

## Research Paper

# Assessment of Ambulance Response Time: A Study of Tabriz Emergency Medical Center, Tabriz City, Iran



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## ABSTRACT

**Background:** Emergency medical services are vital in timely treating victims and reducing injury and mortality rates. Ambulance response time is an essential variable in evaluating the quality of these services. This study aims to determine the ambulance response time and compare it to some background variables.

**Materials and Methods:** This descriptive study was conducted on ambulance emergency missions in Tabriz Emergency Medical Center, Tabriz, Iran. The data file related to the eligible missions in the server of the center was read and listened and ambulance response time and background variables were extracted and analyzed using descriptive statistics.

**Results:** The Mean±SD ambulance response time was 11.58±5.69 min, which was long. The results showed a statistically significant relationship between ambulance response time and technical readiness, traffic conditions, accident time, and the educational level of ambulance personnel.

**Conclusion:** Compared to the standard value, the average ambulance response time in Tabriz Emergency Medical Center was longer. By recognizing the influential variables and taking the required actions, one can improve the ambulance response time and facilitate medical services in emergency conditions.

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## 1. Introduction

In contemporary societies, the emergency medical services (EMS) system is vital in treating and caring for medical emergencies [1]. Emergency medical accidents cause thousands of physical and mental disabilities and deaths and huge economic losses every year. If the injured people or victims are treated timely or in the first 2-8 min, the mortality rate may be reduced to 40% [2]. Also, it has been demonstrated that in the rescuing process of a victim, 90% of actions are essential [3]. Therefore, in this process, it is crucial to be present quickly and timely at the scene and provide needed care by the EMS system personnel. Failure to consider the time index can increase mortality rate, injuries, complications, and dissatisfaction [2]. Therefore, improving time indicators is one of the priorities of the EMS system [4, 5]. Since a long time ago, many efforts have been made to evaluate and improve the quality of EMS [6]. The effective and confident services must be based on standards [4, 7, 8]. EMS system focuses on a wide range of cardiovascular, trauma, and other emergencies, and many variables such as ambulance response time are used to monitor and evaluate the quality of EMS services [9].

Ambulance response time is defined as the time between receiving the message from the dispatch center to the time the ambulance arrives at the scene of the accident [10, 11]. According to the literature, the ambulance response time is divided into 3 categories: short (<4 min), medium (4-8 min), and long (>8 min) [12]. If the accident is in a multi-store building, this time will include some additional time called vertical response time. Vertical response time includes time interval from arrival on-scene to arrival at the patient's side [10]. Although shorter ambulance response time can increase medical effectiveness and satisfaction, it may reduce productivity due to the resources required and increased costs [13-16].

In a study conducted in Singapore, weather conditions, traffic, and the location of the accident had the greatest impact on the ambulance response time [1]. In another study, the relationship between ambulance response time and survival of trauma patients and cardiopulmonary arrest was investigated, and an attempt was made to improve ambulance response time using special instruments such as a Global Positioning System and a Geographic Information System [4]. The results of studies conducted in Iran have reported that the condition of the emergency medical system is unfavorable in terms of personnel and equipment but relatively favorable in

terms of ambulance response time [5]. Also, based on the resources available to researchers, in the city of Tabriz, ambulance response time was studied only in trauma patients [17]. In the present study, ambulance response time and its related variables were assessed in all cases of medical emergencies. Findings from monitoring the current situation can help plan to increase the quality of emergency services and victims' satisfaction. This study aimed to determine the ambulance response time and related components in the Tabriz Emergency Medical Center and compare it to background variables.

## 2. Materials and Methods

### Study setting

Tabriz, the center of the East Azerbaijan Province, is the most populated city in northwest Iran. Tabriz Emergency Medical Center has 22 stations in the city, and many of its missions are performed in the prehospital area.

### Design and samples

Using a random sampling method, we examined 243 ambulance missions recorded in the central digital software system server in the Tabriz Emergency Medical Center from September 2017 to March 2018. First, a pilot study was conducted on 20 eligible missions to determine the sample size. Considering parameters obtained for the pilot study, test power of 80%,  $\alpha$  of 5%, and a potential withdrawal of 10%, the sample size was calculated as 243. The completed ambulance missions (leading to transporting the victim to the hospital) within the city of Tabriz or its suburbs were included in the study. The study exclusion criteria consisted of the false or incomplete mission, mission with the dead, and mission with the outpatient treatment of the victim at the accident scene.

### Data collection tool

The data collection tools used included a researcher-made checklist in determining the ambulance response time with details (10 items) and a form with structured questions inquired about its background variables, consisting of emergency medical service personnel demographic characteristics based on recruitment information (16 questions), ambulance characteristics (4 questions), weather conditions (1 question), the geographical location of the accident (5 questions), the time of the accident (3 questions), and the mechanism of the accident (1 question).

