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Excess Death Rate in Eastern European Countries and Countries of the Former USSR during the COVID-19 Pandemic in the Years 2020 and 2021

Abstract. Measuring the impact of the COVID-19 epidemic on mortality on the basis of deaths reported by statistical offices by cause may be challenging due to the often poor quality of data. Therefore, this study analysed the level of excess mortality, regardless of the cause, to measure the true impact of the epidemic on the number of deaths. The analysis focused on selected countries from Eastern Europe, the Caucasus and Central Asia as well as the Russian Federation, and was limited to the period 2020–2021. Time series analysis methods were used in order to account for seasonal fluctuations in mortality throughout the year. It was determined that some of the studied countries were "blind" to the development of the coronavirus epidemic in selected periods. The findings from this study allow the true scale and extent of the COVID-19 epidemic to be assessed correctly. Taking into account excess deaths would lead to substantial increase in the number of deaths attributed to the COVID-19. In the case of the 19 countries surveyed this number should be increased from the level of nearly 800,000 officially reported deaths to over 2 million excess deaths. The actual scale of deaths experienced during the COVID-19 pandemic has had grave ramifications both for society and various sectors of the economy

Keywords: pandemic, excess deaths, mortality, Eastern Europe, Caucasus, Central Asia

JEL classification: C5, I1, J1

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1. Introduction

In early 2020, a new virus, SARS-COV-20, which causes the acute respiratory system illness COVID-19, spread first in China and then in other parts of the world. In Europe, the first recorded outbreaks of this virus occurred in Italy, where on February 21 the first confirmed COVID-19-related death was recorded (Blangiadro et al., 2020). As early as March 21, the World Health Organisation announced a global pandemic, though at that time most confirmed deaths were being registered only in China (WHOa, 2020). During subsequent months, the pandemic triggered a health-related, social and economic crisis in many countries of the world, which gravely affected people's lives worldwide. In the

light of official statistics, by the end of 2021, nearly 300 million infections and 5.5 million confirmed deaths had been recorded globally (Coronavirus Resource Centre, 2021). State governments implemented a variety of non-standard measures, initially to limit the spread of the disease and then to mitigate its economic consequences.

The COVID-19 pandemic forced authorities in many countries to constantly update the monitoring of the development and consequences of the disease in the form of, inter alia, daily infections and numbers of deaths — statistics which allowed the assessment of the pandemic's scale in particular countries. However, precise measurement of the pandemic's intensity through an analysis of only directly reported COVID-19-related deaths is in some countries hindered on account of the fact that the official data may understate the total number of the virus's victims. As a consequence, the official COVID-19-related-deaths statistics may be unreliable, which is shown in the findings of some studies, e.g. in Great Britain, where analyses of the level of excess deaths, excluding COVID-19-related deaths, display a rapid increase in deaths caused by dementia and other erroneously defined illnesses which may have partly resulted from undiagnosed COVID-19 cases in which the virus exacerbated the earlier condition (Raleigh, 2020). The numbers of reported infections and deaths may also have been affected by the reporting policy and a given country's testing capability (in particular the availability of tests whose shortage was reported early on), which may additionally hinder comparative studies among countries. Some countries only examined patients requiring hospitalisation, others recommended examining every person who showed symptoms, irrespective of the need for hospital care. There are also countries which have still not implemented mass testing (Silva, Jardim and Brito dos Santos, 2020). Furthermore, statistical offices may vary in their ability to store information correctly and may apply different methods of registering causes of death. States identify causes of death in various ways, in accordance with their own domestic terminologies. This affects the comparability of international-statistics as different countries have adopted different COVID-19-related-death definitions, i.e., some of them register only confirmed COVID-19-related deaths, whereas others also include those cases where the disease is only suspected. Some governments may also have purposefully concealed some information (Danilova, 2020). Studies indicate that many countries have understated the numbers of COVID-19-related deaths, suggesting that the figures may have been at least 1.6 times higher than those reported (Karlinsky and Kobak, 2021). On account of these limitations, a detailed analysis of the level of excess mortality, irrespective of cause of death, was carried out for the needs of the present study, attempting to measure the pandemic's actual impact on mortality figures in selected states.

The course of the COVID-19 pandemic differed in many countries in terms of territorial coverage, duration and the extent to which they were affected. The present study aimed to assess the levels of excess deaths during the COVID-19 pandemic in Eastern European countries and countries formerly constituting part of the Soviet Union, Russia

in particular. The notion of Eastern Europe is not unequivocally defined and, depending upon the classification adopted, may include various countries. Therefore, the UN's specification was adopted for the purpose of the study, which includes Belarus, Bulgaria, Czechia, Moldavia, Poland, Romania, Russia, Slovakia, Ukraine and Hungary. The list of the states examined was also extended by the inclusion of former USSR republics, such as Uzbekistan, Kazakhstan, Georgia, Azerbaijan, Lithuania, Latvia, Kirgizstan, Armenia and Estonia (Tajikistan and Turkmenistan were omitted on account of lack of data). It was found on the basis of the author's earlier studies that the statistics of the detectability of COVID-19-related deaths clearly deviated from other countries of Europe and the world (Murkowski, 2022). In the light of the findings it may even be claimed that some of the countries under investigation were, in the periods of time covered in the study, more or less 'blind' to the spread of the coronavirus pandemic. Hence, another aim of the study was to find to what extent COVID-19-death statistics are understated and then to thoroughly analyse this issue in selected cases and to attempt to identify the causes of the differences in this regard. The relation between the number of excess deaths estimated by the author and the officially reported number of COVID-19-related deaths was used for this purpose. The pandemic has hugely affected and will continue to affect social, cultural and economic processes, e.g. it has slowed the pace of economic growth, particularly in the year 2020. Thus specifying its actual extent and impact on demographic processes should constitute the starting point for further analyses in other areas.

