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Clinical paper

Epidemic of the SARS-CoV-2 Omicron variant in Shanghai, China in 2022: Transient and persistent effects on Out-of-hospital cardiac arrests

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Abstract

Objective: To investigate transient and persistent effects of the Shanghai Omicron epidemic in 2022 on the incidence, characteristics, and outcomes of out-of-hospital cardiac arrest (OHCA).

Methods: This retrospective study examined electronic records of patients admitted to the Shanghai Emergency Medical Center during five periods: pre-epidemic, 1 January 2018 to 31 December 2019; low COVID-19 incidence, 1 January 2020 to 27 March 2022; Omicron epidemic, 28 March to 31 May 2022; early post-epidemic, 1 June to 31 July 2022; and late post-epidemic, 1 August to 30 September 2022. Clinicodemographic characteristics and outcomes of OHCA cases were compared between the pre-epidemic and other periods.

Results: A total of 55,104 OHCAs were included. The monthly number of OHCAs in the Omicron epidemic was 2.1 times the number in the pre-epidemic (1702 *vs* 793), while the number in the early post-epidemic was 1.9 times the number in the pre-epidemic (1515 *vs* 793). Compared to the pre-epidemic, OHCA during or after the epidemic was more likely to involve individuals with hypertension, coronary artery disease, heart failure or stroke. The probability that circulation would spontaneously resume after OHCA was significantly lower during the epidemic than before it (aOR 0.61, 95% CI 0.41–0.90; P = 0.012). However, this difference disappeared by the early post-epidemic.

Conclusion: The monthly number of OHCAs doubled during the Omicron epidemic in Shanghai, and it remained elevated for another two months. OHCA affected individuals with cardiovascular and cerebrovascular diseases more during and after the epidemic than before it.

Keywords: Out-of-hospital cardiac arrest, COVID-19, Omicron variant, Epidemic

Introduction

The global pandemic of coronavirus disease 2019 (COVID-19) is probably the most severe public health crisis of the 21st century, and the continuing mutation of the causative virus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), creates uncertainty about how the pandemic will develop.[1] First reported in South Africa in November 2021,[2] the Omicron variant of SARS-CoV-2 has become the predominant strain globally. It contains a large number of mutations in the spike glycoprotein on the viral surface, which make it more transmissible and better at evading immune responses than previously reported variants.[1,3,4] While studies have suggested that the Omicron variant is less pathogenic than other variants,[5,6] it continues to cause high rates of mortality among the elderly,[7] and even low mortality rates can translate to numerous deaths when large proportions of the population are infected.

Research suggests that during the COVID-19 pandemic prior to the spread of the Omicron variant, the incidence of out-of-hospital cardiac arrest (OHCA) increased substantially, as did the risk that OHCA would lead to death.[8] These appear to be not only direct effects from virus infection but also indirect effects of the pandemic and controlling measures, which include exacerbation of chronic conditions due to interrupted primary care,[9,10] psychosocial and

Abbreviations: COVID-19, Coronavirus Disease 2019, COPD, Chronic Obstructive Pulmonary Disease, CPR, Cardiopulmonary Resuscitation, EMS, Emergency Medical Services, OHCA, Out-of-hospital Cardiac Arrest, ROSC, Return of Spontaneous Circulation, SARS-CoV-2, Severe Acute Respiratory Syndrome Coronavirus 2

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economic stresses,[11] longer response time in the EMS system,[12,13] reduced willingness from bystanders and EMS physicians to conduct cardiopulmonary resuscitation (CPR),[14–17] delayed evaluations and treatments at hospitals,[18] reluctancy to seek emergency care due to fear of infection and travel ban,[19,20] etc.

It is unclear whether the increased risk of OHCA and poor outcomes after it continue in the current phase of the pandemic, in which the less pathogenic Omicron variant is by far the predominant strain. We addressed this question here using data collected before, during and after a well-defined epidemic outbreak of the Omicron variant in Shanghai, China. In late February 2022, the BA.2 subvariant of the Omicron variant entered the community from a quarantine hotel and triggered an outbreak,[21,22] leading the government to lock down the city's 25 million residents for 65 days from 28 March 2022 until 31 May 2022.[23] By the end of the lockdown, the number of severe COVID-19 cases had been brought under control. Therefore, we compared the incidence and outcomes of OHCA before, during, and after the lockdown, as well as the clinicodemographic characteristics of individuals who suffered OHCA during these periods. The case of Shanghai allows for uniquely rigorous real-world analysis of the effects of the Omicron variant because the zero-COVID policy of the Chinese government allows us to eliminate many confounders that affect the disease epidemiology in other countries with more permissive COVID policies.

Methods

Study design and data source

This retrospective study was carried out and reported in compliance with the "Strengthening the reporting of observational studies in epidemiology" (STROBE) guidelines.[24] All data came from the database of the Shanghai Emergency Medical Center, which is the only Emergency Medical Services (EMS) system in downtown Shanghai serving approximately-one third of the city's population. The records contain information on clinicodemographic characteristics and outcomes of OHCA cases, which were registered by EMS physicians in concordance with Utstein-style reporting templates.[25] The data quality in this database is regularly evaluated by a Department of Quality Control. The present study was approved by the Ethics Commission of Shanghai Emergency Medical Center, which waived the requirement for informed consent because the study was retrospective and reported only anonymized medical data.

