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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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3 **Factors that induce gender variation in the on-scene time period of emergency medical**
4 **services for high urgent transported patients: A retrospective population-based registry**
5 **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 (IQR 13 – 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

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3 urban areas, and longer than what was found in other countries such as Denmark and the US.¹

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6 The present study aimed to investigate OST and identify differences between sexes
7 regarding the amount of time spent at the scene by EMS crews. It also aims to identify other
8 patient-related factors associated with time spent at the scene for all high urgent emergency
9 cases that were transported to healthcare facilities in the Riyadh province in Saudi Arabia.
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14 15 **METHODS**

16 17 **Study Design and Setting**

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19 This retrospective population-based registry was conducted in the Riyadh province of
20 Saudi Arabia by using all EMS database records in the Saudi red crescent computer aid
21 dispatching (SRCCAD) system, from January 1, 2018, to December 31, 2018. Riyadh Province
22 is located in the central part of Saudi Arabia. It has a geographical size of 404,240 km². It has
23 an approximate population of 6,792,776 million, according to the last national census. It is
24 composed of 39 different cities in terms of size and population. Among those cities is Riyadh,
25 which is the capital and largest city in Saudi Arabia. Besides, there are hundreds of rural
26 villages dotted between or near these cities.¹⁸ In Saudi Arabia, EMS are free of charge and can
27 be accessed by calling the call centre, and in certain exceptional conditions, patients can visit
28 ambulance-grounded centres distributed all over the province, including along highways. EMS
29 crews of Riyadh province are mainly composed of two Emergency Medical Technicians
30 (EMT). They are trained on basic life support (BLS) skills to respond to different levels of
31 emergency cases but do not administer medicine. However, some crews are composed of
32 physicians and emergency paramedics. These are called mobile intensive care units (MICU),
33 and respond to certain high critical cases and provide advanced life support (ALS). A third type
34 of EMS crew consists of senior paramedics and are dispatched in a rapid response non-
35 transporting vehicle (RRNTV). These often arrive earlier to provide ALS before the essential
36 transporting ambulances. Time indicators are built-in SRCCAD with 20 minutes for response
37 time and 15 minutes for OST regardless of urgency level. However, when there are multiple
38 calls for different emergencies at once, SRCCAD may prioritize cases based on three levels of
39 urgency and dispatches crews accordingly. Patients or their families who have guardianship
40 have the right to refuse transportation to hospital after they signed a formal paper of refusal
41 against medical advices. However, EMS crews can either transport patients to the closest
42 hospitals or treat them at the scene. The study proposal was reviewed and approved by the
43 ethical committee in Jazan University with the registry number: REC39/9-S085. The Ethics
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3 Committee, based on no need to contact patients, agreed that informed consent was not required
4 because of the anonymity of the data collected for routine ambulance missions and the study's
5 retrospective design. The study data take into consideration privacy and confidentiality.
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10 **Participants and public involvement**

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

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

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

40 We included all variables related to patient demographics and information related to
41 dispatching missions from the time interval perspective, starting from calling the call centre
42 and ending with the patients' arrival to private and governmental hospitals. The EMS time
43 intervals are composed of 4 different intervals.¹⁹ The first is the response time, which is the
44 time elapsed starting from receiving a call in the call centre and ended by the ambulance's
45 crew's arrival to the scene. The second period is the OST, which is the time elapsed, starting
46 from arrival to the scene and ended by starting to travel back to EMS centre or traveling forward
47 toward healthcare facilities. The third period is traveling time, which is the time elapsed from
48 starting to move from the scene until the crew's arrival to healthcare facilities. The fourth and
49 last period is the hospital stay period, defined as the time elapsed from arrival to the healthcare
50 facility until handover by emergency room staff. EMS database registry recorded all events
51 starting from activation time and ending by crew's departure from the hospitals in case the
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3 patient had been transported. It measures only response time interval and total EMS time
4 interval in seconds. Therefore, the total EMS time in this study reflects the four intervals. We
5 calculated the OST, travel time, hospital time according to standard EMS definition.¹⁹ Those
6 intervals in Saudi EMS have individual target indicators, such as the response time; 20 minutes;
7 the OST is 15 minutes while the travel time has no indicators because of EMS providers' and
8 patient's safety due to driving too fast. Saudi EMS would consider the OST if it exceeded 15
9 minutes as a prolonged OST. In cases where the call centre dispatched two or more EMS crews,
10 we selected by calculating the actual time spent with patient from the first crew arrived either
11 the RRNTV or the main transporting ambulance until the patient was transported by
12 ambulance.

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

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

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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				
Governmental	14,391¶		7,402♦	
Private	12,165 (84.2)	18.0 (11.0 – 26.0)*	6,271 (84.5)	22.0 (15.0 – 30.0)**
	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

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3 EMS interventions and treatment compared to men.^{24 25} Further qualitative research may be
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5 needed to identify factors that lead to prolonged OST at households. This study lacks the data
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7 necessary to do so.
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10 Although we look for explanations in Saudi culture, gender-differences are not confined
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12 to our study. Studies from other countries often found that women had a longer median or
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14 average OST compared to men.^{12 24 26-29} A study conducted by Aguilar et al. in the US found
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16 that women have a more extended OST than men for non-ST-elevation myocardial infarction
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18 and ST-elevation myocardial infarction, despite ECG being implemented for both men and
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20 women.¹² We found the median OST for MICU crews to be significantly longer for women,
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22 and MICU increased the odds of prolonged OST. Schull et al. found dispatching ALS crews
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24 compared to the BLS crew at the scene increase the OST by 5.6 minutes (22.0%).²⁶ However,
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26 our data did not include the type and number of interventions at the scene.
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30 In our study, children represented 3.7% of EMS missions and had significantly shorter
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32 OST. Our study is consistent with multiple studies that found children's OST to be significantly
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34 shorter than adults.^{28 30} In our study elderly patients had the by far the longest median OST.
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36 Culture restrictions of face coverage for elderly females reduce with an increase in age. Elderly
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38 people of both sexes in Saudi Arabia most ordinarily live on the first floor due to comorbidities
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40 and difficulties climbing up to the upper floors. In our study, although the median OST for
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42 elderly people was longer than adults and children and given the inter-gender variation in the
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44 OST duration for elderly people, is negligible in comparison to adults and children. The
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46 plausible explanation for prolonged OST for them might be attributed to the difficulty in
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48 communication with them about the severity of their medical conditions and more time
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50 required to stabilize them.²⁹ A Swedish study found that an increase in age is directly
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52 proportional to an increase in OST.³¹ Sullivan et al. found oldest people are significantly
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3 associated with longer OST.²⁷ However, in another study, no association between age and sex
4 and prolonged OST.³²
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8 More than 50% of emergency cases had an OST of greater than 15 minutes, which is
9 the Saudi EMS standard time for all crews to perform the standard operational procedures
10 during OST duration regardless of urgency levels. Although the median OST for HUTE is
11 closer than HUME to the benchmark of 15-minutes, about 25% of those missions are still more
12 than 22 minutes. McCoy et al. found OST for trauma cases of greater than 20 minutes was
13 associated with higher odds of mortality, especially for penetrating trauma and no associations
14 between increased odds of mortality and out-of-hospital times in blunt trauma victims.³³ A
15 Dutch study conducted found that for every minute spent on the scene in case of out-of-hospital
16 cardiac arrest, the odds of 30-day survival decreases.³⁴ We think 15-minutes may be an
17 inappropriate standard to deal with all cases equally. There is no consensus between researchers
18 on how long the crews should stay on the scene for out-of-hospital cardiac arrest, though the
19 strategic role of scope and run better than stay and play become widespread.^{35 36}
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38 **Strengths and limitations**

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40 Our study as retrospective study has several limitations, all pertaining to the EMS
41 registry. The registry relies on the SRCCAD automated detection of time to compute the
42 timeline. However, one-fourth of data were missing and we observed impossible outliers that
43 may have arisen due to network failure during the communication between call centre and
44 crews at the scene. Our exclusion for those missing data and outliers might have induced
45 selection bias. Another limitation is the availability of variables that may help the gender-
46 differences in more details, such as socioeconomic characteristics, time between onset of
47 symptoms and EMS call, type of treatment at the scene, and OST stratified by its four phases:
48 arrival at the scene until accessing the patient, patient assessment time, treatment phase, and
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3 loading time. On the other hand, using registry data has provided us with much statistical power
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5 to detect between-group differences and associations for the characteristics that were available.
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10 Perceived urgency and severity rely on the call centre's triaging system and additional
11 confirmation by crews during arrival at the scene, which might not reflect the real patient
12 condition when the patients arrive at the hospital. Therefore, some misclassification in the
13 urgency types may have occurred. However, our data do reflect daily practices in which
14 urgency levels are determined as early during the mission as possible. However, with future
15 involvement in the EMS data set, researchers could explain those reasonable and unavoidable
16 causes that lead to the lateness.
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26 Considering the linking the registry data to outcomes data on patients' receiving
27 hospital data such as mortality, 28-day survival, and 6-month survival, we showed OST
28 statistical significance between sexes but limited to show the clinical significance. The last
29 limitation belongs to the study design of clustering heterogeneous emergency types into two
30 cohorts and the Saudi benchmarks of 15-minutes. As a result, our study cannot compare our
31 finding of OST with the essential international guideline like AHA of the recommended OST
32 for specific emergency cases like out-of-hospital cardiac arrest, acute coronary syndrome, and
33 stroke. However, our study showed that female time to access definitive care during medical
34 emergencies is more extended than male. With future involvement in the EMS data set,
35 researchers could explain the relationship between time performance and EMS outcomes.
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49 Finally, our study's generalizability might apply to other urban and rural areas of other
50 different Saudi provinces and the other Arabian Gulf States having similar EMS systems except
51 for the Macca city in Saudi Arabia because of Hajj and hundred-thousands of Muslims
52 gathering during different seasons.
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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.

Conflicts of interest: no conflicts.

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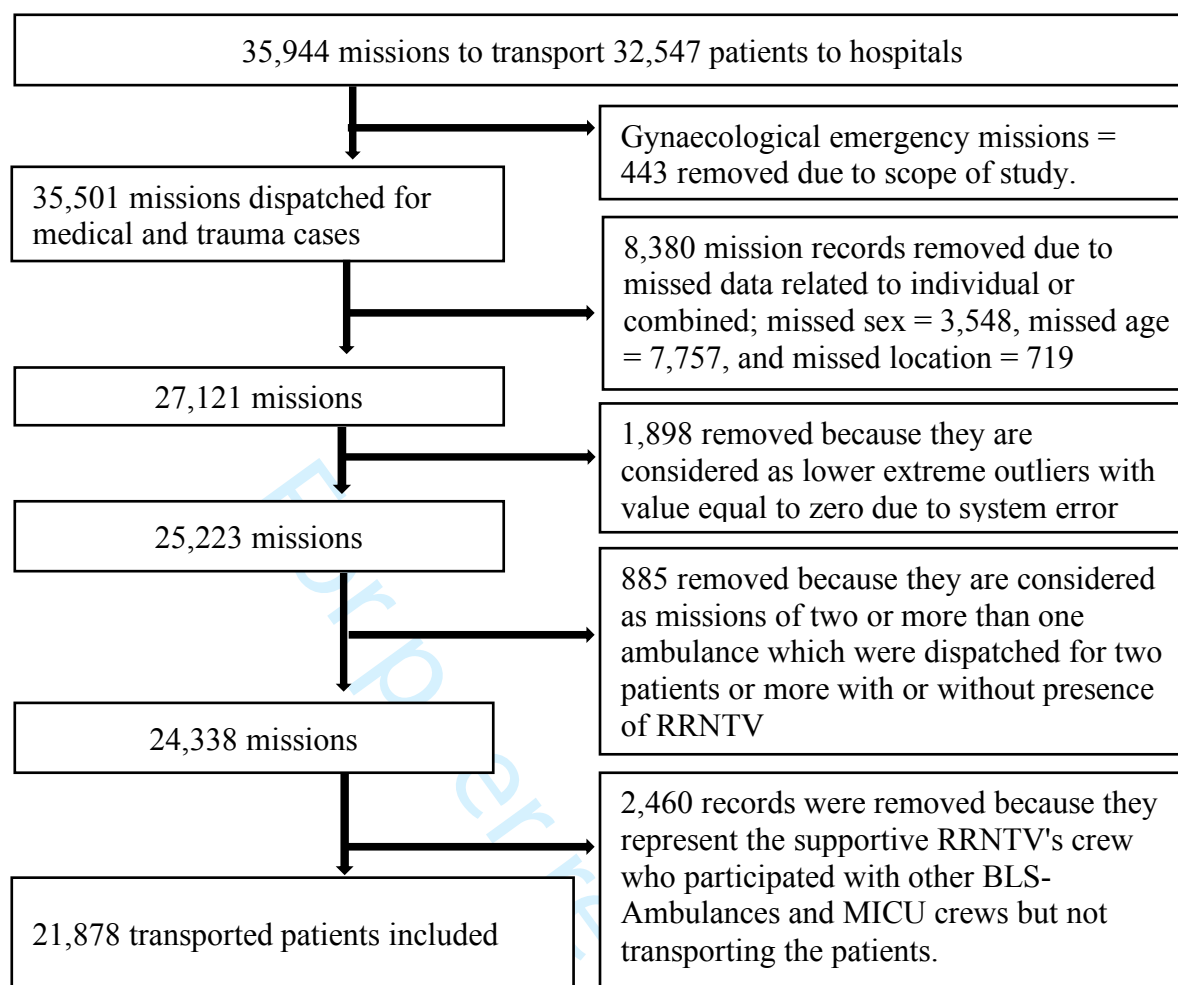
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Figure 1 Flow chart of included and excluded patients

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

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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3 **1 Variation in on-scene time of emergency medical services and the extent of the difference**
4 **2 of on-scene time between genders: A retrospective population-based registry study in**
5 **3 Riyadh province, Saudi Arabia**
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41 **ABSTRACT**

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

45 **Design:** A retrospective population-based registry study.

