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Factors that induce gender variation in the on-scene time period of emergency medical services for high urgent transported patients: A retrospective population-based registry study

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ABSTRACT

Objective: To identify the inter-gender variation of on-scene time (OST) for high urgent emergency cases conveyed by Emergency Medical Services (EMS) in Saudi Arabia and assess other predictors of OST.

Design: A retrospective population-based registry study.

Setting: Riyadh Province is the largest province in terms of population and the second in terms of geographical area.

Participants: all high-urgent transported patients from the scene in urban and rural locations to emergency departments of governmental and private hospitals, be they medical emergencies or trauma-injuries emergencies during 2018.

Outcome measure: OST difference between men and women transported by ambulance as a high-urgent emergency

Results: In total, 21,878 patients were included for analysis: 33.9% women and 66.1% men. The median OST for women was 22 minutes (interquartile range [IQR] 15 – 30) and 18 minutes (IQR 11 – 26) for men, p <0.001; for medical cases, median OST was 23 minutes (IQR 16 – 31) for women compared to 20 minutes (IQR13 – 29) for men, p <0.001; for trauma cases, median OST of both sexes was equal. We found the following additional predictors of OST: Factors of emergency type, sex, age category, geographical locations, types of vehicles, and hospital type were all significantly associated with OST in the crude or adjusted analyses. Factors of emergency type, sex, age category, geographical locations, types of vehicles, and hospital type were also significantly associated with the odds of OST of more than 15-minutes in the crude and adjusted regression analyses.

Conclusion: The median OST was longer than 15 minutes for more than half of transported cases. For medical cases, women had a longer median OST than men. Additional predictors associated with prolonged OST were the patient's age, location (i.e., urban vs. rural), type of ambulance vehicle, and season.

Strengths and limitations of this study

- It is the first study conducted in the Arabian Gulf States that includes vast numbers of high urgent cases.

- The registry relies on the Saudi red crescent computerized aid dispatching (SRCCAD) system for automated detection of time to compute the timeline.
- Using registry data has provided us with much statistical power to detect between-group differences and associations for the available characteristics.
- Registry lacks other important demographic factors related to social status; education, income, and ethnicity, which might be associated with prolonged on-scene time.
- Time registered in the database depends on the information provided by emergency medical services (EMS) providers through wireless communications with the call centre; hence, any network failure lead produces a missed data.

INTRODUCTION

Emergency medical services (EMS) in Saudi Arabia have been well developed during the last decade. They provide different levels of emergency care around the clock and is free of charge. Women's lower EMS utilization is one of the challenges found beside the median total EMS time for high urgent emergency cases greater than one hour.[1 2] The on-scene time (OST) duration may take greater than half of the total period of EMS time and made up the largest proportion of total EMS delays.[3 4] Long OST may lead to consequences affecting patient outcomes.[5 6] In certain medical circumstances, patients' transportation to a hospital as soon as possible is highly recommended.[7-10] In the American Heart Association (AHA) guideline for the early management of stroke patients, it is recommended that the OST should not exceed 15 minutes.[7]

The OST duration can result from the crews' decision to collect patient history and medical examination.[11] In addition, the period of OST varies according to the patient's status with or without mortality and geographical locations as urban or rural locations. Sex may also play a factor in OST. For example, a US study found that OST in women complaining of acute chest pain was higher than in men as the crew needed more time for applying electrocardiogram.[12] Other barriers often prolong OST, particularly in trauma cases, when EMS providers' accessibility to patients is difficult. These barriers can be considered inevitable causes such as waiting for police to arrive in an incident resulting from criminal causes or waiting for the fire brigade to extract a patient from a vehicle or a building. It can also be affected in an outdoor address such as the street during a mass gathering after road traffic accidents.[11 13] On the other hand, it can result from patient wishes and family intervention in crews' performance and decision, especially during the patient presence in house locations. Such intervention is significantly affected by culture and education levels and might differ between urban and rural locations.

Factors related to patient culture or demography that influence OST have not been thoroughly studied in the Arabian Gulf States. A recent systematic review found that EMS crews in Saudi Arabia consider a mass gathering factor during road traffic accidents as one of the most frequent barriers affecting their performance to work effectively and timely while patients' families and bystanders come next.[14 15] Furthermore, the median of total EMS time in the Riyadh province of Saudi Arabia for the trauma cases was longer in rural areas than in

urban areas, and longer than what was found in other countries such as Denmark and the US.[1] [16] [17]

The present study aimed to investigate OST and identify differences between sexes regarding the amount of time spent at the scene by EMS crews. It also aims to identify other patient-related factors associated with time spent at the scene for all high urgent emergency cases that were transported to healthcare facilities in the Riyadh province in Saudi Arabia.

METHODS

Study Design and Setting

This retrospective population-based registry was conducted in the Riyadh province of Saudi Arabia by using all EMS database records in the Saudi red crescent computer aid dispatching (SRCCAD) system, from January 1, 2018, to December 31, 2018. Riyadh Province is located in the central part of Saudi Arabia. It has a geographical size of 404,240 km2. It has an approximate population of 6,792,776 million, according to the last national census. It is composed of 39 different cities in terms of size and population. Among those cities is Riyadh, which is the capital and largest city in Saudi Arabia. Besides, there are hundreds of rural villages dotted between or near these cities.[18] In Saudi Arabia, EMS are free of charge and can be accessed by calling the call centre, and in certain exceptional conditions, patients can visit ambulance-grounded centres distributed all over the province, including along highways. EMS crews of Riyadh province are mainly composed of two Emergency Medical Technicians (EMT). They are trained on basic life support (BLS) skills to respond to different levels of emergency cases but do not administer medicine. However, some crews are composed of physicians and emergency paramedics. These are called mobile intensive care units (MICU), and respond to certain high critical cases and provide advanced life support (ALS). A third type of EMS crew consists of senior paramedics and are dispatched in a rapid response non-transporting vehicle (RRNTV). These often arrive earlier to provide ALS before the essential transporting ambulances. Time indicators are built-in SRCCAD with 20 minutes for response time and 15 minutes for OST regardless of urgency level. However, when there are multiple calls for different emergencies at once, SRCCAD may prioritize cases based on three levels of urgency and dispatches crews accordingly. Patients or their families who have guardianship have the right to refuse transportation to hospital after they signed a formal paper of refusal against medical advices. However, EMS crews can either transport patients to the closest hospitals or treat them at the scene. The study proposal was reviewed and approved by the ethical committee in Jazan University with the registry number: REC39/9-S085. The Ethics

Committee, based on no need to contact patients, agreed that informed consent was not required because of the anonymity of the data collected for routine ambulance missions and the study's retrospective design. The study data take into consideration privacy and confidentiality.

Participants and public involvement

Patients and public were not involved in developing the research question, comment on the database, study design, outcome measures, conduct of the study, or contribute to the writing or editing of this study.

Data collection

The data were obtained through the operations and information department in the Riyadh branch directorate of Saudi red crescent authority (SRCA). Data were exported from Microsoft Excel saved in an encrypted file on a hard disc and converted to an IBM SPSS file (version 25) for further analyses.

Selection of Participants

All incoming calls for patients who were triaged at the dispatching centre of SRCCAD as high urgent cases were included in the current study. Patients of whom age, sex, or location were missing were excluded, as well as cases categorized by the SRCCAD as cases ended by non-conveyance.

Methods of Measurement

We included all variables related to patient demographics and information related to dispatching missions from the time interval perspective, starting from calling the call centre and ending with the patients' arrival to private and governmental hospitals. The EMS time intervals are composed of 4 different intervals.[19] The first is the response time, which is the time elapsed starting from receiving a call in the call centre and ended by the ambulance's crew's arrival to the scene. The second period is the OST, which is the time elapsed, starting from arrival to the scene and ended by starting to travel back to EMS centre or traveling forward toward healthcare facilities. The third period is traveling time, which is the time elapsed from starting to move from the scene until the crew's arrival to healthcare facilities. The fourth and last period is the hospital stay period, defined as the time elapsed from arrival to the healthcare facility until handover by emergency room staff. EMS database registry recorded all events starting from activation time and ending by crew's departure from the hospitals in case the

patient had been transported. It measures only response time interval and total EMS time interval in seconds. Therefore, the total EMS time in this study reflects the four intervals. We calculated the OST, travel time, hospital time according to standard EMS definition.[19] Those intervals in Saudi EMS have individual target indicators, such as the response time; 20 minutes; the OST is 15 minutes while the travel time has no indicators because of EMS providers' and patient's safety due to driving too fast. Saudi EMS would consider the OST if it exceeded 15 minutes as a prolonged OST. In cases where the call centre dispatched two or more EMS crews, we selected by calculating the actual time spent with patient from the first crew arrived either the RRNTV or the main transporting ambulance until the patient was transported by ambulance.

We clustered cases according to urgency level. Missions prioritized as highly urgent by SRCCAD, and EMS missions dispatched for medical cases, such as acute coronary syndrome, stroke, and out-of-hospital cardiac arrest, were clustered in one cohort called high urgent medical emergencies (HUME). Similarly, high urgent trauma emergencies (HUTE) of different patterns were also clustered. Demographic features available in the registry that were extracted are sex, age and geographical location. Patients age was categorized into three different age categories according to Saudi Arabian law; child: patient with an age below 15 years, adult: patient equal to or over 15 years but younger than 60 years old, and elderly: patient equal to or more than 60 years of age. Urban locations were defined as an area where metropolitan and micropolitan cities are located and have a total population of equal or more than 5000 inhabitants. On the other side, areas less than 5000 people or outside urban geographical locations were considered rural.

We included the most considered period during the year study. In Saudi Arabia, the weekdays are considered from Sunday to Thursday while the Friday and Saturday are the weekends. Period of the day categorized into two categories; office time, which is the time that starts from 8:00 AM to 4:00 PM from Sunday to Thursday, while the home time is defined as the time that starts from 4:01 PM on the same day up to the next day 7:59 AM side by side with 48 hours of the weekend Friday and Saturday. Working shifts are the two daily intervals that Saudi EMS schedules to provide emergency services. It is composed of two periods; the day shift from 8:00 AM to 8:00 PM and the night shift from 8:00 PM to 8:00 AM. We also included season. The winter season officially starts from Mid-December to Mid-March, then the spring, which starts from Mid-March until Mid-June. Summer starts from Mid-June to Mid-December, followed by Autumn, which starts from Mid-September 21 and ends by Mid-December.[20]

Operating vehicle types represented by the three types of crews providing EMS for the clustered emergencies were included. The first, Ambulance type II transporting vehicle (BLS-ambulance) is the vehicle equipped by two EMT, who can perform basic life support and rapid patient transport to hospitals. MICU is another transporting vehicle capable of highly qualified physician-based or paramedics exposed to long-term training equal to or more than four years. The last type of vehicle is RRNTV, which is operated in the last decade to arrive at the scene earlier than the transporting vehicle, and it is also operated by highly experienced EMS providers, often an EMS paramedic. The crew of RRNTV can give ALS and do necessary medical work to prepare the victims to be transported. Hospitals that receive emergency patients are of two types. We also include emergency departments (EDs) based on the two types of hospitals. Governmental hospitals are non-profitable healthcare organizations funded by the Saudi authorities to provide health services for all Saudi citizens. Private hospitals are profitable healthcare organizations operated by non-governmental healthcare firms for healthcare services. Selection of hospital according to SRCA is transporting patient to the nearest hospital, unless closes hospital announce its diversion status.

Statistical Analysis

The median and interquartile range were computed for response time, OST, travel time, hospital time and total EMS time, and compared between men and women using the Mann-Whitney U Test. The Kruskal-Wallis and Mann-Whitney U Test were conducted to test for differences in OST based on different demographics related to patients' background, stratified by sex. The following factors were considered: age category, geographical location, period of requesting EMS services, season, emergency type (medical or trauma), emergency vehicles dispatched, type of hospital to which the patient was transferred after.

To assess what variables were associated with OST, first simple linear regression was performed to identify the OST difference between different independent predictive variables. After that, multivariable linear regression was used to identify what variables were independently associated with OST.

Furthermore, we conducted logistic regression to assess the association between variables and the odds of an OST of more than 15 minutes based on the SRCCAD indicator. Data were presented as ORs with 95% CIs. We considered $p < 0.05$ as statistically significant.

RESULTS

Characteristics of study subjects

During the study period, 35,944 missions of two types – transporting and non-transporting vehicles – were dispatched to the scene. RRNTV were accounted to 3,397 (9.5%) while the transporting vehicles were 32,547 (90.5%); BLS-Ambulance 25,988 (72.3%), MICU 6,559 (18.2%). Subsequently, 32,547 high emergency patients were transported to Riyadh province hospitals.

Figure 1 presents the flow chart of the transported patients. The study exclusion criteria of records removal show that 443 missions' records were excluded because of gynaecological emergencies, and 8,380 missions' records were removed due to missed data related to sex, age, and geographical locations. Given to lower extreme outliers that were registered the OST as a zero-value due to system errors, 1,898 missions' records were excluded to avoid bias. Therefore, 24,338 missions that represented 21,878 transported patients were initially included. However, 2,460 additional records were excluded because they represented supportive RRNTV's crews who participated as logistic support side by side to BLS-ambulances crew, which were the primary transporting ambulances of the patients. Subsequently, 21,878 missions of highly emergency patients were included in this study. We found that 14,454 (66.1%) of cases were male. In total, 14,454 (66.1%) missions were for HUME, and 7,424 (33.9%) for HUTE. Of all, 66.5% of cases were attended at the scene by BLS-ambulances crews, 22.3% by MICU ambulances crews, and 11.2% by two crews; 50% of them are RRNTV, and the remaining 50% were BLS-ambulances.

Main results

Table 1 shows time intervals of ambulance service runs, including response time, OST, travel time, and hospital time. The study showed that each duration of OST and travel time for the HUME cohort significantly differed between men and women. The median OST of HUME for women 23 minutes (IQR 16 – 31 minutes) was significantly longer than men 20 minutes (IQR 13 – 29 minutes), p< 0.001. The median travel time for women 19 minutes (IQR 10 – 29 minutes) was significantly longer than men 18.0 minutes (IQR 10 – 29 minutes), p<0.001.

Table 1 The consecutive time intervals of EMS urgent missions according to the two clustered emergency' cases cohorts for 21,878 transported patients**.**

EMS Intervals	Emergency Type	Male		Female	
		No.	Median (IQR)	No.	Median (SD)†
Response Time	HUM Emergencies	8,686	17.0 (12.5 – 23.2)	6,912	17.0 (12.6 – 23.1)
	HUT Emergencies	5,768	15.7 (11.2 – 22.0)	512	15.6 (11.5 – 21.5)
On-Scene time	HUM Emergencies	8,686	20.0 (13.0 – 29.0)	6,912	23.0 (16.0 – 31.0)*
	HUT Emergencies	5,768	15.0 (9.0 – 21.0)	512	15.0 (10.0 – 22.0)
Travel time	HUM Emergencies	8,686	18.0 (10.0 – 29.0)	6,912	19.0 (11.0 – 31.0)*
	HUT Emergencies	5,768	19.0 (11.0 – 30.0)	512	18.0 (12.0 – 30.0)
Hospital time	HUM Emergencies	8,686	17.0 (6.0 – 27.0)	6,912	16.0 (5.0 – 27.0)
	HUT Emergencies	5,768	18.0 (6.0 – 28.0)	512	17.0 (6.0 – 29.0)
Total EMS Time	HUM Emergencies	8,686	79.3 (63.7 – 97.1)	6,912	82.8 (67.0 – 99.8)*
	HUT Emergencies	5,768	73.8 (58.0 – 92.3)	512	74.7 (60.8 – 91.5)

†Mann-Whitney U Test
* Statistically significant difference at p-value <0.05
EMS, Emergency Medical Services; HUM, High Urgent Medical; HUT, High Urgent Trauma

Table 2 shows the median and IQR stratified by patients' demographic and background factors for both HUTE and HUME causes. The total median OST was significantly longer for women 22 minutes (IQR 15 – 30 minutes) than men 18 minutes (IQR 11 – 26 minutes), p = 0.001. Most differences between men and women were significant, all showing longer OST for women. For men, all characteristics besides period of the day, period of the week, and working shift showed a significant difference in OST, for women all besides emergency type.

Table 2 Median on-scene time difference between sexes for high urgent transported patients (N=21,878).

	Male		Female	
	No. (%)	**Median (IQR)** †	**No. (%)**	**Median (IQR)** †,‡
Patients (No./N)	14,454 (66.1)	18.0 (11.0 – 26.0)	7,424 (33.9)	22.0 (15.0 – 30.0)♣
Emergency type				
HUME	8,686 (60.1)	20.0 (13.0 – 29.0)*	6,912 (93.1)	23.0 (16.0 – 31.0)*♣
HUTE	5,768 (39.9)	15.0 (9.0 – 21.0)*	512 (6.9)	15.0 (10.0 – 22.0)*
Age Category				
Child <15	550 (3.8)	14.5 (9.0 – 22.0)*	267 (3.6)	18.0 (11.0 – 25.0)*♣
Adult 15– <60	9,803 (67.8)	16.0 (10.0 – 24.0)*	3,299 (44.4)	21.0 (14.0 – 29.0)*♣
Elderly ≥60	4,101 (28.4)	22.0 (15.0 – 30.0)*	3,858 (52.0)	23.0 (17.0 – 31.0)*♣
Scene location				
Urban	13,562 (93.8)	18.0 (12.0 – 26.0)*	7,238 (97.5)	22.0 (16.0 – 30.0)*♣
Rural	892 (6.2)	11.0 (6.0 – 19.0)*	186 (2.5)	15.0 (9.0 – 21.0)*♣
Daily hours				
Home time	10,901 (75.4)	18.0 (11.0 – 26.0)	5,433 (73.2)	22.0 (15.0 – 30.0)♣
office time	3,553 (24.6)	18.0 (11.0 – 26.0)	1,991 (26.8)	22.0 (15.0 – 30.0)♣
Week days				
Sun-Thursday	10,300 (71.3)	18.0 (11.0 – 26.0)	5,333 (71.8)	22.0 (15.0 – 30.0)♣
Weekend	4,152 (28.7)	18.0 (11.0 – 26.0)	2,091 (28.2)	22.0 (15.0 – 30.0)♣
Working shift				
Day shift	6,770 (46.8)	18.0 (11.0 – 26.0)	3,652 (49.2)	22.0 (15.0 – 30).0♣
Night shift	7,684 (53.2)	18.0 (11.0 – 26.0)	3,772 (50.8)	22.0 (15.0 – 30.0)♣
Season				
Winter	3,512 (24.3)	19.0 (12.0 – 27.0)*	1,901 (25.6)	23.0 (16.0 – 31.0)*♣
Spring	3,583 (24.8)	18.0 (11.0 – 26.0)*	1,756 (23.7)	22.0 (15.0 – 30.0)*♣
Summer	3,573 (24.7)	17.0 (11.0 – 25.0)*	1,771 (23.9)	22.0 (15.0 – 30.0)*♣
Autumn	3,786 (26.2)	18.0 (12.0 – 25.0)*	1,996 (26.9)	22.0 (15.0 – 29.0)*♣
Vehicle types				
BLS	9,722 (67.3)	17.0 (10.0 – 24.0)*	4,817 (64.9)	21.0 (14.0 – 29.0)*♣
MICU	3,204 (22.2)	20.0 (13.0 – 28.0)*	1,675 (22.6)	24.0 (17.0 – 31.0)*♣
Two crews§	1,528 (10.6)	22.0 (16.0 – 30.0)*	932 (12.6)	25.0 (19.0 – 33.0)*♣
Receiving EDs	14,391¶		7,402♦	
Governmental	12,165 (84.2)	18.0 (11.0 – 26.0)*	6,271 (84.5)	22.0 (15.0 – 30.0)*♣
Private	2,226 (15.4)	19.0 (13.0 – 28.0)*	1,131 (15.2)	23.0 (17.0 – 31.0)*♣

† KRUSKAL_WALLIS. ‡Mann-Whitney Test. §Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ¶63 removed because of undocumented hospital.♦22 removed because of undocumented hospital. ♣Statistically significance at p-value <0.05 between groups. *Statistically significance at p-value <0.05 within group. *♣Statistically significance at p-value <0.05 within group and between groups. BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

Table 3 illustrates the association between different variables and OST. Emergency type, sex, age category, geographical locations, types of vehicles, and hospital type were all significantly

associated with OST in the crude, or adjusted analyses. When adjusted for other variables, all besides working hours were retained in the model.

Table 3 Simple linear and multivariable linear regression of on-scene time according to different predictors (N=21,878).

