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Research Article

Excess Mortality in Cyprus during the COVID-19 Epidemic

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Abstract

Background: Excess mortality associated with the COVID-19 pandemic has been reported in many countries. Our study aim was to examine excess deaths in Cyprus during the pandemic as compared to the average mortality documented in the pre-pandemic period. **Methods and Findings:** We performed exploratory statistical analysis to examine the trends of excess mortality in Cyprus using data tabulations and graphical representations. Publicly available data reported by the Cyprus Ministry of Health to the European Statistical Office (Eurostat) were used to analyze excess mortality over a 7-year period (2016-2022). Information collected by the European Centre for Disease Prevention and Control (ECDC) on SARS-CoV-2 vaccination doses and COVID-19 related deaths were also analyzed. Through our study we demonstrate a substantial excess mortality from all causes in the Cyprus population, particularly during 2021 and 2022 even after excluding COVID-19 deaths. This increased mortality is particularly seen as compared to the first pandemic year (2020) and the pre-pandemic period. During the third and fourth quarters of 2021, total deaths represented an increase of +34.1% and +11.8%, respectively, while during the first quarter 2022, total deaths were 2365, an increase of +30.7%. **Conclusion:** Our findings raise serious concerns regarding the potential impact of the vaccination campaign and other causes on mortality. A detailed cause-specific investigation of such a significant excess number of deaths is warranted to explore the potential factors leading to this concerning and unexplained increase in population mortality.

Keywords: Excess mortality; Increased number of deaths; Cyprus; COVID-19; Epidemic

Author Summary

Why was this study done?

- The COVID-19 pandemic constituted a new challenge for public health and has resulted in a number of negative health related consequences, including increased all-cause mortality.
- Excess mortality is a crucial measure of the true impact of the COVID-19 pandemic.

What did the researchers do and find?

- The aim of our present study was to examine the excess deaths occurring in Cyprus over the past three years as compared to the average mortality observed during the pre-pandemic period.
- Data reported by the Cyprus Ministry of Health to the European Statistical Office (Eurostat) were used to analyze excess mortality in Cyprus over a 7-year period (2016 – 2022).
- Information collected by the European Centre for Disease Prevention and Control on a weekly basis regarding COVID-19 vaccination doses and related deaths were also analyzed.
- The findings of our study demonstrated a substantial, statistically significant, increase in mortality (excess mortality) from all causes in the general population, particularly during the third and fourth quarters of 2021 and the first quarter of 2022.

What do these findings mean?

- We concluded that excess mortality occurs in unprecedented levels in Cyprus.
- Based on the findings of our study, we conclude that it is of paramount importance to conduct similar studies across different European countries and do cross-check analysis in order to timely evaluate the excess mortality documented among European populations.
- Public health policy makers and associated professionals need to explore the documented excess mortality in the general population and elicit the underlying causes for this unprecedented negative public health outcome.

Introduction

Coronavirus disease 2019 (COVID-19) was caused by the novel coronavirus SARS-CoV-2. It was first reported in Wuhan, China, in December 2019, and along the way it has emerged as a global pandemic [1]. According to officially published data from the World Health Organization (WHO), on September 6th 2023, a total of 770.437.327 confirmed cases and 6.956.900 deaths have been globally recorded [2]. The COVID-19 pandemic constituted a new public health challenge and has resulted in a number of negative health-related consequences, including increased mortality [3]. However, an accurate measurement of the number of deaths due to the COVID-19 pandemic is crucial for each country and region to understand the magnitude of the pandemic's impact as well as assess the post pandemic period in order to inform appropriate public health policies.

Furthermore, reported deaths facilitate the quantification of the magnitude of the pandemic among different populations and allow for comparisons between countries and within regions over time [4]. However, associated mortality represents only a partial count of total deaths [5], whereas the reliability and validity of reported deaths varied greatly between the different countries given the variant methodologies used to define and count such events over time [6]. Consequently, excess mortality is a crucial measure for assessing the overall impact of the COVID-19 pandemic and associated public health measures.

Due to the above impact, the Coronavirus Disease 2019 has triggered tremendous interest in related statistics. Therefore, in April 2020, in cooperation with the National Statistical Institutes of the European Statistical System and the European Free Trade Association (EFTA), Eurostat set up a special data collection on weekly deaths, in order to support research and policy efforts related to the pandemic. National Statistical Institutes regularly and on a voluntary basis report data to Eurostat on weekly fatalities. The weekly deaths dataset that Eurostat publishes regularly is used to compute the monthly excess mortality indicators by mapping the deaths of each week to a full month [7].

