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Clinical paper

Incidence and temporal trends of out-of-hospital cardiac arrest in Shenzhen, China (2011–2018)

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Abstract

Background: Out-of-hospital cardiac arrest (OHCA) is a significant global public health issue, few studies describe characteristics and trends in China. This study examines OHCA features and trends in Shenzhen, one of the fastest-growing cities.

Methods: This retrospective study analysed data from the Shenzhen Emergency Center database (2011–2018), including ambulance dispatch and pre-hospital medical records. Descriptive statistics and temporal trends were used to examine the incidence, patients characteristics, pre-hospital treatment, and outcome.

Results: Among 18,772 medical cause OHCA cases, the crude incidence rate was 17.4 per 100,000 population, with an age-standardised rate of 38.4. Incidence increased over time. Resuscitation was attempted in 43.8% of cases, with a median patient age of 56 years and 73.5% being male. Most arrest (69.0%) occurred at home, and 82% were presumed to be cardiac cause.The median response time was 11.2 min. Bystander cardiopulmonary resuscitation (CPR) rates increased from 4.6% in 2011 to 14.5% in 2018, while bystander automated external defibrillator (AED) use remained low (0.2%). Pre-hospital electrocardiogram (ECG) recording improved from 40.6% to 91.9%, with shockable rhythms 2.2%. Intravenous access was established in 69.7% of patients, 51.9% received epinephrine, 19.29% received pre-hospital defibrillation, and 16.4% underwent advanced airway management. The pre-hospital Return of Spontaneous Circulation (ROSC) rate increased from 2.7% to 5.8%, with a total ROSC rate of 3.11%.

Conclusions: OHCA incidence in Shenzhen is lower than both domestic and international levels but increasing. Low bystander intervention rated and prolonged response times contribute to poor outcome, underscoring the need for system improvements.

Keywords: Out-of-hospital cardiac arrest, Incidence, Temporal trends, Emergency medical services, Shenzhen

Introduction

Out-of-hospital cardiac arrest (OHCA) is a leading cause of mortality worldwide, and in recent years, survival rates have shown significant improvement in developed countries across Europe and North America.[1–3] In China, rapid socio-economic development over recent decades has led to significant transformations in healthcare infrastructure. However, OHCA survival outcomes in China remain alarmingly poor,[4] with recent studies indicating that only 0.8% of patients are discharged with favourable neurological outcomes,[5] a stark contrast to rates observed in many developed countries.[1–3]

There is a paucity of studies that objectively characterise the epidemiology and temporal trends of out-of-hospital cardiac arrest (OHCA) in China. Both OHCA incidence and Emergency Medical Services (EMS) response exhibit marked regional disparities across the country[6]. Shenzhen, one of China's fastest-growing and largest cities in the south, serves as a microcosm of the nation's rapid urban development. This unique urban environment provides a valuable opportunity to investigate the epidemiological patterns of OHCA, the functioning of the chain of survival, and the evolving trends over time within China.

This study aims to bridge the existing research gap by providing a comprehensive analysis of medical cause OHCA cases in Shenzhen from 2011 to 2018. By investigating the epidemiology, the chain of

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survival, and temporal trends during this period, we seek to glean critical insights into the effectiveness of current emergency response systems and identify key areas for improvement.

Methods

Study design and setting

This retrospective review analysed data on OHCA in Shenzhen, China, from 1 January 2011 to 31 December 2018. Specifically, OHCA cases were extracted from the Emergency Medical Record System database, using the Utstein standardised template to report the processes and outcomes of OHCA events.[7] The study received ethics approval from the ethics committee of Sun Yat-Sen Memorial Hospital, Sun Yat-Sen University (authorization number: SYSKY-2024-266-01).

