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# Influence of respiratory infections pandemics on the mortality of the population of Ukraine

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## ABSTRACT

**Aim:** To analyze the dynamics and structure of the excess mortality of the population of Ukraine for 76 years (1945-2021).

**Materials and Methods:** An observational population study was conducted. Epidemiological methods were used, in particular, the method of graphical construction of time series, intensive, extensive indicators and indicators of excess mortality were calculated.

**Conclusions:** The coronavirus disease pandemic in Ukraine became the largest documented respiratory infection pandemic after 76 years, but did not outweigh the dramatic increase in mortality in the 1990s–2000s, including death in 1995.

**KEY WORDS:** excess mortality, COVID-19, pneumonia, influenza, pandemics

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## INTRODUCTION

The COVID-19 pandemic has become a significant, complex, cross-sectoral problem worldwide. As stated in the Report on the COVID-19 Pandemic: Lessons and Recommendations for the Future (2023), "COVID-19 has cost millions of lives and has had a horizontal impact on all levels and aspects of society, causing enormous damage both in Europe and throughout the world; (...) The EU, like the rest of the world, was not sufficiently prepared to deal with a crisis of this magnitude or its waves, which affected societies and economies around the world, including the provision of continuing education services in the case of confinement; (...) the impact of the COVID-19 pandemic has caused the most complex socio-economic crisis that Europe has had to face since the Second World War" [1].

On a global scale, the coronavirus disease pandemic caused significant excess mortality in 2020-2021 - about 14.83 million deaths. Of them, the excess in 2020 and 2021 was 4.47 and 10.36 million, respectively [2]. The indicator of "excess mortality" has been widely used to assess the consequences of past pandemics and crises in the field of health care, in particular, to assess the impact of the 1918-1920 influenza pandemic, known as the "Spanish flu" [3]. Taking into account the introduction by the WHO of the concept of "disease X" as a framework concept for theoretically possible pathogens capable of epidemic or even pandemic spread and requiring the adaptation of health care systems for a timely response to emergency large-scale chal-

lenges, this indicator can be considered as one of the indicators of the effectiveness of the response to such challenges [4].

A model of monthly excess mortality in Ukraine in 2020 using mortality trends for 2016-2020 showed 38,095 excess deaths. The excess mortality in Ukraine was average compared to 30 other European countries [5].

According to an estimate that used data for 2016-2020 in Ukraine in 2021, the excess of deaths related to the COVID-19 pandemic amounted to 150,049 (21.01% of all registered deaths) [6].

Excess all-cause and cause-specific mortality in 34 categories across models using data from January 2015 to December 2021 were also noted. Excess deaths were caused by pneumonia, circulatory system diseases, these categories accounted for the majority of all cases at the peak of expected all-cause mortality and laboratory-confirmed mortality from COVID-19 [7].

## AIM

To analyze the dynamics and structure of the excess mortality of the population of Ukraine for 76 years (1945-2021).

## MATERIALS AND METHODS

An observational population study was conducted. The object of the study is the epidemic processes of respira-

tory infections that cause pandemics, in particular, the new coronavirus infection caused by the SARS-CoV-2 virus. Epidemiological and statistical methods were used in the work, in particular, the method of graphical construction of time series, intensive, extensive indicators and indicators of excess mortality were calculated.

The main data on the annual number of deaths in Ukraine until 2000 were obtained from the reference edition [8]. Statistical data on the annual number of deaths for the period 2001–2015 were obtained from the directories of the Ukrainian Center for Disease Control and Monitoring of the Ministry of Health of Ukraine (form C-8 “Distribution of the deceased by sex, age groups and causes of death”). Mortality data for 2016–2021 were taken from the website of the State Statistics Service of Ukraine [9]. Data on population mortality for 2022–2023 are not available due to the introduction of martial law in Ukraine.

## REVIEW AND DISCUSSION

Almost immediately after the Second World War in 1947, in the dynamics of the mortality of the population of Ukraine, a peak of deaths was observed, which was related to the famine, which arose due to the drought and the inept or deliberate actions of the Soviet government, which did not avert mass starvation (Fig. 1).