Excess mortality is a term used in epidemiology and public health referring to the number of deaths from all causes occurring during a crisis, above and beyond what we would have expected to observe under "normal" conditions [8]. In the case of the COVID-19 pandemic, excess mortality is a more comprehensive measure of the total impact of the pandemic on mortality compared to the confirmed COVID-19 deaths alone. The excess mortality indicator, which is part of the European Statistical Recovery Dashboard, captures not only the confirmed deaths, but also COVID-19 deaths that were not correctly diagnosed and reported, as well as deaths from other causes that are attributable to the overall COVID-19 crisis and beyond [9]. Eurostat takes the number of people who died from any cause, in a given period, and compares it with a historical baseline calculated from data available between 2016-2019 that was not affected by the COVID-19 pandemic [7]. This indicator highlights the magnitude of the health crisis by providing a comparison of additional deaths among the European countries,

allowing further analysis of the underlying causes. This approach estimates the impact of the COVID-19 crisis as well as the overall population mortality by including all deaths regardless of their cause [10].

According to information collected by Eurostat, the annual excess mortality for the European Union (EU) in 2020 was 11.7% higher than the 2016-2019 average, whilst in 2021 it was 14.0% higher. In 2022, the annual excess mortality for the EU was 11.2% higher than the 2016-2019 average. In June 2023, a month after the World Health Organization declared the end to the COVID-19 public-health emergency, excess mortality in the EU continued to rise with the EU rate reaching 2.5% (around 2,600 additional deaths compared to the average number of deaths for the same period in 2016-2019). Additionally, in June 2023, excess mortality continued to vary across the EU. Over half of the EU Member States recorded excess deaths. The most affected countries were Ireland, the Netherlands, Finland and Cyprus which had excess mortality rates between 13.3% and 14.4%. It is also worth mentioning that Cyprus was one of the EU Member States with the highest excess mortality rates during the pandemic (e.g., in 2022, Cyprus had the highest annual excess mortality reaching 26.4%). Moreover, in the first quarter of 2023 fourteen EU Member States recorded excess deaths, with the highest rates in Cyprus (10.8%) and the Netherlands (10.1%) [7].

Based on a wider literature search, we document an excess mortality being observed worldwide during the COVID-19 pandemic and beyond. Rossen, et al. showed that USA experienced substantial excess mortality in 2020 and 2021 related to the COVID-19 pandemic, which was higher than in Europe for nearly all age groups, with an additional 44.1 excess deaths per 100,000 person years overall from 2020-2021. During 2020-2021, the USA experienced 154.5 cumulative age-standardized excess all-cause deaths per 100,000 person years [11]. Another study estimated excess mortality from the COVID-19 pandemic in 191 countries and territories, and 252 sub-national units for selected countries. Although reported COVID-19 deaths between Jan 1, 2020, and Dec 31, 2021, totaled 5.94 million worldwide, they estimated that 18.2 million people died worldwide because of the COVID-19 pandemic (as measured by excess mortality) over that same period. The global all-age rate of excess mortality due to the COVID-19 pandemic was 120.3 deaths per 100,000 of the population, and excess mortality rate exceeded 300 deaths per 100,000 of the population specifically in 21 countries [12].

We have previously reported on the general population mortality in Cyprus during the pandemic as compared over a six-year period (2016-2021), having observed a substantial increase in population mortality in 2021 compared to 2020. Moreover, we found that, when excluding deaths reported as caused by COVID-19, we still documented significant residual increased mortality in the general population indicating that a significant portion of the worrying increase of 9.7% of all-cause mortality in 2021 was not explained completely by COVID-19 deaths [13].

Consequently, the aim of our present study was to examine possible excess mortality occurring in Cyprus over the past three years as compared to the average mortality observed during the pre-pandemic period.

Materials and Methods

In this study we performed exploratory data analysis with information obtained from publicly available official databases. Information on weekly reported all-cause mortality from Cyprus was downloaded from the European Statistical Office (Eurostat) as the official data reported by the Cyprus Ministry of Health [14]. Eurostat provides packaged information about the total deaths on a weekly basis for all European countries [16]. We selected the Eurostat database that provides the above mortality data in age groups based on 20-year intervals. In addition, we used publicly available data from the European Centre for Disease Prevention and Control (ECDC) on the numbers of COVID-19 related deaths and on vaccination records reported on a daily basis [15].