Shenzhen, one of the fastest-growing cities in China over the past two decades, is situated in the southern part of the country within the Pearl River Delta. The municipality spans an area of 1,997.27 square kilometres and had a total population of 17.63 million as of 2020.[8] The Emergency Medical Services (EMS) in Shenzhen is operated by the Shenzhen Emergency Center which provides 24-hour free medical emergency telephone services and conducts public first aid education. The center coordinates with 72 hospitals and 108 first-aid stations and operates a static ambulance deployment system, dispatching approximately 450 ambulance missions daily based on the location of the emergency and hospitals' medical capacity. Patients requiring resuscitation were typically transported to the nearest tertiary hospital within the dispatch area, which is equipped with percutaneous coronary intervention (PCI) services, advanced cardiovascular life support (ACLS), intensive care units (ICUs), and comprehensive post-resuscitation care. The EMS is physician-based and is activated by dialling 120. Typically, ambulances are equipped with defibrillation monitors, ventilators, aspirators and basic resuscitation medications. Each ambulance crew comprises at least one doctor, one nurse, one ambulance driver, and one stretcher-bearer. These professionals, having completed rigorous training in emergency medicine, are licensed and skilled in providing specialized out-of-hospital emergency care.[9]

During the study period, the Shenzhen Emergency Center had not yet implemented the new pre-hospital emergency dispatch system or standardised dispatcher-assisted CPR (DA-CPR) guidelines. Dispatchers received both pre-service and ongoing training to enhance their ability to accurately identify medical conditions and effectively utilise the dispatch system. In practice, dispatchers relied on their personal experience and judgment to determine whether to provide CPR instructions to bystanders during emergency calls. Additionally, attending physicians might contact patients or their family members to ascertain whether CPR had already been initiated at the scene. First responder teams, including police, taxi drivers and volunteers, were not incorporated into the dispatch system. Furthermore, AEDs were deployed in some public locations, but no public defibrillation programmes were implemented to promote their use.

Data collection

During the study period, we retrieved all pre-hospital EMS dispatch records. Data were extracted using specific keywords such as "cardiac arrest," "sudden cardiac death," "respiratory arrest," and "pre-hospital death" to identify potential OHCA cases. To ensure accuracy, all records underwent manual screening, resulting in the exclusion of 30 false cases involving patients with conditions like heart failure or asthmatic attack that mimicked cardiac arrest. Additionally, traumatic cardiac arrest cases were excluded from the incidence calculations to ensure a complete dataset of non-traumatic OHCAs. For subsequent analyses, patients who did not receive any resuscitation were further excluded. Data were collected and reported using the Utstein template.[7]

Patient characteristics, including sex, age, location of collapse, all EMS timelines primary electrocardiogram (ECG) type, and pre-hospital interventions were recorded. EMS timelines included activation time, defined as the interval from when the call was answered by EMS (first connection, "What is your emergency?") to when ambulance was dispatched. Response time referred to the interval from ambulance dispatch to its arrival at the scene (wheels stop), while total pre-hospital time was defined as the interval from the EMS call being answered to the ambulance's return to the hospital. Pre-hospital interventions included pre-hospital defibrillation, encompassing all defibrillation attempts made prior to hospital arrival, whether performed by bystanders or EMS personnel, and advanced airway management, defined as endotracheal intubation, including unsuccessful attempts, as no alternative advanced airway methods were provided within this EMS system. These standardised definitions ensured consistency and clarity in data collection and interpretation. All elements were documented by the treating doctors upon mission completion.

Outcomes of pre-hospital management were tracked, including pre-hospital death, transfer to hospital, and the number of successful resuscitations. Pre-hospital return of spontaneous circulation (ROSC) was defined as any ROSC occurring during the pre-hospital phase.

Statistical analysis

Medical cause OHCA cases from 2011 to 2018 were used to calculate the crude incidence rate of OHCA in Shenzhen. Annual population data were sourced from the Shenzhen Statistical Yearbook,[8] published by the Shenzhen Bureau of Statistics, to obtain the year-end resident population for each year. For age-standardised incidence rates, we utilised data from the Sixth (2010) and Seventh (2020) National Population Censuses.[10] By interpolating the population changes between these two censuses, we estimated the annual population data, accounted for shifts in Shenzhen's age structure over the study period, and used these estimates to calculate the standardised incidence rates of out-of-hospital cardiac arrest, expressed as the number of OHCA cases per 100,000 population annually.

