

DOI: 10.5455/msm.2024.36.4-9

Received: Jan 20 2024; Accepted: Feb 25, 2024

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ORIGINAL PAPER

Mater Sociomed. 2024; 36(1): 4-9

OHCA in Bosnia and Herzegovina: Before and During the COVID-19 Pandemic

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ABSTRACT

Background: Out-of-hospital cardiac arrest (OHCA) refers to the cessation of mechanical cardiac activity outside healthcare facilities which requires prompt intervention and intensive resuscitative efforts. The COVID-19 pandemic has caused significant disruptions to OHCA systems-of-care, adversely affecting every component of the chain of survival. **Objective:** The objective of this study was to examine the potential impacts of the COVID-19 pandemic on OHCA events, to draw comparisons between the period before and during the COVID-19 pandemic. **Methods:** This cross-sectional study encompassed data pertaining to all OHCA incidents attended to by the Emergency Medical Service of Canton Sarajevo, covering the period from January 2017 to December 2022, before and during the COVID-19 pandemic. **Results:** During observed period, a total of 1418 [796 (56.1%) before and 622 (43.9%) during COVID-19 pandemic] OHCA events have occurred in Canton Sarajevo of which 297 (20.9%) [180 (12.7%) before and 117 (8.2%) during COVID-19 pandemic] obtained ROSC. After a 30-day period following the ROSC) it was observed that the predominant outcome, accounting for 181 (12.7%) [106 (7.4%) before and 75 (5.2%) during COVID-19 pandemic] of cases, was a complete recovery. An examination before and during COVID-19 pandemic revealed a decline in OHCA during the year 2021 and 2022 when COVID-19 pandemic was at its highest in the country Being younger, quicker EMT response time and individuals with the initial rhythm of VF or VT were significantly associated with obtaining ROSC ($p < 0.05$). Only 48 (3.3%) of 1418 OHCA events were assisted by bystanders There was no report of AED use-

age. **Conclusion:** In conclusion, our investigation highlights the impact of the COVID-19 pandemic on OHCA events in Canton Sarajevo, revealing a decrease in OHCA incidence and a reduction in cases achieving ROSC. Notably, EMT response time was shorter during the pandemic.

Keywords: CPR, heart arrest, out-of-hospital cardiac arrest, return of spontaneous circulation, COVID-19.

1. BACKGROUND

Out-of-hospital cardiac arrest (OHCA), ranked as the third leading cause of global mortality, refers to the cessation of mechanical cardiac activity outside healthcare facilities which requires prompt intervention and intensive resuscitative efforts. The primary cause of OHCA is attributed to cardiac causes primarily coronary artery disease (1) and non-cardiac factors such as trauma, drowning, burns, asphyxia, or intoxication (2). Notably, it affects over 350,000 individuals annually in the European region (2) and has a variable survival rate depending on the region, with a European average of 11.7% (3).

The COVID-19 pandemic has caused significant disruptions to OHCA systems-of-care, adversely affecting every component of the chain of survival (4). According to a recent systematic review, there has been a 120% increase in the incidence of OHCA and a 65% decrease in the odds of survival to hospital discharge during the pandemic compared to previous years (5). Globally, the pandemic has hindered the efficient delivery of OHCA care, leading to longer ambulance response times, heightened use of personal protective equip-

ment by responders and clinicians, limited dispatch of community volunteers, first responders, and bystanders, as well as mandated restrictions on aerosol-generating clinical procedures during intra-arrest situations (4-6). Social restrictions have resulted in fewer instances of OHCA in public, diminishing bystander interventions such as public access defibrillation. These disruptions to the chain of survival have particularly impacted the care of patients who experience OHCA before the arrival of EMT. However, there is less understanding of the effects of the COVID-19 pandemic on patients who experience cardiac arrest in the presence of EMT clinicians (7, 8).

2. OBJECTIVE

The objective of this study was to examine the potential impacts of the COVID-19 pandemic on OHCA events, to draw comparisons between the period before and during the COVID-19 pandemic and to compare the results of this study to the previous Bosnia and Herzegovina OHCA studies.