Shanghai Emergency Medical Center, first established in 1951, provides highly qualified prehospital emergency care 24 hours a day for citizens in downtown Shanghai.[26] By the end of 2022, it has more than 1,300 employees, 54 dispatch centers, and more than 400 ambulances. Each ambulance is equipped with a medical suitcase including common drugs and supplies, a monitor, a ventilator, a defibrillator, a stretcher, and other medical devices. A team of 3 personnel, including an EMS physician, a driver, and a staff, will arrive at the scene to provide emergency care within 12 minutes after emergency call activation. The EMS team is capable to conduct CPR, intravenous administration of epinephrine, and tracheal intubation. During each dispatch, information on ambulance responding, patient demographics, OHCA characteristics, medications, and interventions, will be recorded through a mobile device into electronic chart, profile of which is designed according to Utstein-style guidelines.[25] Outcomes of OHCA will be obtained by EMS physicians and confirmed by staff in the Department of Quality Control through feedback from hospitals and family members of OHCA patients. Because of administrative requirements, OHCA patients are first served by EMS physicians in Shanghai. Therefore, the cases in the EMS system represent most of OHCA's total number.

Study population

All patients in the database who were diagnosed with OHCA from 1 January 2018 to 30 September 2022 were included in our analysis, except those for whom data were missing, such as data about sex, age, initial cardiac rhythm or outcomes. Based on official timeline of the Shanghai Omicron epidemic[23] and the aim of our analysis, the entire time interval was divided into five periods: pre-epidemic, 1 January 2018 to 31 December 2019; low COVID-19 incidence, 1 January 2020 to 27 March 2022; Omicron epidemic, 28 March to 31 May 2022; early post-epidemic, 1 June to 31 July 2022; and late post-epidemic, 1 August to 30 September 2022.

During the epidemic period, the entire city was strictly locked down. People were required to stay home and all food or medicines were provided by volunteers and administrative staff in the community. Nucleic Acid Amplification Test (NAAT) or Rapid Antigen Test (RAT) was performed every other day. Those who were confirmed with SARS-CoV-2 infection were transferred to Fangcang shelter hospitals or professional hospitals for observations and treatments. By 31 May 2022, reported cases of confirmed COVID-19 and asymptomatic infections had returned to low levels, and so from 1 June, social activities resumed and people were able to travel. They were required to wear masks and keep social distance.

Data collection

For all five periods, data were collected on patient clinicodemographics, including sex (male/female), age (year), and age group (<65, 65–79 years, or 80+ years); as well as comorbidities, including hypertension, coronary artery disease, atrial fibrillation, heart failure, chronic obstructive pulmonary disease, asthma, respiratory failure, stroke, diabetes, hepatic insufficiency, renal insufficiency, cancer, mental illness, and polymerase chain reaction (PCR)-confirmed SARS-CoV-2 infection. Data were also collected on the characteristics of OHCA, including where it occurred (residence, nursing home, public place), whether bystanders attempted cardiopulmonary resuscitation (CPR), whether initial cardiac rhythm was non-shockable or shockable, whether the cause of cardiac arrest was non-medical or medical, how long it took emergency medical services (EMS) to arrive at the scene after answering the telephone call for help, and whether emergency physicians performed CPR, defibrillation or endotracheal intubation, or whether these treatments were refused by the individual's family. Outcomes of OHCA were recorded as out-of-hospital death, transport with CPR, or return of spontaneous circulation (ROSC).

Statistical analyses

All categorical data were reported as number (percentage) of patients. Continuous data were determined to be skewed based on the Kolmogorov-Smirov test and were therefore reported as median and interquartile range (IQR). A Pearson's Chi-square test was used to compare patient characteristics between the pre-epidemic period and other periods. Odds ratio (OR), with 95% confidence intervals (95% CI) was also calculated. Multivariate logistic regression was used to assess whether the Omicron epidemic or other specific factors were associated with ROSC. When appropriate, results from logistic regression were reported as adjusted odds ratios (ORs) and 95% confidence intervals (CIs). Results were considered statistically significant if $P < 0.05$. All statistical analyses were conducted using SPSS 22 (IBM, Chicago, IL, USA). Graphs were plotted using PRISM 7 (GraphPad, CA, USA).

Results

Between 1 January 2018 and 30 September 2022, 57,458 OHCA cases were entered into the database covering all seven districts of downtown Shanghai (Huangpu, Xuhui, Changning, Jing'an, Putuo, Hongkou, Yangpu). After excluding 2,354 patients because data were missing for their sex, age, EMS arrival time or initial cardiac rhythm, 55,104 patients were included in the final analysis, of whom 47.0% (25,887) were female and whose median age was 84 years (IQR 71–90 years). Exactly half of OHCAs (27559) occurred during the period of low COVID-19 incidence, 34.5% (19027) occurred before the Omicron epidemic, 6.2% (3403) occurred during it, and the remaining 9.3% (5115) occurred afterwards (Fig. 1 and Table 1).

Rates of out-of-hospital cardiac arrests

Before the Omicron epidemic, the monthly number of OHCAs was highest in January-February and lowest in July-August (Fig. 2**).** The number increased steadily since the first report of COVID-19 in January 2020 and peaked during the Omicron epidemic in April-May 2022. Across the five periods, the monthly number of OHCAs increased from 793 in the pre-epidemic period to 1021 in the period of low COVID-19 incidence, further increasing to 1702 during the Omicron epidemic period, and decreasing slightly to 1515 in the early post-epidemic period, and returning nearly to the pre-epidemic level in the late post-epidemic period (1043). In other words, the number of monthly OHCAs during the Omicron epidemic and soon afterward was approximately double the number before the epidemic.

Patient characteristics

A total of 227,936 SARS-CoV-2 infections were reported in downtown during the Omicron epidemic, accounting for one third of total infections in the whole city (Supplementary Fig. 1). However, only 20 (0.6%) OHCA patients were confirmed with SARS-CoV-2 infection during the Omicron epidemic, 21 (0.7%) in the early post-epidemic phase, and 5 (0.2%) in the late post-epidemic phase (Table 1**)**.