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

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

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

53 **Results:** In total, 21,878 patients were included for analysis: 33.9% women and 66.1% men.
54 The median OST for women was 22 minutes (interquartile range [IQR] 15 – 30) and 18 minutes
55 (IQR 11 – 26) for men, $p < 0.001$; for medical cases, median OST was 23 minutes (IQR 16 –
56 31) for women compared to 20 minutes (IQR 13 – 29) for men, $p < 0.001$; for trauma cases, the
57 median OST of both sexes was equal. We found the following additional predictors of OST:
58 factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle,
59 and hospital type were all significantly associated with OST in the crude or adjusted analyses.
60 Factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle,
61 and hospital type were also significantly associated with the odds of OST of more than 15-
62 minutes in the crude and adjusted regression analyses.

63
64 **Conclusion:** The median OST was longer than 15 minutes for more than half of transported
65 cases. For medical cases, women had a longer median OST than men. Additional predictors
66 associated with prolonged OST were the patient's age, area (i.e., urban vs. rural), type of
67 ambulance vehicle, and season.

68

69 **Strengths and limitations of this study**

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

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3 74 ♦ Using registry data has provided us with much statistical power to detect between-group
4 differences and associations for the available characteristics.
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7 76 ♦ Registry lacks other important demographic factors related to social status; education,
8 income, and ethnicity, which might be associated with prolonged on-scene time.
9 77
10 78 ♦ Time registered in the database depends on the information provided by emergency
11 medical services (EMS) providers through wireless communications with the call
12 centre; hence, any network failure leads to missed data.
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120 INTRODUCTION

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

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

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

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

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3 154 patient-related factors associated with time spent at the scene for all highly urgent emergency
4 155 cases that were transported to healthcare facilities in the Riyadh province in Saudi Arabia.
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8 157 **METHODS**

9 158 **Design**

10 159 This retrospective population-based registry was conducted in the Riyadh province of Saudi
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12 160 Arabia by using all EMS database records in the Saudi Red Crescent Computer Aid
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14 161 Dispatching (SRCCAD) system, from January 1, 2018, to December 31, 2018. This study
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16 162 complies with Strengthening the Reporting of Observational Studies in Epidemiology
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18 163 (STROBE).¹⁷
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21 165 **Setting**

22 166 Riyadh Province is in the central part of Saudi Arabia. It has a geographical size of 404,240
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24 167 km². It has an approximate population of 6,792,776 million, according to the last national
25
26 168 census. The province is composed of 39 different cities and Riyadh city is the capital and the
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28 169 largest city in Saudi Arabia. Besides, there are hundreds of rural villages dotted between or
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30 170 near these cities.¹⁸ In Saudi Arabia, EMS are free of charge and can be accessed by calling the
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32 171 call centre, and in certain exceptional conditions, patients can visit ambulance stations
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34 172 distributed all over the province, including along highways. EMS crews of Riyadh province
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36 173 are mainly composed of two Emergency Medical Technicians (EMT). They are trained on
37
38 174 basic life support (BLS) skills to respond to different levels of emergency cases but do not
39
40 175 administer medicine. However, some crews are composed of physicians and emergency
41
42 176 paramedics. These are called mobile intensive care units (MICU) and respond to certain highly
43
44 177 critical cases and provide advanced life support (ALS). A third type of EMS crew consists of
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46 178 senior paramedics and are dispatched in a rapid response non-transporting vehicle (RRNTV).
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48 179 These often arrive earlier to provide ALS before the essential transporting ambulances. Time
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50 180 indicators are built-in SRCCAD with 20 minutes for response time and 15 minutes for OST
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52 181 regardless of urgency level.

53 182 Saudi EMS implements a strategy of scope and run, which emanated from the Anglo-
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55 183 American model. Most EMS chain periods are limited with a predefined time to end with the
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57 184 golden hour of total time.¹⁹ The OST comprises three consecutive periods which are access,
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59 185 treatment, and loading time.²⁰ Access time starts from ambulance vehicles arrival to the scene
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186 up to crew arrival to patients' location. Treatment time is the period of patients' examination
187 and treatment. Loading time starts from moving patients on the stretcher until the crew starts

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3 188 to travel to the hospital. The policy underpinning this 15-minute benchmark for OST is that
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5 189 the Saudi EMS policymakers, based on the number of available crews and the volume of
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7 190 patients' demands, decided that 15 minutes at the scene fit their operational procedures as a
8
9 191 policy target. An additional consideration was to avoid delaying ambulance resources from
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11 192 becoming unavailable for new assignments.

12 193 However, when there are multiple calls for different emergencies at once, SRCCAD
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14 194 may prioritize cases based on three levels of urgency and dispatch crews accordingly. Patients
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16 195 or their families who have guardianship have the right to refuse transportation to hospital after
17
18 196 they have signed a formal paper of refusal against medical advice. However, EMS crews can
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20 197 either transport patients to the closest hospitals or treat them at the scene. The study proposal
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22 198 was reviewed and approved by the ethical committee in Jazan University with the registry
23
24 199 number: REC39/9-S085. The Ethics Committee, based on no need to contact patients, agreed
25
26 200 that informed consent was not required because of the anonymity of the data collected for
27
28 201 routine ambulance missions and the study's retrospective design. The study data take into
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30 202 consideration privacy and confidentiality.

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31 204 **Participants and public involvement**

32 205 Patients and public were not involved in developing the research question, commenting on the
33
34 206 database, study design, outcome measures, conduct of the study, or contributing to the writing
35
36 207 or editing of this study.

37 208

39 209 **Data collection**

41 210 The data were obtained through the operations and information department in the Riyadh
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43 211 branch directorate of Saudi Red Crescent Authority (SRCA). Data were exported from
44
45 212 Microsoft Excel saved in an encrypted file on a hard disc and converted to an IBM SPSS file
46
47 213 (version 25) for further analyses.

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50 215 **Selection of Participants**

51 216 According to the Saudi EMS definition, highly urgent emergency cases are the cases that
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53 217 contacted EMS for support after exposure to serious or life-threatening illness or injuries that
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55 218 require immediate medical intervention and quick transportation to hospital emergency
56
57 219 departments (EDs). In this study, all incoming calls for patients who were triaged at the
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59 220 dispatching centre of SRCCAD as highly urgent emergency cases were included.
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221 Gynaecological emergencies were excluded because of the scope of the study to compare both

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3 222 sexes. In addition, we excluded records of patients for whom age, sex, or area was missing and
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5 223 cases categorized by the SRCCAD as cases ended by non-conveyance. We considered the
6
7 224 potential source of bias; therefore, we excluded the lower extreme outliers with values equal
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9 225 to zero due to system error. Records of missions dispatched for two patients or more in one
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11 226 incident were excluded. Similarly, Missions that involved only Rapid Response Non-
12
13 227 Transporting Vehicles (RRNTV) were also removed.
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229 **Methods of Measurement**

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17 230 We included all variables related to patient demographics and information related to
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19 231 dispatching missions from the time period perspective, starting from calling the call centre and
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21 232 ending with the patients' arrival to private and governmental hospitals. The EMS time intervals
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23 233 are composed of 4 different periods.²¹ First, the response time, which is the time elapsed
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25 234 starting from receiving a call in the call centre and ended by the ambulance's crew's arrival to
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27 235 the scene. Second, the OST, which is the time elapsed, starting from arrival to the scene and
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29 236 ended by starting to travel back to EMS centre or traveling forward toward healthcare facilities.
30
31 237 Third, the travel time, which is the time elapsed from starting to move from the scene until the
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33 238 crew's arrival to healthcare facilities. Fourth, is the hospital period, defined as the time elapsed
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35 239 from arrival to the healthcare facility until handover to emergency room staff. EMS database
36
37 240 registry recorded all events starting from activation time and ending by crew's departure from
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39 241 the hospitals in the cases where the patient had been transported or when the crew leaves the
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41 242 scene when transportation had been refused. It measures only response time period and total
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43 243 EMS time period in seconds. Therefore, the total EMS time in this study reflects the four
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45 244 periods. We calculated the OST, travel time, hospital time according to standard EMS
46
47 245 definition.²¹ Those periods in Saudi EMS have individual target indicators, such as the response
48
49 246 time; 20 minutes; the OST is 15 minutes, while the travel time has no indicator because of EMS
50
51 247 providers' and patients' safety issue arise if the time indicator too strict due to the risk of driving
52
53 248 too fast on the way to hospital. Saudi EMS would consider the OST if it exceeded 15 minutes
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55 249 as a prolonged OST. In cases where the call centre dispatched two or more EMS crews, we
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57 250 selected by calculating the actual time spent with the patient from when the first crew arrived
58
59 251 either the RRNTV or the main transporting ambulance until the patient was transported by
60
252 ambulance.

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

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3 256 that were dispatched for highly urgent medical emergencies (HUME) such as acute coronary
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5 257 syndrome, stroke, and out-of-hospital cardiac arrest. The second cohort was the missions
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7 258 dispatched for highly urgent trauma emergencies (HUTE) such as road traffic accidents.
8
9 259 Demographic features available in the registry that were extracted are sex, age and
10
11 260 geographical area. Patients' age was divided into three categories according to Saudi Arabian
12
13 261 law; child: patient with an age below 15 years old, adult: patient equal to or over 15 years old
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15 262 but younger than 60 years old, and elderly: patient equal to or more than 60 years old. Urban
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17 263 area was defined as an area where metropolitan and micropolitan cities are located and have a
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19 264 total population of equal to or more than 5000 inhabitants. On the other side, areas with less
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21 265 than 5000 people or outside urban geographical area were considered rural.

22 266 We considered the differences in various EMS operational times from the data collected
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24 267 in a one-year time period. In Saudi Arabia, the weekdays are considered from Sunday to
25
26 268 Thursday while the Friday and Saturday are the weekends. Period of the day is categorized into
27
28 269 two categories; office time, which is the time that starts from 8:00 AM to 4:00 PM from Sunday
29
30 270 to Thursday, while the home time is defined as the time that starts from 4:01 PM on the same
31
32 271 day up to the next day 7:59 AM side by side with 48 hours of the weekend Friday and Saturday.
33
34 272 Working shifts are the two daily periods that Saudi EMS schedules to provide emergency
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36 273 services. It is composed of two periods: the day shift from 8:00 AM to 8:00 PM and the night
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38 274 shift from 8:00 PM to 8:00 AM. We also included season. The winter season officially starts
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40 275 from Mid-December to Mid-March, then the spring, which starts from Mid-March until Mid-
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42 276 June. Summer starts from Mid-June to Mid-December, followed by Autumn, which starts from
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44 277 Mid-September 21 and ends by Mid-December.²²

45 278 Operating vehicle types represented by the three types of crews providing EMS for the
46
47 279 clustered emergencies were included. The first, Ambulance type II transporting vehicle (BLS-
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49 280 ambulance) is the vehicle equipped by two EMT, who can perform basic life support and rapid
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51 281 patient transport to hospitals. MICU is another transporting vehicle capable of highly qualified
52
53 282 physician-based or paramedics exposed to long-term training equal to or more than four years.
54
55 283 The last type of vehicle is RRNTV, which is operated in the last decade to arrive at the scene
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57 284 earlier than the transporting vehicle, and it is also operated by highly experienced EMS
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59 285 providers, often EMS paramedics. The crew of RRNTV can give ALS and do the necessary
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286 medical work to prepare the patients to be transported. Hospitals that receive emergency
287 patients are of two types. We also included EDs based on the two types of hospitals.
288 Governmental hospitals are non-profit healthcare organizations funded by the Saudi authorities

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

291

292 **Statistical Analysis**

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

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

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

307

308 **RESULTS**

309 **Characteristics of study subjects**

310 During the study period, 35,944 missions of two types – transporting and non-transporting
311 vehicles – were dispatched to the scene. RRNTV accounted for 3,397 (9.5%) missions while
312 the transporting vehicles were 32,547 (90.5%); BLS-Ambulance 25,988 (72.3%), MICU 6,559
313 (18.2%). Subsequently, 32,547 high emergency patients were transported to Riyadh province
314 hospitals.