In the present study, after reviewing the literature, the researcher-made versions of the tools were developed and distributed to ten professors at Tabriz Faculty of Nursing and Midwifery for content and face validity, and their suggestions were implemented. Then, the tools were redistributed to 5 of them, and the final version was developed and approved by consensus after good matches were found for all the questions and items.

To determine the reliability of the data collection tools, the agreement coefficient between the scores of two independent raters was calculated in a pilot study with 20 samples. Twenty ambulance missions registered and available in the digital system server of Tabriz Emergency Medical Center were audited and reviewed by two independent raters, and the tools were completed ( $\alpha=0.96$  and  $0.89$ ).

### Data collection

To collect the data, after obtaining the necessary permits, the list of the ambulance missions archived in the digital software system server of Tabriz Emergency Medical Center was extracted based on the inclusion criteria and selected randomly for the sample group. The data file of each selected mission was carefully assessed, read, and listened to by the research team in a quiet room, and detailed components of the ambulance response time and the background variables were extracted. During this process, the data collection tools were completed for each mission. Complete details of each ambulance mission process, including time, location, and conversations, are recorded and saved in the software as separate files. Data related to demographic characteristics of the operators and ambulance personnel related to selected missions were extracted and recorded from the recruitment unit of the center.

### Statistical analysis

Data were analyzed in SPSS software v. 13 using descriptive statistics, the independent t test, and ANOVA. In all statistical analyses,  $\alpha=5\%$  was considered the level of statistical significance.

### 3. Results

All of the operators in the message center were female, and their average age was 31.5 years. Most of them were non-native, had a bachelor's degree in midwifery, and were novices. Also, all ambulance personnel was male, and their average age was 38.5 years. Most were native, had a bachelor's degree in medical emergency or nurs-

ing, and were formally employed. Concerning the demographic characteristics of the victims who got service in these ambulance missions, the results showed a mean age of 56.5 years, and 60.5% were female. Table 1 presents the other demographic details of the victims.

According to the results presented in Table 2, the ambulance response time was of 11.58 min compared to the standard value ( $<8$  min). Table 3 demonstrates the ambulance response time compared to the standard values with more details.

The results of the t test and ANOVA showed no significant relationship between the average ambulance response time and message center operators' demographic variables, including education status, certification, employment type, and being native (Table 4).

Also, concerning the demographic characteristics of ambulance personnel, the results of the t test showed a significant relationship ( $P<0.01$ ) only between the education status and the average ambulance response time (Table 5).

Table 6 presents ambulance response time concerning ambulance readiness characteristics. The results of the t test showed a significant relationship only between the mechanical and technical readiness and the average ambulance response time ( $P<0.05$ ).

In analyzing research data in terms of the traffic status and time of the accident, the results of the ANOVA and Scheffe post hoc tests showed that during heavy traffic, the ambulance response time significantly ( $P<0.05$ ) was the longest and in the evening was the shortest (Table 7).

### 4. Discussion

Ambulance response time is one of the most influential variables in monitoring and evaluating the quality of the EMS. The results of this study showed that the average ambulance response time in Tabriz Emergency Medical Center is 11.58 min, and compared to the standard values, it is longer than 8 min. A more detailed analysis showed that 68% of the missions took longer than 8 min (Table 2). Ambulance response time in some other cities, such as Tehran, has been reported as 12.54 to 14.7 min, Urmia 7.1 min, and Kermanshah 7.28 min. Factors such as city size, density and traffic, urban management, and culture may be involved in this outcome. In the present study, the average activation time of the emergency medical system, from receiving the message to the start of the ambulance movement, was 2.52 min. The Dada-

**Table 1.** Ambulance response time according to the characteristics of victims

Variables	Mean±SD	No. (%)	P <sup>†</sup>
Type of illness or injury	Trauma	58(23.8)	0.01
	Cardiovascular disease	43(17.7)	
	Neurological diseases	49(20.2)	
	Respiratory diseases	26(10.7)	
	Internal emergencies	38(15.6)	
	Poisoning	15(6.2)	
	Fall	7(2.9)	
	Other	7(2.9)	
Victim consciousness level	Alert	204(84)	0.06
	Lethargic	24(9.9)	
	Stupor	14(5.8)	
	Coma	1(0.3)	

†One-way ANOVA.

shzadeh et al. study in Tabriz showed this time variable as 2.38 min [17]. This slight difference may be due to sampling error. It should be noted that a short activation time can lead to better ambulance response time. Nevertheless, the longer the activation time, the more ambulance personnel will be exposed to high-speed driving stress and greater risks in trying to reduce the ambulance response time.