All datasets downloaded from the above two databases were transformed into monthly aggregated records by different age groups in order to maintain a global consistent period index reference for relevant comparisons. The resulting transformation outputs included total all-cause deaths, total COVID-19 deaths, and total SARS-CoV-2 vaccination doses for Cyprus by different age groups tabulated on a monthly basis.

Due to the variety of different time intervals used by different international official databases and scientists reporting from around the world, we decided to use the monthly basis format as deemed more appropriate for analyzing mortality data and vaccination records for Cyprus [17]. In addition, monthly grouped data are comparable to the report format used by Eurostat.

In order to compare the potential mortality deviation (excess deaths) before and after the COVID period, we calculated the average monthly mortality using the years 2016 to 2019. This selected reference time period was based on the same time period used by Eurostat [16]. Our data were converged based on the same protocol as defined by Eurostat on excess mortality, which was stated as the rate of additional deaths in a month compared to the average number of deaths over a baseline period (2016-2019) [7]. Quarterly grouped data were also used to generate specific graphs for representation purposes.

Monthly counts and percentage changes were used to compare mortality over time and between years. Cumulative

curves were also employed to provide an unbiased methodological approach to graphically represent the evolution of mortality trend lines over time. This approach is particularly useful for highly fluctuated values at short time intervals such as the small numbers observed with the Cyprus monthly data.

Results

Trends of all-cause mortality is presented in both tabular and graphical forms as delineated below. In Table 1, we present the total number of deaths from all causes over the study period of 7 years (2016-2022) on a monthly basis. It is important to note that the first official SARS-CoV-2 cases were reported in Cyprus on March 10th, 2020 and the vaccination program started on Dec 27th, 2020. Subsequently, in Figure 1 we depict the total number of deaths from all causes presented on an annual basis as reported officially by the Ministry of Health to the Eurostat database. Using the reference line generated by the average mortality from years 2016 to 2019, we have identified significant excess mortality, which is clustered mostly in years 2021 and 2022.

Year	January	February	March	April	May	June	July	August	September	October	November	December
2016	715	496	420	440	482	370	469	381	408	454	440	455
2017	794	647	541	570	423	393	548	372	357	522	414	579
2018	481	564	500	596	417	379	503	409	519	403	443	584
2019	447	613	657	477	472	575	445	393	540	435	419	629
2020	585	586	676	504	673	425	437	533	431	430	585	590
2021	917	553	513	605	636	455	566	793	526	615	544	622
2022	938	732	642	649	616	432	635	457	439	581	534	570

Table 1: Total deaths by month and year in Cyprus (data from Eurostat).

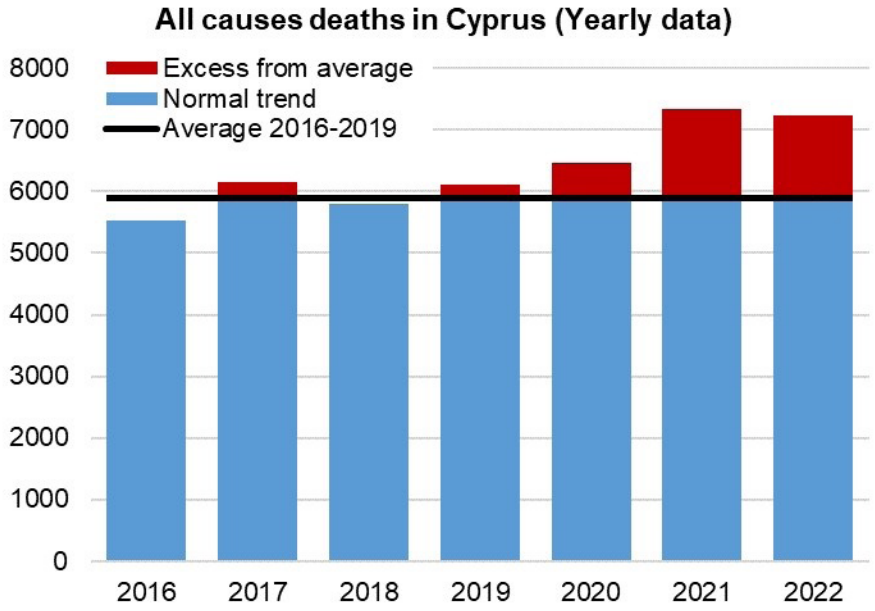

Figure 1: Total deaths from all causes presented on a yearly basis. Data obtained from the Eurostat dataset for the period between 2016 to 2022. The reference average line was generated using mortality data from 2016 to 2019. The average line is used to assess deviation from the pre-COVID-19 period. The excess deaths are shown in red.