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

323 which were the primary transporting ambulances of the patients. Subsequently, 21,878
 324 missions of highly urgent emergency patients were included in this study. We found that 14,454
 325 (66.1%) of cases were male. In total, 14,454 (66.1%) missions were for HUME, and 7,424
 326 (33.9%) for HUTE. Of all, 66.5% of cases were attended at the scene by BLS-ambulances
 327 crews, 22.3% by MICU ambulances crews, and 11.2% by two crews; 50% of them are
 328 RRNTVs, and the remaining 50% were BLS-ambulances.

329

330 Main results

331 Table 1 shows time periods of ambulance service runs, including response time, OST, travel
 332 time, and hospital time. The study showed that each duration of OST and travel time for the
 333 HUME cohort significantly differed between men and women. The median OST of HUME for
 334 women 23 minutes (IQR 16 – 31 minutes) was significantly longer than men 20 minutes (IQR
 335 13 – 29 minutes), $p < 0.001$. The median travel time for women 19 minutes (IQR 10 – 29
 336 minutes) was significantly longer than men 18 minutes (IQR 10 – 29 minutes), $p < 0.001$.

337

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

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3 339 Table 2 shows the median and IQR stratified by patients' demographic and background
4 factors for both HUTE and HUME causes. The total median OST was significantly longer for
5 340 women 22 minutes (IQR 15 – 30 minutes) than men 18 minutes (IQR 11 – 26 minutes), $p =$
6 341 0.001. Most differences related to OST between men and women were significant, all showing
7 342 longer OST for women. In addition, all characteristics variables of patients and missions except
8 343 the daily hours, weekdays, and working shifts were statistically significant among each group
9 344 of men and women.
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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				
Governmental	14,391¶		7,402♦	
Private	12,165 (84.2)	18.0 (11.0 – 26.0)*	6,271 (84.5)	22.0 (15.0 – 30.0)**
	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.

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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

377 significantly associated with OST in the crude, or adjusted analyses. When adjusted for other
 378 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.

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380 We found that 59.4% of men had an OST of more than 15 minutes compared to 75%
 381 for women ($p < 0.001$). Table 4 shows the findings of the crude and adjusted logistic regression
 382 models. Emergency type, sex, age category, geographical areas, types of vehicles, and hospitals
 383 type were all significantly associated with the odds of OST of more than 15 minutes, both in
 384 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.

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5 387 **DISCUSSION**

6 388 Both OST and total EMS time for HUME were significantly longer for women than men, while
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9 389 missions dispatched to HUTE did not show any difference. Our study demonstrates that OST
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11 390 was also prolonged when EMS ambulances missions were dispatched for women, the elderly,
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13 391 in urban areas, during winter, as advanced EMS services, or for transport to private hospitals.

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15 392 HUME missions may be more often for patients in household buildings than to HUTE
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17 393 missions that may be dispatched more often to open areas such as streets (e.g., for vehicle
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19 394 accidents). In that case, the profound sex difference in median OST in HUME missions might
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21 395 partly be explained by Saudi house design and culture. It is customary in Saudi Arabia for the
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23 396 upper floors and rooms far from the residential home's main entrance to be a suitable residence
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25 397 for women. It has been proven that house design has an impact on delaying the access time to
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27 398 the patient after crew arrival to the scene.^{23 24} Saudi houses are relatively large due to the high
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29 399 average number of family members. When EMS crews arrive at the scene, they must usually
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31 400 walk a longer distance to reach the female-patient locations. Moreover, cultural differences in
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33 401 Saudi Arabia require women to be fully covered at the presence of non-primary relative male
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35 402 such the EMS all-males crews and that is why it might take a considerable time before the crew
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37 403 are allowed access to the patient.
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43 404 Another possible reason for the delay during the scene period for Saudi women is the
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45 405 loading process into ambulance vehicles by all-male crews. This process would require strict
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47 406 adherence by crews' members to use the ambulance stretchers even if the patient can walk
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49 407 independently or with crew members' support. While for Saudi men, the stretcher could be
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51 408 waived once the patient prefers walking without it. However, to the best of our knowledge, no
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53 409 previous study has investigated the influence of culture and home design and whether they
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55 410 have a role in prolonging the OST duration for men or women. Thus, further research on this
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57 411 topic is warranted.
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3 412 In Saudi culture, men are usually involved in decision-making related to the
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5 413 transportation of children and elderly of both sexes, and women of all ages. Some Saudi women
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7 414 demand that their primary male relative is present to discuss their health status and plan further
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9 415 action. Some still need guardianship for signing the consent for medical interventions, although
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11 416 they have the right to sign it themselves.^{25 26} In specific circumstances, the women's guardian
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13 417 can prohibit them from transportation to the hospital by ambulance.²⁷ However, studies in the
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15 418 US showed women had received less EMS interventions and treatment compared to men.^{28 29}
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17 419 Further qualitative research may be needed to identify factors that lead to prolonged OST at
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19 420 households. This study lacks the data necessary to do so. No previous narrative inquiry has
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21 421 been performed to study this phenomenon in Saudi Arabia. An Australian qualitative study
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23 422 investigated the barriers confronting paramedics because of cultural barriers of middle eastern
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25 423 people living in Australia who might have a cultural resemblance to Saudi people.³⁰ The
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27 424 informants' paramedics stated that they found difficulties in providing care due to specific
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29 425 norms and behaviour emanating from middle east culture, and time management at the home
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31 426 locations was affected.³⁰

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33 427 Although we look for explanations in Saudi culture, gender-differences are not confined
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35 428 to our study. Studies from other countries often found that women had a longer median or
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37 429 average OST compared to men.^{12 28 31-34} A study conducted by Aguilar et al. in the US found
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39 430 that women have a more extended OST than men for non-ST-elevation myocardial infarction
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41 431 and ST-elevation myocardial infarction, despite ECG being implemented for both men and
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43 432 women.¹² We found the median OST for MICU crews to be significantly longer for women,
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45 433 and MICU increased the odds of prolonged OST. Schull et al. found dispatching ALS crews
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47 434 compared to the BLS crew at the scene increase the OST by 5.6 minutes (22.0%).³¹ However,
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49 435 our data did not include the type and number of interventions at the scene.
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3 436 During the on-scene period, patients' history and medical examination are performed
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6 437 by EMS providers. In the context of other medical practices like general practice, it has been
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8 438 shown that women tend to take longer consultation time than men.³⁵ Furthermore, they may
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10 439 express their dissatisfaction with the allowable time as they prefer to linger a bit longer to
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12 440 communicate further with doctors about their problem.³⁶⁻³⁸ Even with emergency incidents
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14 441 such as heart attacks, women's behaviour for seeking EMS support has been noted as one of a
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16 442 multitude of predisposing factors for delay response, management, or transport. For example,
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18 443 the self-recognition of onset of symptoms, the delay in contacting EMS or hospitals for help,
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20 444 presenting atypical symptoms to EMS call-takers.³⁹⁻⁴² These behaviours might influence the
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22 445 standard time required to provide the optimum healthcare for them. Moreover, these factors
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24 446 may misguide EMS providers of the importance of quick transport to hospitals EDs. For
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26 447 example, two studies from Australia and Norway have compared women diagnosed with acute
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28 448 myocardial infarction upon arrival to hospitals to men. The studies showed that women were
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30 449 less likely to be transported with sirens and lights.^{43 44} A Saudi study found Saudi women had
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32 450 lower health literacy than men.⁴⁵ Two other Saudi studies revealed that Saudi women were
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34 451 less likely to use ambulances and more likely to refuse ambulance transportation than men.^{1 46}
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36 452 Therefore, this noted long time might be partially explained by their reluctance to be
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38 453 transported and that the ambulance crew spent extra time to convince them.
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44 454 In our study, children represented 3.7% of EMS missions and had significantly shorter
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46 455 OST. Our study is consistent with multiple studies that found children's OST to be significantly
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48 456 shorter than adults.^{33 47} In our study, elderly patients had by far the longest median OST.
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50 457 Cultural restrictions of face coverage for elderly females reduce with an increase in age. Elderly
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52 458 people of both sexes in Saudi Arabia most ordinarily live on the first floor due to comorbidities
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54 459 and difficulties climbing up to the upper floors. In our study, although the median OST for
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56 460 elderly people was longer than adults and children but the inter-gender variation in the OST
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3 461 duration for elderly people is negligible in comparison to adults and children. The plausible
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5 462 explanation for prolonged OST for the elderly might be attributed to the difficulty in
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7 463 communication with them about the severity of their medical conditions and that more time
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9 464 was required to stabilize them.³⁴ A Swedish study found that an increase in age is directly
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11 465 proportional to an increase in OST.⁴⁸ Sullivan et al. found oldest people are significantly
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13 466 associated with longer OST.³² However, in another study, no association between age and sex
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15 467 and prolonged OST.⁴⁹

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19 468 More than 50% of emergency cases had an OST of greater than 15 minutes, which is
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21 469 the Saudi EMS standard time for all crews to perform the standard operational procedures
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23 470 during OST regardless of urgency levels. Although the median OST for HUTE is closer than
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25 471 HUME to the benchmark of 15-minutes, about 25% of those missions are still more than 22
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27 472 minutes. McCoy et al. found that OST for trauma cases of greater than 20 minutes was
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29 473 associated with higher odds of mortality, especially for penetrating trauma and no association
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31 474 between increased odds of mortality and out-of-hospital times in blunt trauma victims.⁵⁰ A
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33 475 Dutch study conducted found that for every minute spent on the scene in case of out-of-hospital
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35 476 cardiac arrest, the odds of 30-day survival decreases.⁵¹ We think 15-minutes may be an
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37 477 inappropriate standard to deal with all cases equally. There is no consensus between researchers
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39 478 on how long the crews should stay on the scene for out-of-hospital cardiac arrest, although the
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41 479 strategic role of scope and run versus stay and play is better and has become widespread.^{52 53}
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43 480 In the US, Studnek et al. demonstrated that staying less than 15 minutes at the scene was
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45 481 deemed the appropriate time for acute coronary syndrome patients to receive reperfusion
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47 482 therapy in less than 90 minutes from the onset of symptoms.⁵⁴ Moreover, several studies
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49 483 demonstrated that OST increases were associated with adverse outcomes.^{3 5 50 53 55 56} In
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51 484 addition, the American Stroke Association guideline recommends the OST to be ≤ 15 minutes.⁷
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53 485 Although Saudi EMS recognizes the value of time and applies the scope and run by
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3 486 encouraging commissioned crews members to be time-efficient within a specified OST, it
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5 487 seems that crews are confronted with difficulties in coping with the standardized time during
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7 488 their time at the scene. Our study revealed EMS crews staying a half-hour or more at the scene
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9 489 for 25 % of adult women regardless of the calls' reasons. We compared this finding with their
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11 490 counterpart of adult men, and we found the difference was at a minimum 5 minutes. A
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13 491 significant delay on the scene can deprive women of receiving important medical intervention,
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15 492 unable to be provided by the ambulance crew, in a timely manner in definitive care especially
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17 493 in life threatening cases. Due to the longer OST for women, they are more exposed to
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19 494 unexpected adverse events such as late or unsafe arrival to hospitals, especially when the crews
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21 495 are committed to not exceeding the golden hour, the benchmark related to the total EMS time,
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23 496 and risk road accidents themselves.
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498 **Strengths and limitations**

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33 499 Our study as a retrospective study has several limitations, all pertaining to the EMS registry.
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35 500 The registry relies on the SRCCAD automated detection of time to compute the timeline.
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37 501 However, one-fourth of data were missing, and we observed impossible outliers that may have
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39 502 arisen due to network failure during the communication between call centre and crews at the
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41 503 scene. Our exclusion of those missing data and outliers might have induced selection bias.
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43 504 Another limitation is the non-availability of variables that may explain the gender-differences
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45 505 in more details, such as socioeconomic characteristics, time between onset of symptoms and
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47 506 EMS call, type of treatment at the scene, and OST stratified by its four phases: arrival at the
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49 507 scene until accessing the patient, patient assessment time, treatment phase, and loading time.
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52 508 On the other hand, using registry data has provided us with much statistical power to detect
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54 509 between-group differences and associations for the characteristics that were available.
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3 510 Perceived urgency and severity rely on the call centre's triaging system and additional
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5 511 confirmation by crews during arrival at the scene, which might not reflect the real patient
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7 512 condition when the patients arrive at the hospital. Therefore, some misclassification in the
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9 513 urgency types may have occurred. However, our data do reflect daily practices in which
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11 514 urgency levels are determined as early during the mission as possible. However, with future
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13 515 involvement in the EMS data set, researchers could explain those reasonable and unavoidable
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15 516 causes that lead to the lateness.

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19 517 Considering the linking of the registry data to outcomes data on patients' receiving
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21 518 hospital data such as mortality, 28-day survival, and 6-month survival, we showed OST
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23 519 statistical significance between sexes but limited to show the clinical significance. The last
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25 520 limitation belongs to the study design of clustering heterogeneous emergency types into two
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27 521 cohorts and the Saudi benchmarks of 15-minutes. As a result, our study cannot compare our
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29 522 finding of OST with the essential international guideline like AHA of the recommended OST
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31 523 for specific emergency cases like out-of-hospital cardiac arrest, acute coronary syndrome, and
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33 524 stroke. However, our study showed that female time to access definitive care during medical
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35 525 emergencies is more extended. With future involvement in the EMS data set, researchers could
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37 526 explain the relationship between time performance and EMS outcomes.