Also, according to our results, the average time for the ambulance to move from the scene to the medical center was 14.90 min. The minimum amount was one, and the maximum was 54 min. In another study, this time was reported to be 16 min which is longer than the present

study [18]. In further analysis of the results, the average time from the ambulance to arrive at the medical center until the patient was delivered was 4.25 min. Also, the mean time obtained from the time of patient delivery to the medical center to reach the prehospital emergency station was equal to 30.26 min, which is long. The total time index of the ambulance mission was 63.51 min. These variables are influential indicators in prehospital emergency quality control, and any delay can impact the patient outcome and lead to irreparable damages, disabilities, and death.

In line with the research goal of determining the ambulance response time in terms of background variables,

**Table 2.** Ambulance response time and detailed components in minutes

Variables	Mean±SD	Max	Min
Ambulance response time	11.58±5.69	38	2
The time between receiving the message to move from the station	2.52±1.33	8	1
The time between the move from the scene to arrive the hospital emergency	14.90±9.14	54	1
The time for the victim's delivery	4.25±2.88	24	1
The time between hospital emergency to arrive at the station	30.26± 18.85	130	6
Total, min	61.51±10.14	í	í

**Table 3.** Ambulance response time compared to standard values

Ambulance Response Time (min)	No. (%)
Short (<4)	7(4.0)
Medium (4-8)	70(28.0)
Long (>8)	166(68.0)

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the results of the present study show no significant relationship between the demographic characteristics of message center operators and the average ambulance response time. However, most operators were midwives and often had undergraduate education status with less work experience. It should be noted that the educational content of the undergraduate program in midwifery cannot fully cover the necessary care in prehospital medical emergencies. Less work experience may affect the quality of emergency counseling services. In such challenges, on-the-job training programs are a strategy and can overcome some problems.

The analysis of the results showed a significant relationship between the education status of ambulance personnel and the average duration of ambulance response time so that the ambulance response time in personnel with bachelor's degrees was shorter than personnel with an associate degree. Higher academic education can lead to more knowledge, skill, and critical thinking development in personnel. In recent years, positive steps have been taken to educate this person-

nel in academic programs, but the lack of trained and skilled personnel in Iran's prehospital emergency system is still a serious challenge. According to a study conducted in Yazd, 85.7% of emergency stations face staff shortages [19]. A study reported that 66% of road accident victims in East Azerbaijan Province were transported by unskilled personnel [20]. The analysis of the reports from other countries in a study showed that staff education and recruitment in the prehospital emergency system is still a challenge [21].

In analyzing the research data regarding the ambulance characteristics, only a significant relationship was observed between the mechanical and technical readiness of the ambulance and the ambulance response time. In the missions that the ambulance encountered a mechanical or technical problem, the average ambulance response time was longer. In the present study, although there was no statistically significant relationship between the readiness of medical equipment in the ambulance and the ambulance response time, personnel access to safe medical equipment required in the ambulance mis-

**Table 4.** Ambulance response time according to demographic characteristics of message center operators

Variables	Mean±SD	P
Education status	BSc	12.06±5.8
	MSc	10.56±3.57
Certification	Nursing	12.10±5.06
	Midwifery	11.53±6.38
Employment type	Formal	13.05±5.7
	Informal	11.06±3.4
	Contractual	12.10±5.4
Native	Beginner	11.49±6.3
	Yes	13.12±6.05
	No	11.32±4.6

<sup>§</sup>Independent samples t-test; <sup>‡</sup>One-way ANOVA.

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**Table 5.** Ambulance response time according to demographic characteristics of ambulance personnel

Variables		Mean±SD	P
Education status	BSc	11.06±4.6)	0.001 <sup>§</sup>
	Associate	13.09±7.2	
Certification	Nursing	10.1±5.2	0.079 <sup>‡</sup>
	Medical emergency	12.1±6.1	
	Anesthesiology	13.1±4.2	
Employment type	Formal	11.27±4.8	0.06 <sup>‡</sup>
	Informal	13.35±7.4	
	Contractual	10.62±4.3	
	Beginner	14.18±3.4	
Native	Yes	12.20±6.2	0.062 <sup>§</sup>
	No	11.8±4.1	

<sup>§</sup>Independent samples t-test; <sup>‡</sup>One-way ANOVA

sion can affect prehospital emergency services quality. These findings are consistent with the results of another study in Yazd [19]. In some other countries, the lack of emergency medical equipment is a serious challenge and needs more budget. In the Vaitkaitis study in Lithuania, the damaged or old ambulances and low standards for staff training have been reported as effective contributors to the poor performance in emergency medical services [12]. However, a study in Germany as a developed country reported that 93% of ambulances have ventilators, and 88% have electrocardiographs [22].

