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ORIGINAL ARTICLE

Impact of COVID-19 on Mortality in the Canton of Sarajevo in Period 2020-2022

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Abstract

Background/Aim: Until March 2023, it has been reported over 676 million cases of COVID-19 globally with almost 7 million deaths caused by this disease. Aim of this study was to determine COVID-19-related deaths and to study how COVID-19 pandemic impacted mortality of residents in the Canton of Sarajevo in 2020-2022 time period. Also, aim was to analyse to what extent the number of registered non-COVID-19-related deaths have changed in the Canton of Sarajevo compared to what would have been expected in the absence of the virus to better measure the impact of COVID-19.

Methods: This study used mortality data obtained from Federal Institute for Statistics for period 2017-2022. Data was analysed and presented as raw numbers, age-, sex-, cause of death - crude death rates (CDR), excess mortality and P-score.

Results: CDR in the Canton of Sarajevo in 2020 was 1246.3 per 100.000 persons, 1488.6 in 2021 and 1153.4 in 2022, while in period from 2017-2019 CDR ranged from 1051.3 to 1057.9. Total CDR in 2020 increased by 18.3 % compared to 2017-2019 average CDR, this relative difference being even greater in 2021 (41.3 %) and lower in 2022 (9.5 %). In 2020-2022 time period, 9 of the 10 leading causes of death remained the same as in 2019. COVID-19 was the 3rd leading cause of death in 2020 and 2022, while in 2021 spiked as the leading cause of death. In 2020 there was increase of 7 % in deaths from non-COVID-19 related deaths compared to mean number of deaths for period 2017-2019. As for 2021, this number goes higher (9.5 %) and in 2022 was much lower (1.0 %).

Conclusion: In the Canton of Sarajevo, COVID-19 pandemic made a big impact on mortality in 2020-2022 years period. Data have changed in total mortality, leading causes of death and excess mortality. Deep-rooted organisational weaknesses that were exposed during pandemic that can bring harm to population from preventable chronic diseases needs to be addressed which have impact on morbidity and at the end, on mortality.

Key words: Mortality; COVID-19; Crude death rate; Excess mortality.

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Introduction

Until 10th March 2023, it has been reported over 676 million cases of COVID-19 globally with almost 7 million deaths caused by this disease.[1] In Bosnia and Herzegovina, the death count has reached more than 16,000 people, while over 400,000 people have been diagnosed with COVID-19 as of the same date.[1] It is obvious that the SARS-CoV-2 virus has claimed many lives, while there is possibility that some COVID-19 patients may have died without being diagnosed or had false negative test on COVID-19.

It is quite difficult to assess the data on deaths attributed to COVID-19. The main problem for researchers is not confirmed cases but ones whose death is caused by several pathological states interconnected with COVID-19. Besides, positive COVID-19 test is not enough to determine the cause of death, as some patients may die while infected with SARS-CoV-2 virus and not having serious clinical manifestation of disease.

On the other hand, this "once in a lifetime" situation that was last seen 100 years ago during Spanish flu, might be causing additional health problems or exacerbation of current ones. Some deaths may have occurred due to limited access to health care during the pandemic because main part of healthcare system was redirected to diagnose and care for COVID-19 patients. Hospital capacities were stretched to their limits and many non-life-threatening conditions weren't treated. There was a lack of maintenance of chronic illnesses like diabetes and chronic heart diseases because primary healthcare facilities were overburdened with COVID-19 patients, while chronic patients were fearful to visit their primary physician or to call 911 during an emergency, such as a heart attack or stroke.[2] Of course, there is also reasonable possibility that some of the COVID-19 deaths could be due to other causes and not COVID-19.[3]

There are reports of increase of death rates in many countries during the COVID-19 pandemic as well as shortening of life expectancy at birth.[4, 5] USA study reported that the death rate in USA in 2020 jumped nearly 17 % compared to 2019 and this is the biggest increase in more than a century since the Centers for Disease Control and Prevention has been tracking this data.[4] Also, it was found that COVID-19 mortality figures in USA underestimate the actual death toll and that COVID-19 mortality is likely to be twice as high as reported.[5]