Predictors variable	No. (%)	Crude Regression Coefficient (95% CI)	Adjusted Regression Coefficient (95% CI)
Emergency type			
HUME (ref) %(n/N)	15,598 (71.3)		
HUTE	6,280 (28.7)	-6.5 (-6.9 – - 6.1) *	-4.2 (- 4.6 – - 3.8)*
Sex			
Male (ref) %(n/N)	14,454 (66.1)		
Female	7,424 (33.9)	3.9 (3.6 – 4.3) *	1.8 (1.5 - 2.2)*
Age category			
Adult (ref) %(n/N)	13,102 (59.9)		
Child (<15)	817 (3.7)	-1.5 (- 2.4 – - 0.5)*	- 2.3 (- 3.2 – - 1.4)*
Elderly (≥60)	7,959 (36.4)	4.7 (4.3 – 5.1)*	2.1 (1.7 – 2.5)*
Scene location			
Urban (ref) %(n/N)	20,800 (95.1)		
Rural	1,078 (4.9)	-5.5 (- 6.3 – - 4.7)*	-2.6 (- 3.4 – - 1.8)*
Daily hours			
Home time (ref) %(n/N)	16,334 (74.7)		
Office time	5,544 (25.3)	0.5 (0.15 – 0.95)*	0.4 (- 0.1 – 1.0)
Seven days			
Weekdays (ref) %(n/N)	15,633 (71.5)		
Weekend	6,245 (28.5)	- 0.2 (- 0.4 – 0.4)	0.2 (- 0.2 – 0.6)
Working shift			
Day shift (ref) %(n/N)	10,422 (47.6)		
Night shift	11,456 (52.4)	- 0.5 (- 0.84 – - 0.14)*	- 0.1 (- 0.5 – 0.3)
Season			
Summer (ref) %(n/N)	5,344 (24.4)		
Winter	5,413 (24.8)	1.4 (0.9 – 1.9)*	0.8 (0.3 – 1.2)*
Spring	5,339 (24.4)	0.3 (- 0.2– 0.8)	0.1 (- 0.3 – 0.6)
Autumn	5,782 (26.4)	0.2 (0.3 – 0.6)	- 0.2 (- 0.7 – 0.3)
Ambulance vehicle			
BLS (ref) %(n/N)	14,539 (66.5)		
MICU	4,879 (22.3)	2.8 (2.3 – 3.2)*	2.3 (1.9 – 2.7)*
Two Crews†	2,460 (11.2)	4.9 (4.4 – 5.5)*	3.7 (3.2 – 4.3)*
Receiving EDs‡			
Governmental (ref)%(n/N)	18,436 (84.6)		
Private	3,357 (15.4)	1.6 (1.1 – 2.0)*	0.9 (0.5 – 1.4)*

† Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ‡ 85 records of undocumented hospitals were removed and not counted. *Statistically significance at p-value <0.05.
BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

We found that 59.4% of men had an OST of more than 15 minutes compared to 75% for women (p <0.001). Table 4 shows the findings of the crude and adjusted logistic regression models. Emergency type, sex, age category, geographical locations, types of vehicles, and hospitals type were all significantly associated with the odds of OST of more than 15 minutes, both in crude and adjusted models.

Table 4 Association of predictor variable and on-scene time longer than 15 minutes (N=21,878)

Predictive variable	No. (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
Emergency type			
HUME (ref) %(n/N)	15,598 (71.3)		
HUTE	6,280 (28.7)	0.3 (0.3 – 0.4)*	0.5 (0.47 – 0.55)*
Sex			
Male (ref) %(n/N)	14,454 (66.1)		
Female	7,424 (33.9)	2.0 (1.9 – 2.2)*	1.4 (1.3 – 1.5)*
Age Category			
Adult (ref) %(n/N)	13,102 (59.9)		
Child (<15)	817 (3.7)	0,72 (0.63 – 0.83)*	0.61 (0.5 – 0.7)*
Elderly (≥60)	7,959 (36.4)	2.5 (2.4 – 2.70)*	1.7 (1.6 – 1.8)*
Scene location			
Urban (ref) %(n/N)	20,800 (95.1)		
Rural	1,078 (4.9)	0.3 (0.3 – 0.3)*	0.5 (0.4 – 0.6)*
Daily hours			
Home time (ref) %(n/N)	16,334 (74.7)		
Office time	5,544 (25.3)	1.05 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Seven days			
Weekdays (ref) %(n/N)	15,633 (71.5)		
Weekend	6,245 (28.50	1.0 (0.9 – 1.0)	1.0 (0.9 – 1.0)
Working shift			
Day shift (ref) %(n/N)	10,422 (47.6)		
Night shift	11,456 (52.4)	1.0 (0.9 – 1.0)	1.0 (0.9 – 1.1)
Season			
Summer (ref) % (n/N)	5,344 (24.4)		
Winter	5,413 (24.8)	1.2 (1.1 – 1.3)*	1.1 (1.0 – 1.2)*
Spring	5,339 (24.4)	1.0 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Autumn	5,782 (26.4)	1.0 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Ambulance vehicle			
BLS (ref)%(n/N)	14,539 (66.5)		
MICU	4,879 (22.3)	1.7 (1.6 – 1.8)*	1.5 (1.4 – 1.7)*
Two Crews†	2,460 (11.2)	2.7 (2.5 – 3.0)*	2.2 (2.0 – 2.5)*
Receiving EDs‡			
Governmental (ref)%(n/N)	18,436 (84.6)		
Private Hospital	3,357 (15.4)	1.5 (1.4 – 1.6)*	1.3 (1.2 – 1.5)*

† Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ‡ 85 records of undocumented hospitals' EDs were removed and not counted. *Statistically significance at p-value <0.05.
BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

DISCUSSION

Both OST and total EMS time for HUME were significantly longer for women than men, while missions dispatched to HUT cases did not show a difference. Our study demonstrates that OST was also prolonged when EMS ambulances missions were dispatched for women, elderly, in urban settings, in winter, as advanced EMS services, or for transport to private hospitals.

HUME missions may be more often for clients in house-hold buildings than to HUTE missions that may be dispatched more often to open areas such as streets (e.g., for vehicle accidents). In that case, the profound sex difference in median OST in HUME missions might partly be explained by Saudi house design and culture. It is customary in Saudi Arabia for the upper floors and rooms far from the residential home's main entrance to be a suitable residence for women. Saudi houses' spaces are relatively large due to the high average number of family members. When EMS crews arrive at the scene, they must usually walk a longer distance to reach the female-patient locations. Moreover, covering the female patient and other female family members may take considerable time before the crew are allowed. However, to the best of our knowledge, no previous study has investigated the influence of culture and home designs and whether they have a role in prolonging the OST duration for men or women before. Thus, further research on this topic is warranted.

In Saudi culture, men are usually involved in decision-making related to the transportation of children and elderly of both sexes, and women of all ages. Some Saudi women demand that their primary male relative is present to discuss their health status and plan further action. Some still need guardianship for signing the consent for medical interventions, although they have the right to sign it themselves.[21 22] Hala Aldosari concluded in her recent scientific report that there was a gender-bias against women and a gap in health services accessibility. In specific circumstances, the women's guardian can prohibit them from transportation to the hospital by ambulance.[23] However, also studies in the US showed women had received less

EMS interventions and treatment compared to men.[24 25] Further qualitative research may be needed to identify factors that lead to prolonged OST at households. This study lacks the data necessary to do so.

Although we look for explanations in Saudi culture, gender-differences are not confined to our study. Studies from other countries often found that women had a longer median or average OST compared to men.[12 24 26-29] A study conducted by Aguilar et al. in the US found that women have a more extended OST than men for non-ST-elevation myocardial infarction and ST-elevation myocardial infarction, despite ECG being implemented for both men and women.[12] We found the median OST for MICU crews to be significantly longer for women, and MICU increased the odds of prolonged OST. Schull et al. found dispatching ALS crews compared to the BLS crew at the scene increase the OST by 5.6 minutes (22.0%).[26] However, our data did not include the type and number of interventions at the scene.

In our study, children represented 3.7% of EMS missions and had significantly shorter OST. Our study is consistent with multiple studies that found children's OST to be significantly shorter than adults.[28 30]. In our study elderly patients had the by far the longest median OST. Culture restrictions of face coverage for elderly females reduce with an increase in age. Elderly people of both sexes in Saudi Arabia most ordinarily live on the first floor due to comorbidities and difficulties climbing up to the upper floors. In our study, although the median OST for elderly people was longer than adults and children and given the inter-gender variation in the OST duration for elderly people, is negligible in comparison to adults and children. The plausible explanation for prolonged OST for them might be attributed to the difficulty in communication with them about the severity of their medical conditions and more time required to stabilize them.[29] A Swedish study found that an increase in age is directly proportional to an increase in OST.[31] Sullivan et al. found oldest people are significantly

associated with longer OST.[27] However, in another study, no association between age and sex and prolonged OST.[32]

More than 50% of emergency cases had an OST of greater than 15 minutes, which is the Saudi EMS standard time for all crews to perform the standard operational procedures during OST duration regardless of urgency levels. Although the median OST for HUTE is closer than HUME to the benchmark of 15-minutes, about 25% of those missions are still more than 22 minutes. McCoy et al. found OST for trauma cases of greater than 20 minutes was associated with higher odds of mortality, especially for penetrating trauma and no associations between increased odds of mortality and out-of-hospital times in blunt trauma victims.[33] A Dutch study conducted found that for every minute spent on the scene in case of out-of-hospital cardiac arrest, the odds of 30-day survival decreases.[34] We think 15-minutes may be an inappropriate standard to deal with all cases equally. There is no consensus between researchers on how long the crews should stay on the scene for out-of-hospital cardiac arrest, though the strategic role of scope and run better than stay and play become widespread.[35 36].

Strengths and limitations

Our study as retrospective study has several limitations, all pertaining to the EMS registry. The registry relies on the SRCCAD automated detection of time to compute the timeline. However, one-fourth of data were missing and we observed impossible outliers that may have arisen due to network failure during the communication between call centre and crews at the scene. Our exclusion for those missing data and outliers might have induced selection bias. Another limitation is the availability of variables that may help the gender-differences in more details, such as socioeconomic characteristics, time between onset of symptoms and EMS call, type of treatment at the scene, and OST stratified by its four phases: arrival at the scene until accessing the patient, patient assessment time, treatment phase, and

loading time. On the other hand, using registry data has provided us with much statistical power to detect between-group differences and associations for the characteristics that were available.

Perceived urgency and severity rely on the call centre's triaging system and additional confirmation by crews during arrival at the scene, which might not reflect the real patient condition when the patients arrive at the hospital. Therefore, some misclassification in the urgency types may have occurred. However, our data do reflect daily practices in which urgency levels are determined as early during the mission as possible. However, with future involvement in the EMS data set, researchers could explain those reasonable and unavoidable causes that lead to the lateness.

Considering the linking the registry data to outcomes data on patients' receiving hospital data such as mortality, 28-day survival, and 6-month survival, we showed OST statistical significance between sexes but limited to show the clinical significance. The last limitation belongs to the study design of clustering heterogeneous emergency types into two cohorts and the Saudi benchmarks of 15-minutes. As a result, our study cannot compare our finding of OST with the essential international guideline like AHA of the recommended OST for specific emergency cases like out-of-hospital cardiac arrest, acute coronary syndrome, and stroke. However, our study showed that female time to access definitive care during medical emergencies is more extended than male. With future involvement in the EMS data set, researchers could explain the relationship between time performance and EMS outcomes.

Finally, our study's generalizability might apply to other urban and rural areas of other different Saudi provinces and the other Arabian Gulf States having similar EMS systems except for the Macca city in Saudi Arabia because of Hajj and hundred-thousands of Muslims gathering during different seasons.

CONCLUSIONS

This study shows that median OST was longer than 15 minutes for more than half of transported cases. In Addition, it was longer for women for HUME at every time and place, regardless of age category, crew type, and receiving hospital. For those EMS missions that have been dispatched for HUTE, there was no difference. Furthermore, missions to children, in rural areas, for trauma patients, for crews dispatched by MICU-ambulances, in summer as a season, or transported to EDs of governmental hospitals were significant predictors for shorter OST.

Authors' Contribution: All authors conceived the study, conceptualize the ideas, supervised the study design and definition of essential terms and study measures. H.N.M, S.M.J.V.K, and DMA performed the data cleaning, management, and analysis. H.N.M was the formal analysis, and S.M.J.V.K provided statistical advice on study design and analysis. H.N.M and DMA had full access to all of the data in the study. H.N.M takes responsibility for the integrity of the data and the accuracy of data analysis. H.N.M, S.M.J.V.K, and H.R.H interpreted the data. H.N.M and H.R.H were the project administrators. H.R.H was the primary supervisor. H.N.M drafted the manuscript, and all authors contributed substantially to its revision. H.N.M takes responsibility for the paper as a whole.

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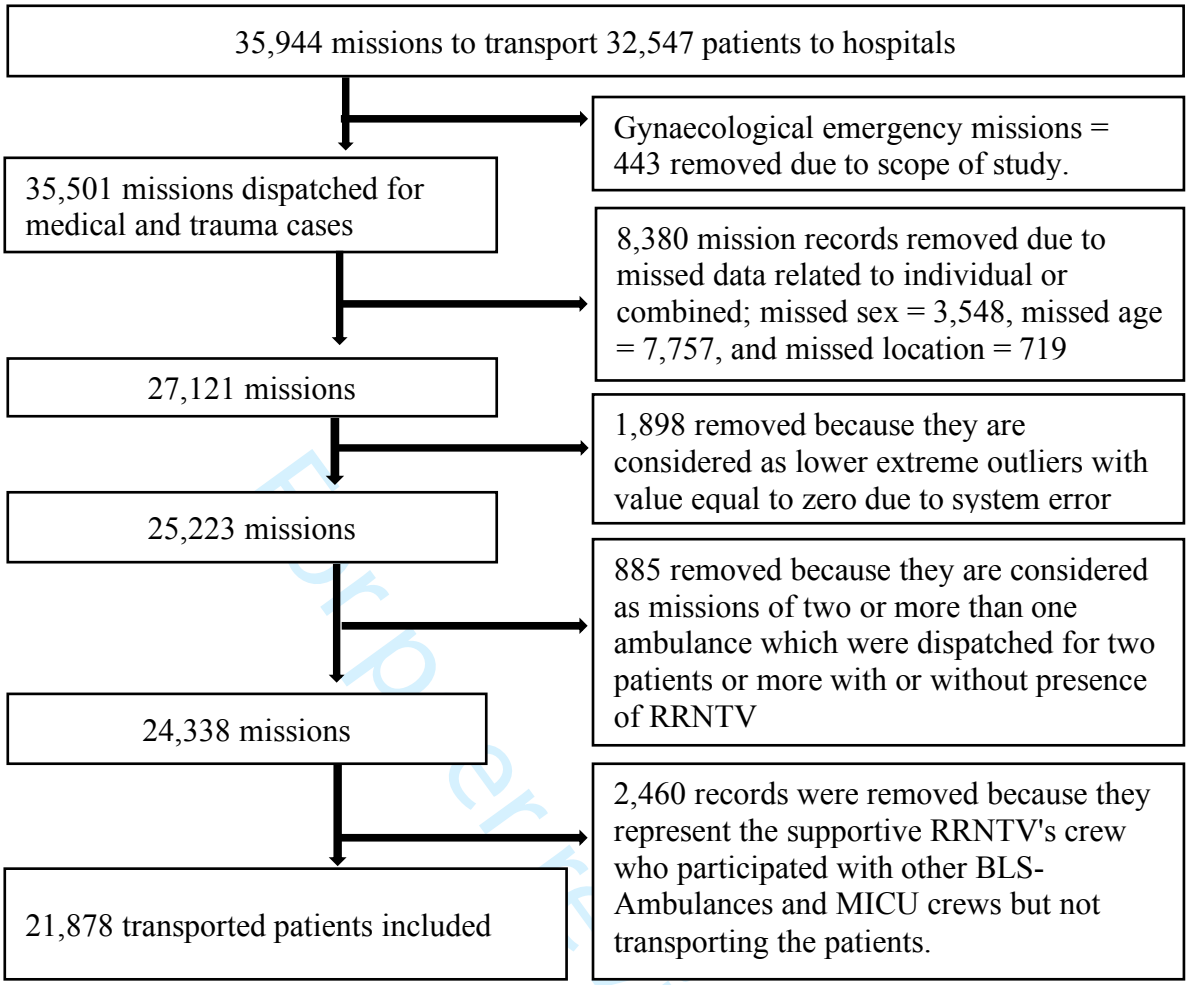

Figure 1 Flow chart of included and excluded patients

BLS, Basic Life Support; MICU, Mobile Intensive Care Unit; RRNTV, Rapid Response Non-Transporting Vehicle.

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Variation in on-scene time of emergency medical services and the extent of the difference of on-scene time between genders: A retrospective population-based registry study in Riyadh province, Saudi Arabia

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Variation in on-scene time of emergency medical services and the extent of the difference of on-scene time between genders: A retrospective population-based registry study in Riyadh province, Saudi Arabia

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ABSTRACT

Objective: To identify the inter-gender variation of on-scene time (OST) for highly urgent emergency cases conveyed by Emergency Medical Services (EMS) in Saudi Arabia and to assess other predictors of OST.

Design: A retrospective population-based registry study.

Setting: Riyadh Province is the largest province in terms of population and the second in terms of geographical area.

Participants: all highly urgent transported patients from the scene in urban and rural areas to emergency departments of governmental and private hospitals, be they medical emergencies or trauma emergencies during 2018.

Outcome measure: OST difference between men and women transported by ambulance as highly urgent emergency cases.

Results: In total, 21,878 patients were included for analysis: 33.9% women and 66.1% men. The median OST for women was 22 minutes (interquartile range [IQR] 15 – 30) and 18 minutes (IQR 11 – 26) for men, p <0.001; for medical cases, median OST was 23 minutes (IQR 16 – 31) for women compared to 20 minutes (IQR13 – 29) for men, p <0.001; for trauma cases, the median OST of both sexes was equal. We found the following additional predictors of OST: factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle, and hospital type were all significantly associated with OST in the crude or adjusted analyses. Factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle, and hospital type were also significantly associated with the odds of OST of more than 15-minutes in the crude and adjusted regression analyses.

Conclusion: The median OST was longer than 15 minutes for more than half of transported cases. For medical cases, women had a longer median OST than men. Additional predictors associated with prolonged OST were the patient's age, area (i.e., urban vs. rural), type of ambulance vehicle, and season.

Strengths and limitations of this study

- It is the first study conducted in the Arabian Gulf States that includes a large number of highly urgent cases.
- The registry relies on the Saudi Red Crescent Computerized Aid Dispatching (SRCCAD) system for automated detection of time to compute the timeline.

- Using registry data has provided us with much statistical power to detect between-group differences and associations for the available characteristics.
- Registry lacks other important demographic factors related to social status; education, income, and ethnicity, which might be associated with prolonged on-scene time.
- Time registered in the database depends on the information provided by emergency medical services (EMS) providers through wireless communications with the call centre; hence, any network failure leads to missed data.

INTRODUCTION

Emergency medical services (EMS) in Saudi Arabia have been well developed during the last decade. They provide different levels of emergency care around the clock and free of charge. Women's lower EMS utilization is one of the challenges found, besides the median total EMS time for high urgent emergency cases was found to be greater than one hour.[1 2] The on-scene time (OST) duration may take greater than half of the total period of EMS time and made up the largest proportion of total EMS delays.[3 4] Long OST may lead to consequences affecting patient outcomes.[5 6] In certain medical circumstances, patients' transportation to a hospital as soon as possible is highly recommended.[7-10] In the American Heart Association (AHA) guideline for the early management of stroke patients, it is recommended that the OST should not exceed 15 minutes.[7]

The OST duration can result from the crews' decision to collect patient history and medical examination.[11] In addition, the period of OST varies according to the patient's status with or without mortality and geographical areas as urban or rural locations. Sex may also play a factor in OST. For example, a US study found that OST in women complaining of acute chest pain was higher than in men as the crew needed more time to apply electrocardiogram.[12] Other barriers often prolong OST, particularly in trauma cases, when EMS providers' accessibility to patients is difficult. These barriers can be considered inevitable causes such as waiting for the police to arrive in an incident resulting from criminal causes or waiting for the fire brigade to extract a patient from a vehicle or a building. It can also be affected in an outdoor address such as the street during a mass gathering after road traffic accidents.[11 13] On the other hand, it can result from patient wishes and family intervention in crews' performance and decision, especially when the crew is called to a patient's house. Such intervention is significantly affected by culture and educational level and might differ between urban and rural areas.

Factors related to patient culture or demography that influence OST have not been thoroughly studied in the Arabian Gulf States. A recent systematic review found that EMS crews in Saudi Arabia consider mass gathering during road traffic accidents as one of the most frequent barriers affecting their performance to work effectively and in a timely manner while the presence of the patients' families or bystanders were cited as the second salient barrier.[2 14] Furthermore, the median of total EMS time in the Riyadh province of Saudi Arabia for trauma cases was longer in rural areas than in urban areas, and longer than what was found in other countries such as Denmark and the US.[1 15 16]

The present study aimed to investigate OST and to identify differences between sexes regarding the amount of time spent at the scene by EMS crews. It also aims to identify other

patient-related factors associated with time spent at the scene for all highly urgent emergency cases that were transported to healthcare facilities in the Riyadh province in Saudi Arabia.