Compared to OHCA cases before the Omicron epidemic, those during and after the epidemic were older, and those during the epidemic were more likely to have hypertension, coronary artery disease or diabetes, while those during the early post-epidemic period were more likely to be female or to have stroke, hepatic insufficiency or mental illness (Table 1).

Several characteristics of OHCAs during the Omicron epidemic differed substantially from the characteristics of OHCAs during pre- or post-epidemic periods. OHCAs during the epidemic were most likely to occur in a nursing home, have a medical etiology, involve a wait of at least 12 min for EMS to arrive, involve refusal of the family for prehospital medical treatments, and have an outcome of death (Table 2). Conversely, OHCAs during the epidemic were least likely to occur at home or in a public place, end in ROSC or involve any of the following: CPR administered by a bystander or EMS physicians, shockable initial cardiac rhythm, or administration of defibrillation, endotracheal intubation, or transport with CPR.

These findings were supported by univariate analysis (Table 3). This analysis also showed that compared to OHCA patients during the pre-epidemic period, those during the epidemic and during the early post-epidemic period were significantly more likely to be female, to be over 65 years old, or to have hypertension, coronary artery disease, or stroke. Patients during the early post-epidemic period were also significantly more likely to have heart failure and hepatic insufficiency, but they were less likely to have asthma or renal insufficiency. Like OHCAs during the epidemic, those during the early post-epidemic period were more likely than those before the epidemic to occur in a nursing home and to involve refusal by family of prehospital medical treatments, and less likely to involve defibrillation or transport with CPR.

Significant differences and Odd ratios for most variables observed between pre-epidemic and early post-epidemic OHCA patients persisted into the late post-epidemic period, for example, age to be over 65 years, coronary artery disease, heart failure, stroke, asthma, location (nursing home), refusal of prehospital medical treatment by family, defibrillation, and transport with CPR (Table 3).

OHCA outcomes

Multivariate analysis showed that, after adjusting for patient characteristics and EMS arrival time, the Omicron epidemic was associated with lower likelihood of ROSC (OR 0.61, 95% CI 0.41–0.90; $P = 0.012$), whereas this likelihood returned to pre-epidemic levels by the early post-epidemic period (Table 4).

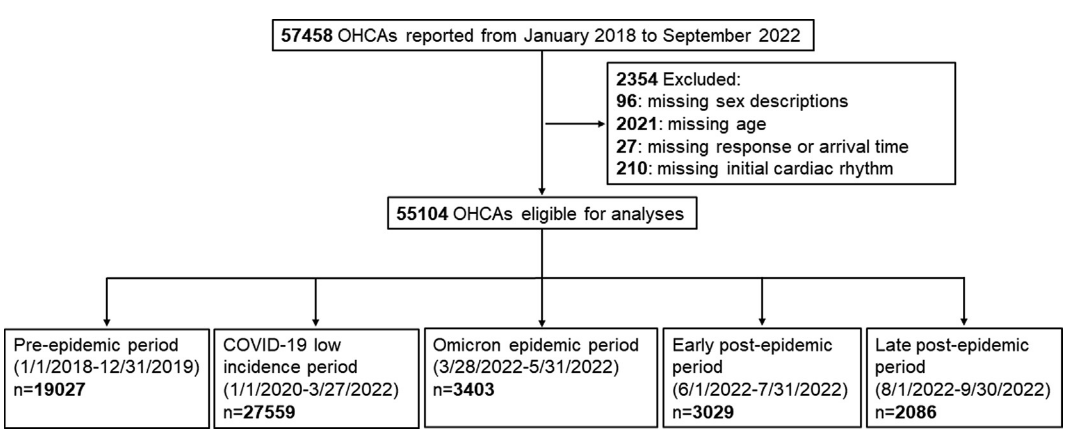

Fig. 1 – Study Flowchart.

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Table 1 – Clinicodemographic Characteristics of Individuals Who Suffered Out-of-hospital Cardiac Arrest, Stratified by Time Period.

Characteristic	Pre-epidemic	Low COVID-19 incidence	Omicron epidemic	Early post-epidemic	Late post-epidemic
n	19,027	27,559	3,403	3,029	2,086
Sex, female	8802 (46.3)	12,921 (46.9)	1657 (48.7)	1524 (50.3)	983 (47.1)
Age, yr	84 (70–90)	85 (72–91)	85 (73–91)	85 (73–91)	85 (71–91)
Comorbidities					
SARS-CoV-2 infection	-	0 (0)	20 (0.6)	21 (0.7)	5 (0.2)
Hypertension	6487 (34.1)	10,073 (36.6)	1351 (39.7)	1095 (36.2)	718 (34.4)
Coronary artery disease	1582 (8.3)	3670 (13.3)	474 (13.9)	400 (13.2)	286 (13.7)
Atrial fibrillation	157 (0.8)	318 (1.2)	39 (1.1)	28 (0.9)	12 (0.6)
Heart failure	636 (3.3)	1114 (4)	134 (3.9)	143 (4.7)	101 (4.8)
COPD	261 (1.4)	343 (1.2)	39 (1.1)	30 (1)	37 (1.8)
Asthma	322 (1.7)	362 (1.3)	56 (1.6)	31 (1)	15 (0.7)
Respiratory failure	121 (0.6)	148 (0.5)	16 (0.5)	14 (0.5)	7 (0.3)
Stroke	1109 (5.8)	2181 (7.9)	289 (8.5)	265 (8.7)	165 (7.9)
Diabetes	3187 (16.7)	4585 (16.6)	585 (17.2)	479 (15.8)	320 (15.3)
Hepatic insufficiency	12 (0.1)	43 (0.2)	5 (0.1)	7 (0.2)	1 (0)
Renal insufficiency	729 (3.8)	1025 (3.7)	120 (3.5)	93 (3.1)	85 (4.1)
Cancer	3385 (17.8)	4824 (17.5)	608 (17.9)	534 (17.6)	396 (19)
Mental illness	264 (1.4)	337 (1.2)	43 (1.3)	53 (1.7)	20 (1)