As the health care system in Bosnia and Herzegovina is characterised by extreme fragmentation considering the fact that the system is organised in various ways in the Federation of B&H, the Republic of Srpska and Brčko District, the response to COVID-19 pandemic was lacking in many ways. In terms of the organisational structure and management, this system generally operates through 13 completely different sub-systems at the level of entities, cantons (one of them being the Canton of Sarajevo) and Brčko District, which significantly complicates the way health care services are provided, increases management and coordination costs and adversely affects the rationality of management of healthcare institutions. During pandemic these problems were heighten as there was no national response to COVID-19 and every previously mentioned fragmented part of health care system had its own risk management plan, own guidelines and own crisis response team, which in summary could worsen the outcomes for rescuing lives.

The aim of this paper was to determine COVID-19-related deaths and to study how COVID-19 pandemic impacted mortality of residents in the Canton of Sarajevo in period 2020-2022. Also, aim was to analyse to what extent the number of registered non-COVID-19-related deaths have changed in the Canton of Sarajevo compared to what would have been expected in the absence of the virus to better measure the impact of COVID-19.

Methods

Type of study and data collection

This descriptive retrospective study used mortality data obtained from Federal Institute for Statistics for years 2017-2022. Data was extracted on 5 June 2023 with accordance to Federal laws and in cooperation with Federal Institute for Statistics as main public institution of Federation of Bosnia and Herzegovina for mortality data collection and distribution. Data used in this study was obtained as electronical databases and values included in these datasets were final and could not be changed in later times. Data were reported by gender, age group, regions/cantons and main cause of death.

Age groups used in this study were: 0–14, 15–64, ≥ 65 as for males and females. As aim of this study was analysis of deaths of residents of the Canton of Sarajevo, only region used from these datasets was the Canton of Sarajevo as integral part of Federation of Bosnia and Herzegovina.

Federal Institute for Statistics Mortality Database included data from Statistical reports of death that were filled for every deceased person in Federation of Bosnia and Herzegovina by doctor coroner, specially educated to recognise main cause

of death. All coroners in Federation of Bosnia and Herzegovina were working in concurrence with international guidelines for certification and classification (coding) of COVID-19 as cause of death formulated by World Health Organization (WHO) as well as others causes of death defined by WHO.[6] All causes of death were reported as International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) codes.

Statistical analysis

Excess mortality was estimated by subtracting the number of deaths in 2020, 2021, 2022 and average number of deaths from pre-COVID-19 period 2017-2019. A similar approach has been used in studies of Swedish and German researches.[7,8]

This approach was also strengthened as crude death rates (CDR) during period 2017-2019 were stable and there was no significant difference in CDR during this period. Exact and the average number of deaths were used for the three previous years as a control group, which also helped smooth out any short-term spikes. As raw number of excess deaths did not provide a sense of scale and it was difficult to compare with other regions and countries, for better comparisons across regions and countries, excess mortality was measured as the percentage difference between the reported and projected number of deaths (P-score) as used by other researchers.[9] P-score was calculated as:

$$\text{P-score} = [(\text{Reported deaths} - \text{Projected deaths}) / \text{Projected deaths}] \times 100$$

The total number of deaths (of any cause) was used as well as the number of COVID-19-related deaths, in order to calculate the number of deaths that were not officially associated to COVID-19 in excess death count. To asses statistical significance Pearson Chi square test was used. The accepted statistical significance was at $p < 0.05$. All calculations were made in software IBM SPSS 21 (IBM Corp, Armonk, NY, USA).

Results

In three-year period 2020-2022, there were 16,334 deaths in the Canton of Sarajevo (5,254 in 2020, 6,241 in 2021 and 4,839 in 2022). Number of deaths of female residents was 8,097 and male residents 8,237. During 3-year period 2016-2019 there were total of 13,262 deaths of residents of the Canton of Sarajevo (4,400 in 2017, 4,437 in 2018, 4,425 in 2019). Average number of deaths in the Canton of Sarajevo during period 2017-2019 was 4,421 ± 19 while in period 2020-2022 was 5,445 ± 720. There was 25.4 % increase in number of deaths in 2020-2022 period compared to average number of deaths in 2017-2019. Detailed view of number of deaths in the Canton of Sarajevo is shown in Figure 1.