3. MATERIAL AND METHODS

Patients and study design

This retrospective cross-sectional study encompassed patients and data associated with all OHCA events in Canton Sarajevo, attended to by the Emergency Medical Service of Canton Sarajevo from January 2017 to December 2022. The study period was categorized into two intervals: January 2017 to December 2019, representing the period before the COVID-19 pandemic, and January 2020 to December 2022, corresponding to the COVID-19 pandemic period. The research obtained approval from the Ethical Committee of the Emergency Medical Service of Canton Sarajevo and followed all revisions of the Helsinki Declaration.

The study included individuals with OHCA treated by the Emergency Medical Service of Canton Sarajevo. Exclusion criteria were (i) insufficient or missing medical documentation and (ii) cases solely transferred between medical institutions without receiving treatment from the Emergency Medical Service of Canton Sarajevo.

Methods

The extensive dataset utilized in this study was carefully gathered from the official protocols maintained by the Emergency Medical Service of Canton Sarajevo, covering the substantial timeframe from January 2017 to December 2022. This repository of information encompassed a variety of essential variables, such as demographic details of the patients, including gender and age, offering a nuanced comprehension of the affected population. The geographical setting of each OHCA event was analyzed, categorizing the location as either urban or rural. Furthermore, the temporal aspect was examined, capturing the exact arrival time of the EMT.

Variables related to bystanders, including their relationship to the victim and the extent of their involvement in providing assistance, were also a central focus of the data collection. This aspect provided insights into the profiles of individuals present at the scene during OHCA incidents and the data regarding whether AEDs were de-

ployed during the emergency response. This provided valuable insights into the prevalence and effectiveness of this life-saving technology in the context of OHCA cases. Furthermore, data on all interventions administered by the EMT, including direct current cardioversion (DC) shock, epinephrine administration, usage of amiodarone, and the implementation of endotracheal intubation, were gathered.

Statistical analysis

The collected data were summarized and analyzed using descriptive statistics. For normally distributed data, frequencies and percentages were used and mean with standard deviation. Not normally distributed data were represented by the median and interquartile range. Relationships between variables were explored using appropriate tests such as independent samples t-test, Mann-Whitney U test, or chi-squared test, with a significance level set at $p < 0.05$ (two-sided) for robust findings.

4. RESULTS

During the period from January 2017 to December 2022, a total of 1418[796 (56.1%) before and 622 (43.9%) during COVID-19 pandemic] OHCA events have occurred in Canton Sarajevo of which 297(20.9 %)[180 (12.7%) before and 117 (8.2%) during COVID-19 pandemic] obtained ROSC, whereas 1121(79.1 %)[616 (43.4%) before and 505 (56.6%) during COVID-19 pandemic] were unsuccessful resuscitations. There was no statistical difference ($\chi^2=3.04$, $p>0.05$) in occurrence of ROSC and unsuccessful resuscitation before and during COVID-19 pandemic.

After a 30-day period following the ROSC) it was observed that the predominant outcome, accounting for 181(12.7%)[106 (7.4%) before and 75(5.2%) during COVID-19 pandemic] of cases, was a complete recovery. However, on the unfortunate side, 116(8.1%)[74 (5.2%) before and 42(2.9%) during COVID-19 pandemic] of patients, did not survive during this period. An examination before and during COVID-19 pandemic revealed a decline in OHCA during the year 2021 and 2022 when COVID-19 pandemic was at its highest in the country with respect to gender, emergency medical team (EMT) response time, and bystander involvement, as indicated in **Table 1**.

Patients undergoing OHCA resuscitations were predominantly males, 985(69.5 %)[540 (38.0%) before and 445(31.3%) during COVID-19 pandemic], of which 216(15.2%) [126 (8.8%) before and 90(6.3%) during COVID-19 pandemic] for ROSC and 769(54.2%)[414 (29.2%) before and 355(25.0%) during COVID-19 pandemic] for unsuccessful resuscitations. COVID-19 pandemic didn't affect gender-related differences [$\chi^2=2.34$, $p>0.05$ for females and $\chi^2=1.37$, $p>0.05$ for males] in OHCA events regarding ROSC and unsuccessful resuscitations in Canton Sarajevo compared to the period before the COVID-19 pandemic.