Data are n (%) or median (interquartile range).
COPD, chronic obstructive pulmonary disease; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

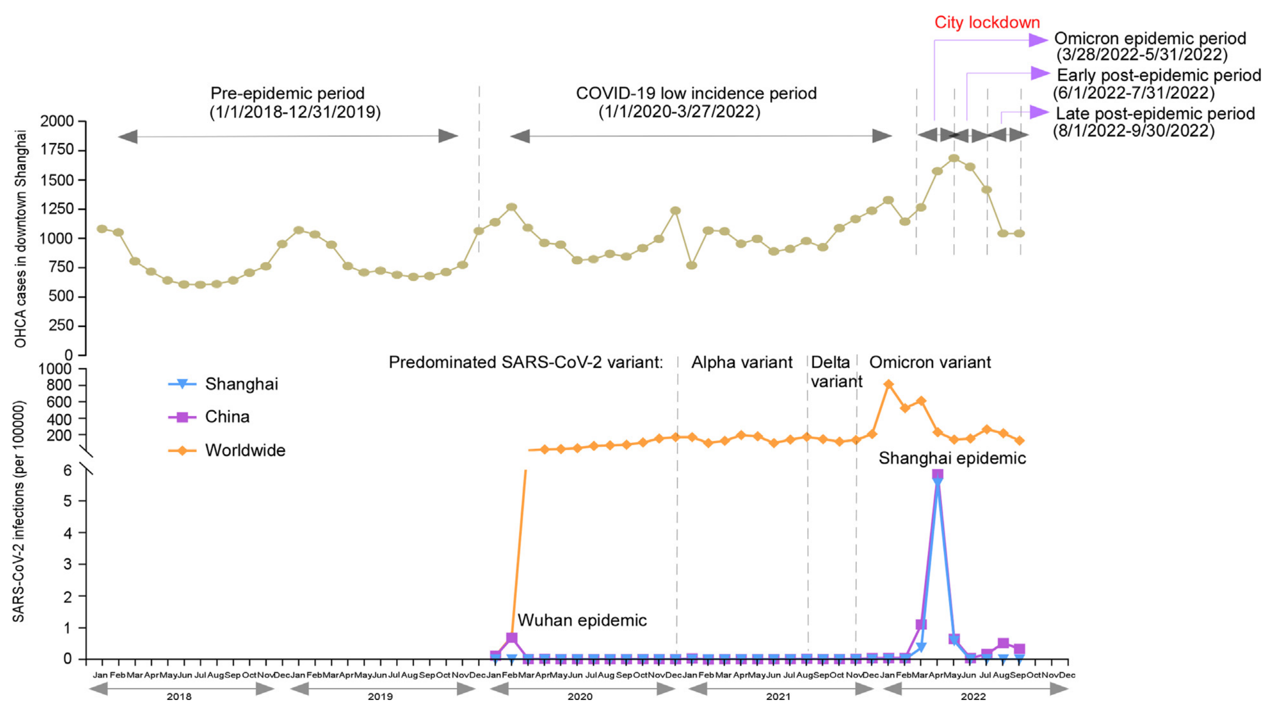

Fig. 2 – Correspondence Between Monthly OHCA Cases in Downtown Shanghai and Monthly SARS-CoV-2 Infections in Shanghai or in China or Worldwide From January 2018 to September 2022. Data on SARS-CoV-2 infections in Shanghai, in China, and Worldwide were collected and plotted based on public information from Shanghai Municipal Health Commission (acquired from: http://wsjkw.sh.gov.cn/yqtb/index.html), National Health Commission of the People's Republic of China (acquired from: http://www.nhc.gov.cn/xcs/yqtb/list_gzbd.shtml), and WHO Coronavirus (COVID-19) Dashboard (acquired from: https://covid19.who.int/), respectively.

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Table 2 – Characteristics and Outcomes of Out-of-hospital Cardiac Arrest, Stratified by Time Period.

Variable	Pre-epidemic	Low COVID-19 incidence	Omicron epidemic	Early post-epidemic	Late post-epidemic
n	19,027	27,559	3,403	3,029	2,086
Location					
Home or residence	15,514 (81.5)	21,572 (78.3)	2640 (77.6)	2405 (79.4)	1637 (78.5)
Nursing home	2819 (14.8)	5072 (18.4)	689 (20.2)	538 (17.8)	363 (17.4)
Public place	694 (3.6)	915 (3.3)	74 (2.2)	86 (2.8)	86 (4.1)
Bystander CPR	396 (2.1)	660 (2.4)	62 (1.8)	55 (1.8)	47 (2.3)
Initial cardiac rhythm					
Non-shockable	18,785 (98.7)	27,180 (98.6)	3387 (99.5)	3002 (99.1)	2052 (98.4)
Shockable	242 (1.3)	379 (1.4)	16 (0.5)	27 (0.9)	34 (1.6)
Etiology					
Non-medical	760 (4)	922 (3.3)	72 (2.1)	106 (3.5)	71 (3.4)
Medical	18,267 (96)	26,637 (96.7)	3331 (97.9)	2923 (96.5)	2015 (96.6)
EMS arrival time					
Absolute time, min	10 (7–14)	8 (6–11)	21 (13–40)	10 (8–13)	9 (7–11)
Time $\geq$ 12 min	7115 (37.4)	5783 (21.0)	2704 (79.5)	1091 (36.0)	486 (23.3)
CPR	3915 (20.6)	6805 (24.7)	605 (17.8)	660 (21.8)	409 (19.6)
Defibrillation	351 (1.8)	485 (1.8)	19 (0.6)	31 (1)	23 (1.1)
Endotracheal intubation	113 (0.6)	320 (1.2)	10 (0.3)	15 (0.5)	14 (0.7)
Refusal of prehospital medical treatments by family	2864 (15.1)	4277 (15.5)	757 (22.2)	595 (19.6)	355 (17)
Outcome					
Out-of-hospital death	16,824 (88.4)	24,828 (90.1)	3224 (94.7)	2791 (92.1)	1844 (89.9)
Transport with CPR	1792 (9.4)	2162 (7.8)	148 (4.3)	183 (6.0)	169 (8.1)
ROSC	411 (2.2)	569 (2.1)	31 (0.9)	55 (1.8)	42 (2.0)