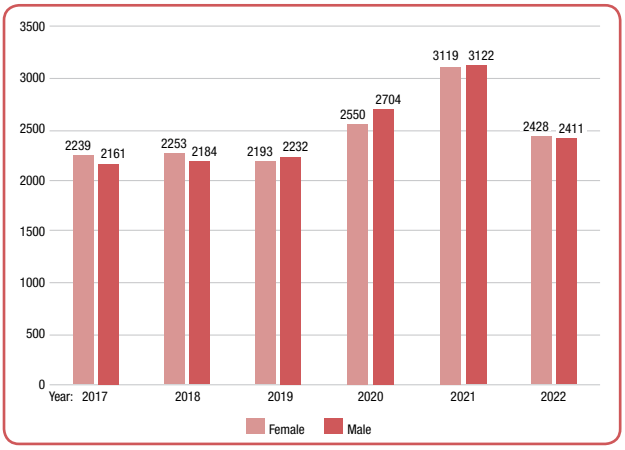

Figure 1: Number of deaths in the Canton of Sarajevo in period 2017-2022, by sex

Impact of COVID-19 on CDR, total and by sex

Figure 2 presents the relative changes in CDR when comparing COVID-19 pandemic period with the years prior to COVID-19 in the Canton of Sarajevo. CDR in the Canton of Sarajevo during COVID-19 pandemic was 1246.3, 1488.6 and 1153.4 per 100.000 persons in 2020, 2021 and in 2022, respectively, while in period from 2016-2019 CDR ranged from 1051.3 (2017) to 1057.9 (2018).

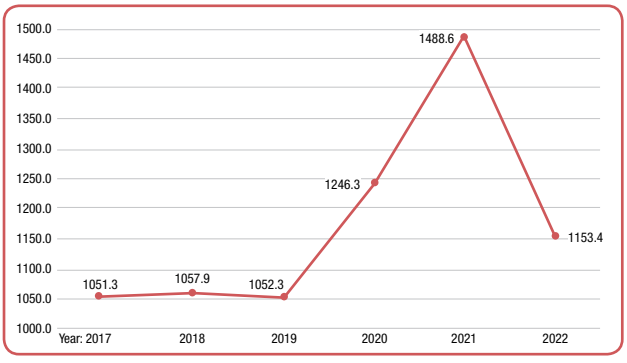

Figure 2: Crude death rates (CDR) per 100,000 people in the Canton of Sarajevo, 2017-2022

The observed CDR in 2020 increased by 18.3 % compared to 2017-2019 average CDR (1053.8 ± 3.6); this relative difference was greater for women (23.8 %) than for men (22.7 %) but with no significant difference ($p > 0.05$). In 2021, this increase had spiked due to large number of registered deaths. CDR increased in 2021 compared to 2017-2019 was 41.3 %, 47.8 % for women and 42.4 % for men. As seen from Table 1, CDR increased in 2022 compared to 2017-2019 average CDR was much lower and it was 9.5 % overall (10.1 % for men and 14.5 % for women).

Table 1: Summary of changes in crude death rates (CDR) comparing 2020-2022 to average CDR in 2017-2019, total and by sex

Year	CDR (%)		
	Total	Men	Women
2017-2019 (mean ± SD)	1053.8 ± 3.6	1106.2 ± 18.3	1007.0 ± 14.2
2020	18.3	22.7	23.8
2021	41.3	42.4	47.8
2022	9.5	10.1	14.5

%: CDR change compared to 2017-2019 average;

Age-specific CDR in period 2020-2022 compared to 2017-2019 average

Comparing 2020-2022 period with 2017-2019 average, CDR increased in every year for age groups 15-64 and ≥ 65 (Table 2). One exception was reported in 2022 for age group 15-64 with CDR decline of -3.2 %. Biggest reported CDR increase was 35.5 %, reported in 2021 for age group ≥ 65. Smallest reported CDR increase was 3.7 %, reported in 2022 for age group ≥ 65. As seen from Figure 3, every year in 2022-2022 period had CDR decline for age group 0-14, as in these years occurred smaller number of infant deaths compared to 2017-2019 period in the Canton of Sarajevo, as infant deaths make the majority in number of deaths in age group 0-14.