In Table 2, we describe the total number of deaths from all causes presented on a quarterly basis for each year including the total and mean weekly deaths and percentage change for each of the two consecutive years over the time period between 2016 and 2022. Similar representation of the data is given in Figure 2. The reference trend line in Figure 2 is generated using baseline mortality data from 2016 to 2019 (1474 deaths per quarter). This is used to assess deviation from the pre COVID-19 period by indicating excess deaths in red.

Year	1st quarter			2nd quarter			3rd quarter			4th quarter		
	total deaths	% change	mean weekly deaths	total deaths	% change	mean weekly deaths	total deaths	% change	mean weekly deaths	total deaths	% change	mean weekly deaths
2016	1516		116.6	1265		97.3	1248		96	1419		109.2
2017	1936	27.7	148.9	1390	9.9	106.9	1281	2.6	98.5	1402	-1.2	107.8
2018	1654	-14.6	127.2	1376	-1	105.8	1338	4.4	102.9	1430	2	110
2019	1842	11.4	141.7	1496	8.7	115.1	1381	3.2	106.2	1499	4.8	115.3
2020	1870	1.5	143.8	1570	4.9	120.8	1397	1.2	107.5	1644	9.7	126.5
2021	1810	-3.2	139.2	1698	8.2	130.6	1873	34.1	144.1	1838	11.8	141.4
2022	2365	30.7	181.9	1645	-3.1	126.5	1579	-15.7	121.5	1760	-4.2	135.4

Table 2: Mortality in Cyprus by quarter including total and mean weekly deaths and percentage change for each of the two consecutive years over the time period 2016-2022.

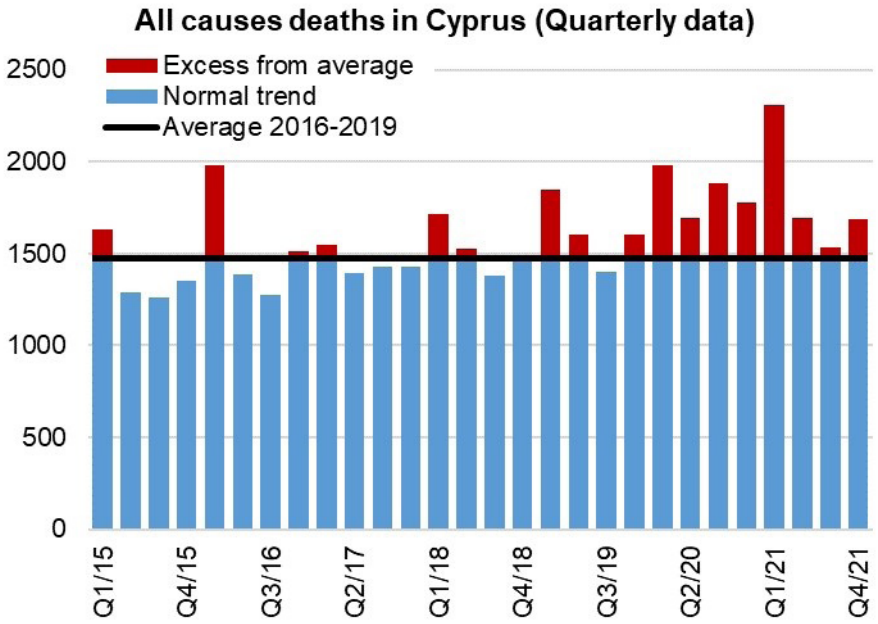

Figure 2: Total deaths from all causes presented on a quarterly basis. Data obtained from the Eurostat dataset for the period between 2016 to 2022. The reference average line generated using mortality data from 2016 to 2019 (1474 deaths per quarter) is used to assess deviation being characterised as pre-COVID-19 period. The excess deaths are shown in red.

In Figure 3 we present the total SARS-CoV-2 vaccination doses submitted on a monthly basis in Cyprus. Two peaks have been identified, in May 2021 with 348,394 doses and in December 2021 with 203,927 doses. In cumulative terms, at the time of the first vaccinations peak event, 42% of the total Cyprus population received their first vaccination dose and increased to 71% at the time of the second peak event. The population estimate is obtained from ECDC based on the total population of 904,705 people in the Republic of Cyprus, excluding the Turkish occupied area. The number of cumulative excess deaths is increasing from December 2021 and continues thereafter.