Data are n (%) or median (interquartile range).

CPR, cardiopulmonary resuscitation; EMS, emergency medical services; ROSC, return of spontaneous circulation.

Discussion

To the best of our knowledge, this is the first report of transient and persistent impacts of the Omicron pandemic on OHCA characteristics and outcomes in a large city. The outbreak in Shanghai doubled the number of monthly OHCAs, and this increase continued for two months after the outbreak was brought under control through strict lockdown measures. OHCA during and after the Omicron epidemic in Shanghai was more likely to affect individuals with chronic cardiovascular or cerebrovascular disease. OHCA was less likely to end with ROSC during the epidemic. After the epidemic, OHCA patients still had obstacles to receive prehospital emergency treatments despite improvements in EMS response.

The doubling of cases during the Omicron epidemic in Shanghai with respect to the months before the epidemic is similar to the substantial increases in OHCA incidence reported in New York, Paris and London during the first months of the overall pandemic in 2020.[13,12,27] During the Omicron epidemic in Shanghai, OHCA incidence increased among individuals with hypertension, coronary artery disease or stroke, indicating high risk of OHCA among those with chronic cardiovascular disease or stroke. Consistently, studies in the US and UK found that during the overall SARS-CoV-2 pandemic, fewer individuals with acute coronary syndrome or stroke were admitted to hospital, but more of them suffered OHCA.[28–30] These observations suggest more concerns on individuals with cardiovascular or cerebrovascular disease in the pandemic.

Our study highlights negative effects of the Omicron epidemic that persisted even months after the epidemic was brought under control. The monthly number of OHCAs remained nearly as high as during the epidemic, which may reflect the distress induced by the epidemic and by the restrictive measures during lockdown. Such distress may help explain why OHCA incidence was higher among individuals with heart failure or hepatic insufficiency after the epidemic than during it. Another lingering effect of the epidemic was reduced use of prehospital emergency treatments such as defibrillation and CPR, even after EMS arrival time had returned to pre-epidemic levels. This may reflect fear among emergency responders of becoming infected with SARS-CoV-2, inadequate personal protective equipment and lack of vaccine protection.[14] Similarly, bystanders remained reluctant to perform CPR even after the epidemic, likely reflecting fear of infection.[15] Our results suggest that at least several months are needed to eliminate the negative effects of a SARS-CoV-2 outbreak, even a less pathogenic one, and of strict restrictive countermeasures.

In our study, only 0.6% of OHCA patients during the Omicron epidemic were confirmed to be infected with SARS-CoV-2, whose infection rate is lower than previously reported 4–5% in France and Italy in early 2020.[12,31] Therefore the increase in OHCA incidence during SARS-CoV-2 outbreaks appears to be due not to the virus but to

Table 3 – Univariate Comparisons for Patient Characteristics During Different Time Periods, With Respect to Before the Omicron Epidemic.