METHODS

Design

This retrospective population-based registry was conducted in the Riyadh province of Saudi Arabia by using all EMS database records in the Saudi Red Crescent Computer Aid Dispatching (SRCCAD) system, from January 1, 2018, to December 31, 2018. This study complies with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).[17]

Setting

Riyadh Province is in the central part of Saudi Arabia. It has a geographical size of 404,240 km2. It has an approximate population of 6,792,776 million, according to the last national census. The province is composed of 39 different cities and Riyadh city is the capital and the largest city in Saudi Arabia. Besides, there are hundreds of rural villages dotted between or near these cities.[18] In Saudi Arabia, EMS are free of charge and can be accessed by calling the call centre, and in certain exceptional conditions, patients can visit ambulance stations distributed all over the province, including along highways. EMS crews of Riyadh province are mainly composed of two Emergency Medical Technicians (EMT). They are trained on basic life support (BLS) skills to respond to different levels of emergency cases but do not administer medicine. However, some crews are composed of physicians and emergency paramedics. These are called mobile intensive care units (MICU) and respond to certain highly critical cases and provide advanced life support (ALS). A third type of EMS crew consists of senior paramedics and are dispatched in a rapid response non-transporting vehicle (RRNTV). These often arrive earlier to provide ALS before the essential transporting ambulances. Time indicators are built-in SRCCAD with 20 minutes for response time and 15 minutes for OST regardless of urgency level.

Saudi EMS implements a strategy of scope and run, which emanated from the Anglo-American model. Most EMS chain periods are limited with a predefined time to end with the golden hour of total time.[19] The OST comprises three consecutive periods which are access, treatment, and loading time. [20] Access time starts from ambulance vehicles arrival to the scene up to crew arrival to patients' location. Treatment time is the period of patients' examination and treatment. Loading time starts from moving patients on the stretcher until the crew starts

to travel to the hospital. The policy underpinning this 15-minute benchmark for OST is that the Saudi EMS policymakers, based on the number of available crews and the volume of patients' demands, decided that 15 minutes at the scene fit their operational procedures as a policy target. An additional consideration was to avoid delaying ambulance resources from becoming unavailable for new assignments.

However, when there are multiple calls for different emergencies at once, SRCCAD may prioritize cases based on three levels of urgency and dispatch crews accordingly. Patients or their families who have guardianship have the right to refuse transportation to hospital after they have signed a formal paper of refusal against medical advice. However, EMS crews can either transport patients to the closest hospitals or treat them at the scene. The study proposal was reviewed and approved by the ethical committee in Jazan University with the registry number: REC39/9-S085. The Ethics Committee, based on no need to contact patients, agreed that informed consent was not required because of the anonymity of the data collected for routine ambulance missions and the study's retrospective design. The study data take into consideration privacy and confidentiality.

Participants and public involvement

Patients and public were not involved in developing the research question, commenting on the database, study design, outcome measures, conduct of the study, or contributing to the writing or editing of this study.

Data collection

The data were obtained through the operations and information department in the Riyadh branch directorate of Saudi Red Crescent Authority (SRCA). Data were exported from Microsoft Excel saved in an encrypted file on a hard disc and converted to an IBM SPSS file (version 25) for further analyses.

Selection of Participants

According to the Saudi EMS definition, highly urgent emergency cases are the cases that contacted EMS for support after exposure to serious or life-threatening illness or injuries that require immediate medical intervention and quick transportation to hospital emergency departments (EDs). In this study, all incoming calls for patients who were triaged at the dispatching centre of SRCCAD as highly urgent emergency cases were included. Gynaecological emergencies were excluded because of the scope of the study to compare both

sexes. In addition, we excluded records of patients for whom age, sex, or area was missing and cases categorized by the SRCCAD as cases ended by non-conveyance. We considered the potential source of bias; therefore, we excluded the lower extreme outliers with values equal to zero due to system error. Records of missions dispatched for two patients or more in one incident were excluded. Similarly, Missions that involved only Rapid Response Non-Transporting Vehicles (RRNTV) were also removed.

Methods of Measurement

We included all variables related to patient demographics and information related to dispatching missions from the time period perspective, starting from calling the call centre and ending with the patients' arrival to private and governmental hospitals. The EMS time intervals are composed of 4 different periods.[21] First, the response time, which is the time elapsed starting from receiving a call in the call centre and ended by the ambulance's crew's arrival to the scene. Second, the OST, which is the time elapsed, starting from arrival to the scene and ended by starting to travel back to EMS centre or traveling forward toward healthcare facilities. Third, the travel time, which is the time elapsed from starting to move from the scene until the crew's arrival to healthcare facilities. Fourth, is the hospital period, defined as the time elapsed from arrival to the healthcare facility until handover to emergency room staff. EMS database registry recorded all events starting from activation time and ending by crew's departure from the hospitals in the cases where the patient had been transported or when the crew leaves the scene when transportation had been refused. It measures only response time period and total EMS time period in seconds. Therefore, the total EMS time in this study reflects the four periods. We calculated the OST, travel time, hospital time according to standard EMS definition.[21] Those periods in Saudi EMS have individual target indicators, such as the response time; 20 minutes; the OST is 15 minutes, while the travel time has no indicator because of EMS providers' and patients' safety issue arise if the time indicator too strict due to the risk of driving too fast on the way to hospital. Saudi EMS would consider the OST if it exceeded 15 minutes as a prolonged OST. In cases where the call centre dispatched two or more EMS crews, we selected by calculating the actual time spent with the patient from when the first crew arrived either the RRNTV or the main transporting ambulance until the patient was transported by ambulance.

In this study, we focused only on the EMS missions that had been registered by SRCCAD as highly urgent and ended by transporting patients into hospitals. Therefore, we clustered emergency cases into two cohorts. The first cohort was the cluster of EMS mission

that were dispatched for highly urgent medical emergencies (HUME) such as acute coronary syndrome, stroke, and out-of-hospital cardiac arrest. The second cohort was the missions dispatched for highly urgent trauma emergencies (HUTE) such as road traffic accidents. Demographic features available in the registry that were extracted are sex, age and geographical area. Patients' age was divided into three categories according to Saudi Arabian law; child: patient with an age below 15 years old, adult: patient equal to or over 15 years old but younger than 60 years old, and elderly: patient equal to or more than 60 years old. Urban area was defined as an area where metropolitan and micropolitan cities are located and have a total population of equal to or more than 5000 inhabitants. On the other side, areas with less than 5000 people or outside urban geographical area were considered rural.

We considered the differences in various EMS operational times from the data collected in a one-year time period. In Saudi Arabia, the weekdays are considered from Sunday to Thursday while the Friday and Saturday are the weekends. Period of the day is categorized into two categories; office time, which is the time that starts from 8:00 AM to 4:00 PM from Sunday to Thursday, while the home time is defined as the time that starts from 4:01 PM on the same day up to the next day 7:59 AM side by side with 48 hours of the weekend Friday and Saturday. Working shifts are the two daily periods that Saudi EMS schedules to provide emergency services. It is composed of two periods: the day shift from 8:00 AM to 8:00 PM and the night shift from 8:00 PM to 8:00 AM. We also included season. The winter season officially starts from Mid-December to Mid-March, then the spring, which starts from Mid-March until Mid-June. Summer starts from Mid-June to Mid-December, followed by Autumn, which starts from Mid-September 21 and ends by Mid-December.[22]

Operating vehicle types represented by the three types of crews providing EMS for the clustered emergencies were included. The first, Ambulance type II transporting vehicle (BLS-ambulance) is the vehicle equipped by two EMT, who can perform basic life support and rapid patient transport to hospitals. MICU is another transporting vehicle capable of highly qualified physician-based or paramedics exposed to long-term training equal to or more than four years. The last type of vehicle is RRNTV, which is operated in the last decade to arrive at the scene earlier than the transporting vehicle, and it is also operated by highly experienced EMS providers, often EMS paramedics. The crew of RRNTV can give ALS and do the necessary medical work to prepare the patients to be transported. Hospitals that receive emergency patients are of two types. We also included EDs based on the two types of hospitals. Governmental hospitals are non-profit healthcare organizations funded by the Saudi authorities

to provide health services for all Saudi citizens. Private hospitals are for-profit healthcare organizations operated by non-governmental healthcare firms for healthcare services.

Statistical Analysis

The median and interquartile range were computed for response time, OST, travel time, hospital time and total EMS time, and compared between men and women using the Mann-Whitney U Test. The Kruskal-Wallis and Mann-Whitney U Test were conducted to test for differences in OST based on different demographics related to patients, stratified by sex. The following factors were considered: age category, geographical area, period of requesting EMS services, season, emergency type (medical or trauma), emergency vehicles, type of hospital to which the patient was transferred.

To assess what variables were associated with OST, first simple linear regression was performed to identify the OST difference between different independent predictive variables. After that, multivariable linear regression was used to identify which variables were independently associated with OST.

Furthermore, we conducted logistic regression to assess the association between variables and the odds of an OST of more than 15 minutes based on the SRCCAD indicator. Data were presented as ORs with 95% CIs. We considered $p < 0.05$ as statistically significant.

RESULTS

Characteristics of study subjects

During the study period, 35,944 missions of two types – transporting and non-transporting vehicles – were dispatched to the scene. RRNTV accounted for 3,397 (9.5%) missions while the transporting vehicles were 32,547 (90.5%); BLS-Ambulance 25,988 (72.3%), MICU 6,559 (18.2%). Subsequently, 32,547 high emergency patients were transported to Riyadh province hospitals.

Figure 1 presents the flow chart of the transported patients. The study exclusion criteria of records removal shows that 443 missions records were excluded because of gynaecological emergencies, and 8,380 missions' records were removed due to missing data related to sex, age, and geographical area. Given to lower extreme outliers that were registered the OST as a zero-value due to system errors, 1,898 missions' records were excluded to avoid bias. Therefore, 24,338 missions that represented 21,878 transported patients were initially included. However, 2,460 additional records were excluded because they represented supportive RRNTV's crews who participated as logistic support side by side to BLS-ambulances crews,

which were the primary transporting ambulances of the patients. Subsequently, 21,878 missions of highly urgent emergency patients were included in this study. We found that 14,454 (66.1%) of cases were male. In total, 14,454 (66.1%) missions were for HUME, and 7,424 (33.9%) for HUTE. Of all, 66.5% of cases were attended at the scene by BLS-ambulances crews, 22.3% by MICU ambulances crews, and 11.2% by two crews; 50% of them are RRNTVs, and the remaining 50% were BLS-ambulances.

Main results

Table 1 shows time periods of ambulance service runs, including response time, OST, travel time, and hospital time. The study showed that each duration of OST and travel time for the HUME cohort significantly differed between men and women. The median OST of HUME for women 23 minutes (IQR 16 – 31 minutes) was significantly longer than men 20 minutes (IQR 13 – 29 minutes), p< 0.001. The median travel time for women 19 minutes (IQR 10 – 29 minutes) was significantly longer than men 18 minutes (IQR 10 – 29 minutes), p<0.001.

Table 1 The consecutive time periods of EMS urgent missions according to the two clustered emergency cases cohorts for 21,878 transported patients**.**

EMS Intervals	Emergency Type	Male		Female	
		No.	Median (IQR)	No.	Median (SD)†
Response Time	HUM Emergencies	8,686	17.0 (12.5 – 23.2)	6,912	17.0 (12.6 – 23.1)
	HUT Emergencies	5,768	15.7 (11.2 – 22.0)	512	15.6 (11.5 – 21.5)
On-Scene time	HUM Emergencies	8,686	20.0 (13.0 – 29.0)	6,912	23.0 (16.0 – 31.0)*
	HUT Emergencies	5,768	15.0 (9.0 – 21.0)	512	15.0 (10.0 – 22.0)
Travel time	HUM Emergencies	8,686	18.0 (10.0 – 29.0)	6,912	19.0 (11.0 – 31.0)*
	HUT Emergencies	5,768	19.0 (11.0 – 30.0)	512	18.0 (12.0 – 30.0)
Hospital time	HUM Emergencies	8,686	17.0 (6.0 – 27.0)	6,912	16.0 (5.0 – 27.0)
	HUT Emergencies	5,768	18.0 (6.0 – 28.0)	512	17.0 (6.0 – 29.0)
Total EMS Time	HUM Emergencies	8,686	79.3 (63.7 – 97.1)	6,912	82.8 (67.0 – 99.8)*
	HUT Emergencies	5,768	73.8 (58.0 – 92.3)	512	74.7 (60.8 – 91.5)

†Mann-Whitney U Test
* Statistically significant difference at p-value <0.05
EMS, Emergency Medical Services; HUM, High Urgent Medical; HUT, High Urgent Trauma

Table 2 shows the median and IQR stratified by patients' demographic and background factors for both HUTE and HUME causes. The total median OST was significantly longer for women 22 minutes (IQR 15 – 30 minutes) than men 18 minutes (IQR 11 – 26 minutes), p = 0.001. Most differences related to OST between men and women were significant, all showing longer OST for women. In addition, all characteristics variables of patients and missions except the daily hours, weekdays, and working shifts were statistically significant among each group of men and women.

Table 2 Median on-scene time difference between sexes for high urgent transported patients (N=21,878).

	Male		Female	
	No. (%)	**Median (IQR) †**	**No. (%)**	**Median (IQR) †,‡**
Patients (No./N)	14,454 (66.1)	18.0 (11.0 – 26.0)	7,424 (33.9)	22.0 (15.0 – 30.0)♣
Emergency type				
HUME	8,686 (60.1)	20.0 (13.0 – 29.0)*	6,912 (93.1)	23.0 (16.0 – 31.0)*♣
HUTE	5,768 (39.9)	15.0 (9.0 – 21.0)*	512 (6.9)	15.0 (10.0 – 22.0)*
Age Category				
Child <15	550 (3.8)	14.5 (9.0 – 22.0)*	267 (3.6)	18.0 (11.0 – 25.0)*♣
Adult 15– <60	9,803 (67.8)	16.0 (10.0 – 24.0)*	3,299 (44.4)	21.0 (14.0 – 29.0)*♣
Elderly ≥60	4,101 (28.4)	22.0 (15.0 – 30.0)*	3,858 (52.0)	23.0 (17.0 – 31.0)*♣
Scene location				
Urban	13,562 (93.8)	18.0 (12.0 – 26.0)*	7,238 (97.5)	22.0 (16.0 – 30.0)*♣
Rural	892 (6.2)	11.0 (6.0 – 19.0)*	186 (2.5)	15.0 (9.0 – 21.0)*♣
Daily hours				
Home time	10,901 (75.4)	18.0 (11.0 – 26.0)	5,433 (73.2)	22.0 (15.0 – 30.0)♣
office time	3,553 (24.6)	18.0 (11.0 – 26.0)	1,991 (26.8)	22.0 (15.0 – 30.0)♣
Week days				
Sun-Thursday	10,300 (71.3)	18.0 (11.0 – 26.0)	5,333 (71.8)	22.0 (15.0 – 30.0)♣
Weekend	4,152 (28.7)	18.0 (11.0 – 26.0)	2,091 (28.2)	22.0 (15.0 – 30.0)♣
Working shift				
Day shift	6,770 (46.8)	18.0 (11.0 – 26.0)	3,652 (49.2)	22.0 (15.0 – 30).0♣
Night shift	7,684 (53.2)	18.0 (11.0 – 26.0)	3,772 (50.8)	22.0 (15.0 – 30.0)♣
Season				
Winter	3,512 (24.3)	19.0 (12.0 – 27.0)*	1,901 (25.6)	23.0 (16.0 – 31.0)*♣
Spring	3,583 (24.8)	18.0 (11.0 – 26.0)*	1,756 (23.7)	22.0 (15.0 – 30.0)*♣
Summer	3,573 (24.7)	17.0 (11.0 – 25.0)*	1,771 (23.9)	22.0 (15.0 – 30.0)*♣
Autumn	3,786 (26.2)	18.0 (12.0 – 25.0)*	1,996 (26.9)	22.0 (15.0 – 29.0)*♣
Vehicle types				
BLS	9,722 (67.3)	17.0 (10.0 – 24.0)*	4,817 (64.9)	21.0 (14.0 – 29.0)*♣
MICU	3,204 (22.2)	20.0 (13.0 – 28.0)*	1,675 (22.6)	24.0 (17.0 – 31.0)*♣
Two crews§	1,528 (10.6)	22.0 (16.0 – 30.0)*	932 (12.6)	25.0 (19.0 – 33.0)*♣
Receiving EDs	14,391¶		7,402♦	
Governmental	12,165 (84.2)	18.0 (11.0 – 26.0)*	6,271 (84.5)	22.0 (15.0 – 30.0)*♣
Private	2,226 (15.4)	19.0 (13.0 – 28.0)*	1,131 (15.2)	23.0 (17.0 – 31.0)*♣

† KRUSKAL_WALLIS. ‡Mann-Whitney Test. §Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ¶63 removed because of undocumented hospital.♦22 removed because of undocumented hospital. ♣Statistically significance at p-value <0.05 between groups. *Statistically significance at p-value <0.05 within group. *♣Statistically significance at p-value <0.05 within group and between groups. BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

Table 3 illustrates the association between different variables and OST. Emergency type, sex, age category, geographical areas, types of vehicles, and hospital type were all

significantly associated with OST in the crude, or adjusted analyses. When adjusted for other variables, all besides working hours were retained in the model.

Table 3 Simple linear and multivariable linear regression of on-scene time according to different predictors (N=21,878).

Predictors' variable	No. (%)	Crude Regression Coefficient (95% CI)	Adjusted Regression Coefficient (95% CI)
Emergency type			
HUME (ref) %(n/N)	15,598 (71.3)		
HUTE	6,280 (28.7)	-6.5 (-6.9 – - 6.1) *	-4.2 (- 4.6 – - 3.8)*
Sex			
Male (ref) %(n/N)	14,454 (66.1)		
Female	7,424 (33.9)	3.9 (3.6 – 4.3) *	1.8 (1.5 - 2.2)*
Age category			
Adult (ref) %(n/N)	13,102 (59.9)		
Child (<15)	817 (3.7)	-1.5 (- 2.4 – - 0.5)*	- 2.3 (- 3.2 – - 1.4)*
Elderly (≥60)	7,959 (36.4)	4.7 (4.3 – 5.1)*	2.1 (1.7 – 2.5)*
Scene location			
Urban (ref) %(n/N)	20,800 (95.1)		
Rural	1,078 (4.9)	-5.5 (- 6.3 – - 4.7)*	-2.6 (- 3.4 – - 1.8)*
Daily hours			
Home time (ref) %(n/N)	16,334 (74.7)		
Office time	5,544 (25.3)	0.5 (0.15 – 0.95)*	0.4 (- 0.1 – 1.0)
Seven days			
Weekdays (ref) %(n/N)	15,633 (71.5)		
Weekend	6,245 (28.5)	- 0.2 (- 0.4 – 0.4)	0.2 (- 0.2 – 0.6)
Working shift			
Day shift (ref) %(n/N)	10,422 (47.6)		
Night shift	11,456 (52.4)	- 0.5 (- 0.84 – - 0.14)*	- 0.1 (- 0.5 – 0.3)
Season			
Summer (ref) %(n/N)	5,344 (24.4)		
Winter	5,413 (24.8)	1.4 (0.9 – 1.9)*	0.8 (0.3 – 1.2)*
Spring	5,339 (24.4)	0.3 (- 0.2– 0.8)	0.1 (- 0.3 – 0.6)
Autumn	5,782 (26.4)	0.2 (0.3 – 0.6)	- 0.2 (- 0.7 – 0.3)
Ambulance vehicle			
BLS (ref) %(n/N)	14,539 (66.5)		
MICU	4,879 (22.3)	2.8 (2.3 – 3.2)*	2.3 (1.9 – 2.7)*
Two Crews†	2,460 (11.2)	4.9 (4.4 – 5.5)*	3.7 (3.2 – 4.3)*
Receiving EDs‡			
Governmental (ref)%(n/N)	18,436 (84.6)		
Private	3,357 (15.4)	1.6 (1.1 – 2.0)*	0.9 (0.5 – 1.4)*

† Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ‡ 85 records of undocumented hospitals were removed and not counted. *Statistically significance at p-value <0.05.
BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

We found that 59.4% of men had an OST of more than 15 minutes compared to 75% for women (p <0.001). Table 4 shows the findings of the crude and adjusted logistic regression models. Emergency type, sex, age category, geographical areas, types of vehicles, and hospitals type were all significantly associated with the odds of OST of more than 15 minutes, both in crude and adjusted models.

