses factors which had an influence on the pandemic in Ukraine in our opinion. An assessment of the effectiveness of the management of the pandemic by state management bodies was made. We can observe many positive activities on the part of the Ukrainian authorities, even before the war, but at a time of the growing threat of a pandemic, which confirms the commitment of the Ukrainian government to the rational identification of the threat (Melnik et al., 2021; Dokova et al., 2021; Kalininchenko, Poltel, 2021; Patel, 2020; Polonova, 2022). During the pandemic, Ukraine particularly strove to maintain its education at the best level of effectiveness (Odintseva, 2022; Semenog, Shamunova, 2020). The main stages of the pandemic were analyzed, and the main challenges related to vaccination and measures to reduce the negative consequences were researched. At the same time, it was assumed that the most relevant and measurable factors in assessing the effectiveness of the fight against the pandemic are the number of deaths and the number of vaccinations per population.

The article also makes a comparative analysis of the course of the vaccination process in Ukraine compared to neighboring countries. The result of comparing the uniformity of vaccination of the population in regions of Ukraine and regions of Russia is interesting, this study showed that the effectiveness of the vaccination campaign in Ukraine was 2.2 times more effective than a similar campaign in Russia at the same time before the war.

Contrary to opinions spread before Russia's war against Ukraine about the inefficiency of the Ukrainian state, which was, according to biased critics, a near-collapsed state, the Ukrainian state demonstrated institutional and managerial agility in meeting the pandemic challenge. Both public administration bodies and the Ukrainian health service effectively handled the vaccination of citizens, who were perhaps more intensely bombarded with disinformation about the alleged harmfulness of vaccines than in other countries. Despite the adversity, Ukrainian services handled the pandemic effectively and efficiently with the resources they had. In general, on the day before the war, the percentage of vaccinated Ukrainians was 38.24% of the country's population, which is 24% less than all applicants according to the April 2021 survey. Of course, in doing so, it should be remembered that at the time of the second observation (February 7, 2022, to be exact), the exodus of the Ukrainian population to neighbouring countries related to the impending Russian threat was already underway, and the population in each oblast was a highly variable figure. Of course, there are more and

more publications in which attempts are made to coolly, and objectively assess the events in Eastern Europe and make their impact on the fate and structure of the entire civilized world (Aslund, 2020; Chandey, 2022). The war forced all Ukrainians, without exception, to change their plans. People took off the masks that protected them from COVID-19 and put on helmets and bulletproof vests to protect themselves from rockets and missiles. On February 24, 2022, the war with COVID-19 ended, and another bloodier war for independence and democratic values began.

Summing up the work from the methodological point of view, it should be noted that the use of the Gini index as a metric for assessing distribution or fair distribution is not a new method. However, the strength of this work, in the opinion of the authors, is not the commonly known method itself, but rather its application in a context that is not necessarily obvious. Here understood as a study of the distribution of deaths in regions throughout the country, as well as vaccinations. While the deaths are clearly a negative consequence, somewhat hidden, of inefficient management, the impact of vaccinations on the course of the pandemic is definitely more controversial. However, the fact that the authors have noticed this factor as a factor worthy of being used in the assessment of pandemic management efficiency is considered to be reasonable and innovative.

The data in the tables used in this work has also been placed in the GitHub repository at: (https://github.com/anonymously-smile/Covid_stat_Ukr_Rus.git).

The authors report there are no competing interests to declare.

References

1. Arti, M.K., Wilinski, A. (2021). Mathematical Modeling and Estimation for Next Wave of COVID-19 in Poland. *Stochastic Environmental Research and Risk Assessment*, DOI:10.1007/s00477-021-02119-5.
2. Åslund, A. (2020). Responses to the COVID-19 crisis in Russia, Ukraine, and Belarus. *Eurasian Geography and Economics*, 61(4-5), 532-545.
3. Bremmer, I. (1993). Reasserting Soviet Nationalities Theory. In: I. Bremmer, R. Taras (eds.), *Nations, Politics in the Soviet Successor States*. Cambridge: Cambridge University Press.
4. Carrère d'Encausse, H. (1992). *The Bolsheviks and the nations, or the Great Urge 1917-1930 (Bolszewicy i narody czyli Wielkie Urągowisko 1917-1930)*. Warszawa: Oficyna Wydawnicza MOST, p. 177.
5. Chotikapanich, D. (Ed.) (2008). *Modeling income distributions and Lorenz curves, Vol. 5*. Springer Science & Business Media.