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42 527 Finally, our study's generalizability might apply to urban and rural areas of other
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44 528 different Saudi provinces and the other Arabian Gulf States having similar EMS systems except
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46 529 for Macca city in Saudi Arabia because of Hajj and the influx of Muslims gathering during
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48 530 different seasons.

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52 532 **CONCLUSIONS**

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55 533 This study shows that median OST was longer than 15 minutes for more than half of
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57 534 transported cases. In addition, it was longer for women for HUME at every time and place,
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3 535 regardless of age category, crew type, and receiving hospital. For those EMS missions that had
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5 536 been dispatched for HUTE, there was no difference. Furthermore, missions to children, in rural
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7 537 areas, for trauma patients, for crews dispatched by BLS-ambulances, in summer as a season,
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9 538 or transported to EDs of governmental hospitals were all significant predictors for shorter OST.

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13 540 **Authors' Contribution:** All authors conceived the study, conceptualize the ideas, supervised
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15 541 the study design and definition of essential terms and study measures. H.N.M, S.M.J.V.K, and
16
17 542 DMA performed the data cleaning, management, and analysis. H.N.M was the formal analysis,
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19 543 and S.M.J.V.K provided statistical advice on study design and analysis. H.N.M and DMA had
20
21 544 full access to all of the data in the study. H.N.M takes responsibility for the integrity of the data
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23 545 and the accuracy of data analysis. H.N.M, S.M.J.V.K, M.E.M, and H.R.H interpreted the data.
24
25 546 H.N.M and H.R.H were the project administrators. H.R.H was the primary supervisor. H.N.M
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27 547 drafted the manuscript, and all authors contributed substantially to its revision. H.N.M takes
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29 548 responsibility for the paper as a whole.

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30 550 **Conflicts of interest:** no conflicts.

31 551

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33 553

34 554 **Ethics approval:** The Ethics Committee of Jazan University.

35 555

36 556 **Data availability statement:** Data are available upon reasonable request.

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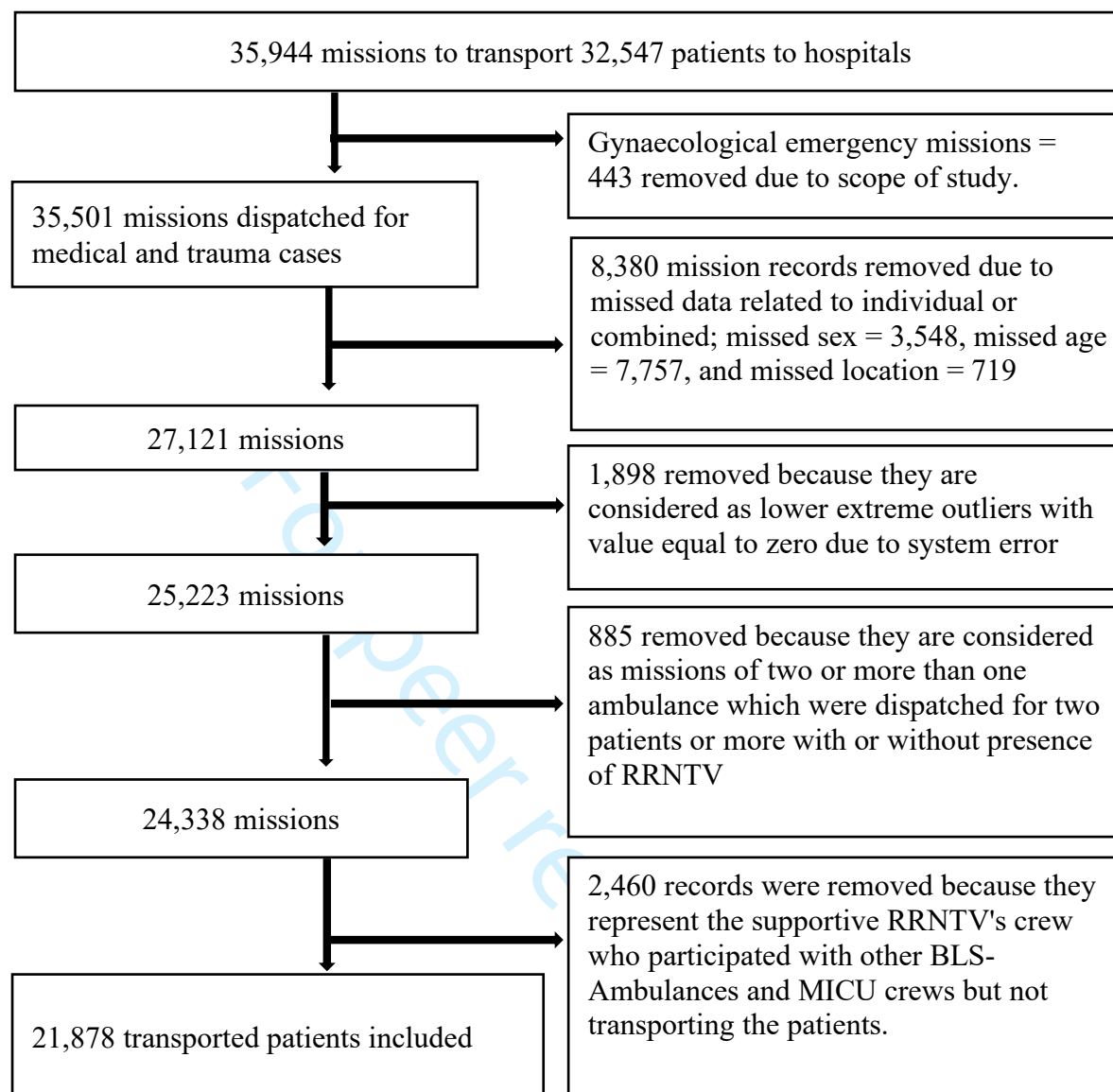
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40 742 Figure 1 Flow chart of included and excluded patients.

41 743 BLS, Basic Life Support; MICU, Mobile Intensive Care Unit; RRNTV, Rapid Response Non-Transporting Vehicle.
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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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6 – 7	Lines 216 – 227
		<i>Case-control study</i> —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		
		<i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants		
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed		
		<i>Case-control study</i> —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	7 – 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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed	NA	NA
		<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	NA	NA
		<i>Cross-sectional study</i> —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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	N/A	N/A
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	14 – 15	380 - 386
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	N/A	N/A
		<i>Cross-sectional study</i> —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	10 – 15	331 – 386
		(b) Report category boundaries when continuous variables were categorized	10 – 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	19 – 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	15 – 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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3 **1 Variation in on-scene time of emergency medical services and the extent of the difference**
4 **2 of on-scene time between genders: A retrospective population-based registry study in**
5 **3 Riyadh province, Saudi Arabia**
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41 ABSTRACT

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

45 **Design:** A retrospective population-based registry study.

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

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

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

51 **Results:** In total, 21,878 patients were included for analysis: 33.9% women and 66.1% men.
52 The median OST for women was 22 minutes (interquartile range [IQR] 15 – 30) and 18 minutes
53 (IQR 11 – 26) for men, $p < 0.001$; for medical cases, median OST was 23 minutes (IQR 16 –
54 31) for women compared to 20 minutes (IQR 13 – 29) for men, $p < 0.001$; for trauma cases, the
55 median OST of both sexes was equal. We found the following additional predictors of OST:
56 factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle,
57 and hospital type were all significantly associated with OST in the crude or adjusted analyses.
58 Factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle,
59 and hospital type were also significantly associated with the odds of OST of more than 15-
60 minutes in the crude and adjusted regression analyses.

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

67 Strengths and limitations of this study

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

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3 74 ♦ Registry lacks other important demographic factors related to social status; education,
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5 75 income, and ethnicity, which might be associated with prolonged on-scene time.
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7 76 ♦ Time registered in the database depends on the information provided by emergency
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9 77 medical services (EMS) providers through wireless communications with the call
10 78 centre; hence, any network failure leads to missed data.
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121 INTRODUCTION

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

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

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

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

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3 155 patient-related factors associated with time spent at the scene for all highly urgent emergency
4 156 cases that were transported to healthcare facilities in the Riyadh province in Saudi Arabia and
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6 157 to hypothesize for possible factors delaying OST.
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10 159 **METHODS**

11 160 **Design**

12
13 161 This retrospective population-based registry was conducted in the Riyadh province of Saudi
14
15 162 Arabia by using all EMS database records in the Saudi Red Crescent Computer Aid
16
17 163 Dispatching (SRCCAD) system, from January 1, 2018, to December 31, 2018. This study
18
19 164 complies with Strengthening the Reporting of Observational Studies in Epidemiology
20
21 165 (STROBE).¹⁷
22
23 166

24 167 **Setting**

25 168 Riyadh Province is in the central part of Saudi Arabia. It has a geographical size of 404,240
26
27 169 km². It has an approximate population of 6,792,776 million, according to the last national
28
29 170 census. The province is composed of 39 different cities and Riyadh city is the capital and the
30
31 171 largest city in Saudi Arabia. Besides, there are hundreds of rural villages dotted between or
32
33 172 near these cities.¹⁸ In Saudi Arabia, EMS are free of charge and can be accessed by calling the
34
35 173 call centre, and in certain exceptional conditions, patients can visit ambulance stations
36
37 174 distributed all over the province, including along highways. EMS crews of Riyadh province
38
39 175 are mainly composed of two Emergency Medical Technicians (EMT). They are trained on
40
41 176 basic life support (BLS) skills to respond to different levels of emergency cases but do not
42
43 177 administer medicine. However, some crews are composed of physicians and emergency
44
45 178 paramedics. These are called mobile intensive care units (MICU) and respond to certain highly
46
47 179 critical cases and provide advanced life support (ALS). A third type of EMS crew consists of
48
49 180 senior paramedics and are dispatched in a rapid response non-transporting vehicle (RRNTV).
50
51 181 These often arrive earlier to provide ALS before the essential transporting ambulances. Time
52
53 182 indicators are built-in SRCCAD with 20 minutes for response time and 15 minutes for OST
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55 183 regardless of urgency level.

56
57 184 Saudi EMS implements a strategy of scoop and run, which emanated from the Anglo-
58
59 185 American model. Most EMS chain periods are limited with a predefined time to end with the
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186 golden hour of total time.¹⁹ The OST comprises three consecutive periods which are access,
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188 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

1
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3 189 and treatment. Loading time starts from moving patients on the stretcher until the crew starts
4
5 190 to travel to the hospital. The policy underpinning this 15-minute benchmark for OST is that
6
7 191 the Saudi EMS policymakers, based on the number of available crews and the volume of
8
9 192 patients' demands, decided that 15 minutes at the scene fit their operational procedures as a
10
11 193 policy target. An additional consideration was to avoid delaying ambulance resources from
12
13 194 becoming unavailable for new assignments.

14 195 However, when there are multiple calls for different emergencies at once, SRCCAD
15
16 196 may prioritize cases based on three levels of urgency and dispatch crews accordingly. Patients
17
18 197 or their families who have guardianship have the right to refuse transportation to hospital after
19
20 198 they have signed a formal paper of refusal against medical advice. However, EMS crews can
21
22 199 either transport patients to the closest hospitals or treat them at the scene. The study proposal
23
24 200 was reviewed and approved by the ethical committee in Jazan University with the registry
25
26 201 number: REC39/9-S085. The Ethics Committee, based on no need to contact patients, agreed
27
28 202 that informed consent was not required because of the anonymity of the data collected for
29
30 203 routine ambulance missions and the study's retrospective design. The study data take into
31
32 204 consideration privacy and confidentiality.

33 205

34 206 **Participants and public involvement**

35 207 Patients and public were not involved in developing the research question, commenting on the
36
37 208 database, study design, outcome measures, conduct of the study, or contributing to the writing
38
39 209 or editing of this study.

40 210

41 211 **Data collection**

42 212 The data were obtained through the operations and information department in the Riyadh
43
44 213 branch directorate of Saudi Red Crescent Authority (SRCA). Data were exported from
45
46 214 Microsoft Excel saved in an encrypted file on a hard disc and converted to an IBM SPSS file
47
48 215 (version 25) for further analyses.

49 216

50 217 **Selection of Participants**

51 218 According to the Saudi EMS definition, highly urgent emergency cases are the cases that
52
53 219 contacted EMS for support after exposure to serious or life-threatening illness or injuries that
54
55 220 require immediate medical intervention and quick transportation to hospital emergency
56
57 221 departments (EDs). In this study, all incoming calls for patients who were triaged at the
58
59 222 dispatching centre of SRCCAD as highly urgent emergency cases were included.