Table 2: Summary of changes in crude death rates (CDR) comparing period 2020-2022 to 2017-2019 average, by age groups

Year	CDR (%)			
	Total	0-14 years	15-64 years	≥ 65 years
2017-2019 (mean ± SD)	1053.8 ± 3.6	68.2 ± 9.4	333.6 ± 10.5	5046.8 ± 116.6
2020	18.3	-18.2	12.6	12.9
2021	41.3	-49.1	29.0	35.5
2022	9.5	-20.0	-3.2	3.7

%: CDR change compared to 2017-2019 average;

Age-specific CDR for age groups 15-64 and ≥ 65 had changed significantly in 2020 and 2021 compared to 2017-2019 average ($p < 0.05$). As for 2022, there was no significant change in CDR comparing it to 2017-2019 average ($p > 0.05$).

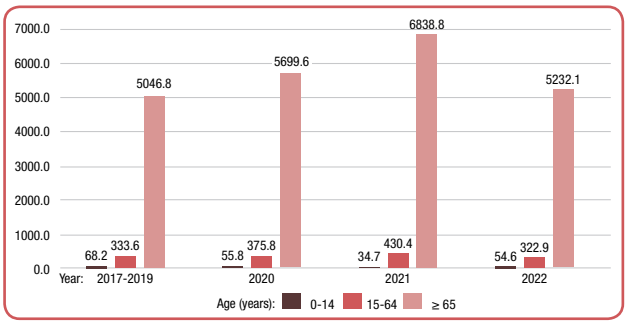

Figure 3: Crude death rates (CDR) for period 2017-2019, 2020, 2021 and 2022, by age groups

Changes in CDR for the 10 leading causes of death

For the analysis of leading causes of death, comparison was made only with 2019, as comparation with other years would be too excessive. Other reasoning for this was that 10 leading causes of death in period 2017-2019 were almost the same with some causes switching positions on the chart.

In years 2020-2022, 9 of the 10 leading causes of death remained the same as in 2019 (Figure 4). As seen from the Figure 4, most causes of death were diseases of the circulatory system. COVID-19 was newly emerged cause of death in 2020-2022, becoming the 3rd leading cause of death in 2020 and 2022 and spiking as number one cause of death in 2021 with more than doubled CDR in comparison to number two cause of death in 2021 (CDR 333.9 for COVID-19 compared to CDR 156.5 for chronic ischaemic heart disease). Of the remaining 10 leading causes of death in 2022, 2021, 2020 and 2019, all were the same, some swapping places on the chart. Excluding COVID-19, in these four years, first five places as causes of death dominantly held these five diseases: chronic ischaemic heart disease, cerebral infarction, myocardial infarction, diabetes mellitus and malignant neoplasm of bronchus and lung. Hypertension, atherosclerosis, cardiomyopathy and chronic obstructive pulmonary disease (COPD) hold, in all these analysed years, bottom four leading causes on the charts of 10 leading causes of death in the Canton of Sarajevo. Analysing death rates for the 10 leading causes of death while comparing pandemic years to 2019, can be seen that there was significant correlation between increase of total CDR and COVID-19 deaths ($p < 0.05$), as COVID-19 being main reason for this increase.