Table 4 Association of predictor variable and on-scene time longer than 15 minutes (N=21,878)

Predictive variable	No. (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
Emergency type			
HUME (ref) %(n/N)	15,598 (71.3)		
HUTE	6,280 (28.7)	0.3 (0.3 – 0.4)*	0.5 (0.47 – 0.55)*
Sex			
Male (ref) %(n/N)	14,454 (66.1)		
Female	7,424 (33.9)	2.0 (1.9 – 2.2)*	1.4 (1.3 – 1.5)*
Age Category			
Adult (ref) %(n/N)	13,102 (59.9)		
Child (<15)	817 (3.7)	0,72 (0.63 – 0.83)*	0.61 (0.5 – 0.7)*
Elderly (≥60)	7,959 (36.4)	2.5 (2.4 – 2.70)*	1.7 (1.6 – 1.8)*
Scene location			
Urban (ref) %(n/N)	20,800 (95.1)		
Rural	1,078 (4.9)	0.3 (0.3 – 0.3)*	0.5 (0.4 – 0.6)*
Daily hours			
Home time (ref) %(n/N)	16,334 (74.7)		
Office time	5,544 (25.3)	1.05 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Seven days			
Weekdays (ref) %(n/N)	15,633 (71.5)		
Weekend	6,245 (28.50	1.0 (0.9 – 1.0)	1.0 (0.9 – 1.0)
Working shift			
Day shift (ref) %(n/N)	10,422 (47.6)		
Night shift	11,456 (52.4)	1.0 (0.9 – 1.0)	1.0 (0.9 – 1.1)
Season			
Summer (ref) % (n/N)	5,344 (24.4)		
Winter	5,413 (24.8)	1.2 (1.1 – 1.3)*	1.1 (1.0 – 1.2)*
Spring	5,339 (24.4)	1.0 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Autumn	5,782 (26.4)	1.0 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Ambulance vehicle			
BLS (ref)%(n/N)	14,539 (66.5)		
MICU	4,879 (22.3)	1.7 (1.6 – 1.8)*	1.5 (1.4 – 1.7)*
Two Crews†	2,460 (11.2)	2.7 (2.5 – 3.0)*	2.2 (2.0 – 2.5)*
Receiving EDs‡			
Governmental (ref)%(n/N)	18,436 (84.6)		
Private Hospital	3,357 (15.4)	1.5 (1.4 – 1.6)*	1.3 (1.2 – 1.5)*

† Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ‡ 85 records of undocumented hospitals' EDs were removed and not counted. *Statistically significance at p-value <0.05.
BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

DISCUSSION

Both OST and total EMS time for HUME were significantly longer for women than men, while missions dispatched to HUTE did not show any difference. Our study demonstrates that OST was also prolonged when EMS ambulances missions were dispatched for women, the elderly, in urban areas, during winter, as advanced EMS services, or for transport to private hospitals.

HUME missions may be more often for patients in household buildings than to HUTE missions that may be dispatched more often to open areas such as streets (e.g., for vehicle accidents). In that case, the profound sex difference in median OST in HUME missions might partly be explained by Saudi house design and culture. It is customary in Saudi Arabia for the upper floors and rooms far from the residential home's main entrance to be a suitable residence for women. It has been proven that house design has an impact on delaying the access time to the patient after crew arrival to the scene.[23 24] Saudi houses are relatively large due to the high average number of family members. When EMS crews arrive at the scene, they must usually walk a longer distance to reach the female-patient locations. Moreover, cultural differences in Saudi Arabia require women to be fully covered at the presence of non-primary relative male such the EMS all-males crews and that is why it might take a considerable time before the crew are allowed access to the patient.

Another possible reason for the delay during the scene period for Saudi women is the loading process into ambulance vehicles by all-male crews. This process would require strict adherence by crews' members to use the ambulance stretchers even if the patient can walk independently or with crew members' support. While for Saudi men, the stretcher could be waived once the patient prefers walking without it. However, to the best of our knowledge, no previous study has investigated the influence of culture and home design and whether they have a role in prolonging the OST duration for men or women. Thus, further research on this topic is warranted.

In Saudi culture, men are usually involved in decision-making related to the transportation of children and elderly of both sexes, and women of all ages. Some Saudi women demand that their primary male relative is present to discuss their health status and plan further action. Some still need guardianship for signing the consent for medical interventions, although they have the right to sign it themselves.[25 26] In specific circumstances, the women's guardian can prohibit them from transportation to the hospital by ambulance.[27] However, studies in the US showed women had received less EMS interventions and treatment compared to men.[28 29] Further qualitative research may be needed to identify factors that lead to prolonged OST at households. This study lacks the data necessary to do so. No previous narrative inquiry has been performed to study this phenomenon in Saudi Arabia. An Australian qualitative study investigated the barriers confronting paramedics because of cultural barriers of middle eastern people living in Australia who might have a cultural resemblance to Saudi people. [30] The informants' paramedics stated that they found difficulties in providing care due to specific norms and behaviour emanating from middle east culture, and time management at the home locations was affected.[30]

Although we look for explanations in Saudi culture, gender-differences are not confined to our study. Studies from other countries often found that women had a longer median or average OST compared to men.[12 28 31-34] A study conducted by Aguilar et al. in the US found that women have a more extended OST than men for non-ST-elevation myocardial infarction and ST-elevation myocardial infarction, despite ECG being implemented for both men and women.[12] We found the median OST for MICU crews to be significantly longer for women, and MICU increased the odds of prolonged OST. Schull et al. found dispatching ALS crews compared to the BLS crew at the scene increase the OST by 5.6 minutes (22.0%).[31] However, our data did not include the type and number of interventions at the scene.

During the on-scene period, patients' history and medical examination are performed by EMS providers. In the context of other medical practices like general practice, it has been shown that women tend to take longer consultation time than men. [35] Furthermore, they may express their dissatisfaction with the allowable time as they prefer to linger a bit longer to communicate further with doctors about their problem. [36-38] Even with emergency incidents such as heart attacks, women's behaviour for seeking EMS support has been noted as one of a multitude of predisposing factors for delay response, management, or transport. For example, the self-recognition of onset of symptoms, the delay in contacting EMS or hospitals for help, presenting atypical symptoms to EMS call-takers. [39-42] These behaviours might influence the standard time required to provide the optimum healthcare for them. Moreover, these factors may misguide EMS providers of the importance of quick transport to hospitals EDs. For example, two studies from Australia and Norway have compared women diagnosed with acute myocardial infarction upon arrival to hospitals to men. The studies showed that women were less likely to be transported with sirens and lights. [43 44] A Saudi study found Saudi women had lower health literacy than men. [45] Two other Saudi studies revealed that Saudi women were less likely to use ambulances and more likely to refuse ambulance transportation than men. [1 46] Therefore, this noted long time might be partially explained by their reluctance to be transported and that the ambulance crew spent extra time to convince them.

In our study, children represented 3.7% of EMS missions and had significantly shorter OST. Our study is consistent with multiple studies that found children's OST to be significantly shorter than adults.[33 47]. In our study, elderly patients had by far the longest median OST. Cultural restrictions of face coverage for elderly females reduce with an increase in age. Elderly people of both sexes in Saudi Arabia most ordinarily live on the first floor due to comorbidities and difficulties climbing up to the upper floors. In our study, although the median OST for elderly people was longer than adults and children but the inter-gender variation in the OST

duration for elderly people is negligible in comparison to adults and children. The plausible explanation for prolonged OST for the elderly might be attributed to the difficulty in communication with them about the severity of their medical conditions and that more time was required to stabilize them.[34] A Swedish study found that an increase in age is directly proportional to an increase in OST.[48] Sullivan et al. found oldest people are significantly associated with longer OST.[32] However, in another study, no association between age and sex and prolonged OST.[49]

More than 50% of emergency cases had an OST of greater than 15 minutes, which is the Saudi EMS standard time for all crews to perform the standard operational procedures during OST regardless of urgency levels. Although the median OST for HUTE is closer than HUME to the benchmark of 15-minutes, about 25% of those missions are still more than 22 minutes. McCoy et al. found that OST for trauma cases of greater than 20 minutes was associated with higher odds of mortality, especially for penetrating trauma and no association between increased odds of mortality and out-of-hospital times in blunt trauma victims.[50] A Dutch study conducted found that for every minute spent on the scene in case of out-of-hospital cardiac arrest, the odds of 30-day survival decreases.[51] We think 15-minutes may be an inappropriate standard to deal with all cases equally. There is no consensus between researchers on how long the crews should stay on the scene for out-of-hospital cardiac arrest, although the strategic role of scope and run versus stay and play is better and has become widespread.[52 53]. In the US, Studnek et al. demonstrated that staying less than 15 minutes at the scene was deemed the appropriate time for acute coronary syndrome patients to receive reperfusion therapy in less than 90 minutes from the onset of symptoms.[54] Moreover, several studies demonstrated that OST increases were associated with adverse outcomes.[3 5 50 53 55 56] In addition, the American Stroke Association guideline recommends the OST to be ≤ 15 minutes.[7] Although Saudi EMS recognizes the value of time and applies the scope and run by

encouraging commissioned crews members to be time-efficient within a specified OST, it seems that crews are confronted with difficulties in coping with the standardized time during their time at the scene. Our study revealed EMS crews staying a half-hour or more at the scene for 25 % of adult women regardless of the calls' reasons. We compared this finding with their counterpart of adult men, and we found the difference was at a minimum 5 minutes. A significant delay on the scene can deprive women of receiving important medical intervention, unable to be provided by the ambulance crew, in a timely manner in definitive care especially in life threatening cases. Due to the longer OST for women, they are more exposed to unexpected adverse events such as late or unsafe arrival to hospitals, especially when the crews are committed to not exceeding the golden hour, the benchmark related to the total EMS time, and risk road accidents themselves.

Strengths and limitations

Our study as a retrospective study has several limitations, all pertaining to the EMS registry. The registry relies on the SRCCAD automated detection of time to compute the timeline. However, one-fourth of data were missing, and we observed impossible outliers that may have arisen due to network failure during the communication between call centre and crews at the scene. Our exclusion of those missing data and outliers might have induced selection bias. Another limitation is the non-availability of variables that may explain the gender-differences in more details, such as socioeconomic characteristics, time between onset of symptoms and EMS call, type of treatment at the scene, and OST stratified by its four phases: arrival at the scene until accessing the patient, patient assessment time, treatment phase, and loading time. On the other hand, using registry data has provided us with much statistical power to detect between-group differences and associations for the characteristics that were available.

Perceived urgency and severity rely on the call centre's triaging system and additional confirmation by crews during arrival at the scene, which might not reflect the real patient condition when the patients arrive at the hospital. Therefore, some misclassification in the urgency types may have occurred. However, our data do reflect daily practices in which urgency levels are determined as early during the mission as possible. However, with future involvement in the EMS data set, researchers could explain those reasonable and unavoidable causes that lead to the lateness.

Considering the linking of the registry data to outcomes data on patients' receiving hospital data such as mortality, 28-day survival, and 6-month survival, we showed OST statistical significance between sexes but limited to show the clinical significance. The last limitation belongs to the study design of clustering heterogeneous emergency types into two cohorts and the Saudi benchmarks of 15-minutes. As a result, our study cannot compare our finding of OST with the essential international guideline like AHA of the recommended OST for specific emergency cases like out-of-hospital cardiac arrest, acute coronary syndrome, and stroke. However, our study showed that female time to access definitive care during medical emergencies is more extended. With future involvement in the EMS data set, researchers could explain the relationship between time performance and EMS outcomes.

Finally, our study's generalizability might apply to urban and rural areas of other different Saudi provinces and the other Arabian Gulf States having similar EMS systems except for Macca city in Saudi Arabia because of Hajj and the influx of Muslims gathering during different seasons.

CONCLUSIONS

This study shows that median OST was longer than 15 minutes for more than half of transported cases. In addition, it was longer for women for HUME at every time and place,

regardless of age category, crew type, and receiving hospital. For those EMS missions that had been dispatched for HUTE, there was no difference. Furthermore, missions to children, in rural areas, for trauma patients, for crews dispatched by BLS-ambulances, in summer as a season, or transported to EDs of governmental hospitals were all significant predictors for shorter OST.

Authors' Contribution: All authors conceived the study, conceptualize the ideas, supervised the study design and definition of essential terms and study measures. H.N.M, S.M.J.V.K, and DMA performed the data cleaning, management, and analysis. H.N.M was the formal analysis, and S.M.J.V.K provided statistical advice on study design and analysis. H.N.M and DMA had full access to all of the data in the study. H.N.M takes responsibility for the integrity of the data and the accuracy of data analysis. H.N.M, S.M.J.V.K, M.E.M, and H.R.H interpreted the data. H.N.M and H.R.H were the project administrators. H.R.H was the primary supervisor. H.N.M drafted the manuscript, and all authors contributed substantially to its revision. H.N.M takes responsibility for the paper as a whole.

Conflicts of interest: no conflicts.

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Ethics approval: The Ethics Committee of Jazan University.

Data availability statement: Data are available upon reasonable request.

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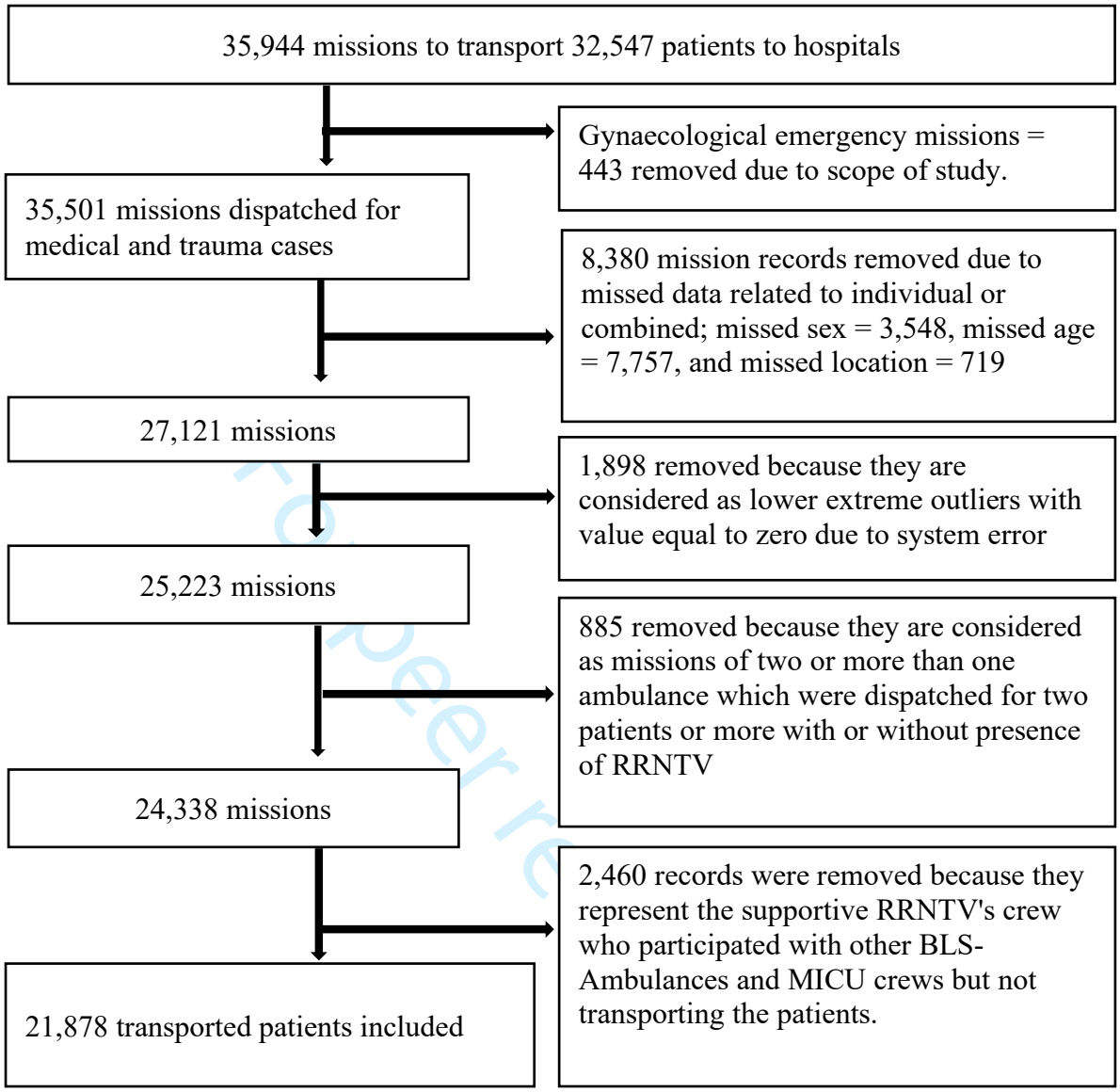
Figure 1 Flow chart of included and excluded patients.
BLS, Basic Life Support; MICU, Mobile Intensive Care Unit; RRNTV, Rapid Response Non-Transporting Vehicle.



STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2	Line 45
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Lines 45 – 62
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	Lines 121 – 151
Objectives	3	State specific objectives, including any prespecified hypotheses	4 – 5	Lines 152 – 155
Methods				
Study design	4	Present key elements of study design early in the paper	5	Lines 159 – 163
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 – 6	Lines 166 – 202
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6 – 7	Lines 216 – 227
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7 – 9	Lines 230 – 290
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7 – 9	Lines 230 – 306
Bias	9	Describe any efforts to address potential sources of bias	7	Lines 223 – 227
Study size	10	Explain how the study size was arrived at	6 – 7	Lines 216 – 227

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8 – 9	Lines 230 – 290
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9	Lines 293 – 306
		(*b*) Describe any methods used to examine subgroups and interactions	9	Lines 293 – 306
		(*c*) Explain how missing data were addressed	7	Lines 222 – 225
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed	NA	NA
		Case-control study—If applicable, explain how matching of cases and controls was addressed	NA	NA
		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	NA	NA
		(*e*) Describe any sensitivity analyses	NA	NA
		Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9 – 10	310 – 328
		(b) Give reasons for non-participation at each stage	9 – 10	315 – 323
		(c) Consider use of a flow diagram	9	315
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10	323 – 328
		(b) Indicate number of participants with missing data for each variable of interest	10 – 11	323 – 345
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	14 – 15	380 - 386
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12 – 15	331 – 386
		(*b*) Report category boundaries when continuous variables were categorized	12 – 15	332 - 386
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A	N/A

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12 – 15	375 – 386
Discussion				
Key results	18	Summarise key results with reference to study objectives	15	388 – 391
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18 – 20	499 – 526
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17 – 19	392 - 496
Generalisability	21	Discuss the generalisability (external validity) of the study results	20	527 – 530
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21	552

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Variation in on-scene time of emergency medical services and the extent of the difference of on-scene time between genders: A retrospective population-based registry study in Riyadh province, Saudi Arabia

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Variation in on-scene time of emergency medical services and the extent of the difference of on-scene time between genders: A retrospective population-based registry study in Riyadh province, Saudi Arabia

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ABSTRACT

Objective: To identify the inter-gender variation of on-scene time (OST) for highly urgent emergency cases conveyed by Emergency Medical Services (EMS) in Saudi Arabia and to assess other predictors of OST and hypothesize for possible factors delaying OST.

Design: A retrospective population-based registry study.

Setting: Riyadh Province is the largest province in terms of population and the second in terms of geographical area.

Participants: All highly urgent transported patients from the scene to emergency departments, be they medical emergencies or trauma emergencies during 2018.

Outcome measure: OST difference between men and women transported by EMS.

Results: In total, 21,878 patients were included for analysis: 33.9% women and 66.1% men. The median OST for women was 22 minutes (interquartile range [IQR] 15 – 30) and 18 minutes (IQR 11 – 26) for men, p <0.001; for medical cases, median OST was 23 minutes (IQR 16 – 31) for women compared to 20 minutes (IQR13 – 29) for men, p <0.001; for trauma cases, the median OST of both sexes was equal. We found the following additional predictors of OST: factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle, and hospital type were all significantly associated with OST in the crude or adjusted analyses. Factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle, and hospital type were also significantly associated with the odds of OST of more than 15-minutes in the crude and adjusted regression analyses.

Conclusion: The median OST was longer than 15 minutes for more than half of transported cases. For medical cases, women had a longer median OST than men. Additional predictors associated with prolonged OST were the patient's age, area (i.e., urban vs. rural), type of ambulance vehicle, and season. These findings are hypothesis generating and require further studies.

Strengths and limitations of this study

- It is the first study conducted in the Arabian Gulf States that includes a large number of highly urgent cases.
- The registry relies on the Saudi Red Crescent Computerized Aid Dispatching (SRCCAD) system for automated detection of time to compute the timeline.
- Using registry data has provided us with much statistical power to detect between-group differences and associations for the available characteristics.

- Registry lacks other important demographic factors related to social status; education, income, and ethnicity, which might be associated with prolonged on-scene time.
- Time registered in the database depends on the information provided by emergency medical services (EMS) providers through wireless communications with the call centre; hence, any network failure leads to missed data.