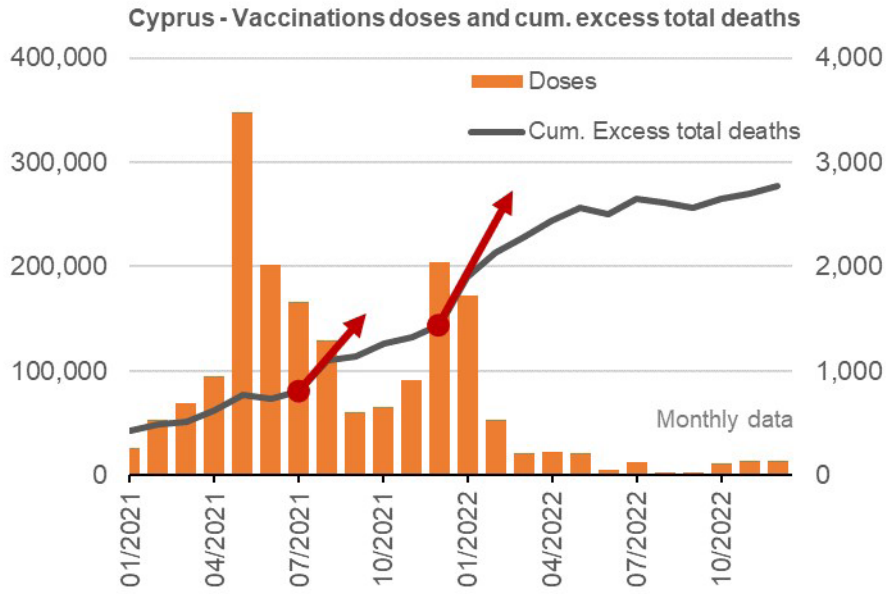

Figure 3: We present the total SARS-CoV-2 vaccination doses submitted on a monthly basis in Cyprus. Two peaks have been identified in May 2021 and December 2021. The peaks correspond to the percentage of people receiving their first vaccination dose, which was 42% and 71% of the total Cyprus population, respectively. The population estimate is from ECDC based on the total population of 904,705 people in the Republic of Cyprus, excluding the Turkish occupied area. In the graph, we recognise that after each vaccination peak, a high-rate trend is followed on the cumulative curve of excess deaths. In July 2021, we observe a delay of three months from the vaccination peak to high-rate trend impact on deaths, while the worse performance is presented in the second vaccination peak, in December 2021 with a higher rate trend and without a delay impact signature. However, as this is a cumulative curve, we realise that the investigated period of 2021-2022 presents a significant increased amount of 2,624 all-caused deaths above the average of period 2016-2019.

In Figure 4 we delineate the mortality deviation from the average trend of years 2016-2019 as outlined in parallel to important key dates indicating the first COVID-19 case reported in Cyprus on March 10th 2020, the initiation of the vaccination campaign on December 27th 2020 and the identified peaks of total vaccination doses delivered in May and December of 2021, respectively [15]. The overall curve represents the cumulative excess total deaths from all causes in Cyprus. We note that during the period between the start of SARS-CoV-2 epidemic in Cyprus and the start of the vaccination campaign, the mortality deviation is very low compared to the vaccination period that followed, which appears to increase during the vaccination period.