All continuous variables were expressed as medians (IQR), while categorical variables were presented as counts and percentages. Group comparisons of categorical variables were performed using Fisher's Exact Test. Trends in dichotomous variables were assessed using the two-tailed Cochran-Armitage test, while the trends in continuous variables were evaluated using the two-tailed Mann-Kendall test. Trends of incidence rate were first examined using Poisson regression, and if overdispersion was detected, a negative binomial regression was applied instead. A p-value < 0.05 was considered statistically significant. All analyses were conducted using RStudio 4.4.1 (Posit PBC, USA), SPSS 19.0 (SPSS Inc., USA), and Microsoft Office Excel 2017 (Microsoft Corporation, USA).

Results

Data was collected spanning 8 years from 2011 to 2018. The Shenzhen Emergency Center dispatched a total of 1,346,988 ambulances, encompassing 19,683 OHCA cases. Of these, 113 cases were excluded due to incomplete data, and 798 cases were excluded due to traumatic, asphyxial (external cause), poison, drowning, electrocution, burn fatality, and thermoplegia-induced cardiac arrest. A total of 18,772 cases were eligible for inclusion. Resuscitation was attempted for 8,213 cases (43.75%) (Fig. 1).

The total crude incidence of EMS-assessed OHCA was 17.4 per 100,000 population, with the age-standardised incidence rate being 38.4 per 100,000 population. Initially, Poisson regression was used to model the trends of crude and age-standardised incidence rates. However, due to overdispersion in the data, we applied negative binomial regression. This model showed a significant upward trend in both crude and age-standardised incidence rates, with annual increases of 4.1% (95% CI: 1.5–6.6%; $p < 0.01$) and 6.89% (95% CI: 4.7–9.1%; $p < 0.01$), respectively (Fig. 2).

We included all OHCA patients who underwent resuscitation attempts (n = 8213) in the subsequent analysis, males consistently accounted for the majority, comprising 73.5% of the cases. The median age of these patients was 56 years (IQR: 43–72). Cardiac arrests most occurred at the patient's home, accounting for 69% of the cases, there was no significant change in this distribution over time (p = 0.37). Based on the Utstein template recommendations for inferring cardiac arrest etiology, presumed cardiac etiology accounted for 82% of the cases, with a significant decreasing trend ($p < 0.01$). (Table 1).

Among all OHCA patients who had resuscitation attempted (n = 8213), the median EMS activation time was 1.8 min (IQR: 1.4–2.6 min), the response time was 11.2 min (IQR: 8.4–14.6 min), and the total pre-hospital time was 61.5 min (IQR: 39.1–86.9 min). An increasing trend was observed in EMS activation time ($p < 0.01$) and pre-hospital time ($p < 0.01$) year by year, while the response time time fluctuated within a narrow range without significant changes($p = 0.45$). Bystander CPR was performed on 743 (9%) OHCA patients. A significant increase in the rate of bystander CPR was noted, rising from 4.6% in 2011 to 14.5% in 2018 ($p < 0.01$). Bystander use of automated external defibrillator (AED) for OHCA patients was first recorded in 2016, however, till 2018, only 14 patients (0.2%) had been assessed by bystanders with a public-access AED, and 9 (0.1%) patients were defibrillated. Regarding pre-hospital initial ECG recording, the completion rate was only 40.6% of all patients in 2011, with ventricular tachycardia/ventricular fibrillation (VT/VF) accounting for just 1.6%. However, there was significant change over time in the distribution of pre-hospital initial ECG rhythms ($p < 0.01$). By 2018, the completion rate had improved, with only 8.1% of cases categorized as 'unknown'. Non-shockable rhythms remained the majority, with asystole accounting for 83.4% of cases. Notably, the number of VT/VF cases showed a significant increasing trend over time ($p < 0.01$). In terms of pre-hospital emergency interventions, intravenous access was established in approximately 69.7% of patients, epinephrine was administered to only