Most patients were categorized in >65 years age group 736(51.9%)[419 (29.5%) before and 317(22.4%) during COVID-19 pandemic] and 45-65 years age group 547(38.6%) [302(21.3%) before and 245(17.3%) during COVID-19 pandemic]. Being younger (age group <65 years) was signifi-

Variable	Before COVID-19 pandemic			COVID-19 pandemic			Total (1418)	p-value	
	2017 (287)	2018 (284)	2019 (225)	2020 (246)	2021 (159)	2022 (217)			
Male/Female (No; %)									
ROSC	41(14.2)/ 20(6.9)	39 (13.7)/24 (8.4)	46 (20.4)/10 (4.4%)	28(11.3)/ 10(4.0)	23(14.4)/ 5(3.1)	39(17.9)/ 12(5.5)	216 (15.2)/ 81(5.7)	>0.05	
Unsuccessful resuscitation	154 (54.7)/ 72(24.2)	141 (49.6)/80 (28.3)	119(52.8)/ 50(22.4)	142 (57.7)/ 66(27.0)	94(59.1)/ 37(23.4)	119 (54.8)/ 47 (21.6)	769 (54.2)/ 352 (24.9)		
ROSC outcomes (No, %)									
Complete recovery	35 (12.2)	32 (11.2)	39 (17.3)	30 (12.1)	26 (16.3)	19 (8.7)	181 (12.7)	N/A	
Death	26 (9.0)	31 (11.1)	17 (7.5)	8 (3.2)	2 (1.2)	32 (14.7)	116 (8.1)		
Response time (median, 25 th ,75 th percentile) (minutes)									
ROSC	5.0 (2.0; 7.0)	3.0 (0.0; 6.0)	3.0 (0.0; 5.0)	1.0 (0.0; 5.0)	2.0 (0.0; 6.0)	2.0 (1.0; 4.0)	2.0 (0.0; 5.0)	<0.05	
Unsuccessful resuscitation	7.0 (3.0; 9.0)	6.0 (3.0, 9.0)	4.0 (2.0; 7.0)	6.0 (3.0; 7.0)	5.0 (3.0, 8.0)	6.0 (3.0; 7.0)	6.0 (3.0;7.0)		
Initial rhythm (No, %)									
ROSC	Asystole/ PEA	19 (6.6)	22 (7.7)	9 (4.0)	10 (4.0)	8 (5.0)	6 (2.7)	74 (5.2)	<0.001
	VF/VT	42 (14.6)	37 (13.0)	38 (16.8)	31 (12.6)	26 (16.3)	49 (22.5)	223 (15.7)	
Unsuccessful resuscitation	Asystole/ PEA	176 (61.4)	185 (65.1)	135 (60.0)	153 (62.1)	81 (50.9)	107 (49.3)	837 (59.0)	
	VF/VT	50 (17.4)	40 (14.2)	43 (19.2)	52 (21.3)	44 (27.8)	55 (25.5)	284 (20.1)	
Bystander involvement (No; %)									
ROSC	3 (1.0)	3 (1.0)	5 (2.2)	2 (0.8)	4 (2.5)	2 (0.9)	19 (1.3)	N/A	
Unsuccessful resuscitation	7 (2.4)	3 (1.0)	8 (3.5)	4 (1.6)	5 (3.1)	2 (0.9)	29 (2/0)		

Table 1. Gender, ROSC outcome, emergency medical team (EMT) response time, initial rhythm and bystanders' involvement in out-of-hospital cardiac arrest (OHCA) events in Canton Sarajevo before and during COVID-19 pandemic in the comparison of return of spontaneous circulation (ROSC) group and unsuccessful resuscitations. N/A, not applicable; PEA-pulseless electrical activity; VF-ventricular fibrillation, VT-ventricular tachycardia without pulse

cantly associated with obtaining ROSC, when older age group (>65 years) was compared between ROSC group and unsuccessful resuscitation ($X^2=3.91$, $p<0.05$).

The EMT's median response time was 4.0(3.0;7.0). In instances where ROSC occurred, the median response time was 2.0(0.0;5.0), whereas for unsuccessful resuscitations, it was 6.0 (3.0; 7.0). A quicker response time showed a significant association with achieving ROSC compared to unsuccessful resuscitations ($p<0.05$). All 1418(100.0%) OHCA events during the observed period occurred in the urban area of Canton Sarajevo.

After initial contact with the dispatch of Emergency Medical Department of Canton Sarajevo, only 48(3.3%) of 1418 OHCA events were assisted by bystanders. Bystanders were mostly medical professionals (medical doctors, medical technicians and emergency medical technicians), 30(62.5%) or close family members, 18(37.5%). Automated external defibrillator usage was not documented in OHCA incidents before and during the COVID-19 pandemic.