Since 1948, mortality rates have stabilized. From 1950 to 1958, excess mortality was negative (Fig. 2).

The first documented pandemic of a respiratory infection in the second half of the 20th century was the “Asian Flu” a global pandemic of influenza A virus subtype H2N2 of 1957–1958, which probably manifested itself in Ukraine in 1959 with a total excess mortality of the population to the level of 17,009 deaths per 100,000 population. In the following 1960, the total excess mortality, as in the previous years before this pandemic (1950–1956), again became negative (Fig. 2). Another and more powerful influenza pandemic occurred already one decade later in 1968–1970 (“Hong Kong flu” caused by an H3N2 strain of the influenza A virus). The total excess mortality from H3N2 influenza in Ukraine at the peak of the pandemic in 1969 reached the level of 54,967 deaths per 100,000 population, and the number of people who died from pneumonia in 1968, 1969, and 1970 was 9,317, 10,254, and 11,359, respectively (Fig. 1). During the Hong Kong flu pandemic in 1970, excess mortality from respiratory diseases (+23.55 per 100,000 population) and circulatory system diseases (+47.34 per 100,000 population) was recorded in Ukraine, but excess mortality from some infectious and parasitic diseases (Class 1) was negative (Fig. 3, Fig. 4, Fig. 5).

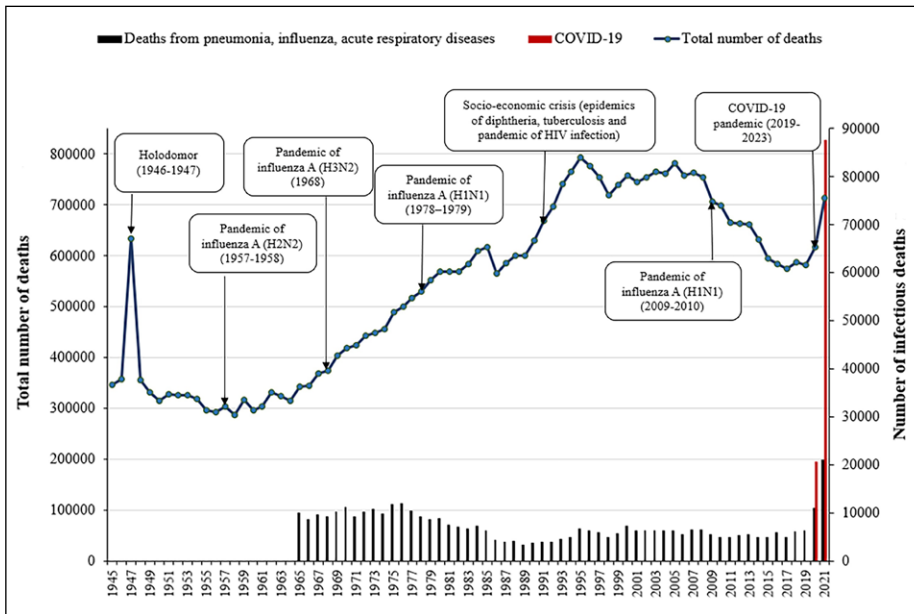
The next pandemic (the “Russian flu” caused by strain

Influenza A (H1N1) in 1978–1979 showed total excess mortality in Ukraine, which did not differ from the excess mortality of the Hong Kong flu. The number of people who died of pneumonia in 1978 and 1979 was 9,254 and 8,768, respectively (Fig. 1). All of the above-mentioned manifestations of excess mortality, in particular, pandemics of respiratory infections, occurred during the period when Ukraine was part of the Soviet Union, and the next dramatic increase in overall excess mortality was registered in independent Ukraine in the 1990s.