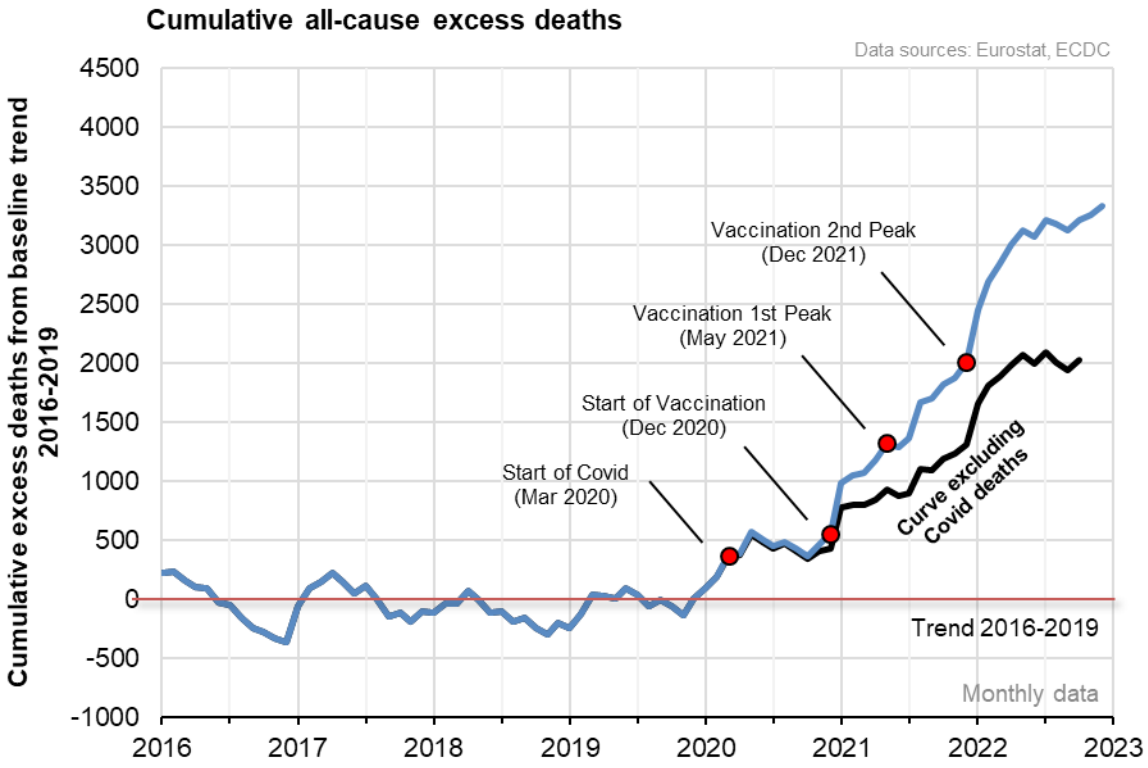

Figure 4: The mortality deviation from the average trend of years 2016 – 2019 is presented in the graph along with important key dates indicating the first COVID-19 cases reported in Cyprus on March 10th 2020, the start of the vaccination campaign on December 27th 2020 and the two identified peaks of total vaccination doses delivered in May and December of 2021, respectively. The overall curve represents the cumulative excess total deaths from all causes in Cyprus. We note that during the period between the start of SARS-CoV-2 epidemic in Cyprus and the start of the vaccination campaign, the mortality deviation is very low compared to the vaccination period that followed, which appears to increase drastically during the vaccination period and thereafter. The cumulative curve also suggests that the proposed assessment method of mortality trend can provide an unbiased result. Therefore, we are able to identify that the critical increased mortality occurring after December 2020 has led to about 3000 excess deaths within the years 2021-2022.

Finally, in Figure 5 we present the cumulative mortality for different age groups (below and above age 40). We note the improved quality of data trends assessment by using the cumulative method in mortality studies. Cumulative excess deaths although are documented among people below age 40, they remain inconclusive in Figure 5A. However, significant cumulative excess deaths are noted for people above age 40 in all age groups starting in the first quarter of 2021 and continuing thereafter (Figure 5B).

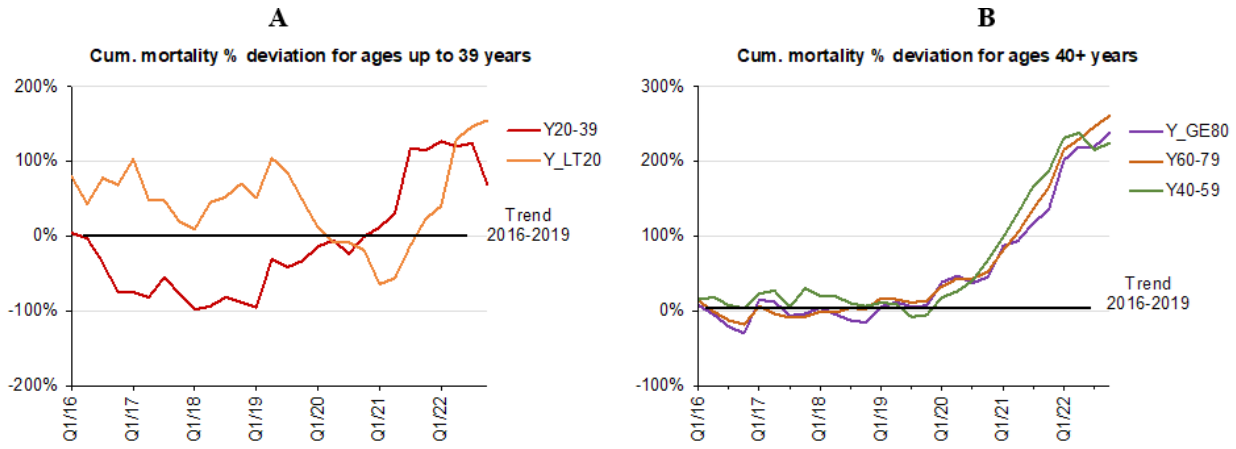

Figure 5 (A and B): In this figure we compare the cumulative mortality for different age groups (below and above age 40). We recognize the improved quality of data trends assessment by using the cumulative method in mortality studies. Cumulative excess deaths although are documented among people below age 40, they remain inconclusive in section A. However, significant cumulative excess deaths are noted for people above age 40 in all age groups starting in the first quarter of 2021 and continuing thereafter (section B).