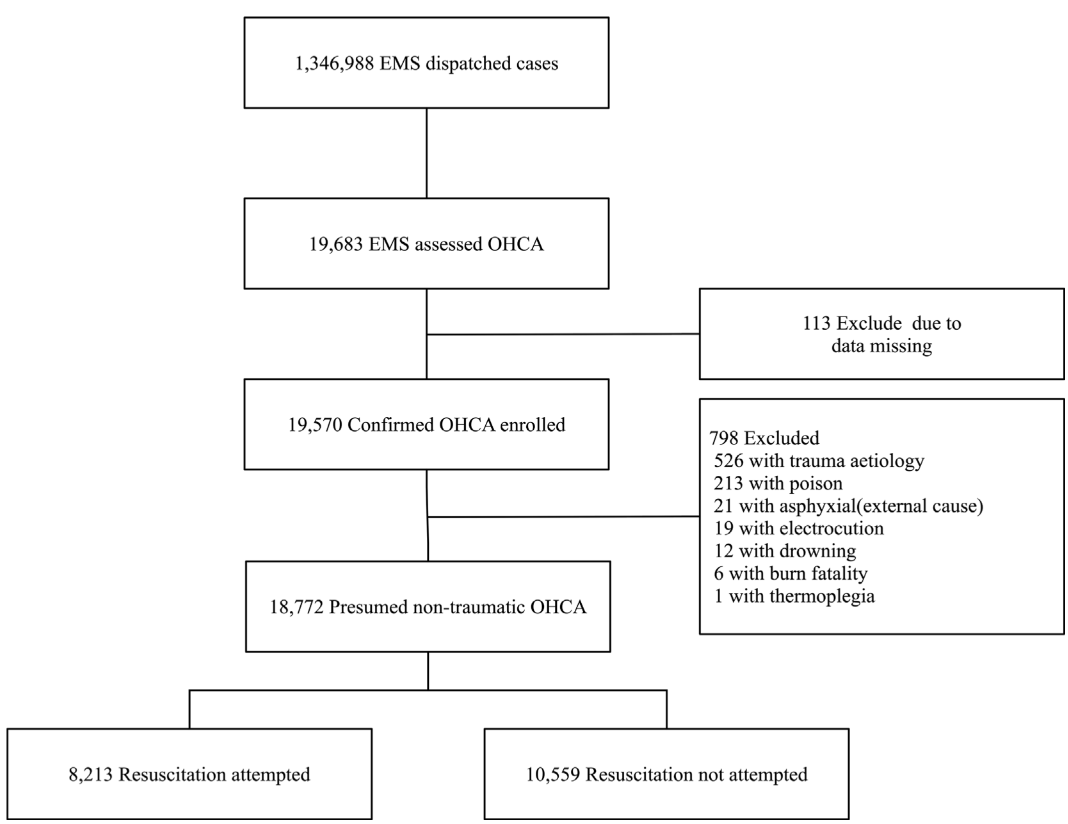

Fig. 1 – Flow Diagram of events for emergency medical service-treated non-traumatic out-of-hospital cardiac arrest in Shenzhen included in Analysis. EMS = emergency medical service. OHCA = out-of-hospital cardiac arrest.

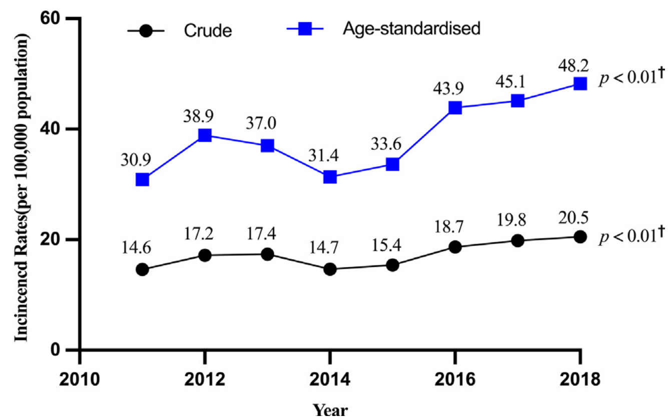

Fig. 2 – Temporal trends of incidence rates for emergency medical service-treated out-of-hospital cardiac arrest in Shenzhen, 2011–2018. †: *p*-values are calculated using negative binomial regression.

Table 1 – Characteristics of patients and events for emergency medical service-treated non-traumatic out-of-hospital cardiac arrest in Shenzhen.