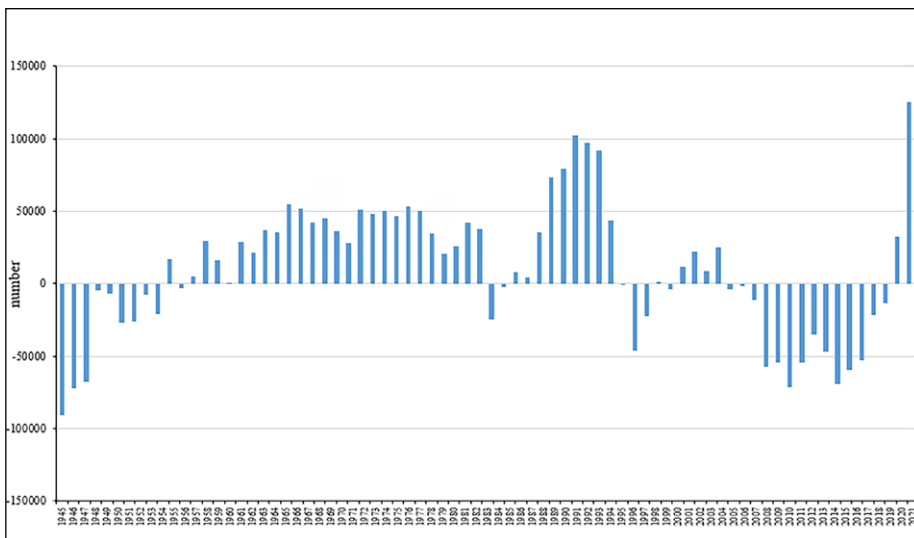
In 1995, the total number of registered deaths was 792,587, the highest annual death rate since World War II, but this rate was not associated with pandemics of respiratory infections, except for the tuberculosis pandemic (Fig.1). The probable reason for the growth in Ukraine of both overall mortality and mortality from individual nosological groups (diseases of the circulatory system, respiratory diseases, some infectious and parasitic diseases) was the socio-economic crisis that occurred in Ukraine after the collapse of the Soviet Union. This crisis lasted from the mid-1990s to the end of the 2000s. During these years, the death rate remained at a high level. At that time, there were severe re-emergent epidemics of diphtheria, tuberculosis and the pandemic of HIV in Ukraine. Also, there was a high overall excess mortality and a high excess mortality from diseases of the circulatory system during this period (Fig. 4), but starting from 2009 to 2019, the economic condition of the country improved somewhat and mortality rates had a pronounced tendency to decrease (Fig. 1). From 2009 to 2019, total excess mortality and infectious excess mortality were negative (Fig.2). The impact of the H1N1 swine flu pandemic was not significantly felt in Ukraine in 2009–2010.

The COVID-19 pandemic began in Ukraine in 2020 and lasted until 2023. The first two years of the pandemic showed a rapid consecutive increase in total excess mortality +32,569 deaths in 2020 and +125,589 deaths in 2021. There were 20,709 deaths from COVID-19 in 2020 or 50.6% of excess mortality and in 2021 there were 87,567 deaths or 64.02% of excess mortality (Fig. 1). COVID-19 (Class 22) was responsible for 3.36% of total deaths in 2020 and for 12.26% of total deaths in 2021. Non-COVID-19 pneumonia, influenza and other acute respiratory infections (Class 10) almost doubled (in 2020) and almost tripled (in 2021) compared to the previous five years (2015–2019). Other infectious mortality (some infectious and parasitic diseases – class 1) showed a drop in mortality in 2020 and 2021 (Fig. 5).