The predominant initial rhythms in OHCA were mostly asystole or pulseless electrical activity (PEA) accounting for 911 (64.2%)[546(38.5%) before and 365(25.7%) during COVID-19 pandemic] patients with 74(5.2%) [50(3.5%) before and 24 (1.7%) during COVID-19 pandemic] instances with ROSC and 837 (59.0%) [496 (34.9%) before and 341 (24.1%) during COVID-19 pandemic]with

unsuccessful resuscitations. On the other hand, only 507(35.8%)[250 (17.6%) before and 257 (18.2%) during COVID-19 pandemic] patients presented with an initial rhythm of ventricular fibrillation (VF) or ventricular tachycardia without a pulse (VT) from which 223 (15.7%) [117 (8.2%) before and 106(7.5%) during COVID-19 pandemic] achieved ROSC and 284(20.1%)[133 (9.3%) before and 151(10.7%) during COVID-19 pandemic] were unsuccessful resuscitations. There were no statistical differences in occurrence of asystole and PEA ($X^2=0.88$, $p>0.05$) and VF or VT ($X^2=1.58$, $p>0.05$) among patients before and during the COVID-19 pandemic, however, individuals whose initial rhythm was VF or VT demonstrated a significantly higher likelihood ($X^2=252.9$, $p<0.001$) of achieving ROSC. All other data regarding gender, ROSC outcome, emergency medical team (EMT) response time, initial rhythm and bystanders' involvement in OHCA events in Canton Sarajevo before and during COVID-19 pandemic are presented in Table 1.

During the observed period in Canton Sarajevo, the treatment of OHCA, included direct current cardioversion (DC shock) in 486 (34.3%) [243 (17.1%) before and 243 (17.1%) during COVID-19 pandemic] from which 208 (14.6%) [113 (7.9%) before and 95 (6.7%) during COVID-19 pandemic] achieved ROSC. Epinephrine was administered in all OHCA events 1418 (100.0%), with 297 (20.9%) [167 (11.7%) before and 130 (9.2%) during COVID-19 pan-

Variable	Before COVID-19 pandemic			COVID-19 pandemic			Total (1418)	p-value	
	2017 (287)	2018 (284)	2019 (225)	2020 (246)	2021 (159)	2022 (217)			
DC shock Yes/No (No; %)									
ROSC	42 (14.6)/ 0 (0.0)	36(12.6)/ 1(0.3)	35 (15.5)/ 3(1.3)	31(100.0)/ 0(0.0)	20(12.5)/ 6(3.0)	44(20.2)/ 5(2.3)	208 (14.6)/ 15 (1.0)	N/A	
Unsuccessful resuscitation	50 (17.4)/ 0 (0,0)	37(13.0)/ 3(0.9)	43(100)/ 0(0.0)	52(100.0)/ 0(0.0)	41(25.0)/ 3(1.5)	55(100.0)/ 0(0.0)	278 (19.6)/ 6 (0.4)		
Epinephrine usage (No, %)									
ROSC	1 ampule	0 (0.0)	0 (0.0)	18 (8.0)	3 (1.2)	2 (1.2)	4 (1.8)	27 (1.9)	<0.001
	2 ampules	8 (2.7)	26 (9.1)	7 (3.1)	2 (0.8)	3 (1.8)	6 (2.7)	52 (3.6)	
	3 ampules	15 (5.2)	11 (3.8)	3 (1.3)	3 (1.2)	5 (3.0)	5 (2.3)	42 (2.9)	
	>3 ampules	38 (13.9)	22 (7.7)	19 (8.4)	33(13.4)	24 (15.0)	40 (18.4)	176 (12.4)	
Unsuccessful resuscitation	1 ampule	10 (3.4)	4 (1.4)	31 (13.7)	9 (3.6)	10 (6.2)	13 (5.9)	77 (5.4)	
	2 ampules	15 (5.2)	13 (4.5)	7 (3.1)	4 (1.6)	14 (8.8)	17 (7.8)	70 (4.9)	
	3 ampules	36 (12.5)	30 (10.5)	32 (13.8)	15 (6.0)	13 (8.1)	33 (15.2)	159 (11.2)	
	>3 ampules	165 (57.5)	178 (62.7)	108 (48.0)	177 (72.2)	88 (55.9)	99 (45.6)	815 (57.4)	
Amiodarone usage (No, %)									
ROSC	150mg	7 (2.4)	9 (3.1)	13 (5.7)	9 (3.6)	5 (3.1)	10 (4.6)	53 (3.7)	>0.05
	300mg	15 (5.2)	11 (3.8)	8 (3.5)	4 (1.6)	7 (4.4)	12 (5.5)	57 (4.0)	
	450mg	10 (3.4)	5 (1.7)	9 (4.0)	6 (2.4)	8 (5.0)	15 (6.9)	53 (3.7)	
Unsuccessful resuscitation	150mg	5 (1.7)	8 (2.8)	9 (4.0)	4 (1.6)	9 (5.6)	14 (6.4)	49 (3.4)	
	300mg	5 (1.7)	1 (0.3)	7 (3.1)	7 (2.8)	8 (5.0)	11 (5.0)	39 (2.7)	
	450mg	17 (5.9)	10 (3.5)	4 (1.8)	2 (0.8)	11 (6.9)	15 (6.9)	59 (4.1)	
Endotracheal intubation Yes/No (No, %)									
ROSC	25 (8.7)	27 (9.5)	18 (8.0)	10 (4.0)	14 (8.8)	25 (11.5)	119 (8.3)	N/A	
Unsuccessful resuscitation	103 (35.9)	46 (16.1)	106 (47.1)	58 (23.5)	43 (27.0)	54 (24.8)	410 (28.9)		