2. The notion and measurement of excess deaths

In compliance with the recommendations of World Health Organisation, COVID-19-related mortality should be shown broadly and it should include all likely or confirmed cases, unless there is a conspicuous alternative cause of death which cannot be related to COVID-19 (e.g. an injury). Furthermore, there should be no time-period of complete recovery from COVID-19 between infection and death. Those deaths should not be attributed to other diseases, e.g. cancer; they should be counted independently of previously existing illnesses suspected of triggering an acute course of COVID-19 (WHOb, 2020). Despite this, many states apply different methods of counting COVID-19-related deaths, which renders the data concerning pertinent deaths, published by different states, incomparable. In some countries, such as Italy, all infected deceased individuals are classified as victims of COVID-19, whereas in other states this may not be the case (Danilova, 2020). A similar situation concerns the number of confirmed COVID-19 infections because these statistics largely depend on test availability and testing policy. Therefore, in official statistics in different countries some COVID-19-related deaths may have remained undiagnosed and unreported e.g. owing to a shortage of tests or erroneous classification of this disease,

or possibly other causes. Therefore, a different death-rate measurement, which would be unaffected by the above-mentioned problems, should be applied for international comparisons. Thus, an accurate assessment of the pandemic's impact on the mortality rate should not only refer to officially registered COVID-19 cases and consequent numbers of deaths, but it should also allow for the total number of deaths regardless of their cause.

There is an academic consensus (Kontis et al., 2020; Beaney et al., 2020; Leon et al., 2020) which advocates that the most objective way of comparing numbers of deaths in different countries during the pandemic is an index that records the number of excess deaths, regardless of their cause. This index is also commonly applied by many countries' statistical offices, such as Eurostat, research organisations, international institutions, analytical organisations and leading publications, e.g. The Financial Times, The Economist or New York Times (Timonin et al., 2020). It is also highlighted in the literature that direct and indirect assessments of excess deaths during wars and epidemics have a relatively long history and the very notion of 'excess deaths' has been commonly used before (Beaney et al., 2020; Leon et al., 2020). Researchers in fields such as epidemiology or public health who assess the pandemic's impact on mortality use the notion of excess mortality which shows that mortality (regardless of cause) exceeds the level which would have occurred in standard conditions, i.e. in the case where the pandemic had never occurred (Vestergaard et al., 2020). Such an approach allows any potential misidentification of the cause of death, which can sometimes occur in medical institutions, to be disregarded. It also enables an accurate assessment of the real impact of the pandemic on mortality, both directly and indirectly, including those deaths attributable to other causes, such as disturbances in access to medical care in relation to other illnesses, in particular regions of a given country affected by the disease (Blangiardo et al., 2020).

Researchers who set out to estimate numbers of excess deaths caused by e.g. war or epidemic must calculate the difference between the observed and expected (in normal conditions) number of deaths (Checchi and Roberts, 2005). A positive value means that, in the given period, there were more deaths than in the referential period (Giattino et al., 2021). Excess mortality should be less than mortality only related to COVID-19 because the latter, in compliance with WHO guidelines, may include deaths not caused by COVID-19 but accompanied by this disease. The percentage of additional deaths in the examined time period relative to the referential time period is usually used as an excess mortality index. Excess mortality indexes enable the assessment of the general impact of the pandemic on mortality figures because they include not only the deaths of COVID-19-infected individuals but also undiagnosed ones and those whose death was indirectly caused by the pandemic, inter alia by reduced access to other medical-care services. During peak periods of the pandemic, temporary paralysis of the health-care system may occur and thus hinder access to medical care (ambulatory in particular),

which may also contribute to an increase in deaths related to causes other than COVID-19. Italy's experience from the initial stages of the pandemic points to the likelihood of near paralysis of local health-care due to the fact that most doctors were primarily preoccupied with COVID-19 patients (Cutler and Summers, 2020; Scortichini et al., 2020). In sum, excess mortality measures the number of extra deaths caused by all factors within a selected geographical area in comparison with what could be expected on the basis of experience of mortality in previous years. Such an approach clearly has its advantages: firstly, it is insensitive to differences in the practices of coding the cause of death; secondly, it encompasses not only infection-related deaths but also those indirectly caused by the pandemic, e.g. by limitations in the functioning of health care brought about by its intensity during critical moments of the epidemic's progress; thirdly, the sources of its estimation include commonly stored objective registration data, largely accessible in developed countries.