Discussion

In this study we examined the excess deaths occurring in Cyprus over the past three years as compared to the average mortality observed during the pre-pandemic period. Overall, the findings of our study are worrisome particularly for years 2021 and 2022, demonstrating a substantial increase in mortality (excess mortality) from all causes in the general population, particularly during the third and fourth quarters of 2021 and the first quarter of 2022. In both years (2021 and 2022) we document much higher excess mortality compared to the first year of the pandemic (2020) and the pre-pandemic period. A reasonable concern arises from this worrying increase, whether it is all explained by the number of deaths that were reported due to COVID-19 during the same period. However, even after excluding the reported number of deaths from COVID-19, the increase in the total mortality from all causes in Cyprus, persisted, particularly in the years 2021 and 2022, based on data released by Eurostat, a phenomenon which coincides with the parallel vaccination campaign.

Notably, the findings of the current investigation are in line with our previously published study. The findings of our previous analysis also demonstrated a substantial, statistically significant, elevation in mortality from all causes in the general population of Cyprus, especially during the third quarter of 2021, which remained even after the exclusion of the reported number of deaths from COVID-19. Therefore, this study confirmed the previous published results and adds more information to the international literature regarding excess mortality occurring in Cyprus over the past three years [13]. According to the monthly excess mortality in the EU reported by Eurostat, between July and December 2021, there was a wave of excess mortality, with the EU rate reaching 26.6% in November and 23.7% in December 2021. This finding parallels our results documenting an increased mortality (excess mortality) from all causes in the general population in Cyprus, particularly during the third and fourth quarters of 2021. However, in the first quarter of 2022, the wave of excess mortality in the EU weakened, in contrast to our finding of continued increased excess mortality during this period. It is worth mentioning that in the third quarter of 2022, the death rate in the EU increased in July and August to 17.1% compared to the average number for the same period in 2016-2019. There were around 58,000 additional deaths in the EU in July of 2022. This is an unusually high number for this month: the excess mortality rate was 2.8% in July 2020 (11,500 excess deaths) and 5.7% in July 2021 (19,700 excess deaths). In August 2022, excess mortality was again higher compared to the same month of the past two years: 13.9% (52,600 additional deaths), versus an excess mortality rate of 9.1% in August 2021 (36,000 excess deaths) and 7.6% in August 2020 (27,300 excess deaths). Moreover, in December 2022, excess mortality in the EU increased compared to the previous month and was 20.4% compared to the average number for the same period in 2016-2019. There were around 82,600 additional deaths in December 2022 in the EU [7].

Other studies have also reported an excess mortality following the pandemic of SARS-CoV-2 and especially in 2021, a finding similar to ours. Harrison mentioned that for the week ending December 10th 2021 – just at the early stage of the Omicron surge, there were excess non-COVID deaths from “all-causes” when compared to the average of the previous five years [18].

The Office for National Statistics (ONS) reported on COVID-19 registered deaths (week ending 17 December 2021), that for England and Wales, 1,650 more deaths (15% excess mortality rate) were recorded in the week compared to the 2015-2019 year average [19]. As reported by WHO, there were 9.49 million more deaths than those globally reported as directly attributable to COVID-19 in the 24 months between 1 January 2020 and 31 December 2021 [20]. In addition, Msemburi, et al. estimated globally, for the period of January 2020 to December 2021, 14.83 million excess deaths with an uncertainty interval (UI) of 13.23 million to 16.58 million, which is 2.74 (UI 2.44 to 3.06) times higher than the 5.42 million COVID-19 deaths reported to the WHO for this period [21]. Karlinsky and Kobak, after collecting all-cause mortality data from 103 countries and territories, openly available as the regularly updated World Mortality Dataset, concluded that the excess mortality was above the expected annual mortality [22]. Moreover, a systematic review and meta-analysis, with a total of 79 countries from twenty studies conducted by Shang et al. between 1 January 2020 and May 2022, showed that the pooled global excess mortality was 104.84 deaths per 100,000, and that the number of reported all-cause deaths was higher than the expected deaths during the global pandemic [23]. Furthermore, an estimated 1,159,580 excess deaths occurred in the United States during the first two years of the pandemic from March 2020 through February 2022 (first: 620,872; second: 538,708) [24].