Characteristic	Omicron epidemic		Early post-epidemic		Late post-epidemic	
	OR (95% CI)	P-value*	OR (95% CI)	P-value*	OR (95% CI)	P-value*
Sex		0.009		< 0.001		0.453
Male	1 [Reference]		1 [Reference]		1 [Reference]	
Female	1.10 (1.03–1.19)		1.18 (1.09–1.27)		1.04 (0.95–1.13)	
Age group, yr		< 0.001		< 0.001		< 0.001
< 65	1 [Reference]		1 [Reference]		1 [Reference]	
65–79	1.71 (1.50–1.95)		1.67 (1.46–1.91)		1.37 (1.18–1.59)	
80 and older	1.72 (1.53–1.93)		1.56 (1.39–1.76)		1.25 (1.10–1.43)	
Comorbidities						
Hypertension	1.27 (1.18–1.37)	< 0.001	1.09 (1.01–1.19)	0.027	1.02 (0.92–1.12)	0.765
Coronary artery disease	1.79 (1.60–1.99)	< 0.001	1.68 (1.49–1.89)	< 0.001	1.75 (1.53–2.01)	< 0.001
Atrial fibrillation	1.39 (0.98–1.98)	0.065	1.12 (0.75–1.68)	0.578	0.70 (0.39–1.25)	0.224
Heart failure	1.19 (0.98–1.43)	0.079	1.43 (1.19–1.73)	< 0.001	1.47 (1.19–1.82)	< 0.001
COPD	0.83 (0.59–1.17)	0.292	0.72 (0.49–1.05)	0.088	1.30 (0.92–1.84)	0.140
Asthma	0.97 (0.73–1.29)	0.845	0.60 (0.42–0.87)	0.006	0.42 (0.25–0.71)	0.001
Respiratory failure	0.74 (0.44–1.25)	0.255	0.73 (0.42–1.26)	0.255	0.53 (0.25–1.13)	0.093
Stroke	1.50 (1.31–1.72)	< 0.001	1.55 (1.35–1.78)	< 0.001	1.39 (1.17–1.65)	< 0.001
Diabetes	1.03 (0.94–1.14)	0.527	0.93 (0.84–1.04)	0.199	0.90 (0.80–1.02)	0.101
Hepatic insufficiency	2.33 (0.82–6.62)	0.102	3.67 (1.44–9.33)	0.003	0.76 (0.10–5.85)	0.791
Renal insufficiency	0.92 (0.75–1.12)	0.390	0.80 (0.64–0.99)	0.040	1.07 (0.85–1.34)	0.584
Cancer	1.01 (0.91–1.11)	0.915	0.99 (0.89–1.09)	0.830	1.08 (0.97–1.22)	0.177
Mental illness	0.91 (0.66–1.26)	0.567	1.27 (0.94–1.70)	0.120	0.69 (0.44–1.09)	0.109
Location		< 0.001		< 0.001		0.003
Home or residence	1 [Reference]		1 [Reference]		1 [Reference]	
Nursing home	1.44 (1.31–1.58)		1.23 (1.11–1.36)		1.22 (1.08–1.38)	
Public place	0.63 (0.49–0.80)		0.80 (0.64–1.00)		1.17 (0.93–1.48)	
Bystander CPR	0.87 (0.67–1.14)	0.325	0.87 (0.66–1.16)	0.338	1.08 (0.80–1.47)	0.603
Initial cardiac rhythm		< 0.001		0.076		0.172
Non-shockable	1 [Reference]		1 [Reference]		1 [Reference]	
Shockable	0.37 (0.22–1.61)		0.70 (0.47–1.04)		1.29 (0.90–1.85)	
Etiology		< 0.001		0.193		0.188
Non-medical	1 [Reference]		1 [Reference]		1 [Reference]	
Medical	1.93 (1.51–2.46)		1.15 (0.93–1.41)		1.18 (0.92–1.51)	
EMS arrival time ≥ 12 min	6.48 (5.93–7.07)	< 0.001	0.94 (0.87–1.02)	0.146	0.51 (0.46–0.57)	< 0.001
CPR	0.84 (0.76–0.92)	< 0.001	1.08 (0.98–1.18)	0.126	0.94 (0.84–1.06)	0.298
Defibrillation	0.30 (0.19–0.48)	< 0.001	0.55 (0.38–0.80)	0.001	0.59 (0.39–0.91)	0.015
Endotracheal intubation	0.49 (0.26–0.94)	0.029	0.83 (0.49–1.43)	0.507	1.13 (0.65–1.97)	0.665
Refusal of prehospital medical treatment by family	1.62 (1.48–1.77)	< 0.001	1.38 (1.25–1.52)	< 0.001	1.16 (1.03–1.31)	0.018
Outcome		< 0.001		< 0.001		0.125
Out-of-hospital death	1 [Reference]		1 [Reference]		1 [Reference]	
Transport with CPR	0.43 (0.36–0.51)		0.62 (0.53–0.72)		0.85 (0.72–1.00)	
ROSC	0.39 (0.27–0.57)		0.81 (0.61–1.07)		0.92 (0.67–1.26)	

CI, confidence interval; COPD, chronic obstructive pulmonary disease; CPR, cardiopulmonary resuscitation; EMS, emergency medical services; OR, odds ratio; ROSC, return of spontaneous circulation.

* P-value is estimated using a Pearson's Chi-square test.

other factors. In Shanghai, the Omicron epidemic and lockdown severely affected the ability and willingness of individuals to seek emergency care. Most hospitals in the city closed to new admissions during the Omicron epidemic in order to prevent in-hospital transmission, and the EMS system was increasingly occupied with transferring and treating COVID-19 patients. As a result, in- and out-patients, especially those with chronic diseases, were less likely to receive timely medical care, as reported in Hong Kong for individuals with ST-segment–elevation myocardial infarction.[18] Furthermore, individuals who fell sick during the Shanghai outbreak may have been less likely to seek medical assistance because of movement restrictions and fear of infection in hospital.[19] Our findings highlight the importance of addressing the indirect negative effects of the pandemic and lockdown.

Limitations

Our analysis is limited by its retrospective design, during which mixed effects from government, health care providers, and patients themselves prevented us from assessing a specific factor on OHCA characteristics and outcomes. Our analysis is also limited because it did not include areas outside downtown Shanghai, yet our sample remained large enough to compare with other major cities such as

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Table 4 – Multivariate Logistic Regression to Reveal Associations of the Omicron Epidemic, Early or Late Post-pandemic Period With the Return of Spontaneous Circulation, Adjusted for Patient Characteristics and EMS Arrival Time.