3. Method

In estimating excess-mortality levels, the most important challenge is to define the expected mortality in a given time period in such a way as if the pandemic were not to occur. The most often applied — owing mainly to its simplicity — method of estimating the expected number of deaths for an examined time period consists in calculating the historical mean on the basis of mortality figures from a few earlier periods (e.g. Docherty et al., 2020). However, such an approach does not allow for long-term mortality trends and does not take into account annual fluctuations in risk factors, such as weather (Scortichini et al., 2020). The estimation of the level of standard weekly (or monthly) absolute number of deaths in the period from 2020 to 2021 (or correspondingly a shorter period, depending on data availability) used the time-sequences analytical method which allows for weekly (these were available for Poland, Romania, Bulgaria, Hungary, Czechia, Slovakia, Lithuania, Estonia and Latvia) or monthly (for Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kirghizstan, Moldavia, Russia, Ukraine and Uzbekistan) seasonal fluctuations in the absolute number of deaths within the whole year, which enabled the seasonal impact of atmospheric temperature on mortality to be ascertained. In the study, an indicator method of extracting seasonal fluctuations of multiplicative character together with an analytically-designated trend was used; it may be represented by the equation:

$$y_i = (a + b \times t) \times S_{s_i} + S_y, \text{ where:}$$

a, b — parameters of linear function of total deaths number trend; t — time (corresponding quarter or month number); S_{s_i} — seasonality indicator designated for i-th quarter (or possibly month); S_y — random indicator.

For estimating seasonality indicators for weekly data with its calculation for the 53rd week of a given year, which does not always occur (in accordance with the adopted statistical terminology, the 53rd week occurred in the period under scrutiny only in 2015 and 2020) its calculation for the years 2016–2019, the mean for the 52nd week of the year under scrutiny and the 1st week of the next year were taken. The obtained results after estimating the standard total number of deaths for the years 2016–2019 displayed an estimation error for all the examined states amounting to 5.2% of mean value of the pertinent variable (from 2.3% for Russia to 7.1% for Estonia).

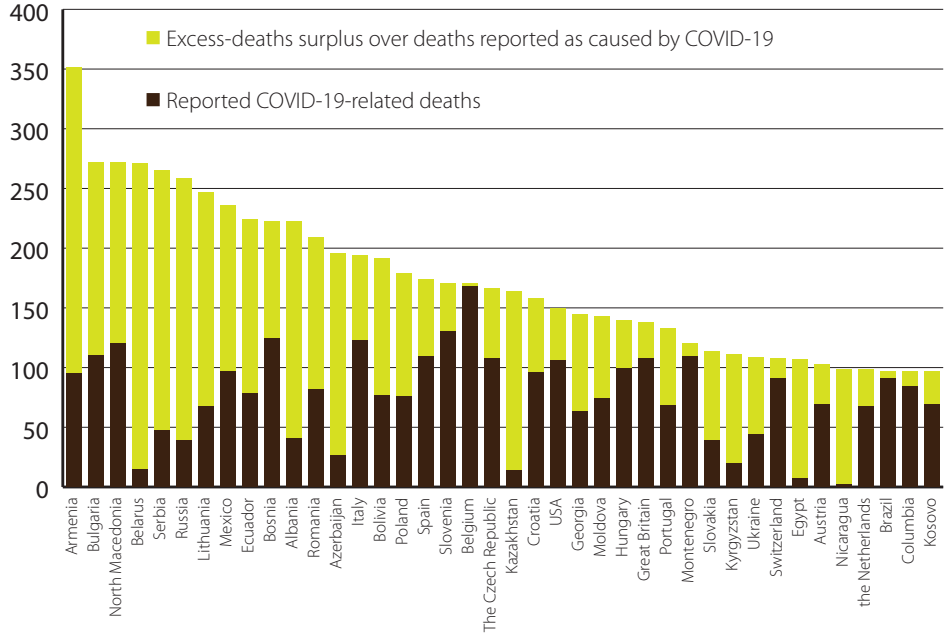
Other approaches to estimating the expected number of deaths can also be found in the literature, e.g. on the basis of the general mortality trend over recent years and seasonal fluctuations by means of the regression analysis method (Simonsen et al., 2005), the using the time series method (Németh, Jdanov and Shkolnikov, 2021), the ARIMA method (Nunes et al., 2011), Poisson's generalised linear model (Farrington et al., 1996) or on the basis of demographic prognosis taking into account the age structure of population changing over time (Karlinsky and Kobak, 2021).

The study applied data concerning the weekly (or monthly) total number of deaths published by Eurostat or other statistical offices from the data repository of the World Mortality Dataset (Karlinsky and Kobak, 2021) and data concerning infections and deaths caused by COVID-19, usually published by national health-care governmental institutions, stored in "The Johns Hopkins Coronavirus Center" database. The expected weekly (or monthly) numbers of deaths, regardless of cause, were estimated for selected countries of the world on the basis of these data. Then the observed number of deaths from January 2020 to the end of 2021 was compared to the predictions based upon these models and the number of excess deaths defined as the difference between the observed number of deaths and the number of deaths estimated on the basis of the model which would be observed in the case of the pandemic not occurring was specified. In order to calculate the numbers of excess deaths separately for the years 2020 and 2021, the weekly data were calculated for the last week of the year under scrutiny proportionately to the number of days in the given year. Furthermore, for the majority of the countries under examination the data for 2021 have an introductory character and are not complete; they may still be reviewed.