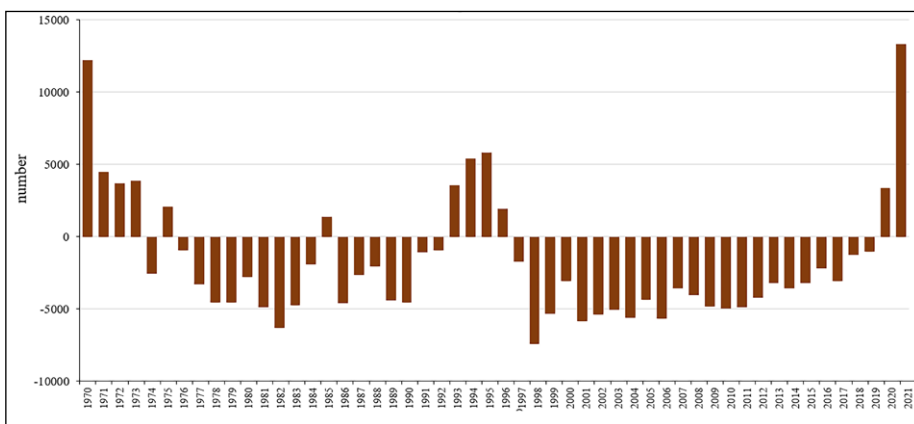
While understanding the direct and indirect effects of a pandemic is important for preparing for and responding to future emergencies, it is also important to



**Fig. 1.** Total mortality, mortality from pneumonia, influenza, acute respiratory infections and COVID-19, Ukraine, 1945–2021.



**Fig. 2.** Total excess mortality, Ukraine, 1950–2021.

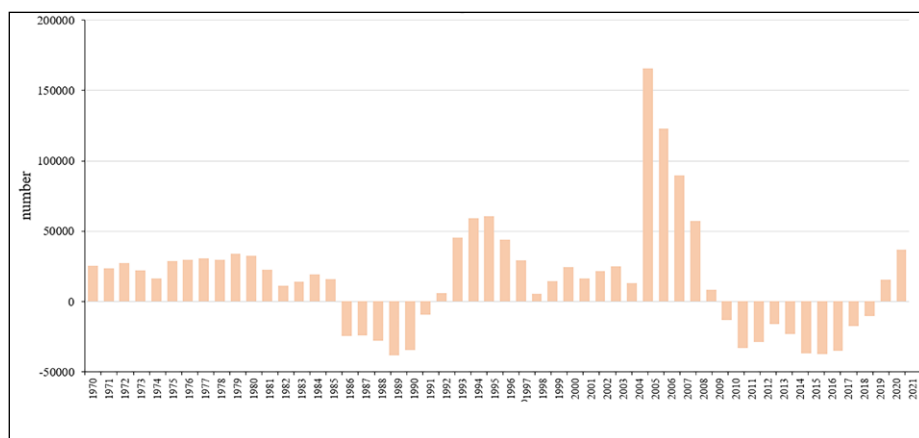


**Fig. 3.** Excess mortality from respiratory diseases, Ukraine, 1970–2021.

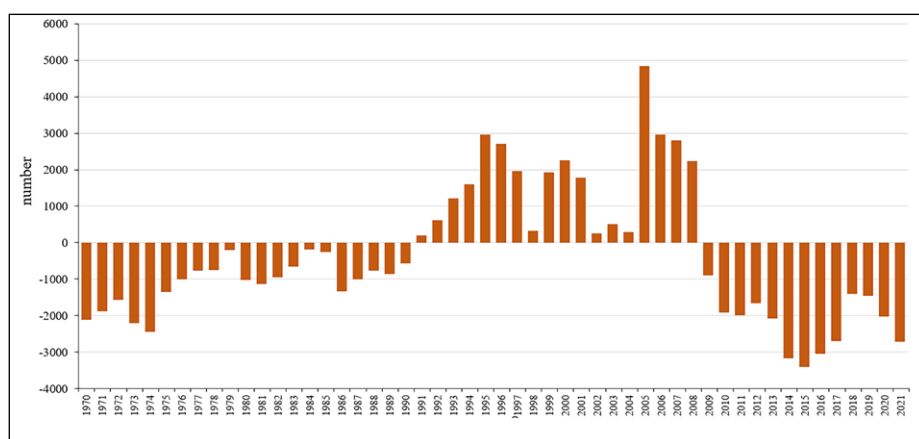
compare mortality during a pandemic with non-pandemic times. According to the CDC/National Center for Health Statistics, deaths in New York state caused by non-communicable diseases lead during non-pandemic periods, with cardiovascular disease and cancer being the leading causes of death, accounting for more

than 44,000 and 34,000 per year respectively [10, 11].