Factor	Omicron epidemic		Early post-epidemic		Late post-epidemic	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Period*	0.61 (0.41–0.90)	0.012	0.93 (0.69–1.24)	0.600	0.83 (0.60–1.17)	0.286
Sex						
Male	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Female	1.07 (0.86–1.32)	0.549	1.07 (0.87–1.32)	0.508	1.10 (0.89–1.35)	0.374
Age group, yr						
< 65	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
65–79	1.26 (0.96–1.65)	0.096	1.31 (1.00–1.71)	0.051	1.34 (1.02–1.75)	0.034
80 and older	0.73 (0.55–0.97)	0.032	0.77 (0.58–1.02)	0.067	0.74 (0.56–0.99)	0.035
Comorbidities						
Hypertension	0.93 (0.75–1.17)	0.547	0.92 (0.74–1.15)	0.462	0.99 (0.79–1.24)	0.935
Coronary artery disease	0.94 (0.65–1.35)	0.758	1.04 (0.74–1.47)	0.805	0.97 (0.68–1.39)	0.875
Atrial fibrillation	2.03 (0.86–4.82)	0.107	2.25 (1.01–5.01)	0.047	2.34 (1.04–5.25)	0.040
Heart failure	0.56 (0.26–1.20)	0.136	0.69 (0.36–1.32)	0.263	0.67 (0.34–1.32)	0.244
COPD	0.80 (0.29–2.19)	0.67	0.78 (0.29–2.13)	0.63	0.56 (0.18–1.77)	0.322
Asthma	1.63 (0.87–3.06)	0.125	2.09 (1.17–3.73)	0.013	1.81 (0.96–3.38)	0.065
Respiratory failure	0	0.996	0	0.996	0	0.996
Stroke	1.05 (0.67–1.63)	0.84	1.11 (0.74–1.68)	0.617	1.18 (0.78–1.79)	0.450
Diabetes	1.04 (0.79–1.38)	0.767	0.90 (0.68–1.20)	0.477	0.97 (0.73–1.29)	0.835
Hepatic insufficiency	0	0.999	0	0.998	0	0.999
Renal insufficiency	0.82 (0.45–1.48)	0.504	1.07 (0.64–1.81)	0.787	0.81(0.45–1.43)	0.465
Cancer	0.74 (0.55–0.99)	0.045	0.82 (0.62–1.09)	0.166	0.78 (0.58–1.04)	0.088
Mental illness	0.26 (0.08–0.83)	0.023	0.23 (0.07–0.75)	0.014	0.27 (0.08–0.87)	0.028
Location						
Home or residence	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Nursing home	0.53 (0.36–0.80)	0.002	0.62 (0.43–0.89)	0.01	0.55 (0.37–0.81)	0.003
Public place	2.44 (1.74–3.42)	< 0.001	3.36 (1.68–3.30)	< 0.001	2.67 (1.91–3.71)	< 0.001
Bystander CPR	4.83 (3.45–6.75)	< 0.001	5.14 (3.71–7.12)	< 0.001	5.23 (3.78–7.24)	< 0.001
Initial cardiac rhythm						
Non-shockable	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Shockable	10.00 (7.09–14.10)	< 0.001	10.14 (7.25–14.17)	< 0.001	9.35 (6.69–13.06)	< 0.001
Etiology						
Non-medical	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]	NA
Medical	0.57 (0.39–0.84)	0.004	0.49 (0.34–0.71)	< 0.001	0.65 (0.44–0.96)	0.029
EMS arrival time $\geq$12 min	0.58 (0.46–0.72)	< 0.001	0.61 (0.49–0.76)	< 0.001	0.59 (0.47–0.74)	< 0.001

CI, confidence interval; COPD, chronic obstructive pulmonary disease; CPR, cardiopulmonary resuscitation; EMS, emergency medical services; NA, not applicable; OR, odds ratio.

* Relative to the pre-epidemic period.

Paris, London and New York. Finally, median age of OHCA patients in our registry was much older than those previously reported in Paris, London and New York, which may limit generality of the results in current study.

Conclusions

Our analysis of a unique situation in which we could compare early and late effects of a well-defined Omicron outbreak indicates that even a less pathogenic SARS-CoV-2 variant can increase OHCA incidence for months after the outbreak has ended, and it can alter the profile of patients who suffer OHCA. Our results also highlight that not only the outbreak itself but also the government's strict response to it, can influence OHCA incidence and outcomes for months afterward. These findings argue for policymakers and health-care workers to maintain health-care access and innovate ways of providing services for vulnerable population so that negative effects of the pandemic can be reduced.

Declaration of Competing Interest

The authors declare that there are no conflicts of interest.

CRediT authorship contribution statement

Guohui Li: Conceptualization, Methodology, Writing – original draft, Funding acquisition. **Wenchao Zhang:** Data curation, Validation. **Dan Jia:** Visualization, Investigation. **Jin Rong:** Validation, Investigation. **Zhiqiang Yu:** Formal analysis, Visualization. **Degen Wu:** Supervision, Writing – review & editing.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resuscitation.2023.109722.