6. Choudhary, O.P., Saied, A.A., Ali, R.K., Maulud, S.Q. (2022). Russo-Ukrainian war: an unexpected event during the COVID-19 pandemic. *Travel Medicine and Infectious Disease*, 48, 102346.
7. Dokova, A., Kostadinova, T., Panayotova, S. (2021). University Partnerships Management in Times of Pandemics–Mission (Im)Possible. *Health Economics and Management*, 20(2), 3-12.
8. Gastwirth, J.L. (1972). The estimation of the Lorenz curve and Gini index. *The Review of Economics and Statistics*, 306-316.
9. Gumilow, L. (1996). *From Rus to Russia (Od Rusi do Rosji)*. Warszawa: Polski Instytut Wydawniczy.
10. Heller, M. (1988). *Cogs in the Wheel: The Formation of Soviet Man*. New York: Knopf.
11. Kalinichenko, O., Poita, I. (2020). The impact of epidemics on the economy of the world. *Economics. Management. Innovations*, 1(26).
12. Koczkodaj, W.W., Mansournia, M.A., Pedrycz, W., Wolny-Dominiak, A., Zabrodskii, P.F., Strzalka, D., Armstrong, T., Zolfaghari, A.H., Debski, M., Mazurek, J. (2020). 1,000,000 cases of COVID-19 outside of China: The date predicted by a simple heuristic. *Global Epidemiology*, 2, 100023, doi.org/10.1016/j.gloepi.2020.100023.
13. Kozłowski, A.R., Yankiv M. (2021). Ukraine's Gradual Westernization - the Eastern Dimension of the European Integration. *WSB Journal of Business and Finance*, Vol. 55, No. 1, eISSN 2657-4950, DOI 10.2478/WSBJBF-2021-0001.
14. Kucharzewski, J. (1990). *From white to red tsarism (Od białego do czerwonego caratu)*. Gdańsk: Oficyna Wydawnicza "Graf".
15. Melnyk, T., Mazaraki, N., Pugachevska, K. (2021). Development Of National Economies In The Conditions Of Pandemics. *Baltic Journal of Economic Studies*, 7(1), 69-76.
16. Murphy, A., Fuhr, D., Roberts, B., Jarvis, C.I., Tarasenko, A., McKee, M. (2022). The health needs of refugees from Ukraine. *BMJ*, 377.
17. Odintsova, T.A., Kopchak, O.O., Bachinskaya, N.Y., Ivniev, B.B., Pokanevych, O.V. (2022). Pros and cons of remote medical education in Ukraine in terms of COVID-19 pandemics. *Informatics in Medicine Unlocked*, 101051.
18. Oronce, C.I.A., Scannell, C.A., Kawachi, I., Tsugawa, Y. (2020). Association between state-level income inequality and COVID-19 cases and mortality in the USA. *Journal of general internal medicine*, 35(9), 2791-2793.
19. Pipes, R. (2008). *Communism*. Warszawa: Świat Książki, p. 161.
20. Polonova, J., Bazalickova, L., Bredova, S., Krcmery, V., Palenikova, M., Jackulikova, M., ... Ulmann, S. (2022). Unexpectedly low Incidence of COVID-19 among Refugees of War from Ukraine to Slovakia in First Month of Conflict. *Clinical Social Work and Health Intervention*, 17-19.

21. Semenog, O., Shamunova, K. (2020). The training of future primary school teachers for a pedagogical internship during COVID-19: challenges and possible solutions. *Scientific Journal of Polonia University*, 38(1-2), 196-203.
22. Snyder, T. (2009). *Reconstruction of nations. Poland, Ukraine, Lithuania, Belarus 1569-1999*. Sejny: Pogranicze.
23. Wiliński, A., Bach-Dąbrowska, I. (2022). COVID-19: Changes in the Ranking of Polish Regions According to the Criterion Taking into Account both the Reluctance to Vaccinate and the Number of Deaths. *European Research Studies Journal*, Vol. XXV, Iss. 1, 423-432.
24. Wiliński, A., Arti, M.K., Kupracz, L. (2022). *COVID-19 Pandemic Severity Criterion Based on the Number of Deaths and the Uneven Distribution of These*. *IEEE Transactions on Computational Social Systems*, doi: 10.1109/TCSS.2022.3188744, pp 1-7.