INTRODUCTION

Emergency medical services (EMS) in Saudi Arabia have been well developed during the last decade. They provide different levels of emergency care around the clock and free of charge. Women's lower EMS utilization is one of the challenges found, besides the median total EMS time for high urgent emergency cases was found to be greater than one hour.[1 2] The on-scene time (OST) duration may take greater than half of the total period of EMS time and made up the largest proportion of total EMS delays.[3 4] Long OST may lead to consequences affecting patient outcomes.[5 6] In certain medical circumstances, patients' transportation to a hospital as soon as possible is highly recommended.[7-10] In the American Heart Association (AHA) guideline for the early management of stroke patients, it is recommended that the OST should not exceed 15 minutes.[7]

The OST duration can result from the crews' decision to collect patient history and medical examination.[11] In addition, the period of OST varies according to the patient's status with or without mortality and geographical areas as urban or rural locations. Sex may also play a factor in OST. For example, a US study found that OST in women complaining of acute chest pain was higher than in men as the crew needed more time to apply electrocardiogram.[12] Other barriers often prolong OST, particularly in trauma cases, when EMS providers' accessibility to patients is difficult. These barriers can be considered inevitable causes such as waiting for the police to arrive in an incident resulting from criminal causes or waiting for the fire brigade to extract a patient from a vehicle or a building. It can also be affected in an outdoor address such as the street during a mass gathering after road traffic accidents.[11 13] On the other hand, it can result from patient wishes and family intervention in crews' performance and decision, especially when the crew is called to a patient's house. Such intervention is significantly affected by culture and educational level and might differ between urban and rural areas.

Factors related to patient culture or demography that influence OST have not been thoroughly studied in the Arabian Gulf States. A recent systematic review found that EMS crews in Saudi Arabia consider mass gathering during road traffic accidents as one of the most frequent barriers affecting their performance to work effectively and in a timely manner while the presence of the patients' families or bystanders were cited as the second salient barrier.[2 14] Furthermore, the median of total EMS time in the Riyadh province of Saudi Arabia for trauma cases was longer in rural areas than in urban areas, and longer than what was found in other countries such as Denmark and the US.[1 15 16]

The present study aimed to investigate OST and to identify differences between sexes regarding the amount of time spent at the scene by EMS crews. It also aims to identify other

patient-related factors associated with time spent at the scene for all highly urgent emergency cases that were transported to healthcare facilities in the Riyadh province in Saudi Arabia and to hypothesize for possible factors delaying OST.

METHODS

Design

This retrospective population-based registry was conducted in the Riyadh province of Saudi Arabia by using all EMS database records in the Saudi Red Crescent Computer Aid Dispatching (SRCCAD) system, from January 1, 2018, to December 31, 2018. This study complies with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).[17]

Setting

Riyadh Province is in the central part of Saudi Arabia. It has a geographical size of 404,240 km2. It has an approximate population of 6,792,776 million, according to the last national census. The province is composed of 39 different cities and Riyadh city is the capital and the largest city in Saudi Arabia. Besides, there are hundreds of rural villages dotted between or near these cities.[18] In Saudi Arabia, EMS are free of charge and can be accessed by calling the call centre, and in certain exceptional conditions, patients can visit ambulance stations distributed all over the province, including along highways. EMS crews of Riyadh province are mainly composed of two Emergency Medical Technicians (EMT). They are trained on basic life support (BLS) skills to respond to different levels of emergency cases but do not administer medicine. However, some crews are composed of physicians and emergency paramedics. These are called mobile intensive care units (MICU) and respond to certain highly critical cases and provide advanced life support (ALS). A third type of EMS crew consists of senior paramedics and are dispatched in a rapid response non-transporting vehicle (RRNTV). These often arrive earlier to provide ALS before the essential transporting ambulances. Time indicators are built-in SRCCAD with 20 minutes for response time and 15 minutes for OST regardless of urgency level.

Saudi EMS implements a strategy of scoop and run, which emanated from the Anglo-American model. Most EMS chain periods are limited with a predefined time to end with the golden hour of total time.[19] The OST comprises three consecutive periods which are access, treatment, and loading time. [20] Access time starts from ambulance vehicles arrival to the scene up to crew arrival to patients' location. Treatment time is the period of patients' examination

and treatment. Loading time starts from moving patients on the stretcher until the crew starts to travel to the hospital. The policy underpinning this 15-minute benchmark for OST is that the Saudi EMS policymakers, based on the number of available crews and the volume of patients' demands, decided that 15 minutes at the scene fit their operational procedures as a policy target. An additional consideration was to avoid delaying ambulance resources from becoming unavailable for new assignments.

However, when there are multiple calls for different emergencies at once, SRCCAD may prioritize cases based on three levels of urgency and dispatch crews accordingly. Patients or their families who have guardianship have the right to refuse transportation to hospital after they have signed a formal paper of refusal against medical advice. However, EMS crews can either transport patients to the closest hospitals or treat them at the scene. The study proposal was reviewed and approved by the ethical committee in Jazan University with the registry number: REC39/9-S085. The Ethics Committee, based on no need to contact patients, agreed that informed consent was not required because of the anonymity of the data collected for routine ambulance missions and the study's retrospective design. The study data take into consideration privacy and confidentiality.

Participants and public involvement

Patients and public were not involved in developing the research question, commenting on the database, study design, outcome measures, conduct of the study, or contributing to the writing or editing of this study.

Data collection

The data were obtained through the operations and information department in the Riyadh branch directorate of Saudi Red Crescent Authority (SRCA). Data were exported from Microsoft Excel saved in an encrypted file on a hard disc and converted to an IBM SPSS file (version 25) for further analyses.

Selection of Participants

According to the Saudi EMS definition, highly urgent emergency cases are the cases that contacted EMS for support after exposure to serious or life-threatening illness or injuries that require immediate medical intervention and quick transportation to hospital emergency departments (EDs). In this study, all incoming calls for patients who were triaged at the dispatching centre of SRCCAD as highly urgent emergency cases were included.

Gynaecological emergencies were excluded because of the scope of the study to compare both sexes. In addition, we excluded records of patients for whom age, sex, or area was missing and cases categorized by the SRCCAD as cases ended by non-conveyance. We considered the potential source of bias; therefore, we excluded the lower extreme outliers with values equal to zero due to system error. Records of missions dispatched for two patients or more in one incident were excluded. Similarly, Missions that involved only Rapid Response Non-Transporting Vehicles (RRNTV) were also removed.

Methods of Measurement

We included all variables related to patient demographics and information related to dispatching missions from the time period perspective, starting from calling the call centre and ending with the patients' arrival to private and governmental hospitals. The EMS time intervals are composed of 4 different periods.[21] First, the response time, which is the time elapsed starting from receiving a call in the call centre and ended by the ambulance's crew's arrival to the scene. Second, the OST, which is the time elapsed, starting from arrival to the scene and ended by starting to travel back to EMS centre or traveling forward toward healthcare facilities. Third, the travel time, which is the time elapsed from starting to move from the scene until the crew's arrival to healthcare facilities. Fourth, is the hospital period, defined as the time elapsed from arrival to the healthcare facility until handover to emergency room staff. EMS database registry recorded all events starting from activation time and ending by crew's departure from the hospitals in the cases where the patient had been transported or when the crew leaves the scene when transportation had been refused. It measures only response time period and total EMS time period in seconds. Therefore, the total EMS time in this study reflects the four periods. We calculated the OST, travel time, hospital time according to standard EMS definition.[21] Those periods in Saudi EMS have individual target indicators, such as the response time; 20 minutes; the OST is 15 minutes, while the travel time has no indicator because of EMS providers' and patients' safety issue arise if the time indicator too strict due to the risk of driving too fast on the way to hospital. Saudi EMS would consider the OST if it exceeded 15 minutes as a prolonged OST. In cases where the call centre dispatched two or more EMS crews, we selected by calculating the actual time spent with the patient from when the first crew arrived either the RRNTV or the main transporting ambulance until the patient was transported by ambulance.

In this study, we focused only on the EMS missions that had been registered by SRCCAD as highly urgent and ended by transporting patients into hospitals. Therefore, we

clustered emergency cases into two cohorts. The first cohort was the cluster of EMS mission that were dispatched for highly urgent medical emergencies (HUME) such as acute coronary syndrome, stroke, and out-of-hospital cardiac arrest. The second cohort was the missions dispatched for highly urgent trauma emergencies (HUTE) such as road traffic accidents. Demographic features available in the registry that were extracted are sex, age and geographical area. Patients' age was divided into three categories according to Saudi Arabian law; child: patient with an age below 15 years old, adult: patient equal to or over 15 years old but younger than 60 years old, and elderly: patient equal to or more than 60 years old. Urban area was defined as an area where metropolitan and micropolitan cities are located and have a total population of equal to or more than 5000 inhabitants. On the other side, areas with less than 5000 people or outside urban geographical area were considered rural.

We considered the differences in various EMS operational times from the data collected in a one-year time period. In Saudi Arabia, the weekdays are considered from Sunday to Thursday while the Friday and Saturday are the weekends. Period of the day is categorized into two categories; office time, which is the time that starts from 8:00 AM to 4:00 PM from Sunday to Thursday, while the home time is defined as the time that starts from 4:01 PM on the same day up to the next day 7:59 AM side by side with 48 hours of the weekend Friday and Saturday. Working shifts are the two daily periods that Saudi EMS schedules to provide emergency services. It is composed of two periods: the day shift from 8:00 AM to 8:00 PM and the night shift from 8:00 PM to 8:00 AM. We also included season. The winter season officially starts from Mid-December to Mid-March, then the spring, which starts from Mid-March until Mid-June. Summer starts from Mid-June to Mid-December, followed by Autumn, which starts from Mid-September 21 and ends by Mid-December.[22]

Operating vehicle types represented by the three types of crews providing EMS for the clustered emergencies were included. The first, Ambulance type II transporting vehicle (BLS-ambulance) is the vehicle equipped by two EMT, who can perform basic life support and rapid patient transport to hospitals. MICU is another transporting vehicle capable of highly qualified physician-based or paramedics exposed to long-term training equal to or more than four years. The last type of vehicle is RRNTV, which is operated in the last decade to arrive at the scene earlier than the transporting vehicle, and it is also operated by highly experienced EMS providers, often EMS paramedics. The crew of RRNTV can give ALS and do the necessary medical work to prepare the patients to be transported. Hospitals that receive emergency patients are of two types. We also included EDs based on the two types of hospitals. Governmental hospitals are non-profit healthcare organizations funded by the Saudi authorities

to provide health services for all Saudi citizens. Private hospitals are for-profit healthcare organizations operated by non-governmental healthcare firms for healthcare services.

Statistical Analysis

The median and interquartile range were computed for response time, OST, travel time, hospital time and total EMS time, and compared between men and women using the Mann-Whitney U Test. The Kruskal-Wallis and Mann-Whitney U Test were conducted to test for differences in OST based on different demographics related to patients, stratified by sex. The following factors were considered: age category, geographical area, period of requesting EMS services, season, emergency type (medical or trauma), emergency vehicles, type of hospital to which the patient was transferred.

To assess what variables were associated with OST, first simple linear regression was performed to identify the OST difference between different independent predictive variables. After that, multivariable linear regression was used to identify which variables were independently associated with OST.

Furthermore, we conducted logistic regression to assess the association between variables and the odds of an OST of more than 15 minutes based on the SRCCAD indicator. Data were presented as ORs with 95% CIs. We considered $p < 0.05$ as statistically significant.

RESULTS

Characteristics of study subjects

During the study period, 35,944 missions of two types – transporting and non-transporting vehicles – were dispatched to the scene. RRNTV accounted for 3,397 (9.5%) missions while the transporting vehicles were 32,547 (90.5%); BLS-Ambulance 25,988 (72.3%), MICU 6,559 (18.2%). Subsequently, 32,547 high emergency patients were transported to Riyadh province hospitals.

Figure 1 presents the flow chart of the transported patients. The study exclusion criteria of records removal shows that 443 missions records were excluded because of gynaecological emergencies, and 8,380 missions' records were removed due to missing data related to sex, age, and geographical area. Given to lower extreme outliers that were registered the OST as a zero-value due to system errors, 1,898 missions' records were excluded to avoid bias. Therefore, 24,338 missions that represented 21,878 transported patients were initially included. However, 2,460 additional records were excluded because they represented supportive RRNTV's crews who participated as logistic support side by side to BLS-ambulances crews,

which were the primary transporting ambulances of the patients. Subsequently, 21,878 missions of highly urgent emergency patients were included in this study. We found that 14,454 (66.1%) of cases were male. In total, 14,454 (66.1%) missions were for HUME, and 7,424 (33.9%) for HUTE. Of all, 66.5% of cases were attended at the scene by BLS-ambulances crews, 22.3% by MICU ambulances crews, and 11.2% by two crews; 50% of them are RRNTVs, and the remaining 50% were BLS-ambulances.

Main results

Table 1 shows time periods of ambulance service runs, including response time, OST, travel time, and hospital time. The study showed that each duration of OST and travel time for the HUME cohort significantly differed between men and women. The median OST of HUME for women 23 minutes (IQR 16 – 31 minutes) was significantly longer than men 20 minutes (IQR 13 – 29 minutes), p< 0.001. The median travel time for women 19 minutes (IQR 10 – 29 minutes) was significantly longer than men 18 minutes (IQR 10 – 29 minutes), p<0.001.

Table 1 The consecutive time periods of EMS urgent missions according to the two clustered emergency cases cohorts for 21,878 transported patients**.**

EMS Intervals	Emergency Type	Male		Female	
		No.	Median (IQR)	No.	Median (SD)†
Response Time	HUM Emergencies	8,686	17.0 (12.5 – 23.2)	6,912	17.0 (12.6 – 23.1)
	HUT Emergencies	5,768	15.7 (11.2 – 22.0)	512	15.6 (11.5 – 21.5)
On-Scene time	HUM Emergencies	8,686	20.0 (13.0 – 29.0)	6,912	23.0 (16.0 – 31.0)*
	HUT Emergencies	5,768	15.0 (9.0 – 21.0)	512	15.0 (10.0 – 22.0)
Travel time	HUM Emergencies	8,686	18.0 (10.0 – 29.0)	6,912	19.0 (11.0 – 31.0)*
	HUT Emergencies	5,768	19.0 (11.0 – 30.0)	512	18.0 (12.0 – 30.0)
Hospital time	HUM Emergencies	8,686	17.0 (6.0 – 27.0)	6,912	16.0 (5.0 – 27.0)
	HUT Emergencies	5,768	18.0 (6.0 – 28.0)	512	17.0 (6.0 – 29.0)
Total EMS Time	HUM Emergencies	8,686	79.3 (63.7 – 97.1)	6,912	82.8 (67.0 – 99.8)*
	HUT Emergencies	5,768	73.8 (58.0 – 92.3)	512	74.7 (60.8 – 91.5)

†Mann-Whitney U Test
* Statistically significant difference at p-value <0.05
EMS, Emergency Medical Services; HUM, High Urgent Medical; HUT, High Urgent Trauma

Table 2 shows the median and IQR stratified by patients' demographic and background factors for both HUTE and HUME causes. The total median OST was significantly longer for women 22 minutes (IQR 15 – 30 minutes) than men 18 minutes (IQR 11 – 26 minutes), p = 0.001. Most differences related to OST between men and women were significant, all showing longer OST for women. In addition, all characteristics variables of patients and missions except the daily hours, weekdays, and working shifts were statistically significant among each group of men and women.

Table 2 Median on-scene time difference between sexes for high urgent transported patients (N=21,878).

	Male		Female	
	No. (%)	**Median (IQR) †**	**No. (%)**	**Median (IQR) †,‡**
Patients (No./N)	14,454 (66.1)	18.0 (11.0 – 26.0)	7,424 (33.9)	22.0 (15.0 – 30.0)♣
Emergency type				
HUME	8,686 (60.1)	20.0 (13.0 – 29.0)*	6,912 (93.1)	23.0 (16.0 – 31.0)*♣
HUTE	5,768 (39.9)	15.0 (9.0 – 21.0)*	512 (6.9)	15.0 (10.0 – 22.0)*
Age Category				
Child <15	550 (3.8)	14.5 (9.0 – 22.0)*	267 (3.6)	18.0 (11.0 – 25.0)*♣
Adult 15– <60	9,803 (67.8)	16.0 (10.0 – 24.0)*	3,299 (44.4)	21.0 (14.0 – 29.0)*♣
Elderly ≥60	4,101 (28.4)	22.0 (15.0 – 30.0)*	3,858 (52.0)	23.0 (17.0 – 31.0)*♣
Scene location				
Urban	13,562 (93.8)	18.0 (12.0 – 26.0)*	7,238 (97.5)	22.0 (16.0 – 30.0)*♣
Rural	892 (6.2)	11.0 (6.0 – 19.0)*	186 (2.5)	15.0 (9.0 – 21.0)*♣
Daily hours				
Home time	10,901 (75.4)	18.0 (11.0 – 26.0)	5,433 (73.2)	22.0 (15.0 – 30.0)♣
office time	3,553 (24.6)	18.0 (11.0 – 26.0)	1,991 (26.8)	22.0 (15.0 – 30.0)♣
Week days				
Sun-Thursday	10,300 (71.3)	18.0 (11.0 – 26.0)	5,333 (71.8)	22.0 (15.0 – 30.0)♣
Weekend	4,152 (28.7)	18.0 (11.0 – 26.0)	2,091 (28.2)	22.0 (15.0 – 30.0)♣
Working shift				
Day shift	6,770 (46.8)	18.0 (11.0 – 26.0)	3,652 (49.2)	22.0 (15.0 – 30).0♣
Night shift	7,684 (53.2)	18.0 (11.0 – 26.0)	3,772 (50.8)	22.0 (15.0 – 30.0)♣
Season				
Winter	3,512 (24.3)	19.0 (12.0 – 27.0)*	1,901 (25.6)	23.0 (16.0 – 31.0)*♣
Spring	3,583 (24.8)	18.0 (11.0 – 26.0)*	1,756 (23.7)	22.0 (15.0 – 30.0)*♣
Summer	3,573 (24.7)	17.0 (11.0 – 25.0)*	1,771 (23.9)	22.0 (15.0 – 30.0)*♣
Autumn	3,786 (26.2)	18.0 (12.0 – 25.0)*	1,996 (26.9)	22.0 (15.0 – 29.0)*♣
Vehicle types				
BLS	9,722 (67.3)	17.0 (10.0 – 24.0)*	4,817 (64.9)	21.0 (14.0 – 29.0)*♣
MICU	3,204 (22.2)	20.0 (13.0 – 28.0)*	1,675 (22.6)	24.0 (17.0 – 31.0)*♣
Two crews§	1,528 (10.6)	22.0 (16.0 – 30.0)*	932 (12.6)	25.0 (19.0 – 33.0)*♣
Receiving EDs	14,391¶		7,402♦	
Governmental	12,165 (84.2)	18.0 (11.0 – 26.0)*	6,271 (84.5)	22.0 (15.0 – 30.0)*♣
Private	2,226 (15.4)	19.0 (13.0 – 28.0)*	1,131 (15.2)	23.0 (17.0 – 31.0)*♣

† KRUSKAL_WALLIS. ‡Mann-Whitney Test. §Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ¶63 removed because of undocumented hospital.♦22 removed because of undocumented hospital. ♣Statistically significance at p-value <0.05 between groups. *Statistically significance at p-value <0.05 within group. *♣Statistically significance at p-value <0.05 within group and between groups. BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

Table 3 illustrates the association between different variables and OST. Emergency type, sex, age category, geographical areas, types of vehicles, and hospital type were all

significantly associated with OST in the crude, or adjusted analyses. When adjusted for other variables, all besides working hours were retained in the model.

Table 3 Simple linear and multivariable linear regression of on-scene time according to different predictors (N=21,878).