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REFERENCES

1. WHO. Tracking SARS-CoV-2 variants. 202(Accessed 12 November 2022, at https://www.who.int/en/activities/tracking-SARS-CoV-2-variants).
2. WHO. Classification of Omicron (B.1.1.529): SARS-CoV-2 Variant of Concern. 2021. (Accessed 12 November 2022, at https://www.who.int/news/item/26-11-2021-classification-of-omicron-(b.1.1.529)-sars-cov-2-variant-of-concern).
3. Callaway E, Ledford H. How bad is Omicron? What scientists know so far. Nature 2021;600:197–9.
4. Magazine N, Zhang T, Wu Y, McGee MC, Veggiani G, Huang W. Mutations and Evolution of the SARS-CoV-2 Spike Protein. Viruses 2022;14.
5. Al Hasan SM, Saulam J, Mikami F, Kanda K, Yokoi H, Hirao T. COVID-19 outbreak trends in South Africa: A comparison of Omicron (B.1.1.529), Delta (B.1.617.2), and Beta (B.1.351) variants outbreak periods. J Infect Public Health 2022;15:726–33.
6. Jassat W, Abdool Karim SS, Mudara C, et al. Clinical severity of COVID-19 in patients admitted to hospital during the omicron wave in South Africa: a retrospective observational study. Lancet Glob Health 2022;10:e961–9.
7. Cheung PH, Chan CP, Jin DY. Lessons learned from the fifth wave of COVID-19 in Hong Kong in early 2022. Emerg Microbes Infect 2022;11:1072–8.
8. Teoh SE, Masuda Y, Tan DJH, et al. Impact of the COVID-19 pandemic on the epidemiology of out-of-hospital cardiac arrest: a systematic review and meta-analysis. Ann Intensive Care 2021;11:169.
9. Christian MD, Couper K. COVID-19 and the global OHCA crisis: An urgent need for system level solutions. Resuscitation 2020;157:274–6.
10. Danhieux K, Buffel V, Pairon A, et al. The impact of COVID-19 on chronic care according to providers: a qualitative study among primary care practices in Belgium. BMC Fam Pract 2020;21:255.
11. Hammoudeh AJ, Madanat E, Tabbalat R, et al. Acute cardiovascular events triggered by the COVID-19 pandemic-related stress in non-infected individuals. The Jordan COVID-19 Acute Cardiovascular Events (JoCORE) study. Rev Cardiovasc Med 2021;22:1677–83.
12. Marijon E, Karam N, Jost D, et al. Out-of-hospital cardiac arrest during the COVID-19 pandemic in Paris, France: a population-based, observational study. Lancet Public Health 2020;5:e437–43.
13. Lai PH, Lancet EA, Weiden MD, et al. Characteristics Associated With Out-of-Hospital Cardiac Arrests and Resuscitations During the Novel Coronavirus Disease 2019 Pandemic in New York City. JAMA Cardiol 2020;5:1154–63.
14. Al-Shiakh S, Tran QK, Caggiula A, Berezowski I, Barnawi B, Pourmand A. Attitudes among healthcare professionals towards cardiopulmonary resuscitation during COVID-19. Am J Emerg Med 2022;52:34–42.
15. Hawkes CA, Kander I, Contreras A, et al. Impact of the COVID-19 pandemic on public attitudes to cardiopulmonary resuscitation and publicly accessible defibrillator use in the UK. Resusc Plus 2022;10 100256.
16. Ball J, Nehme Z, Bernard S, Stub D, Stephenson M, Smith K. Collateral damage: Hidden impact of the COVID-19 pandemic on the out-of-hospital cardiac arrest system-of-care. Resuscitation 2020;156:157–63.
17. Scquizzato T, Landoni G, Scandroglio AM, et al. Outcomes of out-of-hospital cardiac arrest in patients with SARS-CoV-2 infection: a systematic review and meta-analysis. Eur J Emerg Med 2021;28:423–31.
18. Tam CF, Cheung KS, Lam S, et al. Impact of Coronavirus Disease 2019 (COVID-19) Outbreak on ST-Segment-Elevation Myocardial Infarction Care in Hong Kong, China. Circ Cardiovasc Qual Outcomes 2020;13:e006631.
19. Anderson KE, McGinty EE, Presskreischer R, Barry CL. Reports of Forgone Medical Care Among US Adults During the Initial Phase of the COVID-19 Pandemic. JAMA Netw Open 2021;4:e2034882.
20. Wessler BS, Kent DM, Konstam MA. Fear of Coronavirus Disease 2019-An Emerging Cardiac Risk. JAMA Cardiol 2020;5:981–2.
21. Zhang X, Zhang W, Chen S. Shanghai's life-saving efforts against the current omicron wave of the COVID-19 pandemic. Lancet 2022;399:2011–2.
22. Cai J, Deng X, Yang J, et al. Modeling transmission of SARS-CoV-2 Omicron in China. Nat Med 2022.
23. Chen Z, Deng X, Fang L, et al. Epidemiological characteristics and transmission dynamics of the outbreak caused by the SARS-CoV-2 Omicron variant in Shanghai, China: A descriptive study. Lancet Reg Health West Pac 2022;29 100592.
24. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. BMJ 2007;335:806–8.
25. Perkins GD, Jacobs IG, Nadkarni VM, et al. Cardiac Arrest and Cardiopulmonary Resuscitation Outcome Reports: Update of the Utstein Resuscitation Registry Templates for Out-of-Hospital Cardiac Arrest: A Statement for Healthcare Professionals From a Task Force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia); and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care. Perioperat Resus Resus 2015;96:328–40.
26. Gui L, Gu S, Lu F, Zhou B, Zhang L. Prehospital emergency care in Shanghai: present and future. J Emerg Med 2012;43:1132–7.
27. Fothergill RT, Smith AL, Wrigley F, Perkins GD. Out-of-Hospital Cardiac Arrest in London during the COVID-19 pandemic. Resusc Plus 2021;5 100066.
28. Jain N, Berkenbush M, Feldman DC, Eskin B, Allegra JR. Effect of COVID19 on prehospital pronouncements and ED visits for stroke and myocardial infarction. Am J Emerg Med 2021;43:46–9.
29. Mountantonakis SE, Saleh M, Coleman K, et al. Out-of-Hospital Cardiac Arrest and Acute Coronary Syndrome Hospitalizations During the COVID-19 Surge. J Am Coll Cardiol 2020;76:1271–3.
30. Rashid Hons M, Gale Hons CP, Curzen Hons N, et al. Impact of Coronavirus Disease 2019 Pandemic on the Incidence and Management of Out-of-Hospital Cardiac Arrest in Patients Presenting With Acute Myocardial Infarction in England. J Am Heart Assoc 2020;9:e018379.
31. Baldi E, Sechi GM, Mare C, et al. COVID-19 kills at home: the close relationship between the epidemic and the increase of out-of-hospital cardiac arrests. Eur Heart J 2020;41:3045–54.

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