Excess mortality in 2020-2022

The differences in number of deaths between

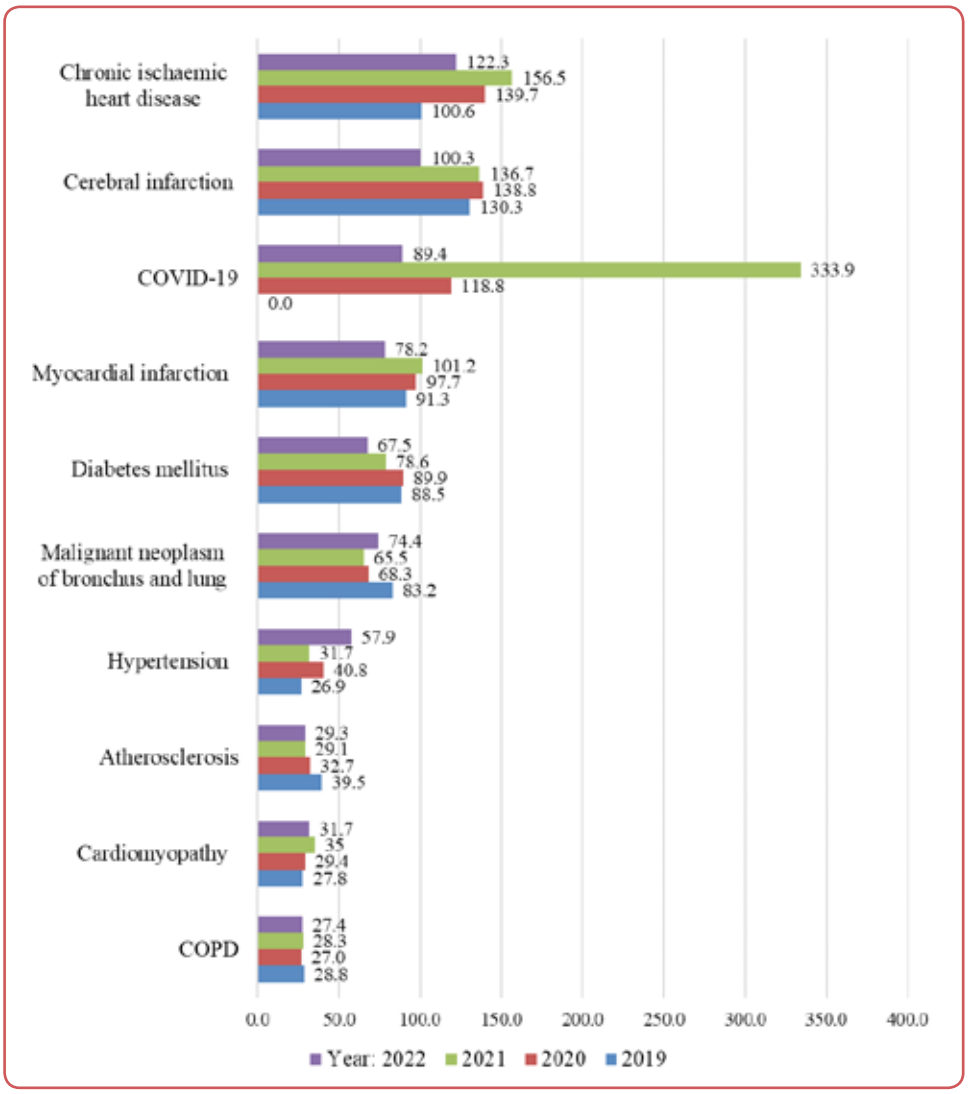

Figure 4: Death rates for the 10 leading causes of death in the Canton of Sarajevo, 2019 - 2022

COPD: Chronic obstructive pulmonary disease;

Table 3: P-score values, number of deaths and difference in number of deaths

Year	N	P-score	Difference	N (COVID-19)
2020	5,245	18.8	+824	+824
2021	6,241	41.2	+1,820	+1,820
2022	4,839	9.5	+418	+418

N: number of deaths; N (COVID-19): number of registered deaths caused by COVID-19; Difference: Difference in number of deaths compared to 2017-2019 mean;

2022 (4,839), 2021 (6,241), 2020 (5,245) and previous three-years mean (4,421) for the Canton of Sarajevo were 418, 1820 and 824, respectively. P-score in 2020 was 18.8 indicating that mortality in 2020 was almost 19 % higher than the mean value for the previous 3 years in the Canton of Sarajevo. Analysing 2021, P-score gets staggeringly high with 41.2 % higher mortality compared to 2017-2019. P-score in 2022 was much lower, with 9.5 % higher mortality compared to 2017-2019 (Table 3).