	Total	2011	2012	2013	2014	2015	2016	2017	2018	*p* –Value
Sex										$p = 0.40^*$
Male	6037 (73.5%)	655 (74.7%)	729 (70.6%)	776 (75.6%)	626 (72.5%)	718 (76.6%)	751 (74.2%)	839 (74.8%)	943 (70.2%)	
Female	2176 (26.5%)	222 (25.3%)	304 (29.4%)	251 (24.4%)	237 (27.5%)	219 (23.4%)	261 (25.8%)	282 (25.2%)	400 (29.8%)	
Age										
Median (IQR)	56 (43–72)	53 (40–69)	57 (42–73)	55 (42–70)	56 (43–70)	56 (44–70)	56 (44–73)	55 (45–70)	61 (45–79)	$p = 0.37^{\#}$
≤14	105 (1.3%)	24 (2.8%)	8 (0.8%)	8 (0.8%)	21 (2.5%)	9 (1%)	13 (1.2%)	13 (1.2%)	9 (0.6%)	
15–64	5120 (62.3%)	588 (67%)	649 (62.8%)	662 (64.4%)	543 (62.9%)	599 (63.8%)	627 (62%)	726 (64.8%)	726 (54.1%)	
≥65	2988 (36.4%)	265 (30.2%)	376 (36.4%)	357 (34.8%)	299 (34.6%)	329 (35.1%)	372 (36.8%)	382 (34.0%)	608 (45.3%)	
Location										$p = 0.53^*$
Home/resident	5669 (69%)	603 (68.8%)	741 (71.7%)	707 (68.8%)	583 (67.6%)	646 (68.9%)	695 (68.7%)	754 (67.3%)	940 (70%)	
Public and other	2544 (31%)	274 (31.2%)	292 (28.3%)	320 (31.2%)	280 (32.4%)	291 (31.1%)	317 (31.3%)	367 (32.7%)	403 (30%)	
Cardiac aetiology	6731 (82%)	743 (84.7%)	858 (83.1%)	863 (84%)	711 (82.4%)	747 (79.7%)	825 (81.5%)	915 (81.6%)	1069 (79.6%)	$p < 0.01^*$
Total	8213	877	1033	1027	863	937	1012	1121	1343	

Data are N (%) or Median (IQR).

* *p*-values are calculated for the Cochran-Armitage test.

\# *p*-values are calculated for the Mann-Kendall test.

51.9% of patients, 19.3% received pre-hospital defibrillation, and 16.4% underwent advanced airway management, An increasing trend was observed in the administration of epinephrine ($p < 0.01$), while decreases were noted in intravenous access ($p < 0.01$) and advanced airway management ($p < 0.01$). No significant trend was observed in pre-hospital defibrillation over the study period ($p = 0.18$) (Table 2).

Among the 8,213 EMS-treated patients with medical OHCA, 6,219 (75.1%) died at the scene, 1,994 (24.9%) were transported to hospital, and 256 (3.11%) achieved pre-hospital ROSC. From 2011 to 2017, these outcomes showed minimal variation. However, in 2018, the proportion of OHCA patients transported to hospital increased significantly to 35.4% ($p < 0.01$), accompanied by a significant increase in pre-hospital ROSC, reaching 5.8% ($p < 0.01$) (Table 3).

Discussion

This epidemiological study of medical cause OHCA in Shenzhen, South China, provides valuable insights into the characteristics and trends of OHCA from 2011 to 2018. Our findings show an annual increase in the incidence of OHCA, underscoring the escalating public health burden in this rapidly growing city. Shenzhen's unique

Table 2 – Process of care for emergency medical service-treated non-traumatic out-of-hospital cardiac arrest in Shenzhen.