1
2
3 223 Gynaecological emergencies were excluded because of the scope of the study to compare both
4
5 224 sexes. In addition, we excluded records of patients for whom age, sex, or area was missing and
6
7 225 cases categorized by the SRCCAD as cases ended by non-conveyance. We considered the
8
9 226 potential source of bias; therefore, we excluded the lower extreme outliers with values equal
10
11 227 to zero due to system error. Records of missions dispatched for two patients or more in one
12
13 228 incident were excluded. Similarly, Missions that involved only Rapid Response Non-
14
15 229 Transporting Vehicles (RRNTV) were also removed.

16 230

17 231 **Methods of Measurement**

18
19 232 We included all variables related to patient demographics and information related to
20
21 233 dispatching missions from the time period perspective, starting from calling the call centre and
22
23 234 ending with the patients' arrival to private and governmental hospitals. The EMS time intervals
24
25 235 are composed of 4 different periods.²¹ First, the response time, which is the time elapsed
26
27 236 starting from receiving a call in the call centre and ended by the ambulance's crew's arrival to
28
29 237 the scene. Second, the OST, which is the time elapsed, starting from arrival to the scene and
30
31 238 ended by starting to travel back to EMS centre or traveling forward toward healthcare facilities.
32
33 239 Third, the travel time, which is the time elapsed from starting to move from the scene until the
34
35 240 crew's arrival to healthcare facilities. Fourth, is the hospital period, defined as the time elapsed
36
37 241 from arrival to the healthcare facility until handover to emergency room staff. EMS database
38
39 242 registry recorded all events starting from activation time and ending by crew's departure from
40
41 243 the hospitals in the cases where the patient had been transported or when the crew leaves the
42
43 244 scene when transportation had been refused. It measures only response time period and total
44
45 245 EMS time period in seconds. Therefore, the total EMS time in this study reflects the four
46
47 246 periods. We calculated the OST, travel time, hospital time according to standard EMS
48
49 247 definition.²¹ Those periods in Saudi EMS have individual target indicators, such as the response
50
51 248 time; 20 minutes; the OST is 15 minutes, while the travel time has no indicator because of EMS
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53 249 providers' and patients' safety issue arise if the time indicator too strict due to the risk of driving
54
55 250 too fast on the way to hospital. Saudi EMS would consider the OST if it exceeded 15 minutes
56
57 251 as a prolonged OST. In cases where the call centre dispatched two or more EMS crews, we
58
59 252 selected by calculating the actual time spent with the patient from when the first crew arrived
60
253 either the RRNTV or the main transporting ambulance until the patient was transported by
254 ambulance.

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

1
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3 257 clustered emergency cases into two cohorts. The first cohort was the cluster of EMS mission
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5 258 that were dispatched for highly urgent medical emergencies (HUME) such as acute coronary
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7 259 syndrome, stroke, and out-of-hospital cardiac arrest. The second cohort was the missions
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9 260 dispatched for highly urgent trauma emergencies (HUTE) such as road traffic accidents.
10
11 261 Demographic features available in the registry that were extracted are sex, age and
12
13 262 geographical area. Patients' age was divided into three categories according to Saudi Arabian
14
15 263 law; child: patient with an age below 15 years old, adult: patient equal to or over 15 years old
16
17 264 but younger than 60 years old, and elderly: patient equal to or more than 60 years old. Urban
18
19 265 area was defined as an area where metropolitan and micropolitan cities are located and have a
20
21 266 total population of equal to or more than 5000 inhabitants. On the other side, areas with less
22
23 267 than 5000 people or outside urban geographical area were considered rural.

24 268 We considered the differences in various EMS operational times from the data collected
25
26 269 in a one-year time period. In Saudi Arabia, the weekdays are considered from Sunday to
27
28 270 Thursday while the Friday and Saturday are the weekends. Period of the day is categorized into
29
30 271 two categories; office time, which is the time that starts from 8:00 AM to 4:00 PM from Sunday
31
32 272 to Thursday, while the home time is defined as the time that starts from 4:01 PM on the same
33
34 273 day up to the next day 7:59 AM side by side with 48 hours of the weekend Friday and Saturday.
35
36 274 Working shifts are the two daily periods that Saudi EMS schedules to provide emergency
37
38 275 services. It is composed of two periods: the day shift from 8:00 AM to 8:00 PM and the night
39
40 276 shift from 8:00 PM to 8:00 AM. We also included season. The winter season officially starts
41
42 277 from Mid-December to Mid-March, then the spring, which starts from Mid-March until Mid-
43
44 278 June. Summer starts from Mid-June to Mid-December, followed by Autumn, which starts from
45
46 279 Mid-September 21 and ends by Mid-December.²²

47 280 Operating vehicle types represented by the three types of crews providing EMS for the
48
49 281 clustered emergencies were included. The first, Ambulance type II transporting vehicle (BLS-
50
51 282 ambulance) is the vehicle equipped by two EMT, who can perform basic life support and rapid
52
53 283 patient transport to hospitals. MICU is another transporting vehicle capable of highly qualified
54
55 284 physician-based or paramedics exposed to long-term training equal to or more than four years.
56
57 285 The last type of vehicle is RRNTV, which is operated in the last decade to arrive at the scene
58
59 286 earlier than the transporting vehicle, and it is also operated by highly experienced EMS
60
287 providers, often EMS paramedics. The crew of RRNTV can give ALS and do the necessary
288 medical work to prepare the patients to be transported. Hospitals that receive emergency
289 patients are of two types. We also included EDs based on the two types of hospitals.
290 Governmental hospitals are non-profit healthcare organizations funded by the Saudi authorities

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

293

294 **Statistical Analysis**

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

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

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

309

310 **RESULTS**

311 **Characteristics of study subjects**

312 During the study period, 35,944 missions of two types – transporting and non-transporting
313 vehicles – were dispatched to the scene. RRNTV accounted for 3,397 (9.5%) missions while
314 the transporting vehicles were 32,547 (90.5%); BLS-Ambulance 25,988 (72.3%), MICU 6,559
315 (18.2%). Subsequently, 32,547 high emergency patients were transported to Riyadh province
316 hospitals.

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

325 which were the primary transporting ambulances of the patients. Subsequently, 21,878
 326 missions of highly urgent emergency patients were included in this study. We found that 14,454
 327 (66.1%) of cases were male. In total, 14,454 (66.1%) missions were for HUME, and 7,424
 328 (33.9%) for HUTE. Of all, 66.5% of cases were attended at the scene by BLS-ambulances
 329 crews, 22.3% by MICU ambulances crews, and 11.2% by two crews; 50% of them are
 330 RRNTVs, and the remaining 50% were BLS-ambulances.

331

332 Main results

333 Table 1 shows time periods of ambulance service runs, including response time, OST, travel
 334 time, and hospital time. The study showed that each duration of OST and travel time for the
 335 HUME cohort significantly differed between men and women. The median OST of HUME for
 336 women 23 minutes (IQR 16 – 31 minutes) was significantly longer than men 20 minutes (IQR
 337 13 – 29 minutes), $p < 0.001$. The median travel time for women 19 minutes (IQR 10 – 29
 338 minutes) was significantly longer than men 18 minutes (IQR 10 – 29 minutes), $p < 0.001$.

339

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

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1
2
3 341 Table 2 shows the median and IQR stratified by patients' demographic and background
4
5 342 factors for both HUTE and HUME causes. The total median OST was significantly longer for
6
7 343 women 22 minutes (IQR 15 – 30 minutes) than men 18 minutes (IQR 11 – 26 minutes), $p =$
8
9 344 0.001. Most differences related to OST between men and women were significant, all showing
10
11 345 longer OST for women. In addition, all characteristics variables of patients and missions except
12
13 346 the daily hours, weekdays, and working shifts were statistically significant among each group
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15 347 of men and women.

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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				
Governmental	14,391¶		7,402♦	
Private	12,165 (84.2)	18.0 (11.0 – 26.0)*	6,271 (84.5)	22.0 (15.0 – 30.0)**
	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.

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376

377

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

378 significantly associated with OST in the crude, or adjusted analyses. When adjusted for other
 379 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.

380

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

386

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.

387 DISCUSSION

388 The present study showed that more than 50% of emergency cases had an OST of greater than
389 15 minutes, which is the Saudi EMS standard time for all crews to perform the standard
390 operational procedures during OST regardless of urgency level. Although the median OST for
391 HUTE was closer than HUME to the benchmark of 15 minutes, about 25% of those missions
392 still took more than 22 minutes. OST was also prolonged when EMS ambulances missions
393 were dispatched for women, the elderly, in urban areas, during winter, as advanced EMS
394 services, or for transport to private hospitals. Several studies demonstrated that an increase in
395 OST was associated with adverse outcome.^{3 5 23-26} In addition, the American Stroke Association
396 guideline recommends OST to be ≤ 15 minutes.⁷

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

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

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3 413 men regardless of any explanatory factor. For example, in looking at EMS crew types, we
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5 414 found EMS missions that were dispatched by MICU crews had longer OST than BLS crews,
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7 415 and the dispatching of MICU crews increased the odds of prolonged OST regardless of the
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9 416 patients' gender. This finding is line with Schull et al. who found dispatching ALS crews
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11 417 compared to the BLS crews at the scene increase the OST by 5.6 minutes.³³ Yet, we found that
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13 418 the median OST for MICU crews was longer for women than men, although, our data did not
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15 419 include the type and number of interventions at the scene. Our study revealed EMS crews
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17 420 staying a half-hour or more at the scene for 25 % of adult women regardless of the calls'
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19 421 reasons. We compared this finding with their counterpart of adult men, and we found the
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21 422 difference was at a minimum 5 minutes. Given the unavailable data elucidating number and
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23 423 type of medical interventions at the scene, we are unable to clarify the medical reasons
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25 424 triggering this difference. Moreover, our study data cannot reveal whether women could
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27 425 receive less or more intervention than men at the scene. For example, studies in the US showed
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29 426 women had received less EMS interventions and treatment compared to men.^{34 35} Although we
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31 427 look for explanations in Saudi EMS setting, the gender differences are not confined to our
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33 428 study. Our findings are in line with several studies from other countries often found that women
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35 429 had a longer median or average OST compared to men.^{12 28 29 31 33 34} None of these studies
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37 430 investigated the impact of different sociocultural factors on spent time at the scene for patients.
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39 431 One of these found that women had more extended OST than men for non-ST-elevation
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41 432 myocardial infarction and ST-elevation myocardial infarction, despite ECG being
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43 433 implemented for both men and women.¹²

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45 434 In our study, OST and total EMS time for HUME were longer for women than men,
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47 435 while missions dispatched to HUTE did not show any difference. HUME missions may be
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49 436 more often for patients in household buildings than to HUTE missions that may be dispatched
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51 437 more often to open areas such as streets (e.g., for vehicle accidents). Most of HUTE are
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3 438 involved by third parties like the Saudi Police which limit any cultural barriers. While in
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5 439 HUME, the profound sex difference in median OST in HUME missions might primarily be
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8 440 explained by Saudi house design and culture. It is customary in Saudi Arabia for the upper
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10 441 floors and rooms far from the residential home's main entrance to be a suitable residence for
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12 442 women. It has been proven that house design has an impact on delaying the access time to the
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14 443 patient after crew arrival to the scene.^{36 37} Saudi houses are relatively large due to the high
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16 444 average number of family members.³⁸ When EMS crews arrive at the scene, they must usually
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18 445 walk a longer distance to reach the female-patient locations. Moreover, cultural differences in
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20 446 Saudi Arabia require women to be fully covered at the presence of non-primary relative male
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22 447 such the EMS all-males crews and that is why it might take a considerable time before the crew
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24 448 are allowed access to the patient.

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28 449 Another possible reason for the delay during the scene period for Saudi women is the
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30 450 loading process into ambulance vehicles by all-male crews. This process would require strict
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32 451 adherence by crews' members to use the ambulance stretchers even if the patient can walk
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34 452 independently or with crew members' support. While for Saudi men, the stretcher could be
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36 453 waived if the patient prefers walking without it. However, to the best of our knowledge, no
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38 454 previous study has investigated the influence of culture and home design and whether they
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40 455 have a role in prolonging the OST duration for men or women. Thus, further research on this
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42 456 topic is warranted.

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47 457 In Saudi culture, men are usually involved in decision-making related to the
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49 458 transportation of children and elderly of both sexes, and women of all ages. Some Saudi women
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51 459 demand that their primary male relative is present to discuss their health status and plan further
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53 460 action. Some still need guardianship for signing the consent for medical intervention, although
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55 461 they have the right to sign it themselves.^{39 40} In specific circumstances, the women's guardian
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57 462 can prohibit them from transportation to the hospital by ambulance.⁴¹ A Saudi study found that
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3 463 Saudi women had lower health literacy than men.⁴² Two other Saudi studies revealed that
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5 464 Saudi women were less likely to use EMS and were more likely to refuse transportation by
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8 465 ambulance than men.¹⁴³ Therefore, the longer OST among women might be explained by their
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10 466 reluctance to be transported and that the ambulance crew spent more time to educate them and
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12 467 their guardians about the importance of ambulance transportation. Further qualitative research
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14 468 may be needed to identify factors that lead to prolonged OST at households. This study lacks
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16 469 the data necessary to do so. No previous narrative inquiry has been performed to study this
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18 470 phenomenon in Saudi Arabia. An Australian qualitative study investigated the barriers
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20 471 confronting paramedics because of cultural barriers of middle eastern people living in Australia
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22 472 who might have a cultural resemblance to Saudi people.⁴⁴ The informants' paramedics stated
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24 473 that they found difficulties in providing care due to specific norms and behaviour emanating
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26 474 from middle east culture, and time management at the home locations was affected.⁴⁴

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30 475 A significant delay on the scene can deprive women of receiving important medical
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32 476 intervention, unable to be provided by the ambulance crew, in a timely manner in definitive
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34 477 care especially in life-threatening cases. Due to the longer OST for women, they are more
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36 478 exposed to unexpected adverse events such as late or unsafe arrival to hospitals, especially
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38 479 when the crews are committed to not exceeding the golden hour, the benchmark related to the
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40 480 total EMS time, and risk road accidents themselves.