In analyzing the research data in terms of the traffic conditions, the results showed that the average ambulance response time in heavy traffic conditions was longer than in other traffic conditions. This finding is consistent with the Lam et al. study in Singapore. Also, in analyzing the research data regarding the geographical location of the accident, there was no statistically significant difference in ambulance response time between missions in urban and suburban areas. This finding is inconsistent with the Lam et al. study [1]. These different results can be due to heavier city traffic conditions, longer vertical response time in high-rise

**Table 6.** Ambulance response time according to ambulance readiness characteristics

Variables		No. (%)	Mean±SD	P <sup>§</sup>
Mechanical & technical readiness	Yes	238(98)	11.51±5.55	0.01
	No	5(2)	15.0±5.45	
Medical equipment readiness	Yes	237(97)	11.5±5.5	0.2
	No	6(3)	13.1±5.35	
Sirens system readiness	Yes	235(96)	11.4±5.1	0.2
	No	8(4)	12.25±4.9	
Radio system readiness	Yes	236(97.1)	11.5±4.2	0.16
	No	7(2.9)	13.2±3.8	

<sup>§</sup>Independent samples t-test.

**Table 7.** Ambulance response time according to characteristics of the accident

Variables		Mean±SD	P
Geographical location of the accident site	In the city	11.50±5.7	0.65 <sup>§</sup>
	Suburbs	12.03±5.5	
Traffic status	No traffic	10.01±3.4	0.01 <sup>‡</sup>
	Light traffic	10.51±4.06	
	Semi-heavy traffic	13.15±6.37	
	Heavy traffic	17.15±9.34	
Location of the accident	Outdoor environment	11.20±5.5	0.46 <sup>‡</sup>
	Public and commercial buildings	10.18±2.4	
	Private residential buildings	11.4±4.9	
	Industrial centers	14.50±2.1	
Time of the accident	Morning	13.34±6.7	0.012 <sup>‡</sup>
	Evening	10.17±4.3	
	Night	11.18±5.1	
The days of the accident	Normal	11.50±6.09	0.76 <sup>‡</sup>
	Weekend	12.4±4.23	
	Special occasion	11.15±4.09	
Accident season	Fall	11.43±7.6	0.69 <sup>§</sup>
	Winter	12.12±4.6	
Accident mechanism	Driving accident	10.29±5.7	0.44 <sup>§</sup>
	Non-driving	12.21±4.7	

<sup>§</sup>Independent samples t-test; <sup>‡</sup>One-way ANOVA

buildings, and difficult access to the victims in their study that can increase the ambulance response time.

In the analysis of research data related to the time of the accident, the results showed only a significant relationship between the work shift and the average ambulance response time. The ambulance response time in the morning shift was longer than in the evening and night shifts, which needs further investigation. There was no statistically significant relationship between other components of the time of the accident, including the days of the week and the season, and the ambulance response time. Finally, the study results showed a significant relationship between the type of disease or accident with the ambulance response time,

so that the lowest ambulance response time was related to poisoning and the highest was related to falls.

## 5. Conclusion

The average ambulance response time in Tabriz Emergency Medical Center was longer than the standard value. Influential background variables were ambulance personnel education status, type of illness or injury, mechanical and technical readiness of the ambulance, traffic status, and time of the accident. It is necessary to take the required actions to improve the ambulance response time and facilitate medical services in emergency conditions.



## Study limitations

The weather condition at the time of the ambulance missions did not record by the emergency medical system software; it was a limitation to the present study to determine and compare the ambulance response time according to the weather conditions. Moreover, the sampling of the subjects was limited to the Tabriz Emergency Medical Center. For this reason, generalizing the findings should be done with caution. In the present study, we used a researcher-made instrument to extract and assess existing data recorded in emergency medical system software. It may affect the reliability and precision of the instrument and measurement.

## Ethical Considerations

### Compliance with ethical guidelines

Permission to conduct this research was obtained from the Ethics Committee of [Tabriz University of Medical Sciences](#) (Code: IR.TBZMED.REC.1397.092). The confidentiality related to the patients and emergency medical service personnel were observed.

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The paper was extracted from the MSc thesis of the second author, Department of Medical-surgical Nursing, Faculty of Nursing & Midwifery, [Tabriz University of Medical Sciences](#).

### Authors' contributions

Conceptualization and Supervision: Hossein Feizollahzadeh; Methodology: Hossein Feizollahzadeh, Bagher Safa, and Abbas Dadashzadeh; Investigation, Writing-original draft, and Writing-review & editing: All authors; Data collection: Bagher Safa ; Data analysis: Hossein Feizollahzadeh, Bagher Safa, and Azizeh Bari; Funding acquisition and Resources: All authors.

### Conflict of interest

The authors declared no conflict of interest.

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