4. Findings

The findings of the study indicate that the level of coronavirus pandemic recognition largely depends on the time period (commonly referred to as coronavirus pandemic wave) in which it concerns — during the first stage of the pandemic's development in a given country fewer cases of both infections and related deaths are detected. Despite this, it is possible to identify countries in which COVID-19-related mortality statistics are

Figure 1. Forty countries with the highest number of excess deaths per 100 thousand people in 2020



Source: author's elaboration on the basis of Johns Hopkins Coronavirus Resource Center's and World Mortality Dataset's data. Note: the level of excess deaths in appr. 80 countries was estimated in the study; the graph presents 40 states with the highest numbers of excess deaths per 100 thousand people. The brown bar expresses the level of daily reported COVID-19-related deaths in the whole year 2020. The green bar indicates the excess-deaths surplus over deaths reported as COVID-19-related in the year 2020 estimated by means of the econometric model.

significantly understated. In the light of the findings of the study (more than 80 countries whose data were available were subject to the scrutiny) it can be said that there are a group of countries which, in the pertinent time periods, were "blind" to the development of the coronavirus pandemic. It was found that Armenia suffered the highest level of excess deaths per 100 thousand people in the year 2020 (see Figure 1). It needs to be remembered at the same time that, when examining and analysing the data for Armenia and Azerbaijan, there was a war in Upland Karabakh towards the end of 2020 which, besides the COVID-19 pandemic, beyond doubt also contributed to excess mortality. The group of countries with a high number of excess deaths per 100 thousand people included mainly Eastern European states or former parts of the Soviet Union. At the same time, in these countries the level of reported COVID-19-related deaths significantly differed from the estimated number of excess deaths. For example, in Belarus only 15 COVID-19-related deaths per 100 thousand inhabitants were reported in 2020, whereas according to the estimated model of excess deaths in this country, the number, amounted to as many as 271 per 100 thousand people (see Table 1). In other Eastern European states or former Soviet states the differences between these two values in 2020 were equally large — e.g. in

Uzbekistan (2 and 43), Azerbaijan (26 and 196), Russia (39 and 268), Kirghizstan (20 and 111), Armenia (95 and 352), Lithuania (67 and 247), Slovakia (39 and 115), Estonia (17 and 33), Romania (82 and 210), Bulgaria (110 and 272). Similar differences were also observed in other countries of the world: in some Latino-American countries, such as Nicaragua, Mexico, Ecuador, Bolivia (but not all, e.g. Brazil or Columbia, see Figure 1) or in some African countries, such as Egypt (it needs to be remembered, however, that for most countries in this continent no reliable data exist).

Table 1. Number of excess deaths in Eastern-European and formerly Soviet countries during the COVID-19 pandemic in 2020 and 2021

Specification	Excess deaths		COVID-19-related deaths		Excess deaths		COVID-19-related deaths	
	01.01.2020 – 31.12.2020				01.01.2021 – 31.12.2021			
	1st, 3rd, 5th and 7th columns in thousands of people 2nd, 4th, 6th and 8th columns per 100,000 people							
Armenia	10,5	352,1	2,8	95,1	9,7[1]	326,8[1]	5,1	173,5
Azerbaijan	20,0	196,1	2,6	25,8	19,3[1]	189,0[1]	5,7	55,9
Belarus	25,6	271,1	1,4	15,1	8,0[2]	84,2[2]	4,2	44,0
Bulgaria	18,8	272,1	7,6	109,9	43,8	635,0	23,4	339,0
The Czech Republic	17,8	166,4	11,6	108,0	27,8[5]	259,5[5]	24,5	228,9
Estonia	0,4	33,2	0,2	17,3	3,4	258,0	1,7	128,5
Georgia	5,8	145,4	2,5	62,9	3,0[3]	76,1[3]	11,3	283,8
Kazakhstan	31,3	164,8	2,7	14,5	48,8[1]	257,0[1]	15,5	81,4
Kyrgyzstan	7,4	111,2	1,4	20,4	6,3[1]	95,0[1]	1,4	21,8
Lithuania	6,6	246,5	1,8	66,8	11,4	423,9	5,6	207,9
Latvia	1,2	65,7	0,6	34,0	7,1	378,7	3,9	210,8
Moldova	5,8	144,0	3,0	74,2	7,2[4]	180,1[4]	6,7	166,6
Poland	67,4	178,4	28,6	75,5	106,9	282,7	68,5	181,2
Russia	391,0	268,0	56,3	38,6	732,4	501,9	246,4	168,9
Romania	40,1	209,7	15,8	82,4	74,5[6]	389,7[6]	43,0	224,7
Slovakia	6,2	114,7	2,1	39,2	20,0[7]	366,8[7]	14,5	266,0
Ukraine	47,6	109,4	19,3	44,4	134,6[1]	309,6[1]	82,8	190,5
Uzbekistan	14,7	43,2	0,6	1,8	11,7	34,5	0,9	2,6
Hungary	13,5	140,3	9,5	99,0	28,2	292,8	29,6	307,7