Predictors' variable	No. (%)	Crude Regression Coefficient (95% CI)	Adjusted Regression Coefficient (95% CI)
Emergency type			
HUME (ref) %(n/N)	15,598 (71.3)		
HUTE	6,280 (28.7)	-6.5 (-6.9 – - 6.1) *	-4.2 (- 4.6 – - 3.8)*
Sex			
Male (ref) %(n/N)	14,454 (66.1)		
Female	7,424 (33.9)	3.9 (3.6 – 4.3) *	1.8 (1.5 - 2.2)*
Age category			
Adult (ref) %(n/N)	13,102 (59.9)		
Child (<15)	817 (3.7)	-1.5 (- 2.4 – - 0.5)*	- 2.3 (- 3.2 – - 1.4)*
Elderly (≥60)	7,959 (36.4)	4.7 (4.3 – 5.1)*	2.1 (1.7 – 2.5)*
Scene location			
Urban (ref) %(n/N)	20,800 (95.1)		
Rural	1,078 (4.9)	-5.5 (- 6.3 – - 4.7)*	-2.6 (- 3.4 – - 1.8)*
Daily hours			
Home time (ref) %(n/N)	16,334 (74.7)		
Office time	5,544 (25.3)	0.5 (0.15 – 0.95)*	0.4 (- 0.1 – 1.0)
Seven days			
Weekdays (ref) %(n/N)	15,633 (71.5)		
Weekend	6,245 (28.5)	- 0.2 (- 0.4 – 0.4)	0.2 (- 0.2 – 0.6)
Working shift			
Day shift (ref) %(n/N)	10,422 (47.6)		
Night shift	11,456 (52.4)	- 0.5 (- 0.84 – - 0.14)*	- 0.1 (- 0.5 – 0.3)
Season			
Summer (ref) %(n/N)	5,344 (24.4)		
Winter	5,413 (24.8)	1.4 (0.9 – 1.9)*	0.8 (0.3 – 1.2)*
Spring	5,339 (24.4)	0.3 (- 0.2– 0.8)	0.1 (- 0.3 – 0.6)
Autumn	5,782 (26.4)	0.2 (0.3 – 0.6)	- 0.2 (- 0.7 – 0.3)
Ambulance vehicle			
BLS (ref) %(n/N)	14,539 (66.5)		
MICU	4,879 (22.3)	2.8 (2.3 – 3.2)*	2.3 (1.9 – 2.7)*
Two Crews†	2,460 (11.2)	4.9 (4.4 – 5.5)*	3.7 (3.2 – 4.3)*
Receiving EDs‡			
Governmental (ref)%(n/N)	18,436 (84.6)		
Private	3,357 (15.4)	1.6 (1.1 – 2.0)*	0.9 (0.5 – 1.4)*

† Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ‡ 85 records of undocumented hospitals were removed and not counted. *Statistically significance at p-value <0.05.
BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

We found that 59.4% of men had an OST of more than 15 minutes compared to 75% for women (p <0.001). Table 4 shows the findings of the crude and adjusted logistic regression models. Emergency type, sex, age category, geographical areas, types of vehicles, and hospitals type were all significantly associated with the odds of OST of more than 15 minutes, both in crude and adjusted models.

Table 4 Association of predictor variable and on-scene time longer than 15 minutes (N=21,878)

Predictive variable	No. (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
Emergency type			
HUME (ref) %(n/N)	15,598 (71.3)		
HUTE	6,280 (28.7)	0.3 (0.3 – 0.4)*	0.5 (0.47 – 0.55)*
Sex			
Male (ref) %(n/N)	14,454 (66.1)		
Female	7,424 (33.9)	2.0 (1.9 – 2.2)*	1.4 (1.3 – 1.5)*
Age Category			
Adult (ref) %(n/N)	13,102 (59.9)		
Child (<15)	817 (3.7)	0,72 (0.63 – 0.83)*	0.61 (0.5 – 0.7)*
Elderly (≥60)	7,959 (36.4)	2.5 (2.4 – 2.70)*	1.7 (1.6 – 1.8)*
Scene location			
Urban (ref) %(n/N)	20,800 (95.1)		
Rural	1,078 (4.9)	0.3 (0.3 – 0.3)*	0.5 (0.4 – 0.6)*
Daily hours			
Home time (ref) %(n/N)	16,334 (74.7)		
Office time	5,544 (25.3)	1.05 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Seven days			
Weekdays (ref) %(n/N)	15,633 (71.5)		
Weekend	6,245 (28.50	1.0 (0.9 – 1.0)	1.0 (0.9 – 1.0)
Working shift			
Day shift (ref) %(n/N)	10,422 (47.6)		
Night shift	11,456 (52.4)	1.0 (0.9 – 1.0)	1.0 (0.9 – 1.1)
Season			
Summer (ref) % (n/N)	5,344 (24.4)		
Winter	5,413 (24.8)	1.2 (1.1 – 1.3)*	1.1 (1.0 – 1.2)*
Spring	5,339 (24.4)	1.0 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Autumn	5,782 (26.4)	1.0 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Ambulance vehicle			
BLS (ref)%(n/N)	14,539 (66.5)		
MICU	4,879 (22.3)	1.7 (1.6 – 1.8)*	1.5 (1.4 – 1.7)*
Two Crews†	2,460 (11.2)	2.7 (2.5 – 3.0)*	2.2 (2.0 – 2.5)*
Receiving EDs‡			
Governmental (ref)%(n/N)	18,436 (84.6)		
Private Hospital	3,357 (15.4)	1.5 (1.4 – 1.6)*	1.3 (1.2 – 1.5)*

† Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ‡ 85 records of undocumented hospitals' EDs were removed and not counted. *Statistically significance at p-value <0.05.
BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

DISCUSSION

The present study showed that more than 50% of emergency cases had an OST of greater than 15 minutes, which is the Saudi EMS standard time for all crews to perform the standard operational procedures during OST regardless of urgency level. Although the median OST for HUTE was closer than HUME to the benchmark of 15 minutes, about 25% of those missions still took more than 22 minutes. OST was also prolonged when EMS ambulances missions were dispatched for women, the elderly, in urban areas, during winter, as advanced EMS services, or for transport to private hospitals. Several studies demonstrated that an increase in OST was associated with adverse outcome.[3 5 23-26] In addition, the American Stroke Association guideline recommends OST to be ≤ 15 minutes.[7]

Children represented 3.7% of EMS missions and had significantly shorter OST. Our study is consistent with multiple studies that found children's OST to be significantly shorter than adults.[27 28] In our study, elderly patients had by far the longest median OST. Cultural restrictions of face coverage for elderly females reduce with an increase in age. Elderly people of both sexes in Saudi Arabia most ordinarily live on the first floor due to comorbidities and difficulties climbing up to the upper floors. In our study, although the median OST for elderly people was longer than adults and children, the inter-gender variation in the OST duration for elderly people was negligible compared to adults and children. A plausible explanation for prolonged OST for the elderly might be attributed to the difficulty in communication with them about the severity of their medical conditions and that more time was required to stabilize them.[29] A Swedish study found that an increase in age is directly proportional to an increase in OST.[30] Sullivan et al. found oldest people are significantly associated with longer OST.[31] However, in another study, no association between age and sex and prolonged OST was found.[32]

Although EMS crews had spent more than 15 minutes for most patients at the scene before they transported them to hospitals, women were most likely to have longer time than

men regardless of any explanatory factor. For example, in looking at EMS crew types, we found EMS missions that were dispatched by MICU crews had longer OST than BLS crews, and the dispatching of MICU crews increased the odds of prolonged OST regardless of the patients' gender. This finding is line with Schull et al. who found dispatching ALS crews compared to the BLS crews at the scene increase the OST by 5.6 minutes.[33] Yet, we found that the median OST for MICU crews was longer for women than men, although, our data did not include the type and number of interventions at the scene. Our study revealed EMS crews staying a half-hour or more at the scene for 25 % of adult women regardless of the calls' reasons. We compared this finding with their counterpart of adult men, and we found the difference was at a minimum 5 minutes. Given the unavailable data elucidating number and type of medical interventions at the scene, we are unable to clarify the medical reasons triggering this difference. Moreover, our study data cannot reveal whether women could receive less or more intervention than men at the scene. For example, studies in the US showed women had received less EMS interventions and treatment compared to men.[34 35] Although we look for explanations in Saudi EMS setting, the gender differences are not confined to our study. Our findings are in line with several studies from other countries often found that women had a longer median or average OST compared to men.[12 28 29 31 33 34] None of these studies investigated the impact of different sociocultural factors on spent time at the scene for patients. One of these found that women had more extended OST than men for non-ST-elevation myocardial infarction and ST-elevation myocardial infarction, despite ECG being implemented for both men and women.[12]

In our study, OST and total EMS time for HUME were longer for women than men, while missions dispatched to HUTE did not show any difference. HUME missions may be more often for patients in household buildings than to HUTE missions that may be dispatched more often to open areas such as streets (e.g., for vehicle accidents). Most of HUTE are

involved by third parties like the Saudi Police which limit any cultural barriers. While in HUME, the profound sex difference in median OST in HUME missions might primarily be explained by Saudi house design and culture. It is customary in Saudi Arabia for the upper floors and rooms far from the residential home's main entrance to be a suitable residence for women. It has been proven that house design has an impact on delaying the access time to the patient after crew arrival to the scene.[36 37] Saudi houses are relatively large due to the high average number of family members.[38] When EMS crews arrive at the scene, they must usually walk a longer distance to reach the female-patient locations. Moreover, cultural differences in Saudi Arabia require women to be fully covered at the presence of non-primary relative male such the EMS all-males crews and that is why it might take a considerable time before the crew are allowed access to the patient.

Another possible reason for the delay during the scene period for Saudi women is the loading process into ambulance vehicles by all-male crews. This process would require strict adherence by crews' members to use the ambulance stretchers even if the patient can walk independently or with crew members' support. While for Saudi men, the stretcher could be waived if the patient prefers walking without it. However, to the best of our knowledge, no previous study has investigated the influence of culture and home design and whether they have a role in prolonging the OST duration for men or women. Thus, further research on this topic is warranted.

In Saudi culture, men are usually involved in decision-making related to the transportation of children and elderly of both sexes, and women of all ages. Some Saudi women demand that their primary male relative is present to discuss their health status and plan further action. Some still need guardianship for signing the consent for medical intervention, although they have the right to sign it themselves.[39 40] In specific circumstances, the women's guardian can prohibit them from transportation to the hospital by ambulance.[41] A Saudi study found that

Saudi women had lower health literacy than men. [42] Two other Saudi studies revealed that Saudi women were less likely to use EMS and were more likely to refuse transportation by ambulance than men. [1 43] Therefore, the longer OST among women might be explained by their reluctance to be transported and that the ambulance crew spent more time to educate them and their guardians about the importance of ambulance transportation. Further qualitative research may be needed to identify factors that lead to prolonged OST at households. This study lacks the data necessary to do so. No previous narrative inquiry has been performed to study this phenomenon in Saudi Arabia. An Australian qualitative study investigated the barriers confronting paramedics because of cultural barriers of middle eastern people living in Australia who might have a cultural resemblance to Saudi people. [44] The informants' paramedics stated that they found difficulties in providing care due to specific norms and behaviour emanating from middle east culture, and time management at the home locations was affected.[44]

A significant delay on the scene can deprive women of receiving important medical intervention, unable to be provided by the ambulance crew, in a timely manner in definitive care especially in life-threatening cases. Due to the longer OST for women, they are more exposed to unexpected adverse events such as late or unsafe arrival to hospitals, especially when the crews are committed to not exceeding the golden hour, the benchmark related to the total EMS time, and risk road accidents themselves.

Strengths and limitations

Our study as a retrospective study has several limitations, all pertaining to the EMS registry. The registry relies on the SRCCAD automated detection of time to compute the timeline. However, one-fourth of data were missing, and we observed impossible outliers that may have arisen due to network failure during the communication between call centre and crews at the scene. Our exclusion of those missing data and outliers might have induced selection bias.

Another limitation is the non-availability of variables that may explain the gender differences in more details, such as socioeconomic characteristics, time between onset of symptoms and EMS call, type of treatment at the scene, and OST stratified by its four phases: arrival at the scene until accessing the patient, patient assessment time, treatment phase, and loading time. On the other hand, using registry data has provided us with much statistical power to detect between-group differences and associations for the characteristics that were available.

Perceived urgency and severity rely on the call centre's triaging system and additional confirmation by crews during arrival at the scene, which might not reflect the real patient condition when the patients arrive at the hospital. Therefore, some misclassification in the urgency types may have occurred. However, our data do reflect daily practices in which urgency levels are determined as early during the mission as possible. However, with future involvement in the EMS data set, researchers could explain those reasonable and unavoidable causes that lead to the lateness.

Considering the linking of the registry data to outcomes data on patients' receiving hospital data such as mortality, 28-day survival, and 6-month survival, we showed OST statistical significance between sexes but limited to show the clinical significance. The last limitation belongs to the study design of clustering heterogeneous emergency types into two cohorts and the Saudi benchmarks of 15-minutes. As a result, our study cannot compare our finding of OST with the essential international guideline like AHA of the recommended OST for specific emergency cases like out-of-hospital cardiac arrest, acute coronary syndrome, and stroke. However, our study showed that female time to access definitive care during medical emergencies is more extended. With future involvement in the EMS data set, researchers could explain the relationship between time performance and EMS outcomes.

Finally, our study's generalizability might apply to urban and rural areas of other different Saudi provinces and the other Arabian Gulf States having similar EMS systems except

for Macca city in Saudi Arabia because of Hajj and the influx of Muslims gathering during different seasons.

CONCLUSIONS

This study shows that median OST was longer than 15 minutes for more than half of transported cases. In addition, it was longer for women for HUME at every time and place, regardless of age category, crew type, and receiving hospital. For those EMS missions that had been dispatched for HUTE, there was no difference. Furthermore, missions to children, in rural areas, for trauma patients, for crews dispatched by BLS-ambulances, in summer as a season, or transported to EDs of governmental hospitals were all significant predictors for shorter OST. These findings are hypothesis generating and require further studies.

Authors' Contribution: All authors conceived the study, conceptualize the ideas, supervised the study design and definition of essential terms and study measures. H.N.M, S.M.J.V.K, and DMA performed the data cleaning, management, and analysis. H.N.M was the formal analysis, and S.M.J.V.K provided statistical advice on study design and analysis. H.N.M and DMA had full access to all of the data in the study. H.N.M takes responsibility for the integrity of the data and the accuracy of data analysis. H.N.M, S.M.J.V.K, M.E.M, and H.R.H interpreted the data. H.N.M and H.R.H were the project administrators. H.R.H was the primary supervisor. H.N.M drafted the manuscript, and all authors contributed substantially to its revision. H.N.M takes responsibility for the paper as a whole.

Conflicts of interest: no conflicts.

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Ethics approval: The study proposal was reviewed and approved by the ethical committee in Jazan University with the registry number: REC39/9-S085.

Data availability statement: Data are available upon reasonable request.

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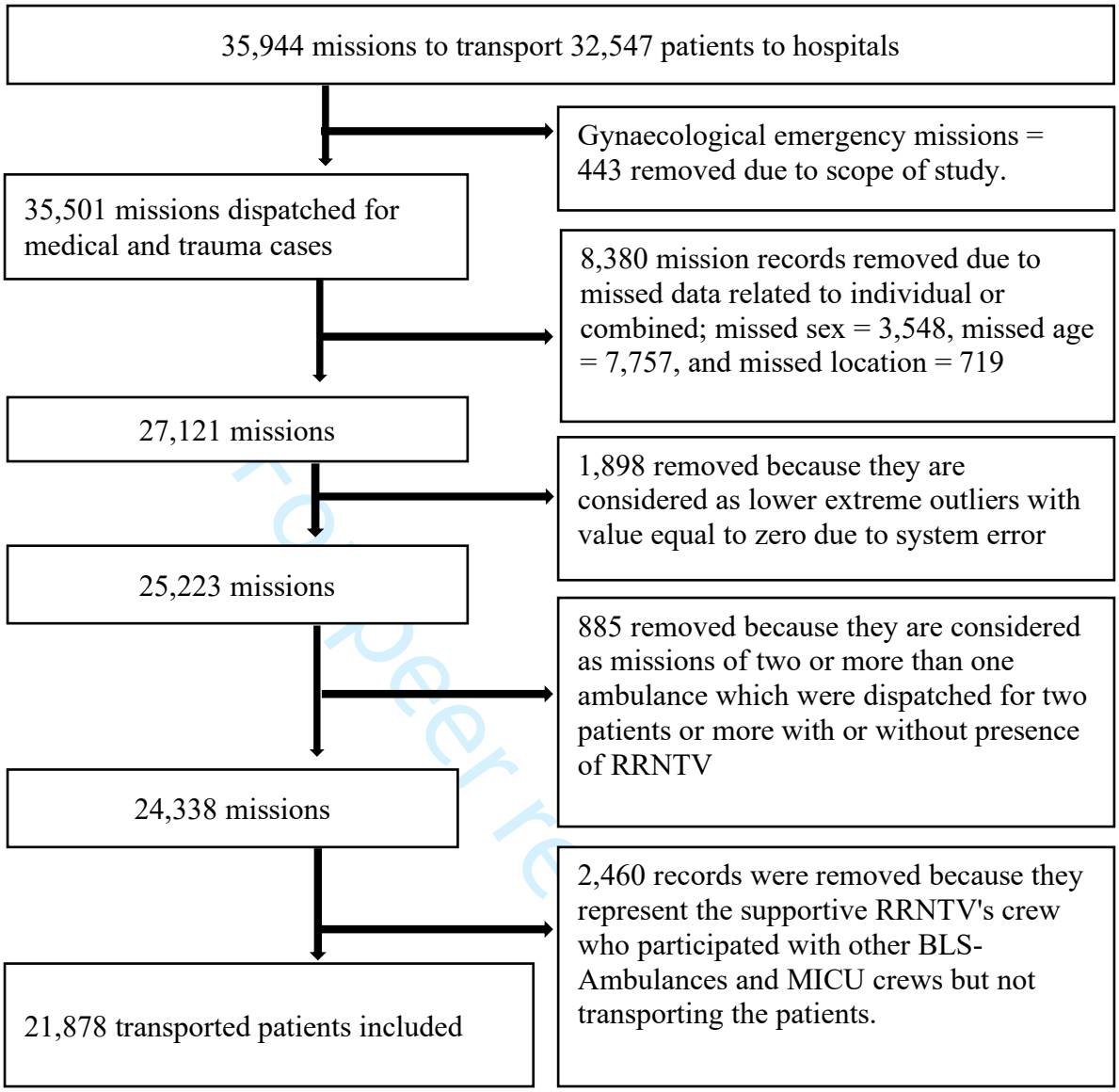
Figure 1 Flow chart of included and excluded patients.
BLS, Basic Life Support; MICU, Mobile Intensive Care Unit; RRNTV, Rapid Response Non-Transporting Vehicle.



STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2	Line 45
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Lines 45 – 62
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	Lines 121 – 151
Objectives	3	State specific objectives, including any prespecified hypotheses	4 – 5	Lines 152 – 155
Methods				
Study design	4	Present key elements of study design early in the paper	5	Lines 159 – 163
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 – 6	Lines 166 – 202
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6 – 7	Lines 216 – 227
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7 – 9	Lines 230 – 290
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7 – 9	Lines 230 – 306
Bias	9	Describe any efforts to address potential sources of bias	7	Lines 223 – 227
Study size	10	Explain how the study size was arrived at	6 – 7	Lines 216 – 227

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8 – 9	Lines 230 – 290
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9	Lines 293 – 306
		(*b*) Describe any methods used to examine subgroups and interactions	9	Lines 293 – 306
		(*c*) Explain how missing data were addressed	7	Lines 222 – 225
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed	NA	NA
		Case-control study—If applicable, explain how matching of cases and controls was addressed	NA	NA
		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	NA	NA
		(*e*) Describe any sensitivity analyses	NA	NA
		Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9 – 10	310 – 328
		(b) Give reasons for non-participation at each stage	9 – 10	315 – 323
		(c) Consider use of a flow diagram	9	315
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10	323 – 328
		(b) Indicate number of participants with missing data for each variable of interest	10 – 11	323 – 345
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	14 – 15	380 - 386
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12 – 15	331 – 386
		(*b*) Report category boundaries when continuous variables were categorized	12 – 15	332 - 386
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A	N/A

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13 – 15	375 – 386
Discussion				
Key results	18	Summarise key results with reference to study objectives	15	388 – 391
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18 – 20	499 – 526
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17 – 19	392 - 496
Generalisability	21	Discuss the generalisability (external validity) of the study results	20	527 – 530
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21	552

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Variation in on-scene time of emergency medical services and the extent of the difference of on-scene time between genders: A retrospective population-based registry study in Riyadh province, Saudi Arabia

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Variation in on-scene time of emergency medical services and the extent of the difference of on-scene time between genders: A retrospective population-based registry study in Riyadh province, Saudi Arabia

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ABSTRACT

Objective: To identify the inter-gender variation of on-scene time (OST) for highly urgent emergency cases conveyed by Emergency Medical Services (EMS) in Saudi Arabia and to assess other predictors of OST and hypothesize for possible factors delaying OST.

Design: A retrospective population-based registry study.

Setting: Riyadh Province is the largest province in terms of population and the second in terms of geographical area.

Participants: All highly urgent transported patients from the scene to emergency departments, be they medical emergencies or trauma emergencies during 2018.

Outcome measure: OST difference between men and women transported by EMS.

Results: In total, 21,878 patients were included for analysis: 33.9% women and 66.1% men. The median OST for women was 22 minutes (interquartile range [IQR] 15 – 30) and 18 minutes (IQR 11 – 26) for men, p <0.001; for medical cases, median OST was 23 minutes (IQR 16 – 31) for women compared to 20 minutes (IQR13 – 29) for men, p <0.001; for trauma cases, the median OST of both sexes was equal. We found the following additional predictors of OST: factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle, and hospital type were all significantly associated with OST in the crude or adjusted analyses. Factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle, and hospital type were also significantly associated with the odds of OST of more than 15-minutes in the crude and adjusted regression analyses.