There were more non-COVID-19 related deaths in 2020-2022 compared to mean number of deaths in 2017-2019, so excess death count cannot be contributed only to COVID-19. There were more than 7 % more deaths from non-COVID-19 related deaths in 2020 compared to mean number of deaths for period 2017-2019. This percentage was even higher for 2021 (9.5 %), while for 2022 was much lower (1.0 %) and it can be stated that there were no non-COVID-19 related excess deaths in 2022.

*Table 4: Death rates and number of deaths for 5 leading causes of death by ICD-10 chapters in 2022, 2021, 2020 and 2019**

	2022		2021		2020		2019	
ICD-10 chapter	**N**	**CDR**	**N**	**CDR**	**N**	**CDR**	**N**	**CDR**
Diseases of the circulatory system	2,071	493.6	2,331	555.1	2,281	541.1	2,000	475.6
Neoplasms	1,141	272.0	1,181	281.2	1,157	274.5	1,195	284.2
Endocrine, nutritional and metabolic diseases	321	76.5	347	82.6	379	89.9	374	88.9
Diseases of the respiratory system	179	42.7	201	47.9	221	52.4	204	48.5
Diseases of the digestive system	109	26.0	121	28.8	127	30.1	111	26.4

** Only excluded chapter was codes for special purpose (U00-U99) as leading cause of death by ICD-10 chapters which was only composed of COVID-19 deaths. N: Number of deaths; CDR: crude death rates.*

As seen from the Table 4, the biggest increase of CDR by chapters in ICD-10 in 2020 and 2021 compared to 2019 was in chapter "diseases of circulatory system". There were 2,281 deaths caused by circulatory diseases in 2020 and 2,331 in 2021 compared to 2,000 in 2019. Increase of CDR for this group of diseases was 13.8 % in 2020 and 16.6 % in 2021 compared to 2019 and the difference was statistically significant ($p < 0.05$). There was no statistically significant change of CDR for other chapters including neoplasms, endocrine, nutritional and metabolic diseases, diseases of the respiratory system and diseases of the digestive system in 2020 and 2021 compared to 2019.

Discussion

The definite consequences that COVID-19 pandemic had on mortality, not only in 2020-2022 years period but years that follow and its impact on other aspects of life will be known after many studies and research. However, by analysing age and sex-specific death rates for all-cause mortality during 2020-2022 and previous years, a perception can be made of the mortality burden. This analysis showed that in 2020-2022 period total mortality in the Canton of Sarajevo increased, as for male and female citizens. There was increase in total CDR ranged from 9.5 – 41.3 % compared to years 2017–2019. In 2020 in USA was registered 16.8 % CDR increase compared to 2019.[4] In Switzerland CDR was 8.8 % higher in 2020 than in 2019.[10] This increase was larger for women than for men in the Canton of Sarajevo.

It has been argued that the pandemic affected the frailest and the oldest the most and in such case it would be expected that the biggest increase in CDR would be in age group ≥ 65. This was the case in the Canton of Sarajevo, where this happened in all three analysed years. If absolute numbers were analysed, most deaths occurred in age group ≥ 65, from all causes, as well as from COVID-19. But most indicative for this assumption is CDR, where biggest CDR increase was reported in age group ≥ 65. Comparing 2020-2022 period with previous years, for age group 15-64 CDR increase ranged from -3.2 to +29.0 %, while these numbers ranged from +3.7 to 35.5 % for age group ≥ 65. These results correspond with results found in analysis of USA mortality in 2020 where biggest increases in CDR were reported in older age groups.[4]

In 2020-2022, 9 of the 10 leading causes of death remained the same as in 2019. Excluding COVID-19, in these four years, first five places as causes of death dominantly hold same five diseases: chronic ischaemic heart disease, cerebral infarction, myocardial infarction, diabetes mellitus and malignant neoplasm of bronchus and lung. There was CDR increase of diseases of the circulatory system in 2020-2022. Similar changes reported Murphy et al in their study in USA.[4] It must be added that COVID-19 infection provokes elevated troponin values in 20–30 % of hospitalised COVID-19 patients that may aggravate clinical outcomes of patients with preexisting diseases of the circulatory system.[11] Both direct and indirect effects of infection with SARS-CoV-2 have been proposed to underlie these adverse cardiovascular effects and significantly increase the burden of morbidity and mortality related to COVID-19.[12] These could be reasons why an in-

crease of CDR of diseases of the circulatory system during pandemics was noted. COVID-19 became the 3rd leading cause of death, newly added as a cause of death in 2020 and 2022, while in 2021 was leading cause of death, spiking in death chats with CDR of 333.9. It was expected that this number would be this staggering in 2021 as during third COVID-19 pandemic wave in February, March and April of 2021 was noticed the biggest spike in COVID-19 death count.