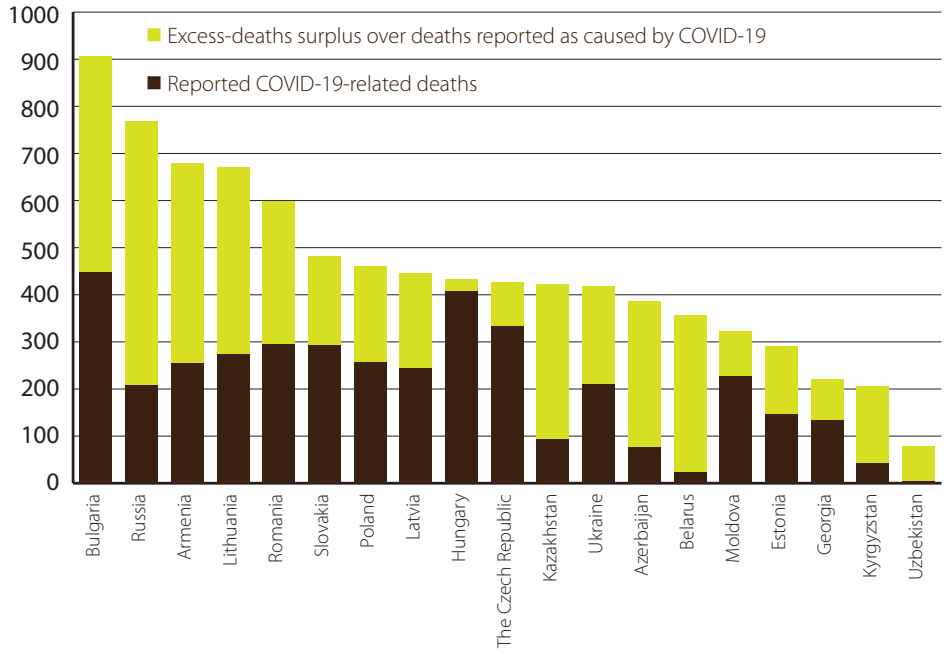
Source: author's elaboration based on Johns Hopkins Coronavirus Resource Center's and World Mortality Dataset's data.
Notes: [1]data for Armenia, Azerbaijan, Kazakhstan, Kirghizstan and Ukraine do not include December 2021, [2]data for Belarus do not include the period April–December 2021, [3]data for Georgia do not include the period July–December 2021, [4]data for Moldavia do not include the period October–December 2021, [5]data for Czechia do not include the 52nd week of 2021, [6]data for Romania do not include the period of the 48th–52nd week of 2021, [7]data for Slovakia do not include the period of the 51st–52nd week of 2021. Data for 2021 are of a preliminary nature and may be subject to review.

It seems that the course of the COVID-19 pandemic in many Eastern-European and former USRR countries has been described on the basis of unreliable COVID-19-related mortality data reported daily by their authorities. Such sizeable differences between excess mortality figures and reported COVID-19-related mortality figures may be accounted for in two ways: firstly, wrong identification of cause of death other than COVID-19, and secondly, an increase in mortality indirectly caused by the pandemic and the consequent limitations of some individuals to health-care services during spikes (Blangiardo et al., 2020). At the same time, it is unlikely that such a rapid increase in mortality figures should have resulted only from COVID-19-unrelated illnesses which directly or indirectly affected mortality, e.g. by overwhelmed health-care institutions, delays in the treatment of time-dependent diseases, such as stroke or myocardial infarction, etc. (Conti et al., 2020). Therefore, it seems more likely that in the majority of those states a large number of deaths must have been misidentified in terms of their cause, that is — COVID-19. Verifying these hypotheses will be possible after publishing full data concerning weekly or monthly data related to causes of reported deaths reported during the pandemic. Nevertheless, the analysis of solely COVID-19-related mortality statistics may lead to misleading conclusions as to the actual extent, course and scale of the pandemic. For instance, in the second quarter of 2020 relatively the highest level of excess mortality in all Europe was recorded for Eastern Europe, though the actual reported COVID-19-related mortality does not confirm this.