	Total	2011	2012	2013	2014	2015	2016	2017	2018	p –Value
EMS Timing, min										
Activation time	1.8 (1.4–2.6)	1.4 (1.1–1.8)	1.5 (1.2–1.9)	1.7 (1.4–2.5)	1.8 (1.4–2.4)	2 (1.5–2.7)	2 (1.5–2.7)	2.2 (1.7–2.8)	2.2 (1.7–2.9)	$p < 0.01$[#]
Response time	11.2 (8.4–14.6)	10.7 (8–14.2)	11 (8.3–14.2)	11.5 (8.6–15)	11.4 (8.3–14.7)	11.6 (8.6–14.9)	11.6 (8.6–15.2)	11.4 (8.7–14.7)	10.8 (8–14.3)	$p = 0.45$[#]
Total time	61.5 (39.1–86.9)	56.9 (35.5–81.7)	59.3 (39–80.7)	59.6 (42.2–83.2)	60.2 (41.2–83.7)	65 (45–87.2)	63.9 (39.2–93.3)	66.9 (40.3–97.1)	61.4 (32–91.1)	$p < 0.01$[#]
Bystander CPR	743 (9%)	40 (4.6%)	55 (5.3%)	70 (6.8%)	67 (7.8%)	72 (7.7%)	104 (10.3%)	140 (12.5%)	195 (14.5%)	$p < 0.01$[*]
Bystander AED										
with defibrillation	9 (0.1%)	0	0	0	0	0	1 (0.1%)	2 (0.2%)	6 (0.4%)	
without defibrillation	5 (0.1%)	0	0	0	0	0	0	0	5 (0.4%)	
Initial ECG rhythm										$p < 0.01$[&]
VT/VF	183 (2.2%)	14 (1.6%)	10 (1%)	13 (1.3%)	13 (1.5%)	14 (1.5%)	22 (2.2%)	32 (2.9%)	65 (4.8%)	$p < 0.01$[*]
PEA	78 (0.9%)	5 (0.6%)	5 (0.4%)	2 (0.2%)	2 (0.2%)	7 (0.7%)	4 (0.4%)	4 (0.4%)	49 (3.6%)	
Asystole	4626 (56.3%)	337 (38.4%)	384 (37.2%)	475 (46.2%)	460 (53.3%)	559 (59.7%)	593 (58.6%)	698 (62.2%)	1120 (83.4%)	
Unknow	3326 (40.6%)	521 (59.4%)	634 (61.4%)	537 (52.3%)	388 (45%)	357 (38.1%)	393 (38.8%)	387 (34.5%)	109 (8.2%)	
EMS Process										
Intravenous access	5722 (69.7%)	624 (71.2%)	757 (73.3%)	729 (71%)	597 (69.2%)	660 (70.4%)	675 (66.7%)	723 (64.5%)	957 (71.3%)	$p < 0.01$[*]
Epinephrine	4261 (51.9%)	406 (46.3%)	465 (45%)	496 (48.3%)	447 (51.8%)	556 (59.3%)	535 (52.9%)	606 (54.1%)	750 (55.8%)	$p < 0.01$[*]
Defibrillation	1585 (19.3%)	212 (24.2%)	189 (18.3%)	171 (16.7%)	150 (17.4%)	149 (15.9%)	171 (16.9%)	214 (19.1%)	329 (24.5%)	$p = 0.18$[*]
Advance Airway	1347 (16.4%)	201 (22.9%)	245 (23.7%)	202 (19.7%)	153 (17.7%)	118 (12.6%)	146 (14.4%)	109 (9.7%)	173 (12.9%)	$p < 0.01$[*]
Total	8213	877	1033	1027	863	937	1012	1121	1343	

Data are N (%) or Median (IQR).

EMS = emergency medical service. CPR = cardiopulmonary resuscitation. AED = automated external defibrillator. ECG = electrocardiogram.VT/VF = ventricular tachycardia/ventricular fibrillation. PEA = pulseless electrical activity.

[*] *p*-values are calculated for the Cochran-Armitage test.

[#] *p*-values are calculated for the Mann-Kendall test.

[&] *p*-values are calculated for the Fisher's Exact Test.

Table 3 – Outcomes of emergency medical service-treated non-traumatic out-of-hospital cardiac arrest in Shenzhen.

	Total	2011	2012	2013	2014	2015	2016	2017	2018	p –Value
Scene outcome										$p < 0.01$[*]
Death at the scene	6219 (75.1%)	659 (75.7%)	789 (76.4%)	784 (76.3%)	664 (76.9%)	779 (83.1%)	790 (78.1%)	887 (79.1%)	867 (64.6%)	
Transported	1994 (24.9%)	218 (24.3%)	244 (23.6%)	243 (23.7%)	199 (23.1%)	158 (16.9%)	222 (21.9%)	234 (20.9%)	476 (35.4%)	
Prehospital ROSC	256 (3.1%)	24 (2.7%)	23 (2.2%)	26 (2.5%)	21 (2.4%)	21 (2.2%)	35 (3.5%)	28 (2.5%)	78 (5.8%)	$p < 0.01$[*]
Total	8213	877	1033	1027	863	937	1012	1121	1343	

Data are N (%).