As far as associated concerns regarding the vaccination campaign, Schmeling et al. examined rates of Suspected Adverse Effects (SAEs) between different BNT162b2 mRNA (Pfizer-BioNTech) vaccines batches administered in Denmark from 27 December 2020 to 11 January 2022. It is worrisome that three predominant trend lines were discerned, with noticeable lower SAE rates in larger vaccine batches and additional batch-dependent heterogeneity in the distribution of SAE seriousness between the batches representing the three trend lines [25]. Rancourt, et al. studied seventeen equatorial and Southern-Hemisphere countries, which comprise of 9.1% of the world population, 10.3% of worldwide SARS-CoV-2 vaccine doses (vaccination rate of 1.91 injections per person for all ages), and virtually every vaccine type and manufacturer that spanned 4 continents. Unprecedented peaks in all-cause mortality occurred between January and February of 2022 in the Southern Hemisphere, and in equatorial-latitude countries, which are seen in parallel with the rapid vaccine-booster-dose rollouts (3rd or 4th doses). This phenomenon is present in every case with sufficient mortality data (15 out of 17 countries) [26] highlighting the concerns that the vaccination campaign may have contributed to this worldwide observed excess mortality requiring further detailed investigation.

Our findings should be interpreted in the light of study limitations. Our study is based on secondary data analyses and is subject to limitations of available databases. However, the sources of data used in our study are publicly available databases from official government sources. We were unable to explore the etiologies of the documented excess mortality due to lack of access to detailed death certificates. We call for official authorities to share information on diagnoses and causes of death from corresponding death certificates in order to further explore the underlying causes of these troublesome increased mortality findings. Another limitation is that the reported COVID-19 deaths might be either under- or over-diagnosed due to testing and reporting challenges, or due to higher than expected mortality occurring from other causes and/or health-behavior changes (e.g. changes in nutrition, drug and alcohol use) or reduced access to health care and other essential services [27]. It is also worth mentioning that the SARS-CoV-2 pandemic induced pressures on the health care system causing adverse effects on the accessibility and quality of non-COVID-19 care that could contribute to this worldwide observed excess mortality. During the pandemic, several observations included persistently worsened performance and longer waiting times in emergency departments; drastically limited access to specialist care; notably delayed or inaccessible diagnostic services; and acutely undermined access to and quality of provided cancer care [28,29]. Furthermore, researchers have reported that strict lockdowns could have contributed to excess mortality due to the associated impact on individual and collective basis [30].

In summary, we have observed a significant increase in the total all-cause mortality in Cyprus, particularly during the third and fourth quarters of 2021 and the first quarter of 2022 in parallel to the vaccination campaign. Owing to this worrying observation, there is a need for a detailed and comprehensive investigation of the underlying causes of the observed excess mortality in order to address these dire consequences with appropriate public health measures and policies.

Conclusion

Official statistics on reported COVID-19 deaths represent only a partial but necessary picture of the true burden of associated mortality. Excess mortality due to the COVID-19 pandemic, is a crucial measure of the true toll of the pandemic. Excess mortality in Europe has been identified as an important indicator for assessing additional deaths and complementing other health indicators followed by the European Statistical Recovery Dashboard. Based on our findings, we conclude that excess mortality occurs in unprecedented levels in the general population of Cyprus. We believe that it is of paramount importance to conduct similar studies at the European level and across different European countries in order to further evaluate the excess mortality documented among European populations. Furthermore, access to detailed death certificates needs to be made available to researchers in order to

investigate the direct consequences of the COVID-19 pandemic and identify the potential underlying causes leading to this concerning and unexplained excess mortality.

Author Contributions

Conceptualization: Elpidoforos S. Soteriades, Demetris Avraam, Eleftheria C. Economidou

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Formal analysis: Demetris Avraam, Nikolaos Markou

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Methodology: Demetris Avraam, Nikolaos Markou, Kyriakos Prokopi

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Resources: Demetris Avraam, Nikolaos Markou, Kyriakos Prokopi

Software: Demetris Avraam, Nikolaos Markou

Supervision: Elpidoforos S. Soteriades, Demetris Avraam

Validation: Elpidoforos S. Soteriades, Demetris Avraam

Visualization: Nikolaos Markou, Kyriakos Prokopi

Writing – original draft: Eleftheria C. Economidou

Writing – review & editing: All authors

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Conflict of Interest: None

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