Conclusion: The median OST was longer than 15 minutes for more than half of transported cases. For medical cases, women had a longer median OST than men. Additional predictors associated with prolonged OST were the patient's age, area (i.e., urban vs. rural), type of ambulance vehicle, and season. These findings are hypothesis generating and require further studies.

Strengths and limitations of this study

- It is the first study conducted in the Arabian Gulf States that includes a large number of highly urgent cases.
- The registry relies on the Saudi Red Crescent Computerized Aid Dispatching (SRCCAD) system for automated detection of time to compute the timeline.
- Using registry data has provided us with much statistical power to detect between-group differences and associations for the available characteristics.

- Registry lacks other important demographic factors related to social status; education, income, and ethnicity, which might be associated with prolonged on-scene time.
- Time registered in the database depends on the information provided by emergency medical services (EMS) providers through wireless communications with the call centre; hence, any network failure leads to missed data.

INTRODUCTION

Emergency medical services (EMS) in Saudi Arabia have been well developed during the last decade. They provide different levels of emergency care around the clock and free of charge. Women's lower EMS utilization is one of the challenges found, besides the median total EMS time for high urgent emergency cases was found to be greater than one hour.[1 2] The on-scene time (OST) duration may take greater than half of the total period of EMS time and made up the largest proportion of total EMS delays.[3 4] Long OST may lead to consequences affecting patient outcomes.[5 6] In certain medical circumstances, patients' transportation to a hospital as soon as possible is highly recommended.[7-10] In the American Heart Association (AHA) guideline for the early management of stroke patients, it is recommended that the OST should not exceed 15 minutes.[7]

The OST duration can result from the crews' decision to collect patient history and medical examination.[11] In addition, the period of OST varies according to the patient's status with or without mortality and geographical areas as urban or rural locations. Sex may also play a factor in OST. For example, a US study found that OST in women complaining of acute chest pain was higher than in men as the crew needed more time to apply electrocardiogram.[12] Other barriers often prolong OST, particularly in trauma cases, when EMS providers' accessibility to patients is difficult. These barriers can be considered inevitable causes such as waiting for the police to arrive in an incident resulting from criminal causes or waiting for the fire brigade to extract a patient from a vehicle or a building. It can also be affected in an outdoor address such as the street during a mass gathering after road traffic accidents.[11 13] On the other hand, it can result from patient wishes and family intervention in crews' performance and decision, especially when the crew is called to a patient's house. Such intervention is significantly affected by culture and educational level and might differ between urban and rural areas.

Factors related to patient culture or demography that influence OST have not been thoroughly studied in the Arabian Gulf States. A recent systematic review found that EMS crews in Saudi Arabia consider mass gathering during road traffic accidents as one of the most frequent barriers affecting their performance to work effectively and in a timely manner while the presence of the patients' families or bystanders were cited as the second salient barrier.[2 14] Furthermore, the median of total EMS time in the Riyadh province of Saudi Arabia for trauma cases was longer in rural areas than in urban areas, and longer than what was found in other countries such as Denmark and the US.[1 15 16]

The present study aimed to investigate OST and to identify differences between sexes regarding the amount of time spent at the scene by EMS crews. It also aims to identify other

patient-related factors associated with time spent at the scene for all highly urgent emergency cases that were transported to healthcare facilities in the Riyadh province in Saudi Arabia and to hypothesize for possible factors delaying OST.

METHODS

Design

This retrospective population-based registry was conducted in the Riyadh province of Saudi Arabia by using all EMS database records in the Saudi Red Crescent Computer Aid Dispatching (SRCCAD) system, from January 1, 2018, to December 31, 2018. This study complies with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).[17]

Setting

Riyadh Province is in the central part of Saudi Arabia. It has a geographical size of 404,240 km2. It has an approximate population of 6,792,776 million, according to the last national census. The province is composed of 39 different cities and Riyadh city is the capital and the largest city in Saudi Arabia. Besides, there are hundreds of rural villages dotted between or near these cities.[18] In Saudi Arabia, EMS are free of charge and can be accessed by calling the call centre, and in certain exceptional conditions, patients can visit ambulance stations distributed all over the province, including along highways. EMS crews of Riyadh province are mainly composed of two Emergency Medical Technicians (EMT). They are trained on basic life support (BLS) skills to respond to different levels of emergency cases but do not administer medicine. However, some crews are composed of physicians and emergency paramedics. These are called mobile intensive care units (MICU) and respond to certain highly critical cases and provide advanced life support (ALS). A third type of EMS crew consists of senior paramedics and are dispatched in a rapid response non-transporting vehicle (RRNTV). These often arrive earlier to provide ALS before the essential transporting ambulances. Time indicators are built-in SRCCAD with 20 minutes for response time and 15 minutes for OST regardless of urgency level.

Saudi EMS implements a strategy of scoop and run, which emanated from the Anglo-American model. Most EMS chain periods are limited with a predefined time to end with the golden hour of total time.[19] The OST comprises three consecutive periods which are access, treatment, and loading time. [20] Access time starts from ambulance vehicles arrival to the scene up to crew arrival to patients' location. Treatment time is the period of patients' examination

and treatment. Loading time starts from moving patients on the stretcher until the crew starts to travel to the hospital. The policy underpinning this 15-minute benchmark for OST is that the Saudi EMS policymakers, based on the number of available crews and the volume of patients' demands, decided that 15 minutes at the scene fit their operational procedures as a policy target. An additional consideration was to avoid delaying ambulance resources from becoming unavailable for new assignments.

However, when there are multiple calls for different emergencies at once, SRCCAD may prioritize cases based on three levels of urgency and dispatch crews accordingly. Patients or their families who have guardianship have the right to refuse transportation to hospital after they have signed a formal paper of refusal against medical advice. However, EMS crews can either transport patients to the closest hospitals or treat them at the scene. The study proposal was reviewed and approved by the ethical committee in Jazan University with the registry number: REC39/9-S085. The Ethics Committee, based on no need to contact patients, agreed that informed consent was not required because of the anonymity of the data collected for routine ambulance missions and the study's retrospective design. The study data take into consideration privacy and confidentiality.

Participants and public involvement

Patients and public were not involved in developing the research question, commenting on the database, study design, outcome measures, conduct of the study, or contributing to the writing or editing of this study.

Data collection

The data were obtained through the operations and information department in the Riyadh branch directorate of Saudi Red Crescent Authority (SRCA). Data were exported from Microsoft Excel saved in an encrypted file on a hard disc and converted to an IBM SPSS file (version 25) for further analyses.

Selection of Participants

According to the Saudi EMS definition, highly urgent emergency cases are the cases that contacted EMS for support after exposure to serious or life-threatening illness or injuries that require immediate medical intervention and quick transportation to hospital emergency departments (EDs). In this study, all incoming calls for patients who were triaged at the dispatching centre of SRCCAD as highly urgent emergency cases were included.

Gynaecological emergencies were excluded because of the scope of the study to compare both sexes. In addition, we excluded records of patients for whom age, sex, or area was missing and cases categorized by the SRCCAD as cases ended by non-conveyance. We considered the potential source of bias; therefore, we excluded the lower extreme outliers with values equal to zero due to system error. Records of missions dispatched for two patients or more in one incident were excluded. Similarly, Missions that involved only Rapid Response Non-Transporting Vehicles (RRNTV) were also removed.

Methods of Measurement

We included all variables related to patient demographics and information related to dispatching missions from the time period perspective, starting from calling the call centre and ending with the patients' arrival to private and governmental hospitals. The EMS time intervals are composed of 4 different periods.[21] First, the response time, which is the time elapsed starting from receiving a call in the call centre and ended by the ambulance's crew's arrival to the scene. Second, the OST, which is the time elapsed, starting from arrival to the scene and ended by starting to travel back to EMS centre or traveling forward toward healthcare facilities. Third, the travel time, which is the time elapsed from starting to move from the scene until the crew's arrival to healthcare facilities. Fourth, is the hospital period, defined as the time elapsed from arrival to the healthcare facility until handover to emergency room staff. EMS database registry recorded all events starting from activation time and ending by crew's departure from the hospitals in the cases where the patient had been transported or when the crew leaves the scene when transportation had been refused. It measures only response time period and total EMS time period in seconds. Therefore, the total EMS time in this study reflects the four periods. We calculated the OST, travel time, hospital time according to standard EMS definition.[21] Those periods in Saudi EMS have individual target indicators, such as the response time; 20 minutes; the OST is 15 minutes, while the travel time has no indicator because of EMS providers' and patients' safety issue arise if the time indicator too strict due to the risk of driving too fast on the way to hospital. Saudi EMS would consider the OST if it exceeded 15 minutes as a prolonged OST. In cases where the call centre dispatched two or more EMS crews, we selected by calculating the actual time spent with the patient from when the first crew arrived either the RRNTV or the main transporting ambulance until the patient was transported by ambulance.

In this study, we focused only on the EMS missions that had been registered by SRCCAD as highly urgent and ended by transporting patients into hospitals. Therefore, we

clustered emergency cases into two cohorts. The first cohort was the cluster of EMS mission that were dispatched for highly urgent medical emergencies (HUME) such as acute coronary syndrome, stroke, and out-of-hospital cardiac arrest. The second cohort was the missions dispatched for highly urgent trauma emergencies (HUTE) such as road traffic accidents. Demographic features available in the registry that were extracted are sex, age and geographical area. Patients' age was divided into three categories according to Saudi Arabian law; child: patient with an age below 15 years old, adult: patient equal to or over 15 years old but younger than 60 years old, and elderly: patient equal to or more than 60 years old. Urban area was defined as an area where metropolitan and micropolitan cities are located and have a total population of equal to or more than 5000 inhabitants. On the other side, areas with less than 5000 people or outside urban geographical area were considered rural.

We considered the differences in various EMS operational times from the data collected in a one-year time period. In Saudi Arabia, the weekdays are considered from Sunday to Thursday while the Friday and Saturday are the weekends. Period of the day is categorized into two categories; office time, which is the time that starts from 8:00 AM to 4:00 PM from Sunday to Thursday, while the home time is defined as the time that starts from 4:01 PM on the same day up to the next day 7:59 AM side by side with 48 hours of the weekend Friday and Saturday. Working shifts are the two daily periods that Saudi EMS schedules to provide emergency services. It is composed of two periods: the day shift from 8:00 AM to 8:00 PM and the night shift from 8:00 PM to 8:00 AM. We also included season. The winter season officially starts from Mid-December to Mid-March, then the spring, which starts from Mid-March until Mid-June. Summer starts from Mid-June to Mid-December, followed by Autumn, which starts from Mid-September 21 and ends by Mid-December.[22]

Operating vehicle types represented by the three types of crews providing EMS for the clustered emergencies were included. The first, Ambulance type II transporting vehicle (BLS-ambulance) is the vehicle equipped by two EMT, who can perform basic life support and rapid patient transport to hospitals. MICU is another transporting vehicle capable of highly qualified physician-based or paramedics exposed to long-term training equal to or more than four years. The last type of vehicle is RRNTV, which is operated in the last decade to arrive at the scene earlier than the transporting vehicle, and it is also operated by highly experienced EMS providers, often EMS paramedics. The crew of RRNTV can give ALS and do the necessary medical work to prepare the patients to be transported. Hospitals that receive emergency patients are of two types. We also included EDs based on the two types of hospitals. Governmental hospitals are non-profit healthcare organizations funded by the Saudi authorities

to provide health services for all Saudi citizens. Private hospitals are for-profit healthcare organizations operated by non-governmental healthcare firms for healthcare services.

Statistical Analysis

The median and interquartile range were computed for response time, OST, travel time, hospital time and total EMS time, and compared between men and women using the Mann-Whitney U Test. The Kruskal-Wallis and Mann-Whitney U Test were conducted to test for differences in OST based on different demographics related to patients, stratified by sex. The following factors were considered: age category, geographical area, period of requesting EMS services, season, emergency type (medical or trauma), emergency vehicles, type of hospital to which the patient was transferred.

To assess what variables were associated with OST, first simple linear regression was performed to identify the OST difference between different independent predictive variables. After that, multivariable linear regression was used to identify which variables were independently associated with OST.

Furthermore, we conducted logistic regression to assess the association between variables and the odds of an OST of more than 15 minutes based on the SRCCAD indicator. Data were presented as ORs with 95% CIs. We considered $p < 0.05$ as statistically significant.

RESULTS

Characteristics of study subjects

During the study period, 35,944 missions of two types – transporting and non-transporting vehicles – were dispatched to the scene. RRNTV accounted for 3,397 (9.5%) missions while the transporting vehicles were 32,547 (90.5%); BLS-Ambulance 25,988 (72.3%), MICU 6,559 (18.2%). Subsequently, 32,547 high emergency patients were transported to Riyadh province hospitals.

Figure 1 presents the flow chart of the transported patients. The study exclusion criteria of records removal shows that 443 missions records were excluded because of gynaecological emergencies, and 8,380 missions' records were removed due to missing data related to sex, age, and geographical area. Given to lower extreme outliers that were registered the OST as a zero-value due to system errors, 1,898 missions' records were excluded to avoid bias. Therefore, 24,338 missions that represented 21,878 transported patients were initially included. However, 2,460 additional records were excluded because they represented supportive RRNTV's crews who participated as logistic support side by side to BLS-ambulances crews,

which were the primary transporting ambulances of the patients. Subsequently, 21,878 missions of highly urgent emergency patients were included in this study. We found that 14,454 (66.1%) of cases were male. In total, 14,454 (66.1%) missions were for HUME, and 7,424 (33.9%) for HUTE. Of all, 66.5% of cases were attended at the scene by BLS-ambulances crews, 22.3% by MICU ambulances crews, and 11.2% by two crews; 50% of them are RRNTVs, and the remaining 50% were BLS-ambulances.

Main results

Table 1 shows time periods of ambulance service runs, including response time, OST, travel time, and hospital time. The study showed that each duration of OST and travel time for the HUME cohort significantly differed between men and women. The median OST of HUME for women 23 minutes (IQR 16 – 31 minutes) was significantly longer than men 20 minutes (IQR 13 – 29 minutes), p< 0.001. The median travel time for women 19 minutes (IQR 10 – 29 minutes) was significantly longer than men 18 minutes (IQR 10 – 29 minutes), p<0.001.

Table 1 The consecutive time periods of EMS urgent missions according to the two clustered emergency cases cohorts for 21,878 transported patients**.**

EMS Intervals	Emergency Type	Male		Female	
		No.	Median (IQR)	No.	Median (SD)†
Response Time	HUM Emergencies	8,686	17.0 (12.5 – 23.2)	6,912	17.0 (12.6 – 23.1)
	HUT Emergencies	5,768	15.7 (11.2 – 22.0)	512	15.6 (11.5 – 21.5)
On-Scene time	HUM Emergencies	8,686	20.0 (13.0 – 29.0)	6,912	23.0 (16.0 – 31.0)*
	HUT Emergencies	5,768	15.0 (9.0 – 21.0)	512	15.0 (10.0 – 22.0)
Travel time	HUM Emergencies	8,686	18.0 (10.0 – 29.0)	6,912	19.0 (11.0 – 31.0)*
	HUT Emergencies	5,768	19.0 (11.0 – 30.0)	512	18.0 (12.0 – 30.0)
Hospital time	HUM Emergencies	8,686	17.0 (6.0 – 27.0)	6,912	16.0 (5.0 – 27.0)
	HUT Emergencies	5,768	18.0 (6.0 – 28.0)	512	17.0 (6.0 – 29.0)
Total EMS Time	HUM Emergencies	8,686	79.3 (63.7 – 97.1)	6,912	82.8 (67.0 – 99.8)*
	HUT Emergencies	5,768	73.8 (58.0 – 92.3)	512	74.7 (60.8 – 91.5)

†Mann-Whitney U Test
* Statistically significant difference at p-value <0.05
EMS, Emergency Medical Services; HUM, High Urgent Medical; HUT, High Urgent Trauma

Table 2 shows the median and IQR stratified by patients' demographic and background factors for both HUTE and HUME causes. The total median OST was significantly longer for women 22 minutes (IQR 15 – 30 minutes) than men 18 minutes (IQR 11 – 26 minutes), p = 0.001. Most differences related to OST between men and women were significant, all showing longer OST for women. In addition, all characteristics variables of patients and missions except the daily hours, weekdays, and working shifts were statistically significant among each group of men and women.

Table 2 Median on-scene time difference between sexes for high urgent transported patients (N=21,878).

	Male		Female	
	No. (%)	**Median (IQR) †**	**No. (%)**	**Median (IQR) †,‡**
Patients (No./N)	14,454 (66.1)	18.0 (11.0 – 26.0)	7,424 (33.9)	22.0 (15.0 – 30.0)♣
Emergency type				
HUME	8,686 (60.1)	20.0 (13.0 – 29.0)*	6,912 (93.1)	23.0 (16.0 – 31.0)*♣
HUTE	5,768 (39.9)	15.0 (9.0 – 21.0)*	512 (6.9)	15.0 (10.0 – 22.0)*
Age Category				
Child <15	550 (3.8)	14.5 (9.0 – 22.0)*	267 (3.6)	18.0 (11.0 – 25.0)*♣
Adult 15– <60	9,803 (67.8)	16.0 (10.0 – 24.0)*	3,299 (44.4)	21.0 (14.0 – 29.0)*♣
Elderly ≥60	4,101 (28.4)	22.0 (15.0 – 30.0)*	3,858 (52.0)	23.0 (17.0 – 31.0)*♣
Scene location				
Urban	13,562 (93.8)	18.0 (12.0 – 26.0)*	7,238 (97.5)	22.0 (16.0 – 30.0)*♣
Rural	892 (6.2)	11.0 (6.0 – 19.0)*	186 (2.5)	15.0 (9.0 – 21.0)*♣
Daily hours				
Home time	10,901 (75.4)	18.0 (11.0 – 26.0)	5,433 (73.2)	22.0 (15.0 – 30.0)♣
office time	3,553 (24.6)	18.0 (11.0 – 26.0)	1,991 (26.8)	22.0 (15.0 – 30.0)♣
Week days				
Sun-Thursday	10,300 (71.3)	18.0 (11.0 – 26.0)	5,333 (71.8)	22.0 (15.0 – 30.0)♣
Weekend	4,152 (28.7)	18.0 (11.0 – 26.0)	2,091 (28.2)	22.0 (15.0 – 30.0)♣
Working shift				
Day shift	6,770 (46.8)	18.0 (11.0 – 26.0)	3,652 (49.2)	22.0 (15.0 – 30).0♣
Night shift	7,684 (53.2)	18.0 (11.0 – 26.0)	3,772 (50.8)	22.0 (15.0 – 30.0)♣
Season				
Winter	3,512 (24.3)	19.0 (12.0 – 27.0)*	1,901 (25.6)	23.0 (16.0 – 31.0)*♣
Spring	3,583 (24.8)	18.0 (11.0 – 26.0)*	1,756 (23.7)	22.0 (15.0 – 30.0)*♣
Summer	3,573 (24.7)	17.0 (11.0 – 25.0)*	1,771 (23.9)	22.0 (15.0 – 30.0)*♣
Autumn	3,786 (26.2)	18.0 (12.0 – 25.0)*	1,996 (26.9)	22.0 (15.0 – 29.0)*♣
Vehicle types				
BLS	9,722 (67.3)	17.0 (10.0 – 24.0)*	4,817 (64.9)	21.0 (14.0 – 29.0)*♣
MICU	3,204 (22.2)	20.0 (13.0 – 28.0)*	1,675 (22.6)	24.0 (17.0 – 31.0)*♣
Two crews§	1,528 (10.6)	22.0 (16.0 – 30.0)*	932 (12.6)	25.0 (19.0 – 33.0)*♣
Receiving EDs	14,391¶		7,402♦	
Governmental	12,165 (84.2)	18.0 (11.0 – 26.0)*	6,271 (84.5)	22.0 (15.0 – 30.0)*♣
Private	2,226 (15.4)	19.0 (13.0 – 28.0)*	1,131 (15.2)	23.0 (17.0 – 31.0)*♣

† KRUSKAL_WALLIS. ‡Mann-Whitney Test. §Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ¶63 removed because of undocumented hospital.♦22 removed because of undocumented hospital. ♣Statistically significance at p-value <0.05 between groups. *Statistically significance at p-value <0.05 within group. *♣Statistically significance at p-value <0.05 within group and between groups. BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

Table 3 illustrates the association between different variables and OST. Emergency type, sex, age category, geographical areas, types of vehicles, and hospital type were all

significantly associated with OST in the crude, or adjusted analyses. When adjusted for other variables, all besides working hours were retained in the model.

Table 3 Simple linear and multivariable linear regression of on-scene time according to different predictors (N=21,878).