A study of excess mortality from epidemic influenza, 1957–1966, showed that more than half of the excess deaths were attributable to diseases of the heart, circulatory, or nervous systems, and that severe influenza epidemics resulted in a small but signifi-



**Fig. 4.** Excess mortality from diseases of the circulatory system, Ukraine, 1970–2021.



**Fig. 5.** Excess mortality from some infectious and parasitic diseases, Ukraine, 1970–2021.

cant excess mortality attributable to tuberculosis, asthma, chronic rheumatic heart disease, diabetes and neoplasms [12].

The total number of deaths in Ukraine shows significant fluctuations over the past 76 years. In 1947, one can see a jump not related to pandemics and epidemics of respiratory infections. Subsequent influenza A pandemics, particularly in 1957–1958 and 2009–2010, did not cause significant overall excess mortality. The influenza pandemics of 1968–1970 and 1978–1979 resulted in modest increases in total excess mortality, but total mortality between these two pandemics (throughout the 1970s) remained at the same level. Moderate excess mortality from diseases of the circulatory system was also present in the 1970s, but it was not only during the influenza pandemics of 1968–1970 and 1978–1979. During this period, the largest number of deaths from pneumonia, influenza, and acute respiratory infections were recorded both in pandemic years: 1969 – 10,254 deaths and 1970 – 11,359 deaths, and in non-pandemic years: 1975 – 11,935 deaths and 1976 – 12,091. Such data may indicate that that only part of the excess mortality is of pandemic origin. Perhaps this is also evidenced by the dramatic increase in all types of excess mortality (the highest in Ukraine over the

past 76 years) in the 1990s and 2000s. Pandemics of respiratory infections were absent in Ukraine during this period.

The COVID-19 pandemic has had a global impact on all areas of human life, has slowed advances in healthcare and highlighted deficiencies in healthcare infrastructure worldwide, as healthcare systems were unprepared and ill-equipped to deal with the pandemic and simultaneously provide general and specialized medical care [13, 14]. The diversion of health care system resources to respond to the coronavirus disease pandemic has led to a prolonged disruption in the provision of basic medical services. New challenges impeding demand for health care services, such as limited mobility, fear of infection, and shortages of infection prevention and testing facilities create additional, unprecedented challenges [14].

Previous studies examining changes in non-COVID-19 hospitalizations and all-cause mortality during the pandemic show that the decline in other-cause hospitalizations was likely due to hospital overcrowding during peak periods of coronavirus disease, and also with a drop in demand for help from citizens who were afraid of contracting COVID-19 [15].

Our results also confirm previous data, as in the 5 years (2015–2019) preceding the COVID-19 pandemic, an

average of 584,266 deaths per year were registered in Ukraine, and during the COVID-19 pandemic in 2021, a peak of 714,263 deaths was registered, of which 125,589 (or 64.02%) of deaths were excess. Of these excess deaths, 87,567 were attributable to COVID-19 (more than 95% of these deaths were laboratory confirmed). The occurrence of 35.08% of non-COVID-19 deaths probably contributed to the overload of the health care system in the conditions of anti-epidemic restrictive measures (lockdowns).

Thus, both the total excess mortality and its components in different periods of time cannot always be caused only by pandemics of respiratory infections. In some periods, excess mortality may be higher when there are no pandemics.

## CONCLUSIONS

If during influenza A pandemics, a significant part of non-infectious excess mortality can be explained by the lack of laboratory diagnostics, then during the COVID-19 pandemic, non-infectious excess mortality can be explained, among other things, by the overloading of the health care system in the context of anti-epidemic restrictive measures (lockdowns).

Despite the fact that the COVID-19 pandemic has become in Ukraine over the past 76 years the largest documented pandemic of a respiratory infection with the largest number of annual laboratory-confirmed excess deaths, it did not exceed the dramatic increase in mortality in the 1990s-2000s, in particular, the indicator of 1995 year.

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### **CONFLICT OF INTEREST**

The Authors declare no conflict of interest

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