ROSC = return of spontaneous circulation.

[*] *p*-values are calculated for the Cochran-Armitage test.

demographic and socio-economic profile makes it a valuable case study for understanding OHCA in the rapidly urbanising cities of developing countries.

Similar to the findings of the International Liaison Committee on Resuscitation (ILCOR) (57.1–70.5%),[11] our research showed that the majority of OHCA patients were male (70.2–76.6%). The median age of OHCA patients in our study was 56, aligning closely with registry studies from North America (median age 54),[12] but significantly lower than Europe (mean age 58.4–75.6).[13] It is also slightly below findings from domestic studies (median age 64–69),[5,14,15] and markedly lower compared to other regions in Asia (median age 50–76),[16] Australia and New Zealand (median age 66–68).[17] Furthermore, it remains substantially lower than the median age reported in ILCOR studies (median age 64–80).[11] This finding suggests that Shenzhen, as a "young" city, may have different risk factors for OHCA, potentially influenced by modern lifestyle factors such as high stress, unhealthy diets, lack of exercise, smoking, and drinking. These factors contribute to an increased risk of cardiovascular diseases, necessitating targeted public health interventions for middle-aged populations.[18] The yearly increase in OHCA incidence could be related to continuous population influx and the onset of an aging society, indicating a rising public health burden.[19] Strengthening the healthcare system and focusing on high-risk groups are essential to address these challenges.[20]

Response time is a crucial metric for assessing the effectiveness of EMS,[21] as shorter response times are significantly linked to better neurological outcomes in OHCA patients.[22] In our study, the median response time for EMS was 11.2 min. This is longer than the response time reported in many developed countries according to ILCOR (6.1–9.0 min),[11] but is comparable to domestic studies (12–12.7 min),[5,15] and shorter than the response time observed in Malaysia, Southeast Asia (17.4 min).[16] In nations with a highly organized emergency response framework, the response time can be under 8 min. In contrast to many cities worldwide, Shenzhen's urban areas feature a higher density of residential buildings, which poses challenges for EMS access. Factors such as hard-to-locate addresses, long elevator wait times, and poorly planned fire access routes significantly hinder the efficiency of emergency medical services.[23] To address these challenges, it is essential to enhance pre-hospital emergency resources by increasing the density of emergency stations, optimising spatial layouts, and deploying additional ambulances to high-density residential and high-rise building areas. Moreover, developing an informatized pre-hospital emergency system is imperative. This system should automate the collection of location data, integrate with urban geographic information systems, and generate optimal navigation routes based on real-time traffic conditions,[24] thereby enabling EMS personnel to reach the scene more swiftly.

Bystander interventions in Shenzhen are significantly lower than both domestic and international standards. The bystander CPR rate is only 9.05%, far below the 46.1%-80.3% reported by ILCOR,[11] and slightly below the domestic average of 10.4%–20.3%.[5,14] Similarly, AED use in Shenzhen remains minimal at 0.1%, aligning with domestic levels[5] yet significantly lagging behind the 2.0%-19.0% reported internationally.[11] These disparities highlight the urgent need to enhance bystander intervention rates to improve OHCA outcomes. During the study period, dispatcher-assisted CPR (DA-CPR) had not yet been implemented, which may have limited bystander CPR rates. Although evidence from previous studies have demonstrated that DA-CPR is strongly associated with improved OHCA outcomes.[25] To address this, Shenzhen introduced the Medical Priority Dispatch System (MPDS) in 2023 to facilitate such interventions. Public CPR awareness has improved in recent years through national policies, medical guidelines, and training programmes. However, a shift is needed from simply increasing CPR knowledge to addressing bystanders' fear of taking action.[26] In October 2017, China implemented Good Samaritan laws, which have played a crucial role in boosting bystander confidence and CPR rates. Furthermore, since 2016, Shenzhen government has deployed AEDs in locations such as transport hubs and nursing homes, while also introducing programmes using traffic police motorcycles and taxis as mobile AED platforms. By 2018, Shenzhen's bystander CPR rate had increased to 14.5%, and AED use had risen slightly to 0.4%, indicating an improving trend. The ROSC rate also reached 5.8%, the highest recorded during the study period. However, these rates remain significantly lower than those in developed countries,[11] underscoring the need for further improvements. We must continue to enhance public CPR training programmes, increase AED accessibility, and fully implement dispatcher-assisted CPR to bridge the gap in OHCA outcomes. Additionally, we believe that establishing a comprehensive emergency response system with active community engagement is essential to improving survival rates.[27]