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45 482 **Strengths and limitations**

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47 483 Our study as a retrospective study has several limitations, all pertaining to the EMS registry.
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49 484 The registry relies on the SRCCAD automated detection of time to compute the timeline.
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51 485 However, one-fourth of data were missing, and we observed impossible outliers that may have
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53 486 arisen due to network failure during the communication between call centre and crews at the
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55 487 scene. Our exclusion of those missing data and outliers might have induced selection bias.
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3 488 Another limitation is the non-availability of variables that may explain the gender differences
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5 489 in more details, such as socioeconomic characteristics, time between onset of symptoms and
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7 490 EMS call, type of treatment at the scene, and OST stratified by its four phases: arrival at the
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9 491 scene until accessing the patient, patient assessment time, treatment phase, and loading time.
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11 492 On the other hand, using registry data has provided us with much statistical power to detect
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13 493 between-group differences and associations for the characteristics that were available.
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17 494 Perceived urgency and severity rely on the call centre's triaging system and additional
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19 495 confirmation by crews during arrival at the scene, which might not reflect the real patient
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21 496 condition when the patients arrive at the hospital. Therefore, some misclassification in the
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23 497 urgency types may have occurred. However, our data do reflect daily practices in which
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25 498 urgency levels are determined as early during the mission as possible. However, with future
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27 499 involvement in the EMS data set, researchers could explain those reasonable and unavoidable
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29 500 causes that lead to the lateness.
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33 501 Considering the linking of the registry data to outcomes data on patients' receiving
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35 502 hospital data such as mortality, 28-day survival, and 6-month survival, we showed OST
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37 503 statistical significance between sexes but limited to show the clinical significance. The last
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39 504 limitation belongs to the study design of clustering heterogeneous emergency types into two
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41 505 cohorts and the Saudi benchmarks of 15-minutes. As a result, our study cannot compare our
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43 506 finding of OST with the essential international guideline like AHA of the recommended OST
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45 507 for specific emergency cases like out-of-hospital cardiac arrest, acute coronary syndrome, and
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47 508 stroke. However, our study showed that female time to access definitive care during medical
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49 509 emergencies is more extended. With future involvement in the EMS data set, researchers could
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51 510 explain the relationship between time performance and EMS outcomes.
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55 511 Finally, our study's generalizability might apply to urban and rural areas of other
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57 512 different Saudi provinces and the other Arabian Gulf States having similar EMS systems except
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3 513 for Macca city in Saudi Arabia because of Hajj and the influx of Muslims gathering during
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5 514 different seasons.
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10 516 **CONCLUSIONS**

12 517 This study shows that median OST was longer than 15 minutes for more than half of
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14 518 transported cases. In addition, it was longer for women for HUME at every time and place,
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16 519 regardless of age category, crew type, and receiving hospital. For those EMS missions that had
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18 520 been dispatched for HUTE, there was no difference. Furthermore, missions to children, in rural
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20 521 areas, for trauma patients, for crews dispatched by BLS-ambulances, in summer as a season,
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22 522 or transported to EDs of governmental hospitals were all significant predictors for shorter OST.
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24 523 These findings are hypothesis generating and require further studies.
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30 525 **Authors' Contribution:** All authors conceived the study, conceptualize the ideas, supervised
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32 526 the study design and definition of essential terms and study measures. H.N.M, S.M.J.V.K, and
33
34 527 DMA performed the data cleaning, management, and analysis. H.N.M was the formal analysis,
35
36 528 and S.M.J.V.K provided statistical advice on study design and analysis. H.N.M and DMA had
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38 529 full access to all of the data in the study. H.N.M takes responsibility for the integrity of the data
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40 530 and the accuracy of data analysis. H.N.M, S.M.J.V.K, M.E.M, and H.R.H interpreted the data.
41
42 531 H.N.M and H.R.H were the project administrators. H.R.H was the primary supervisor. H.N.M
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44 532 drafted the manuscript, and all authors contributed substantially to its revision. H.N.M takes
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46 533 responsibility for the paper as a whole.
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47 535 **Conflicts of interest:** no conflicts.
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53 539 **Ethics approval:** The study proposal was reviewed and approved by the ethical committee
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55 540 in Jazan University with the registry number: REC39/9-S085.
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57 542 **Data availability statement:** Data are available upon reasonable request.
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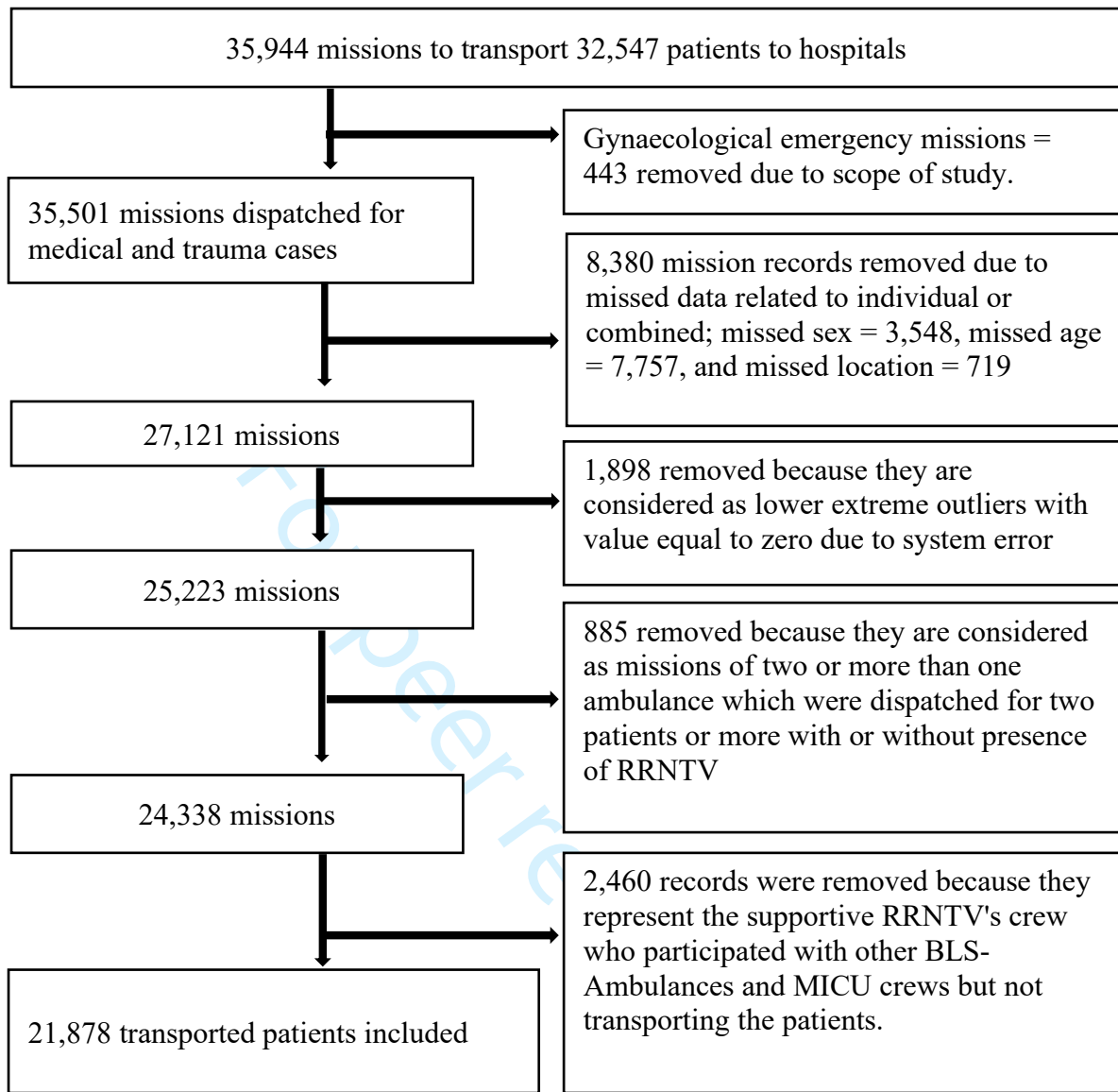
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686 43. Moafa HN, van Kuijk SMJ, Moukhyer ME, et al. Non-Conveyance Due to Patient-Initiated
687 Refusal in Emergency Medical Services: A Retrospective Population-Based Registry
688 Analysis Study in Riyadh Province, Saudi Arabia. *International journal of*
689 *environmental research and public health* 2021;18(17) doi: 10.3390/ijerph18179252
690 44. Hartley PR. Paramedic practice and the cultural and religious needs of pre-hospital
691 patients in Victoria. Victoria University, 2012.
692

693 Figure 1 Flow chart of included and excluded patients.
694 BLS, Basic Life Support; MICU, Mobile Intensive Care Unit; RRNTV, Rapid Response Non-Transporting Vehicle.
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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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6 – 7	Lines 216 – 227
		<i>Case-control study</i> —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		
		<i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants		
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed		
		<i>Case-control study</i> —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	7 – 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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed	NA	NA
		<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	NA	NA
		<i>Cross-sectional study</i> —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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	N/A	N/A
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	14 – 15	380 - 386
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	N/A	N/A
		<i>Cross-sectional study</i> —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	10 – 15	331 – 386
		(b) Report category boundaries when continuous variables were categorized	10 – 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	19 – 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	15 – 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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3 **1 Variation in on-scene time of emergency medical services and the extent of the difference**
4 **2 of on-scene time between genders: A retrospective population-based registry study in**
5 **3 Riyadh province, Saudi Arabia**
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8

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29 25
30 26
31 27 **Word count:** 4762
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41 **ABSTRACT**

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

45 **Design:** A retrospective population-based registry study.

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

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

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

51 **Results:** In total, 21,878 patients were included for analysis: 33.9% women and 66.1% men.
52 The median OST for women was 22 minutes (interquartile range [IQR] 15 – 30) and 18 minutes
53 (IQR 11 – 26) for men, $p < 0.001$; for medical cases, median OST was 23 minutes (IQR 16 –
54 31) for women compared to 20 minutes (IQR 13 – 29) for men, $p < 0.001$; for trauma cases, the
55 median OST of both sexes was equal. We found the following additional predictors of OST:
56 factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle,
57 and hospital type were all significantly associated with OST in the crude or adjusted analyses.
58 Factors of emergency type, sex, age category, geographical areas, type of ambulance vehicle,
59 and hospital type were also significantly associated with the odds of OST of more than 15-
60 minutes in the crude and adjusted regression analyses.

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

67 **Strengths and limitations of this study**

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

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3 74 ♦ Registry lacks other important demographic factors related to social status; education,
4
5 75 income, and ethnicity, which might be associated with prolonged on-scene time.
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7 76 ♦ Time registered in the database depends on the information provided by emergency
8
9 77 medical services (EMS) providers through wireless communications with the call
10 78 centre; hence, any network failure leads to missed data.
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121 INTRODUCTION

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

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

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

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

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3 155 patient-related factors associated with time spent at the scene for all highly urgent emergency
4 156 cases that were transported to healthcare facilities in the Riyadh province in Saudi Arabia and
5
6 157 to hypothesize for possible factors delaying OST.
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10 159 **METHODS**

11 160 **Design**

12
13 161 This retrospective population-based registry was conducted in the Riyadh province of Saudi
14
15 162 Arabia by using all EMS database records in the Saudi Red Crescent Computer Aid
16
17 163 Dispatching (SRCCAD) system, from January 1, 2018, to December 31, 2018. This study
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19 164 complies with Strengthening the Reporting of Observational Studies in Epidemiology
20
21 165 (STROBE).¹⁷
22
23 166

24 167 **Setting**

25 168 Riyadh Province is in the central part of Saudi Arabia. It has a geographical size of 404,240
26
27 169 km². It has an approximate population of 6,792,776 million, according to the last national
28
29 170 census. The province is composed of 39 different cities and Riyadh city is the capital and the
30
31 171 largest city in Saudi Arabia. Besides, there are hundreds of rural villages dotted between or
32
33 172 near these cities.¹⁸ In Saudi Arabia, EMS are free of charge and can be accessed by calling the
34
35 173 call centre, and in certain exceptional conditions, patients can visit ambulance stations
36
37 174 distributed all over the province, including along highways. EMS crews of Riyadh province
38
39 175 are mainly composed of two Emergency Medical Technicians (EMT). They are trained on
40
41 176 basic life support (BLS) skills to respond to different levels of emergency cases but do not
42
43 177 administer medicine. However, some crews are composed of physicians and emergency
44
45 178 paramedics. These are called mobile intensive care units (MICU) and respond to certain highly
46
47 179 critical cases and provide advanced life support (ALS). A third type of EMS crew consists of
48
49 180 senior paramedics and are dispatched in a rapid response non-transporting vehicle (RRNTV).
50
51 181 These often arrive earlier to provide ALS before the essential transporting ambulances. Time
52
53 182 indicators are built-in SRCCAD with 20 minutes for response time and 15 minutes for OST
54
55 183 regardless of urgency level.