The ratio of excessive deaths to daily reported COVID-19-related mortality has also been calculated in the study. It should be pointed out that it is optimal if the ratio amounts to 1, for excessive mortality should equal or be lower than mortality caused by COVID-19 because it also includes other causes of death which could have increased during the pandemic. This indicator shows how many times higher the number of excessive deaths is than reported COVID-19-related deaths. High values of this indicator indicate that the daily reported COVID-19-related mortality data are unreliable and do not reflect the epidemiological situation in a given country. For example, the 2020 value of this indicator for Belarus, amounting to 18, means that the number of excessive deaths was 18 times higher than the reported deaths caused by COVID-19. It has been found in the study that the value of this indicator in Eastern-European and former USRR states was in many cases clearly higher than 1. In 2020 this indicator amounted to as much as 24 for Uzbekistan, 18 for Belarus, 11.4 for Kazakhstan, 7.6 for Azerbaijan, 6.7 for Russia, 5.4 for Kirghizstan, 3.7 for Armenia and Lithuania, 2.9 for Slovakia, 2.5 for Romania, Bulgaria and Ukraine and 2.4 in Poland. Amongst the Eastern-European countries under scrutiny the indicator for 2020 was low only in Hungary (1.4) and Czechia (1.5). In other regions across the globe high values of this indicator were also observed in Nicaragua (40.4), Egypt (14.6), Ecuador (2.9) or Lebanon (2.5). To a larger or smaller degree, in all the above-mentioned countries the statistics concerning the COVID-19 pandemic in 2020

did not reflect the actual epidemiological situation. Because most of these countries are Eastern-European or non-European but formerly parts of the USRR, they were subject to a detailed analysis in terms of statistics concerning excess deaths in 2020 and partly in 2021 (depending on data availability). For example, over 900 excess deaths per 100 thousand people were reported in Bulgaria for 2020 and 2021, while only half of that figure was reported as caused by COVID-19 (see Figure 2). In turn, as many as nearly 770 excess deaths may have occurred in Russia in the above-mentioned time-period, out of which only an average of 207 of the cases were attributed to COVID-19. In the case of Russia, similar results are also indicated by other studies in which it was found that by November 2020 the reported number of COVID-19-related deaths was in fact three times less than the actual number of deaths related to the pandemic (Kobak, 2021). The Belarus and Uzbekistan data turned out to be the least reliable in this respect; amongst all the excess deaths only a small percentage (a few cases per 100) was identified as caused by COVID-19. In turn, in Hungary nearly 94% of all excess deaths reported by December 31 2021 were identified as due to COVID-19.

Figure 2. Number of excessive deaths per 100 thousand people in 2020 and 2021



Explanations as with Figure 1
The data are not directly comparable because in the case of Armenia, Azerbaijan, Kazakhstan, Kirghizstan, and Ukraine they do not include the 12th month of 2021, for Belarus they do not include months 4–12 of 2021, for Georgia they do not include months 7–12 of 2021, for Romania they do not include the 48th–52nd week of 2021, for Slovakia they do not include the 51st and 52nd week of 2021. Furthermore, the 2021 data often have a preliminary character.

The absolute number of all excess deaths in the countries under scrutiny was highest in Russia, where in 2020 approximately 391 thousand deaths more than usual were reported, which gives a mean of 268 excess deaths per 100 thousand people (see Table 1). However, other researchers have estimated the level of excess deaths in Russia in 2020 to be 244 according to one method and 189 according to a different one (Timonin et al., 2020). Comparing only the number of deaths in Russia in 2020 to the previous years shows the scale of excess mortality: in 2020 the number of deaths in Russia amounted to 2.14 million, whereas in the years 2019 and 2018 appr. 1.8 deaths were reported. It needs to be additionally pointed out that in 2020 only 56 thousand deaths were reported by Russia to have been caused by COVID-19, which equalled less than 12% of all excess deaths. By contrast, the USA reported in the same time-period, according to the author's estimation, nearly 690 thousand excess deaths, out of which nearly 605 thousand cases were identified as caused by COVID-19. The reliability of Russian data concerning COVID-19 has been questioned by many researchers (Oxenstierna, 2021), which could only have been justified by the country's insufficient testing possibilities at the beginning of the pandemic. Some researchers have even speculated about the deliberate manipulation of data concerning mortality in connection with political pressure or avoiding sending negative messages by bureaucrats. Others have pointed out that the most likely cause of this could have been the country's principles of disease classification, which are different from those of the WHO, in the light of which doctors more often identify co-existing illness as a cause of death different from COVID-19. Even if the patient's coronavirus test was positive, the death may be reported as caused by something else (Oxenstierna, 2021).

The subsequent year turned out to be yet more adverse for Russia in terms of mortality — the preliminary statistics show that in 2021 Russia saw the death of 2.4 million people, out of which 730 thousand may be regarded as excessive — on average 502 excess deaths per 100 thousand people. Considering the fact that currently the number of annual births in Russia amounts on average to 1.5 million, the year 2021 appears to have been the worst for the country in terms of birth rate since World War II, and population decrease may amount to as many as 1 million people less. Nonetheless, the official data in Russia for 2021 show the number of deaths caused by COVID-19 to be only 246.4 thousand, which constitutes less than 33.6% of all excess deaths. As already mentioned, the relatively low percentage of COVID-19-related deaths in Russia, and probably in part also in other countries of the region, is primarily the result of a particular approach to determining the cause of death. For instance, if cancer, atherosclerosis or diabetes complicate the course of illness caused by coronavirus infection, then in most countries COVID-19 is identified as the cause or one of the causes of death, whilst in Russia it is customary to point to only one main cause, and in those cases it is usually cancer, acute vascular disease and diabetes (Oxenstierna, 2021). In essence, such definitions of causes of death are contrary to WHO

guidelines. Similar or even less reliable pertinent statistics are also observed for other countries of the region, e.g. Belarus, Uzbekistan, Kirghizstan, Kazakhstan, Azerbaijan or Armenia, where at best one quarter of excessive deaths were classified as caused by COVID-19 (see Table 1). Whereas in Hungary or in Czechia most excess deaths during the time-period under scrutiny were classified as caused by COVID-19. In the case of Hungary, in the said period approximately 42 thousand excess deaths were registered, out of which 39 thousand were reported to have been caused by COVID-19. However, in the case of Czechia over 45 thousand excess deaths had been registered by the 51st week of the year 2021, out of which nearly 36 thousand were reported as deaths caused by COVID-19.