Analysing excess mortality, P-score in 2020-2022 ranged from 9.5 to 41.2 indicating that mortality in 2020 and 2021 was much higher than the mean value of the previous three years in the Canton of Sarajevo. This score was by far the highest in Latin America: Peru (153 %), Bolivia (68 %) and Mexico (61 %), while in Europe these numbers were lower.[13]

Confirmed COVID-19 deaths accounted for about 60.8 % of the excess mortality in 2020 observed. These numbers went higher for 2021 and 2022 (77.3 % and 89.7 %, respectively). The remaining percentage represented excess mortality from non-COVID-19-related causes of death. This data might represent an increase of deaths from other causes as an indirect consequence of the pandemic, eg due to restriction of healthcare resources, treatments and/or surgeries, or a changed behaviour of seeking medical care for severe conditions. But some of these death cases could have been people with false negative COVID-19 tests or people dying from COVID-19 and not being previously tested. Unfortunately, during 2020, especially in first half of the year, in Bosnia and Herzegovina testing was scarce as there were lack of access to large number of tests. On the other hand, some of the COVID-19 deaths could be due to other causes and not COVID-19.[3]

Official data in this study reported increase of 7 % in deaths from non-COVID-19 related deaths in 2020 compared to mean number of deaths for period 2017-2019. As for 2021 this number was higher (9.5 %) and in 2022 was much lower (1.0 %). Main part of this increase can be associated with increase of number of deaths caused by circulatory and hearth diseases. Considering pathophysiology of COVID-19 and its effects on cardiovascular system that have been shown in studies of Cheng et al as well as Mitrani et al, this increase could be expected.[11, 12] On the other hand, in 2020-2022 CDR for neoplasms decreased compared to 2019. This kind of effect on mortality caused by COVID-19 was also reported in study of USA mortality in 2020.[4] The reasoning behind this could be because the mortality rate of COVID-19 was high in cancer patients and cause of death for these patients was mainly reported as COVID-19 infection and not cancer, consequently decreasing numbers for neoplasm mortality.[14, 15] In non-pandemic circumstances deaths of these patients would be associated to cancers and neoplasm mortality rates would be higher.

Conclusion

In the Canton of Sarajevo, COVID-19 pandemic made a big impact on mortality in 2020-2022 years period. Data has changed dramatically in total mortality, leading causes of death and excess mortality. In 2023, we are comprehending how big of an impact COVID-19 pandemic had on population of the Canton of Sarajevo in 2020-2022 and the consequences the pandemic will eventually have later on demographics. Predicting long-term impacts requires caution, but the abrupt and extensive reprioritisation of healthcare services, that happened during last three years, might have consequences on health status of general population. Deep-rooted organisational weaknesses that were exposed during pandemic needs to be addressed that can bring harm to population from preventable chronic diseases which will have impact on morbidity and at the end, on mortality. Similar estimates of age-, sex- and cause of death- specific death rates as well as excess mortality data from other countries are necessary to be able to do properly compare the impact of COVID-19 on mortality in the Canton of Sarajevo.

Ethics

This study was a secondary analysis based on the currently existing database from the Federal Institute for Statistics and did not directly involve human participants or experimental animals. Therefore, the ethics approval was not required for this paper.

Acknowledgement

None.

Conflicts of interest

The authors declare that there is no conflict of interest.

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Data access

The data that support the findings of this study are available from the corresponding author upon reasonable individual request.

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Data curation: AŽ
Writing - original draft: DA, AŽ
Writing - review and editing: DA, AŽ
Visualisation: DA
Project administration: DA

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