56
57 184 Saudi EMS implements a strategy of scoop and run, which emanated from the Anglo-
58
59 185 American model. Most EMS chain periods are limited with a predefined time to end with the
60
186 golden hour of total time.¹⁹ The OST comprises three consecutive periods which are access,
187
188 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

1
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3 189 and treatment. Loading time starts from moving patients on the stretcher until the crew starts
4
5 190 to travel to the hospital. The policy underpinning this 15-minute benchmark for OST is that
6
7 191 the Saudi EMS policymakers, based on the number of available crews and the volume of
8
9 192 patients' demands, decided that 15 minutes at the scene fit their operational procedures as a
10
11 193 policy target. An additional consideration was to avoid delaying ambulance resources from
12
13 194 becoming unavailable for new assignments.

14 195 However, when there are multiple calls for different emergencies at once, SRCCAD
15
16 196 may prioritize cases based on three levels of urgency and dispatch crews accordingly. Patients
17
18 197 or their families who have guardianship have the right to refuse transportation to hospital after
19
20 198 they have signed a formal paper of refusal against medical advice. However, EMS crews can
21
22 199 either transport patients to the closest hospitals or treat them at the scene. The study proposal
23
24 200 was reviewed and approved by the ethical committee in Jazan University with the registry
25
26 201 number: REC39/9-S085. The Ethics Committee, based on no need to contact patients, agreed
27
28 202 that informed consent was not required because of the anonymity of the data collected for
29
30 203 routine ambulance missions and the study's retrospective design. The study data take into
31
32 204 consideration privacy and confidentiality.

33 205

34 206 **Participants and public involvement**

35 207 Patients and public were not involved in developing the research question, commenting on the
36
37 208 database, study design, outcome measures, conduct of the study, or contributing to the writing
38
39 209 or editing of this study.

40 210

41 211 **Data collection**

42 212 The data were obtained through the operations and information department in the Riyadh
43
44 213 branch directorate of Saudi Red Crescent Authority (SRCA). Data were exported from
45
46 214 Microsoft Excel saved in an encrypted file on a hard disc and converted to an IBM SPSS file
47
48 215 (version 25) for further analyses.

49 216

50 217 **Selection of Participants**

51 218 According to the Saudi EMS definition, highly urgent emergency cases are the cases that
52
53 219 contacted EMS for support after exposure to serious or life-threatening illness or injuries that
54
55 220 require immediate medical intervention and quick transportation to hospital emergency
56
57 221 departments (EDs). In this study, all incoming calls for patients who were triaged at the
58
59 222 dispatching centre of SRCCAD as highly urgent emergency cases were included.

1
2
3 223 Gynaecological emergencies were excluded because of the scope of the study to compare both
4
5 224 sexes. In addition, we excluded records of patients for whom age, sex, or area was missing and
6
7 225 cases categorized by the SRCCAD as cases ended by non-conveyance. We considered the
8
9 226 potential source of bias; therefore, we excluded the lower extreme outliers with values equal
10
11 227 to zero due to system error. Records of missions dispatched for two patients or more in one
12
13 228 incident were excluded. Similarly, Missions that involved only Rapid Response Non-
14
15 229 Transporting Vehicles (RRNTV) were also removed.

16 230

17 231 **Methods of Measurement**

18
19 232 We included all variables related to patient demographics and information related to
20
21 233 dispatching missions from the time period perspective, starting from calling the call centre and
22
23 234 ending with the patients' arrival to private and governmental hospitals. The EMS time intervals
24
25 235 are composed of 4 different periods.²¹ First, the response time, which is the time elapsed
26
27 236 starting from receiving a call in the call centre and ended by the ambulance's crew's arrival to
28
29 237 the scene. Second, the OST, which is the time elapsed, starting from arrival to the scene and
30
31 238 ended by starting to travel back to EMS centre or traveling forward toward healthcare facilities.
32
33 239 Third, the travel time, which is the time elapsed from starting to move from the scene until the
34
35 240 crew's arrival to healthcare facilities. Fourth, is the hospital period, defined as the time elapsed
36
37 241 from arrival to the healthcare facility until handover to emergency room staff. EMS database
38
39 242 registry recorded all events starting from activation time and ending by crew's departure from
40
41 243 the hospitals in the cases where the patient had been transported or when the crew leaves the
42
43 244 scene when transportation had been refused. It measures only response time period and total
44
45 245 EMS time period in seconds. Therefore, the total EMS time in this study reflects the four
46
47 246 periods. We calculated the OST, travel time, hospital time according to standard EMS
48
49 247 definition.²¹ Those periods in Saudi EMS have individual target indicators, such as the response
50
51 248 time; 20 minutes; the OST is 15 minutes, while the travel time has no indicator because of EMS
52
53 249 providers' and patients' safety issue arise if the time indicator too strict due to the risk of driving
54
55 250 too fast on the way to hospital. Saudi EMS would consider the OST if it exceeded 15 minutes
56
57 251 as a prolonged OST. In cases where the call centre dispatched two or more EMS crews, we
58
59 252 selected by calculating the actual time spent with the patient from when the first crew arrived
60
253 either the RRNTV or the main transporting ambulance until the patient was transported by
254 ambulance.

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

1
2
3 257 clustered emergency cases into two cohorts. The first cohort was the cluster of EMS mission
4
5 258 that were dispatched for highly urgent medical emergencies (HUME) such as acute coronary
6
7 259 syndrome, stroke, and out-of-hospital cardiac arrest. The second cohort was the missions
8
9 260 dispatched for highly urgent trauma emergencies (HUTE) such as road traffic accidents.
10
11 261 Demographic features available in the registry that were extracted are sex, age and
12
13 262 geographical area. Patients' age was divided into three categories according to Saudi Arabian
14
15 263 law; child: patient with an age below 15 years old, adult: patient equal to or over 15 years old
16
17 264 but younger than 60 years old, and elderly: patient equal to or more than 60 years old. Urban
18
19 265 area was defined as an area where metropolitan and micropolitan cities are located and have a
20
21 266 total population of equal to or more than 5000 inhabitants. On the other side, areas with less
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23 267 than 5000 people or outside urban geographical area were considered rural.

24 268 We considered the differences in various EMS operational times from the data collected
25
26 269 in a one-year time period. In Saudi Arabia, the weekdays are considered from Sunday to
27
28 270 Thursday while the Friday and Saturday are the weekends. Period of the day is categorized into
29
30 271 two categories; office time, which is the time that starts from 8:00 AM to 4:00 PM from Sunday
31
32 272 to Thursday, while the home time is defined as the time that starts from 4:01 PM on the same
33
34 273 day up to the next day 7:59 AM side by side with 48 hours of the weekend Friday and Saturday.
35
36 274 Working shifts are the two daily periods that Saudi EMS schedules to provide emergency
37
38 275 services. It is composed of two periods: the day shift from 8:00 AM to 8:00 PM and the night
39
40 276 shift from 8:00 PM to 8:00 AM. We also included season. The winter season officially starts
41
42 277 from Mid-December to Mid-March, then the spring, which starts from Mid-March until Mid-
43
44 278 June. Summer starts from Mid-June to Mid-December, followed by Autumn, which starts from
45
46 279 Mid-September 21 and ends by Mid-December.²²

47 280 Operating vehicle types represented by the three types of crews providing EMS for the
48
49 281 clustered emergencies were included. The first, Ambulance type II transporting vehicle (BLS-
50
51 282 ambulance) is the vehicle equipped by two EMT, who can perform basic life support and rapid
52
53 283 patient transport to hospitals. MICU is another transporting vehicle capable of highly qualified
54
55 284 physician-based or paramedics exposed to long-term training equal to or more than four years.
56
57 285 The last type of vehicle is RRNTV, which is operated in the last decade to arrive at the scene
58
59 286 earlier than the transporting vehicle, and it is also operated by highly experienced EMS
60
287 providers, often EMS paramedics. The crew of RRNTV can give ALS and do the necessary
288 medical work to prepare the patients to be transported. Hospitals that receive emergency
289 patients are of two types. We also included EDs based on the two types of hospitals.
290 Governmental hospitals are non-profit healthcare organizations funded by the Saudi authorities

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

293

294 **Statistical Analysis**

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

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

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

309

310 **RESULTS**

311 **Characteristics of study subjects**

312 During the study period, 35,944 missions of two types – transporting and non-transporting
313 vehicles – were dispatched to the scene. RRNTV accounted for 3,397 (9.5%) missions while
314 the transporting vehicles were 32,547 (90.5%); BLS-Ambulance 25,988 (72.3%), MICU 6,559
315 (18.2%). Subsequently, 32,547 high emergency patients were transported to Riyadh province
316 hospitals.

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

325 which were the primary transporting ambulances of the patients. Subsequently, 21,878
 326 missions of highly urgent emergency patients were included in this study. We found that 14,454
 327 (66.1%) of cases were male. In total, 14,454 (66.1%) missions were for HUME, and 7,424
 328 (33.9%) for HUTE. Of all, 66.5% of cases were attended at the scene by BLS-ambulances
 329 crews, 22.3% by MICU ambulances crews, and 11.2% by two crews; 50% of them are
 330 RRNTVs, and the remaining 50% were BLS-ambulances.

331

332 Main results

333 Table 1 shows time periods of ambulance service runs, including response time, OST, travel
 334 time, and hospital time. The study showed that each duration of OST and travel time for the
 335 HUME cohort significantly differed between men and women. The median OST of HUME for
 336 women 23 minutes (IQR 16 – 31 minutes) was significantly longer than men 20 minutes (IQR
 337 13 – 29 minutes), $p < 0.001$. The median travel time for women 19 minutes (IQR 10 – 29
 338 minutes) was significantly longer than men 18 minutes (IQR 10 – 29 minutes), $p < 0.001$.

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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

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3 341 Table 2 shows the median and IQR stratified by patients' demographic and background
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5 342 factors for both HUTE and HUME causes. The total median OST was significantly longer for
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7 343 women 22 minutes (IQR 15 – 30 minutes) than men 18 minutes (IQR 11 – 26 minutes), $p =$
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9 344 0.001. Most differences related to OST between men and women were significant, all showing
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11 345 longer OST for women. In addition, all characteristics variables of patients and missions except
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13 346 the daily hours, weekdays, and working shifts were statistically significant among each group
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15 347 of men and women.

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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				
Governmental	14,391¶		7,402♦	
Private	12,165 (84.2)	18.0 (11.0 – 26.0)*	6,271 (84.5)	22.0 (15.0 – 30.0)**
	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.

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376 Table 3 illustrates the association between different variables and OST. Emergency

377 type, sex, age category, geographical areas, types of vehicles, and hospital type were all

378 significantly associated with OST in the crude, or adjusted analyses. When adjusted for other
 379 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.

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

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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.