Equally high excess-death statistics in the examined time-period occurred in Ukraine and Poland. In Ukraine, by November 2021 over 180 thousand excess deaths had been noted (mostly towards the end of 2021), out of which only a few more than 100 thousand were identified as related to the pandemic. The highest number of excess deaths occurred in Ukraine during the so-called 4th coronavirus wave, that is — during the last months of 2021, when mortality was as much as 80% higher than historically. In turn, in Poland the 2nd wave of the pandemic turned out to be the most adverse; the number of excess deaths by around the 45th week of 2020 was over 100% higher than historically. In the light of preliminary estimations, by the end of 2021 over 170 thousand excess deaths had occurred in Poland (the biggest number recorded at the end of 2020), out of which almost 100 thousand were identified as caused by COVID-19.

Considering mortality per 100 thousand people, Romania, Bulgaria and Lithuania fared very badly. Bulgaria noted high mortality statistics during the 2nd wave (in the 49th week of 2020 the number of deaths was nearly 130% higher than usual), the 3rd wave (in the 13th week of 2021 the number of deaths was nearly 130% higher than usual) and the 4th wave of the coronavirus pandemic (in the 44th week of 2021 the number of deaths was almost 107% higher than usual). This being the case, over 63 thousand excess deaths had occurred in Bulgaria by the end of 2021, out of which only 50% were registered as COVID-19-related, which constituted a total mean of 900 deaths per 100 thousand people in the time-period examined — the highest value amongst all the countries under scrutiny. In turn, the 4th wave of the pandemic proved the worst in Romania, where from the 41st to the 44th week of 2021 approximately 130% deaths more than usual were registered. As a result, in the light of the study, from 2020 until the 47th week of 2021 the number of deaths was higher by 115 thousand than normal, out of which 50% were reported to have been caused by COVID-19. In the Baltic states, Lithuania noted the worst mortality statistics; as many as 18 thousand people more than usual had died there by the end of 2021, thus since 2020 on average over 670 excess deaths per 100 inhabitants than usual had occurred there.

By contrast, the course of the pandemic in Kazakhstan, Uzbekistan and partly in Kirghizstan was different from that in Europe because the excess-mortality peak inci-

dence both in 2020 and in 2021 occurred in July and August. The pertinent statistics were also unfavourable in Kazakhstan, where mortality in July 2020 and August 2021 was correspondingly over 140% and 130% higher than normal. By only comparing the number of deaths in 2020 and 2019 one can see the scale of excess mortality in this country: in 2020 the number of deaths in Kazakhstan was 162 thousand, whereas the figure for 2019 was only 133 thousand. By November 2021over 80 thousand deaths more than normal had been registered in Kazakhstan, of which less than 18 thousand were reported as caused by COVID-19. This notwithstanding, Kazakhstan would note a clearly positive birth rate on account of high fertility levels — over 425 thousand children were born there in 2020. This is why the scale of the demographic crisis in this country will be incomparably smaller than in the other countries under examination. In the case of Azerbaijan and Armenia, excess-mortality spikes fell at the end of 2020 — in Azerbaijan there were as many as 200% more deaths in December than at normal times, while in Armenia November saw a 184%-rise relative to usual mortality. It seems, however, that it was not the pandemic that caused the increase in mortality there, but rather the war being waged between these two countries in Nagorno-Karabakh.

5. Discussion and conclusions

Summing up, in the light of the model's estimation, all the countries under examination had recorded over 2 million excess deaths by the end of 2021, of which 1.1 million occurred in Russia, though less than 40% of this figure was attributed to COVID-19. It seems that in some countries (primarily Eastern-European and former USRR countries) the course of the pandemic can be characterised by a large proportion of excess deaths, while only a relatively small number of them were reported as related to COVID-19. Identifying the states which understated the cause of mortality during the pandemic will enable a correct estimation of its scale and reach on the basis of examining excess mortality regardless of cause. Using only the statistics concerning reported COVID-19-related deaths in those countries for this purpose may be misleading with respect to the pandemic's development there. Nonetheless, in journalistic discourse one may sometimes observe an attempt to question the endeavour to estimate COVID-19-related mortality on the basis of analysing only excess deaths regardless of their cause. To illustrate this, it is contended that inhibitive measures applied in many countries (particularly in the initial stages of the pandemic's development) may have lowered the baseline mortality owing to lowering mortality due to such factors as e.g. car accidents, which would mean that the actual mortality related to COVID-19 could even surpass these estimations. Others point out that the inhibitive measures may have raised baseline mortality due to lack of exercise, economic difficulties or chronically ill patients' limitations in access to health-