Table 2. Treatment modalities such as DC shock, epinephrine and amiodarone usage and endotracheal intubation in out-of-hospital cardiac arrest (OHCA) events in Canton Sarajevo before and during COVID-19 pandemic in the comparison of return of spontaneous circulation (ROSC) group and unsuccessful resuscitations. N/A-non applicable, DC shock-direct current cardioversion shock

demic] achieving ROSC and 1121 (79.1%) [629 (44.3%) before and 492 (34.8%) during COVID-19 pandemic] cases experiencing unsuccessful resuscitation. There was no difference in epinephrine administration between ROSC and unsuccessful resuscitation before and during COVID-19 pandemic ($X^2=0.0013$, $p>0.05$), however more epinephrine is administered in the group where resuscitation efforts were not successful ($X^2=20.1$, $p<0.001$).

Amiodarone was used in 310 cases (21.8%) [153(10.7%) before and 157(11.1%) during COVID-19 pandemic], leading to ROSC in 163 (11.5%) [87(6.1%) before and 76(5.4%) during COVID-19 pandemic] cases and unsuccessful resuscitation in 147(10.3%) [66(4.6%) before and 81(5.7%) during COVID-19 pandemic] cases. There was no difference in amiodarone administration between ROSC and unsuccessful resuscitation before and during COVID-19 pandemic ($X^2=0.72$, $p>0.05$).

Endotracheal intubation was performed in 529(37.3%) [325(22.9%) before and 204(14.4%) during COVID-19 pandemic] cases, resulting in ROSC in 119(8.3%) [70(4.9%) before and 49(3.4%) during COVID-19 pandemic] cases and unsuccessful resuscitation in 410(29.0%) [255(17.9%) before and 155(11.1%) during COVID-19 pandemic] cases. Further information regarding treatment aspects, encompassing administered DC shocks, utilization of epinephrine and amiodarone, as well as instances of endotracheal intubation, is presented in Table 2.

5. DISCUSSION

This study explores current OHCA patterns in Bosnia and Herzegovina, analyzing diagnostic and therapeutic approaches before and during the COVID-19 pandemic. In the observed period, our study revealed 20.9% of ROSC, while 79.1% resuscitation attempts were unsuccessful. The occurrence of ROSC and unsuccessful resuscitations, the outcome following ROSC, gender disparities, the initial rhythm during OHCA, and treatment modalities were not influenced by the COVID-19 pandemic. However, a decline in OHCA events especially during the year 2021 was noticed. Younger age, swifter EMT response times, and an initial rhythm of VF or VT were identified as factors linked to the attainment of ROSC. We also documented a critically low bystanders participation and no AED usage before and during COVID-19 pandemic.