Predictors' variable	No. (%)	Crude Regression Coefficient (95% CI)	Adjusted Regression Coefficient (95% CI)
Emergency type			
HUME (ref) %(n/N)	15,598 (71.3)		
HUTE	6,280 (28.7)	-6.5 (-6.9 – - 6.1) *	-4.2 (- 4.6 – - 3.8)*
Sex			
Male (ref) %(n/N)	14,454 (66.1)		
Female	7,424 (33.9)	3.9 (3.6 – 4.3) *	1.8 (1.5 - 2.2)*
Age category			
Adult (ref) %(n/N)	13,102 (59.9)		
Child (<15)	817 (3.7)	-1.5 (- 2.4 – - 0.5)*	- 2.3 (- 3.2 – - 1.4)*
Elderly (≥60)	7,959 (36.4)	4.7 (4.3 – 5.1)*	2.1 (1.7 – 2.5)*
Scene location			
Urban (ref) %(n/N)	20,800 (95.1)		
Rural	1,078 (4.9)	-5.5 (- 6.3 – - 4.7)*	-2.6 (- 3.4 – - 1.8)*
Daily hours			
Home time (ref) %(n/N)	16,334 (74.7)		
Office time	5,544 (25.3)	0.5 (0.15 – 0.95)*	0.4 (- 0.1 – 1.0)
Seven days			
Weekdays (ref) %(n/N)	15,633 (71.5)		
Weekend	6,245 (28.5)	- 0.2 (- 0.4 – 0.4)	0.2 (- 0.2 – 0.6)
Working shift			
Day shift (ref) %(n/N)	10,422 (47.6)		
Night shift	11,456 (52.4)	- 0.5 (- 0.84 – - 0.14)*	- 0.1 (- 0.5 – 0.3)
Season			
Summer (ref) %(n/N)	5,344 (24.4)		
Winter	5,413 (24.8)	1.4 (0.9 – 1.9)*	0.8 (0.3 – 1.2)*
Spring	5,339 (24.4)	0.3 (- 0.2– 0.8)	0.1 (- 0.3 – 0.6)
Autumn	5,782 (26.4)	0.2 (0.3 – 0.6)	- 0.2 (- 0.7 – 0.3)
Ambulance vehicle			
BLS (ref) %(n/N)	14,539 (66.5)		
MICU	4,879 (22.3)	2.8 (2.3 – 3.2)*	2.3 (1.9 – 2.7)*
Two Crews†	2,460 (11.2)	4.9 (4.4 – 5.5)*	3.7 (3.2 – 4.3)*
Receiving EDs‡			
Governmental (ref)%(n/N)	18,436 (84.6)		
Private	3,357 (15.4)	1.6 (1.1 – 2.0)*	0.9 (0.5 – 1.4)*

† Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ‡ 85 records of undocumented hospitals were removed and not counted. *Statistically significance at p-value <0.05.
BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

We found that 59.4% of men had an OST of more than 15 minutes compared to 75% for women (p <0.001). Table 4 shows the findings of the crude and adjusted logistic regression models. Emergency type, sex, age category, geographical areas, types of vehicles, and hospitals type were all significantly associated with the odds of OST of more than 15 minutes, both in crude and adjusted models.

Table 4 Association of predictor variable and on-scene time longer than 15 minutes (N=21,878)

Predictive variable	No. (%)	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
Emergency type			
HUME (ref) %(n/N)	15,598 (71.3)		
HUTE	6,280 (28.7)	0.3 (0.3 – 0.4)*	0.5 (0.47 – 0.55)*
Sex			
Male (ref) %(n/N)	14,454 (66.1)		
Female	7,424 (33.9)	2.0 (1.9 – 2.2)*	1.4 (1.3 – 1.5)*
Age Category			
Adult (ref) %(n/N)	13,102 (59.9)		
Child (<15)	817 (3.7)	0,72 (0.63 – 0.83)*	0.61 (0.5 – 0.7)*
Elderly (≥60)	7,959 (36.4)	2.5 (2.4 – 2.70)*	1.7 (1.6 – 1.8)*
Scene location			
Urban (ref) %(n/N)	20,800 (95.1)		
Rural	1,078 (4.9)	0.3 (0.3 – 0.3)*	0.5 (0.4 – 0.6)*
Daily hours			
Home time (ref) %(n/N)	16,334 (74.7)		
Office time	5,544 (25.3)	1.05 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Seven days			
Weekdays (ref) %(n/N)	15,633 (71.5)		
Weekend	6,245 (28.50	1.0 (0.9 – 1.0)	1.0 (0.9 – 1.0)
Working shift			
Day shift (ref) %(n/N)	10,422 (47.6)		
Night shift	11,456 (52.4)	1.0 (0.9 – 1.0)	1.0 (0.9 – 1.1)
Season			
Summer (ref) % (n/N)	5,344 (24.4)		
Winter	5,413 (24.8)	1.2 (1.1 – 1.3)*	1.1 (1.0 – 1.2)*
Spring	5,339 (24.4)	1.0 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Autumn	5,782 (26.4)	1.0 (1.0 – 1.1)	1.0 (0.9 – 1.1)
Ambulance vehicle			
BLS (ref)%(n/N)	14,539 (66.5)		
MICU	4,879 (22.3)	1.7 (1.6 – 1.8)*	1.5 (1.4 – 1.7)*
Two Crews†	2,460 (11.2)	2.7 (2.5 – 3.0)*	2.2 (2.0 – 2.5)*
Receiving EDs‡			
Governmental (ref)%(n/N)	18,436 (84.6)		
Private Hospital	3,357 (15.4)	1.5 (1.4 – 1.6)*	1.3 (1.2 – 1.5)*

† Missions attended by rapid response non-transporting vehicles and the essential transporting vehicle. ‡ 85 records of undocumented hospitals' EDs were removed and not counted. *Statistically significance at p-value <0.05.
BLS, Basic Life Support; EDs, Emergency Departments; HUME, High Urgent Medical Emergencies; HUTE, High Urgent Trauma Emergencies; MICU, Mobile Intensive Care Unit.

DISCUSSION

The present study showed that more than 50% of emergency cases had an OST of greater than 15 minutes, which is the Saudi EMS standard time for all crews to perform the standard operational procedures during OST regardless of urgency level. Although the median OST for HUTE was closer than HUME to the benchmark of 15 minutes, about 25% of those missions still took more than 22 minutes. OST was also prolonged when EMS ambulances missions were dispatched for women, the elderly, in urban areas, during winter, as advanced EMS services, or for transport to private hospitals. Several studies demonstrated that an increase in OST was associated with adverse outcome.[3 5 23-26] In addition, the American Stroke Association guideline recommends OST to be ≤ 15 minutes.[7]

Children represented 3.7% of EMS missions and had significantly shorter OST. Our study is consistent with multiple studies that found children's OST to be significantly shorter than adults.[27 28] In our study, elderly patients had by far the longest median OST. Cultural restrictions of face coverage for elderly females reduce with an increase in age. Elderly people of both sexes in Saudi Arabia most ordinarily live on the first floor due to comorbidities and difficulties climbing up to the upper floors. In our study, although the median OST for elderly people was longer than adults and children, the inter-gender variation in the OST duration for elderly people was negligible compared to adults and children. A plausible explanation for prolonged OST for the elderly might be attributed to the difficulty in communication with them about the severity of their medical conditions and that more time was required to stabilize them.[29] A Swedish study found that an increase in age is directly proportional to an increase in OST.[30] Sullivan et al. found oldest people are significantly associated with longer OST.[31] However, in another study, no association between age and sex and prolonged OST was found.[32]

Although EMS crews had spent more than 15 minutes for most patients at the scene before they transported them to hospitals, women were most likely to have longer time than

men regardless of any explanatory factor. For example, in looking at EMS crew types, we found EMS missions that were dispatched by MICU crews had longer OST than BLS crews, and the dispatching of MICU crews increased the odds of prolonged OST regardless of the patients' gender. This finding is line with Schull et al. who found dispatching ALS crews compared to the BLS crews at the scene increase the OST by 5.6 minutes.[33] Yet, we found that the median OST for MICU crews was longer for women than men, although, our data did not include the type and number of interventions at the scene. Our study revealed EMS crews staying a half-hour or more at the scene for 25 % of adult women regardless of the calls' reasons. We compared this finding with their counterpart of adult men, and we found the difference was at a minimum 5 minutes. Given the unavailable data elucidating number and type of medical interventions at the scene, we are unable to clarify the medical reasons triggering this difference. Moreover, our study data cannot reveal whether women could receive less or more intervention than men at the scene. For example, studies in the US showed women had received less EMS interventions and treatment compared to men.[34 35] Although we look for explanations in Saudi EMS setting, the gender differences are not confined to our study. Our findings are in line with several studies from other countries often found that women had a longer median or average OST compared to men.[12 28 29 31 33 34] None of these studies investigated the impact of different sociocultural factors on spent time at the scene for patients. One of these found that women had more extended OST than men for non-ST-elevation myocardial infarction and ST-elevation myocardial infarction, despite ECG being implemented for both men and women.[12]

In our study, OST and total EMS time for HUME were longer for women than men, while missions dispatched to HUTE did not show any difference. HUME missions may be more often for patients in household buildings than to HUTE missions that may be dispatched more often to open areas such as streets (e.g., for vehicle accidents). Most of HUTE are

involved by third parties like the Saudi Police which limit any cultural barriers. While in HUME, the profound sex difference in median OST in HUME missions might primarily be explained by Saudi house design and culture. It is customary in Saudi Arabia for the upper floors and rooms far from the residential home's main entrance to be a suitable residence for women. It has been proven that house design has an impact on delaying the access time to the patient after crew arrival to the scene.[36 37] Saudi houses are relatively large due to the high average number of family members.[38] When EMS crews arrive at the scene, they must usually walk a longer distance to reach the female-patient locations. Moreover, cultural differences in Saudi Arabia require women to be fully covered at the presence of non-primary relative male such the EMS all-males crews and that is why it might take a considerable time before the crew are allowed access to the patient.

Another possible reason for the delay during the scene period for Saudi women is the loading process into ambulance vehicles by all-male crews. This process would require strict adherence by crews' members to use the ambulance stretchers even if the patient can walk independently or with crew members' support. While for Saudi men, the stretcher could be waived if the patient prefers walking without it. However, to the best of our knowledge, no previous study has investigated the influence of culture and home design and whether they have a role in prolonging the OST duration for men or women. Thus, further research on this topic is warranted.

In Saudi culture, men are usually involved in decision-making related to the transportation of children and elderly of both sexes, and women of all ages. Some Saudi women demand that their primary male relative is present to discuss their health status and plan further action. Some still need guardianship for signing the consent for medical intervention, although they have the right to sign it themselves.[39 40] In specific circumstances, the women's guardian can prohibit them from transportation to the hospital by ambulance.[41] A Saudi study found that

Saudi women had lower health literacy than men. [42] Two other Saudi studies revealed that Saudi women were less likely to use EMS and were more likely to refuse transportation by ambulance than men. [1 43] Therefore, the longer OST among women might be explained by their reluctance to be transported and that the ambulance crew spent more time to educate them and their guardians about the importance of ambulance transportation. Further qualitative research may be needed to identify factors that lead to prolonged OST at households. This study lacks the data necessary to do so. No previous narrative inquiry has been performed to study this phenomenon in Saudi Arabia. An Australian qualitative study investigated the barriers confronting paramedics because of cultural barriers of middle eastern people living in Australia who might have a cultural resemblance to Saudi people. [44] The informants' paramedics stated that they found difficulties in providing care due to specific norms and behaviour emanating from middle east culture, and time management at the home locations was affected.[44]

A significant delay on the scene can deprive women of receiving important medical intervention, unable to be provided by the ambulance crew, in a timely manner in definitive care especially in life-threatening cases. Due to the longer OST for women, they are more exposed to unexpected adverse events such as late or unsafe arrival to hospitals, especially when the crews are committed to not exceeding the golden hour, the benchmark related to the total EMS time, and risk road accidents themselves.

Strengths and limitations

Our study as a retrospective study has several limitations, all pertaining to the EMS registry. The registry relies on the SRCCAD automated detection of time to compute the timeline. However, one-fourth of data were missing, and we observed impossible outliers that may have arisen due to network failure during the communication between call centre and crews at the scene. Our exclusion of those missing data and outliers might have induced selection bias.

Another limitation is the non-availability of variables that may explain the gender differences in more details, such as socioeconomic characteristics, time between onset of symptoms and EMS call, type of treatment at the scene, and OST stratified by its four phases: arrival at the scene until accessing the patient, patient assessment time, treatment phase, and loading time. On the other hand, using registry data has provided us with much statistical power to detect between-group differences and associations for the characteristics that were available.

Perceived urgency and severity rely on the call centre's triaging system and additional confirmation by crews during arrival at the scene, which might not reflect the real patient condition when the patients arrive at the hospital. Therefore, some misclassification in the urgency types may have occurred. However, our data do reflect daily practices in which urgency levels are determined as early during the mission as possible. However, with future involvement in the EMS data set, researchers could explain those reasonable and unavoidable causes that lead to the lateness.

Considering the linking of the registry data to outcomes data on patients' receiving hospital data such as mortality, 28-day survival, and 6-month survival, we showed OST statistical significance between sexes but limited to show the clinical significance. The last limitation belongs to the study design of clustering heterogeneous emergency types into two cohorts and the Saudi benchmarks of 15-minutes. As a result, our study cannot compare our finding of OST with the essential international guideline like AHA of the recommended OST for specific emergency cases like out-of-hospital cardiac arrest, acute coronary syndrome, and stroke. However, our study showed that female time to access definitive care during medical emergencies is more extended. With future involvement in the EMS data set, researchers could explain the relationship between time performance and EMS outcomes.

Finally, our study's generalizability might apply to urban and rural areas of other different Saudi provinces and the other Arabian Gulf States having similar EMS systems except

for Macca city in Saudi Arabia because of Hajj and the influx of Muslims gathering during different seasons.

CONCLUSIONS

This study shows that median OST was longer than 15 minutes for more than half of transported cases. In addition, it was longer for women for HUME at every time and place, regardless of age category, crew type, and receiving hospital. For those EMS missions that had been dispatched for HUTE, there was no difference. Furthermore, missions to children, in rural areas, for trauma patients, for crews dispatched by BLS-ambulances, in summer as a season, or transported to EDs of governmental hospitals were all significant predictors for shorter OST. These findings are hypothesis generating and require further studies.

Authors' Contribution: All authors conceived the study, conceptualize the ideas, supervised the study design and definition of essential terms and study measures. H.N.M, S.M.J.V.K, and DMA performed the data cleaning, management, and analysis. H.N.M was the formal analysis, and S.M.J.V.K provided statistical advice on study design and analysis. H.N.M and DMA had full access to all of the data in the study. H.N.M takes responsibility for the integrity of the data and the accuracy of data analysis. H.N.M, S.M.J.V.K, M.E.M, and H.R.H interpreted the data. H.N.M and H.R.H were the project administrators. H.R.H was the primary supervisor. H.N.M drafted the manuscript, and all authors contributed substantially to its revision. H.N.M takes responsibility for the paper as a whole.

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Conflicts of interest: no conflicts.

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Ethics approval: The study proposal was reviewed and approved by the ethical committee in Jazan University with the registry number: REC39/9-S085.

Data availability statement: Data are available upon reasonable request.

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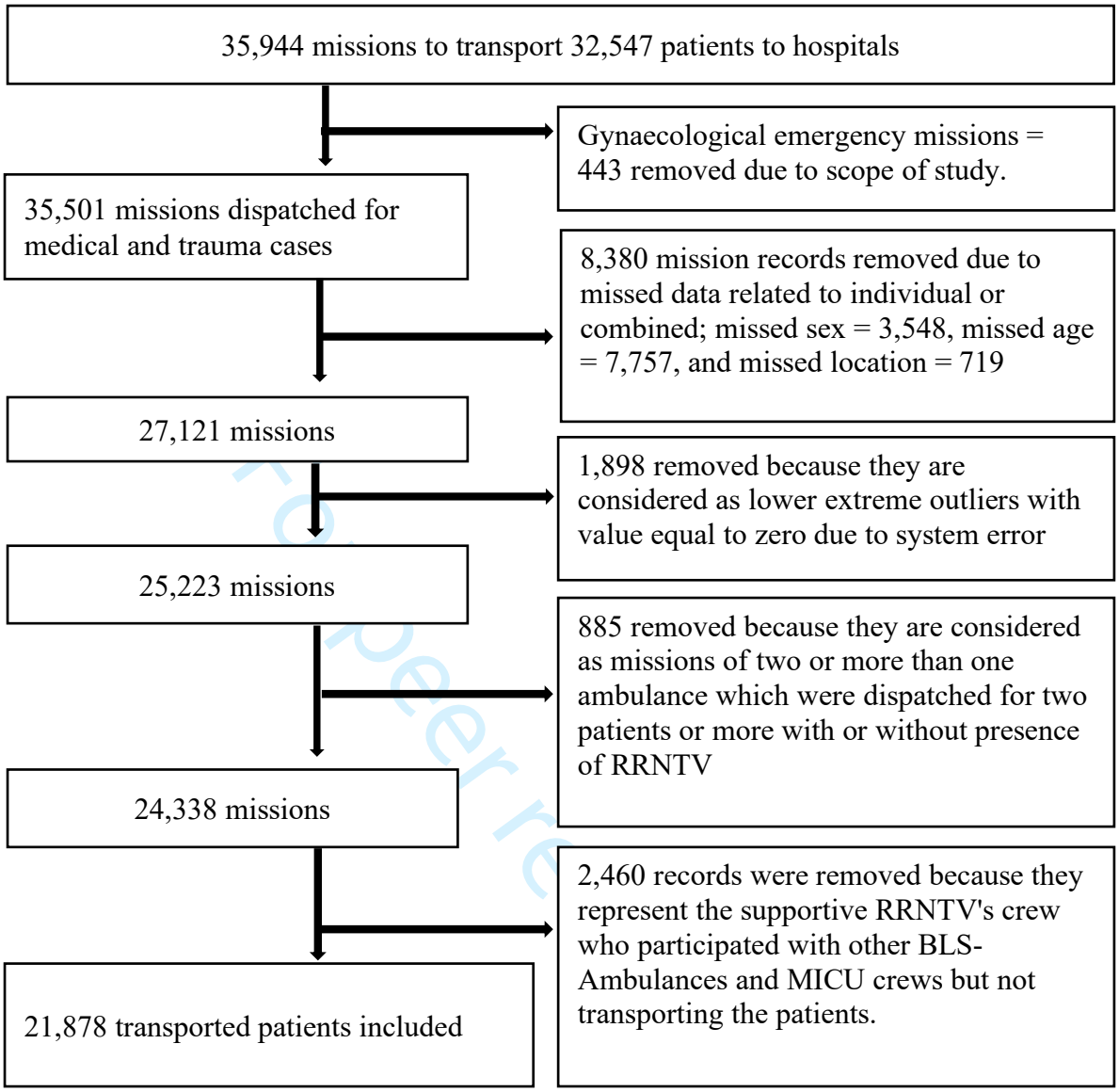
Figure 1 Flow chart of included and excluded patients.
BLS, Basic Life Support; MICU, Mobile Intensive Care Unit; RRNTV, Rapid Response Non-Transporting Vehicle.



STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2	Line 45
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Lines 45 – 62
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	Lines 121 – 151
Objectives	3	State specific objectives, including any prespecified hypotheses	4 – 5	Lines 152 – 155
Methods				
Study design	4	Present key elements of study design early in the paper	5	Lines 159 – 163
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5 – 6	Lines 166 – 202
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6 – 7	Lines 216 – 227
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7 – 9	Lines 230 – 290
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7 – 9	Lines 230 – 306
Bias	9	Describe any efforts to address potential sources of bias	7	Lines 223 – 227
Study size	10	Explain how the study size was arrived at	6 – 7	Lines 216 – 227

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Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8 – 9	Lines 230 – 290
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9	Lines 293 – 306
		(*b*) Describe any methods used to examine subgroups and interactions	9	Lines 293 – 306
		(*c*) Explain how missing data were addressed	7	Lines 222 – 225
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed	NA	NA
		Case-control study—If applicable, explain how matching of cases and controls was addressed	NA	NA
		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	NA	NA
		(*e*) Describe any sensitivity analyses	NA	NA
		Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9 – 10	310 – 328
		(b) Give reasons for non-participation at each stage	9 – 10	315 – 323
		(c) Consider use of a flow diagram	9	315
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10	323 – 328
		(b) Indicate number of participants with missing data for each variable of interest	10 – 11	323 – 345
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	14 – 15	380 - 386
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12 – 15	331 – 386
		(*b*) Report category boundaries when continuous variables were categorized	12 – 15	332 - 386
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A	N/A

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Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13 – 15	375 – 386
Discussion				
Key results	18	Summarise key results with reference to study objectives	15	388 – 391
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18 – 20	499 – 526
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17 – 19	392 - 496
Generalisability	21	Discuss the generalisability (external validity) of the study results	20	527 – 530
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21	552

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.