Our study highlights improvements in the completion rate of initial ECG rhythm recordings for OHCA cases by EMS personnel in Shenzhen, increasing from 40.60% in 2011 to 91.89% in 2018, driven by a substantial decrease in the proportion of "unknown" rhythms. Despite this progress, the detection of shockable rhythms only rose modestly from 2.2% to 4.8%, remaining significantly lower than the rates reported in developed countries by ILCOR (6.5–25.9%)[11] and some domestic studies (5.4–6.8%).[14,15,5] This discrepancy may be attributed to longer EMS response times and the persistently low rates of bystander CPR, both of which limit the timely identification of shockable rhythms and early intervention. In terms of advanced pre-hospital life support, such as the use of epinephrine and the establishment of advanced airways, the rates in Shenzhen remain notably low. According to the BASIC-OHCA registry,[5] the use of epinephrine in China is reported to be 76.3%, while the rate of advanced airway management is 32.8%. Similarly, a study from Singapore reported pre-hospital medication usage rates ranging from 46.2% to 60.1%, and advanced airway management rates as high as 82.6% to 87.3%.[28] These findings highlight significant disparities between Shenzhen and both domestic and international standards. To address these challenges, it is crucial to implement standardised pre-hospital advanced cardiac life support (ACLS) protocols. This includes adhering to guidelines for early defibrillation and timely administration of medications by pre-hospital emergency physicians.[29]

Our study has several limitations. Firstly, it is retrospective, resulting in some missing data that had to be excluded. While the excluded portion is small, it could still have a disproportionate impact on key variables required by the Utstein template. Secondly, our study is limited to data from 2011 to 2018, which may not fully reflect more recent trends in OHCA incidence and management. Future studies should incorporate updated data to provide a more comprehensive analysis of current patterns.Additionally, our data, sourced exclusively from EMS, represents only cases attended by emergency responders. While Shenzhen's emergency medical network provides comprehensive coverage and reliably reflects OHCA incidence, some cases might be missed, such as elderly patients with terminal illnesses or those who self-admit to hospitals without calling for EMS assistance, potentially leading to an underestimation of the overall incidence rate. Furthermore, due to our reliance on EMS data, we were unable to access details on in-hospital treatments, which means our report does not cover the ultimate survival outcomes. Since many patients continue CPR upon hospital admission, the actual ROSC rate may be underestimated.

Conclusions

Our findings indicate that the incidence of medical cause OHCA in Shenzhen is lower compared to both domestic and international levels, but has shown a gradual upward trend over the study period. The extremely low rate of bystander resuscitation attempts and AED use, coupled with prolonged EMS response times, may contribute to the poor ROSC rate. Efforts to enhance pre-hospital care and emergency response systems are critical to improving outcomes for OHCA patients in China.

CRediT authorship contribution statement

Hong Zhu: Writing – original draft, Visualization, Software, Resources, Methodology, Formal analysis, Data curation, Conceptualization. **Junpeng Liu:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Tianqi Yang:** Formal analysis, Data curation. **Yan Zhang:** Formal analysis, Data curation. **Yanjun Xu:** Formal analysis, Data curation. **Yunfeng Xu:** Formal analysis, Data curation. **Hao Wu:** Validation. **Li Li:** Validation. **Yufeng Luo:** Validation. **Cai Wen:** Validation, Supervision, Project administration, Funding acquisition, Conceptualization. **Tao Yu:** Validation, Supervision, Project administration, Funding acquisition, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2025.100882.

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