Compared to the first study (9), this study showed less ROSC achievement, similar bystanders' involvement, similar factors associated with achieving ROSC (age, EMT response time, initial rhythm) and a decline in OHCA events, especially in year 2021, the peak of COVID-19 pandemic in the country. The variation noted, decrease in achieving ROSC, could be associated with alterations in the underlying causes of cardiac arrest incidents such as respiratory failure attributed to COVID-19 infections (10-12). Furthermore, the decline in the number of OHCA events during the COVID-19 pandemic could be because

patients avoided seeking necessary medical attention during this period due to COVID-19 restrictions, fear and anxiety accompanied with the disease and the stigma towards the infected (13, 14).

In comparison to the EuReCA ONE study (15), the mean OHCA incidence was 57/100,000 inhabitants, indicating a lower rate than that observed in neighboring countries such as Croatia, Serbia and Slovenia. Again the study showed that the ROSC rate among OHCA cases was lower than the European average, but among the highest in the region of West Balkan, (15) Compared to the European average, this discrepancy could be linked to low bystander involvement in OHCA events and insufficient availability and distribution of AEDs (9). A variable that demonstrated significant variation and exerted a considerable influence on the outcome of OHCA was the response time of EMT. The prompt response by EMT has the potential to be a pivotal factor contributing to a positive overall survival rate for OHCA in our nation.

Our study's findings on the impact of the COVID-19 pandemic on the incidence and outcomes of OHCA events are consistent with parallel research (16), indicating a notable influence of the pandemic on OHCA incidence and outcome. The COVID-19 pandemic was associated with a reduction in the number of ROSC cases, aligning with similar research (17). Some authors have attributed this decrease to prolonged transportation, delayed administration of epinephrine (17) and constrained hospital capacities, as the surge in COVID-19 cases has led to overcrowded intensive care units, potentially resulting in prolonged hospital admission, which may contribute to these events. We noted, also, a reduced median EMT response time, a contrast to findings in other studies. (18-20) This variance might be attributable to the presence of pre-prepared COVID-19 response teams within the Canton Sarajevo EMT which required no extra time for personal protective equipment (PPE) readiness. Additionally, the limited movement imposed by government measures decreased traffic congestion, potentially contributing to the observed shorter response times.

Our study didn't find a significant difference in the proportion of cases with an initially shockable rhythm and are in accordance with a similar study (16). Conversely, some studies have reported a decrease in the number of OHCA presenting with an initially shockable rhythm during the pandemic period (18-20), probably because hypoxic respiratory failure due to COVID-19 is less likely to exhibit a shockable rhythm (21, 22).

Our study revealed a concerning pattern marked with a low level of bystander involvement in CPR and AEDs utilization before and during the COVID-19 pandemic which contrasts with the European average AED usage rate of 50.0% (15). Factors contributing to this trend include inadequate knowledge about basic life support (BLS), uncertainty among individuals regarding appropriate CPR circumstances, lack of prior training in both BLS and AED usage, and an underdeveloped AED network with suboptimal distribution (23, 24). Expanding and improving the AED network is essential to meet the demand and enhance overall survival rates for OHCA events, moving

closer to the European average (25).

Our research faced several limitations. First, the cross-sectional design of the study hinders our capacity to establish causation. Second, the data obtained from Emergency Medical Service Protocols lacked specific details about bystanders' educational backgrounds and their actions during the EMT response to the OHCA event. To mitigate these limitations, future studies should be undertaken prospectively, incorporating a more extensive dataset (26-37).

6. CONCLUSION

Our investigation highlights the impact of the COVID-19 pandemic on OHCA events in Canton Sarajevo, revealing a decrease in OHCA incidence and a reduction in cases achieving ROSC. Notably, EMT response time was shorter during the pandemic. The factors influencing OHCA outcomes in our population align with those observed in the European context. However, a noteworthy concern arises from the limited bystander involvement and minimal utilization of AEDs during the study period.

- **Author's contribution:** Every author participated in every stage of preparing this article. Data sampling was conducted by A.Š., A.A., A.M. and V.L. Data processing, coding and initial descriptive data analysis was done by A.Š., I.M., E.K., M.R. The statistical analysis was done by A.Š. and I.M. The initial draft was written by A.M., A.A., E.M and I.M. Critical revision was conducted by A.A., V.L and I.M. The final proofreading was approved by all authors.
- **Conflict of interest:** None to declare.
- **Financial support and sponsorship:** None.

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