care services, which in turn means that the actual COVID-19-related mortality may have been lower than excess-mortality estimations, although the findings of some studies suggest that none of these possible causes related to inhibition had a statistically significant impact on excess mortality — see e.g. analysis of variation in regional mortality in Russia (Timonin et al. 2020). One should therefore accept the statement that estimating COVID-19's impact on mortality on the basis of examining excess mortality regardless of cause is the only feasible objective solution which allows the full impact of the pandemic on mortality to be recognised, especially in countries whose statistics concerning causes of deaths are of questionable quality. Ideally, registered COVID-19-related mortality and mortality surplus should be on more or less the same level. However, on account of the low quality of the statistics concerning causes of deaths, discrepancy between legislative solutions concerning identification of cause of death or even deliberate manipulation of statistical data, these statistics often differ. Thus, applying excess mortality data for determining the COVID-19 pandemic's impact on mortality is by far a more objective and reliable approach.

The analysis has shown that a relatively low proportion of deaths caused by COVID-19 in the countries under scrutiny may have resulted from a special approach to identifying cause of death, i.e. owing to certain peculiarities of statistical accountancy. Nevertheless, the numbers of excess deaths, regardless of cause, allows an objective overview of mortality in those countries. There are also other countries that have been accused of understating COVID-19-related-deaths figures, e.g. Turkey, Iran, India, Brazil, Venezuela, Nicaragua and Mexico. If one were to take into account excess-mortality statistics, the figures in global databases would rise significantly. The data from the 19 examined countries alone indicate that the global COVID-19-death related statistics for the time-period under examination should be corrected by 1.2 million deaths — from approximately the 800 thousand reported deaths caused by COVID-19 to over two million excess deaths.

The method of calculating expected mortality as if the pandemic had not occurred is of key importance in assessing the size of excess mortality. For this purpose modelling time series taking into account seasonal fluctuations was used in the study. One of the limitations of the approach adopted was the fact that the extrapolation of excess mortality over an extended time-period (e.g. 3 years or more) may be reduced and marked by high risk of error. It seems that in such a case changes in population-age structure need to be taken into account to a greater extent, including those resulting from the pandemic and their impact on standard mortality. In addition, estimating expected mortality by means of the method applied in the study has certain limitations in small populations, where one may observe significant fluctuations of a random nature which may affect the quality of the resulting estimations. Nevertheless, for most of the countries studied, comparing the obtained excess-mortality estimations with the findings of other studies (see e.g. COVID-19 Excess Mortality Collaborators, 2022) did not demonstrate significant

differences. Thus, a group of scientists (COVID-19 Excess Mortality Collaborators, 2022) obtained very similar excess-mortality estimations for 2020 and 2021 for Russia, which amounted to 1.070 thousand deaths against the 1.123.4 thousand obtained in the present study (equally similar findings were obtained e.g. for Czechia — 49.1 against 45.6 correspondingly, Lithuania: 20.0 against 18.0; Romania: 119.0 against 114.6, or Ukraine: 181.0 against 182.2), although relatively bigger differences were recorded for Poland (214.0 against 174.3), Estonia (5.6 against 3.8), Bulgaria (82.5 against 62.2), Latvia (12.4 against 8.3) or Hungary (53.8 against 41.7).

A correct assessment of the pandemic's extent by e.g. assessing its actual impact on mortality figures should be the starting point for many other studies, those of a demographic character in particular, in which demographic processes are of vital importance. Initially, reactions to the pandemic's development in the individual countries were quite significant; various restrictions and limitations were introduced, which significantly reduced business activity, international economic cooperation, or the supply of and demand for certain goods. The impact of the pandemic was felt most severely by enterprises which were forced by authorities to limit their business activity, particularly in gastronomy and accommodation, tourism, culture, education or recreation and entertainment. The other sector of the economy directly affected by the outbreak of the pandemic was the NHS, whose overload of patients may also have translated into increased mortality. It seems that in the long run the pandemic will also adversely affect the NHS by engaging a share of its resources in treating its long-term consequences. It would be a future task worthwhile undertaking to investigate the pandemic's consequences for the health-care system and ways of financing it in the context of better efficiency of public funds involved in health care. Nonetheless, one should also bear in mind the fact that the pandemic has contributed to long-term beneficial economic changes. This may be exemplified by accelerated digitisation, automatisation and robotisation in certain sectors, or the permanent use of online work in certain areas, even after the pandemic had passed. Furthermore, the majority of COVID-19-related deaths concerned people aged 60 and older, which in the long run may turn out to be beneficial for pension systems or even the NHS. For instance, in the light of the author's other findings, in 2020 in Poland nearly 91% of excess deaths concerned people aged 60 and older (Murkowski, 2021), which is likely to reduce public insurance spending in the years to come by approximately 20 billion PLN relative to earlier prognoses (Murkowski, Szczyt, 2022).

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