387 DISCUSSION

388 The present study showed that more than 50% of emergency cases had an OST of greater than
389 15 minutes, which is the Saudi EMS standard time for all crews to perform the standard
390 operational procedures during OST regardless of urgency level. Although the median OST for
391 HUTE was closer than HUME to the benchmark of 15 minutes, about 25% of those missions
392 still took more than 22 minutes. OST was also prolonged when EMS ambulances missions
393 were dispatched for women, the elderly, in urban areas, during winter, as advanced EMS
394 services, or for transport to private hospitals. Several studies demonstrated that an increase in
395 OST was associated with adverse outcome.^{3 5 23-26} In addition, the American Stroke Association
396 guideline recommends OST to be ≤ 15 minutes.⁷

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

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

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3 413 men regardless of any explanatory factor. For example, in looking at EMS crew types, we
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5 414 found EMS missions that were dispatched by MICU crews had longer OST than BLS crews,
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7 415 and the dispatching of MICU crews increased the odds of prolonged OST regardless of the
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9 416 patients' gender. This finding is line with Schull et al. who found dispatching ALS crews
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11 417 compared to the BLS crews at the scene increase the OST by 5.6 minutes.³³ Yet, we found that
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13 418 the median OST for MICU crews was longer for women than men, although, our data did not
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15 419 include the type and number of interventions at the scene. Our study revealed EMS crews
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17 420 staying a half-hour or more at the scene for 25 % of adult women regardless of the calls'
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19 421 reasons. We compared this finding with their counterpart of adult men, and we found the
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21 422 difference was at a minimum 5 minutes. Given the unavailable data elucidating number and
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23 423 type of medical interventions at the scene, we are unable to clarify the medical reasons
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25 424 triggering this difference. Moreover, our study data cannot reveal whether women could
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27 425 receive less or more intervention than men at the scene. For example, studies in the US showed
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29 426 women had received less EMS interventions and treatment compared to men.^{34 35} Although we
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31 427 look for explanations in Saudi EMS setting, the gender differences are not confined to our
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33 428 study. Our findings are in line with several studies from other countries often found that women
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35 429 had a longer median or average OST compared to men.^{12 28 29 31 33 34} None of these studies
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37 430 investigated the impact of different sociocultural factors on spent time at the scene for patients.
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39 431 One of these found that women had more extended OST than men for non-ST-elevation
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41 432 myocardial infarction and ST-elevation myocardial infarction, despite ECG being
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43 433 implemented for both men and women.¹²

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45 434 In our study, OST and total EMS time for HUME were longer for women than men,
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47 435 while missions dispatched to HUTE did not show any difference. HUME missions may be
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49 436 more often for patients in household buildings than to HUTE missions that may be dispatched
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51 437 more often to open areas such as streets (e.g., for vehicle accidents). Most of HUTE are
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3 438 involved by third parties like the Saudi Police which limit any cultural barriers. While in
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5 439 HUME, the profound sex difference in median OST in HUME missions might primarily be
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8 440 explained by Saudi house design and culture. It is customary in Saudi Arabia for the upper
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10 441 floors and rooms far from the residential home's main entrance to be a suitable residence for
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12 442 women. It has been proven that house design has an impact on delaying the access time to the
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14 443 patient after crew arrival to the scene.^{36 37} Saudi houses are relatively large due to the high
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16 444 average number of family members.³⁸ When EMS crews arrive at the scene, they must usually
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18 445 walk a longer distance to reach the female-patient locations. Moreover, cultural differences in
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20 446 Saudi Arabia require women to be fully covered at the presence of non-primary relative male
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22 447 such the EMS all-males crews and that is why it might take a considerable time before the crew
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24 448 are allowed access to the patient.

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28 449 Another possible reason for the delay during the scene period for Saudi women is the
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30 450 loading process into ambulance vehicles by all-male crews. This process would require strict
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32 451 adherence by crews' members to use the ambulance stretchers even if the patient can walk
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34 452 independently or with crew members' support. While for Saudi men, the stretcher could be
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36 453 waived if the patient prefers walking without it. However, to the best of our knowledge, no
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38 454 previous study has investigated the influence of culture and home design and whether they
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40 455 have a role in prolonging the OST duration for men or women. Thus, further research on this
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42 456 topic is warranted.

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47 457 In Saudi culture, men are usually involved in decision-making related to the
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49 458 transportation of children and elderly of both sexes, and women of all ages. Some Saudi women
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51 459 demand that their primary male relative is present to discuss their health status and plan further
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53 460 action. Some still need guardianship for signing the consent for medical intervention, although
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55 461 they have the right to sign it themselves.^{39 40} In specific circumstances, the women's guardian
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57 462 can prohibit them from transportation to the hospital by ambulance.⁴¹ A Saudi study found that
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3 463 Saudi women had lower health literacy than men.⁴² Two other Saudi studies revealed that
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5 464 Saudi women were less likely to use EMS and were more likely to refuse transportation by
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8 465 ambulance than men.¹⁴³ Therefore, the longer OST among women might be explained by their
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10 466 reluctance to be transported and that the ambulance crew spent more time to educate them and
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12 467 their guardians about the importance of ambulance transportation. Further qualitative research
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14 468 may be needed to identify factors that lead to prolonged OST at households. This study lacks
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17 469 the data necessary to do so. No previous narrative inquiry has been performed to study this
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19 470 phenomenon in Saudi Arabia. An Australian qualitative study investigated the barriers
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21 471 confronting paramedics because of cultural barriers of middle eastern people living in Australia
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23 472 who might have a cultural resemblance to Saudi people.⁴⁴ The informants' paramedics stated
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25 473 that they found difficulties in providing care due to specific norms and behaviour emanating
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28 474 from middle east culture, and time management at the home locations was affected.⁴⁴

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31 475 A significant delay on the scene can deprive women of receiving important medical
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33 476 intervention, unable to be provided by the ambulance crew, in a timely manner in definitive
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35 477 care especially in life-threatening cases. Due to the longer OST for women, they are more
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37 478 exposed to unexpected adverse events such as late or unsafe arrival to hospitals, especially
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39 479 when the crews are committed to not exceeding the golden hour, the benchmark related to the
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42 480 total EMS time, and risk road accidents themselves.

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46 47 482 **Strengths and limitations**

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49 483 Our study as a retrospective study has several limitations, all pertaining to the EMS registry.
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51 484 The registry relies on the SRCCAD automated detection of time to compute the timeline.
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53 485 However, one-fourth of data were missing, and we observed impossible outliers that may have
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55 486 arisen due to network failure during the communication between call centre and crews at the
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58 487 scene. Our exclusion of those missing data and outliers might have induced selection bias.
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3 488 Another limitation is the non-availability of variables that may explain the gender differences
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5 489 in more details, such as socioeconomic characteristics, time between onset of symptoms and
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7 490 EMS call, type of treatment at the scene, and OST stratified by its four phases: arrival at the
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9 491 scene until accessing the patient, patient assessment time, treatment phase, and loading time.
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11 492 On the other hand, using registry data has provided us with much statistical power to detect
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13 493 between-group differences and associations for the characteristics that were available.
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17 494 Perceived urgency and severity rely on the call centre's triaging system and additional
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19 495 confirmation by crews during arrival at the scene, which might not reflect the real patient
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21 496 condition when the patients arrive at the hospital. Therefore, some misclassification in the
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23 497 urgency types may have occurred. However, our data do reflect daily practices in which
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25 498 urgency levels are determined as early during the mission as possible. However, with future
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27 499 involvement in the EMS data set, researchers could explain those reasonable and unavoidable
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29 500 causes that lead to the lateness.
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33 501 Considering the linking of the registry data to outcomes data on patients' receiving
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35 502 hospital data such as mortality, 28-day survival, and 6-month survival, we showed OST
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37 503 statistical significance between sexes but limited to show the clinical significance. The last
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39 504 limitation belongs to the study design of clustering heterogeneous emergency types into two
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41 505 cohorts and the Saudi benchmarks of 15-minutes. As a result, our study cannot compare our
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43 506 finding of OST with the essential international guideline like AHA of the recommended OST
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45 507 for specific emergency cases like out-of-hospital cardiac arrest, acute coronary syndrome, and
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47 508 stroke. However, our study showed that female time to access definitive care during medical
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49 509 emergencies is more extended. With future involvement in the EMS data set, researchers could
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51 510 explain the relationship between time performance and EMS outcomes.
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55 511 Finally, our study's generalizability might apply to urban and rural areas of other
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57 512 different Saudi provinces and the other Arabian Gulf States having similar EMS systems except
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3 513 for Macca city in Saudi Arabia because of Hajj and the influx of Muslims gathering during
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5 514 different seasons.
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10 516 **CONCLUSIONS**
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12 517 This study shows that median OST was longer than 15 minutes for more than half of
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14 518 transported cases. In addition, it was longer for women for HUME at every time and place,
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16 519 regardless of age category, crew type, and receiving hospital. For those EMS missions that had
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18 520 been dispatched for HUTE, there was no difference. Furthermore, missions to children, in rural
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20 521 areas, for trauma patients, for crews dispatched by BLS-ambulances, in summer as a season,
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22 522 or transported to EDs of governmental hospitals were all significant predictors for shorter OST.
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24 523 These findings are hypothesis generating and require further studies.
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29 525 **Authors' Contribution:** All authors conceived the study, conceptualize the ideas, supervised
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31 526 the study design and definition of essential terms and study measures. H.N.M, S.M.J.V.K, and
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33 527 DMA performed the data cleaning, management, and analysis. H.N.M was the formal analysis,
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35 528 and S.M.J.V.K provided statistical advice on study design and analysis. H.N.M and DMA had
36
37 529 full access to all of the data in the study. H.N.M takes responsibility for the integrity of the data
38
39 530 and the accuracy of data analysis. H.N.M, S.M.J.V.K, M.E.M, and H.R.H interpreted the data.
40
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42
43 532 drafted the manuscript, and all authors contributed substantially to its revision. H.N.M takes
44
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54

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57

58 541
59 542 **Ethics approval:** The study proposal was reviewed and approved by the ethical committee
60 543 in Jazan University with the registry number: REC39/9-S085.

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3 544
4 545 **Data availability statement:** Data are available upon reasonable request.
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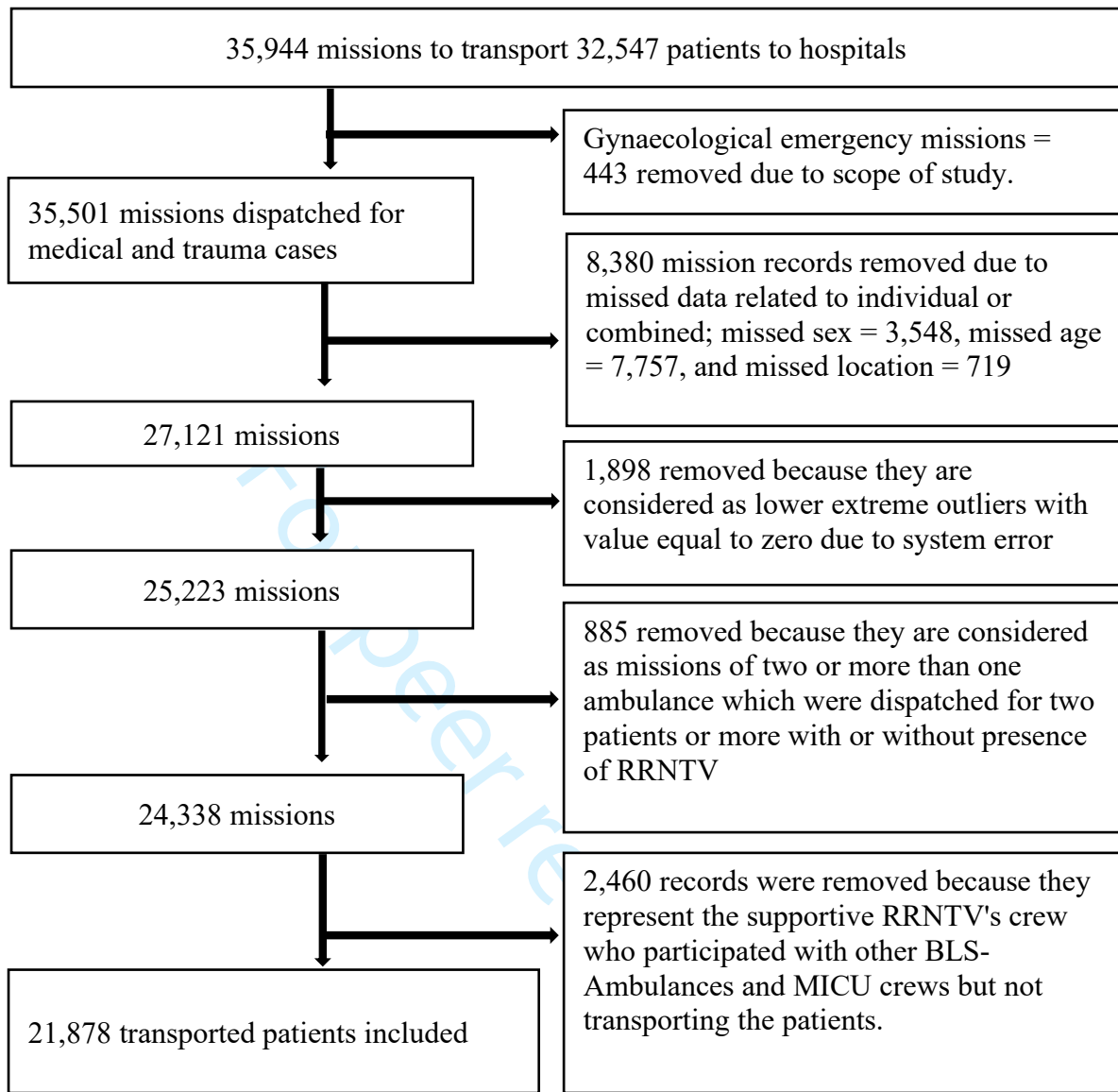
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15 696 Figure 1 Flow chart of included and excluded patients.

16 697 BLS, Basic Life Support; MICU, Mobile Intensive Care Unit; RRNTV, Rapid Response Non-Transporting Vehicle.
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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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6 – 7	Lines 216 – 227
		<i>Case-control study</i> —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		
		<i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants		
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed		
		<i>Case-control study</i> —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	7 – 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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed	NA	NA
		<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	NA	NA
		<i>Cross-sectional study</i> —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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	N/A	N/A
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	14 – 15	380 - 386
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	N/A	N/A
		<i>Cross-sectional study</i> —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	10 – 15	331 – 386
		(b) Report category boundaries when continuous variables were categorized	10 – 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	19 – 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	15 – 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.