

# The Effect of Socioeconomic Status on Ambulance Requests in Mashhad, Iran

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## Abstract

**Objectives:** Emergency medical events are not randomly distributed over a certain area. Many hidden patterns may influence this distribution due to several socioeconomic, demographic, and geospatial factors. Identifying these patterns will help health policy makers have a better planning for emergency medical services (EMS) in finding high-risk places, and people at high risk.

**Methods:** Mashhad city EMS calls records have been analyzed retrospectively. The data came from a city wide registry including 154528 calls to EMS from March 21, 2013 to March 20, 2014. To recognize the location of the requests all the recorded addresses were mapped into a single number representing the municipality district of the call. Pearson correlation coefficient is used to represent the association between ambulance calls and socioeconomic factors (e.g. income level, house ownership).

**Results:** The average of age of the patients is 42.43 years (S.D=21.7) with 50.5% male, 40.7% female and

8.8% of the sex are not registered. 64% of the calls are medical related and the remaining 36% are trauma related requests. Although the regions with lower socioeconomic status are more vulnerable, they request ambulances less frequently than the regions with higher socioeconomic status. The ambulance requests are more frequent in regions with higher education (university studies) than the regions with lower education. In addition, there is a relationship between the economic status of people and their ambulance requests that regions with higher economic status request ambulances more frequently.

**Conclusion:** Results of the study shows that there is a relationship between the socioeconomic status of people and their calls to EMS that can help policy makers in finding people in potentially high risk locations and provide services to reduce mortality and morbidity.

## Keywords

Emergency medical services; Socio-economic status; Mashhad Region; Ambulance

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## 1 Introduction

Emergency Medical Services (EMS) have crucial effect on saving patients as they are the first option in emergency situations. Their importance is considered as if they fail to give on time service to patients, there would be a life loss. The number of the ambulances dispatched to the accident scene is limited. On the other hand emergency medical events are not randomly distributed over a certain area [1]. Many hidden patterns may influence this distribution due to several socioeconomic, demographic, and geospatial factors [2].

The “chain of survival” concept [3] illuminates that survival from out of hospital cardiac arrest can be enhanced with early

EMS response. Also there are many conditions such as heart diseases and accidents which are affected by early EMS response. Peter et al. suggest that socio-spatial differentiation such as location factors, demographic and organizational features of the system are crucial predictors of the spatial-temporal patterns of recognized response times [4].

Prior studies indicating the use of EMS have concentrated on characteristics of patients taken by ambulance to emergency departments (ED) [5], movement patterns of people during the day, geographical epidemiology and population features [2], and socioeconomic status of people [6]. There have been a few population based studies investigating the ambulance usage for

EMS which have focused on specific age groups and demand of ambulance [7, 8].

In this study, we investigated the association between regional factors (e.g. Socio-economic status and educational level of people) and number of ambulance requests and response time in Mashhad. If the relation is specified, effective actions could be implemented to reduce to response time.

## 2 Methods

Mashhad is a city in northeast of Iran with a land area of 322.04 square kilometers and land mass area of 30000 acre in 2015 is located at 36° 20'N latitude and 59° 35' E longitude. Mashhad is located 970 meters above the sea level and a population of approximately 3057679 (2015) and containing one of the most important Shiite shrines which hosts about 20 million pilgrims during a year from Iran and other countries [9]. Like other metropolitan cities, EMS is an important property of this city and providing appropriate information to the managers of EMS department would help them in optimizing their services and service provision. The medical emergency department covers the entire city that there are 39 stations with 47 ambulances. All the ambulances are type B (built on van type chassis and mostly is used by hospitals, ministry of health and when the patients need basic life support features). Anyone can call the emergency department to use an ambulance by dialing "115". 20 centers admit pre-hospital emergency patients in the entire city containing 14 academic and 6 private hospitals.

A retrospective analysis of Mashhad city ambulance calls records has been implemented. The emergency medical information system of this city was established in 2007 to form a centralized registry for pre-hospital data. The data has been provided from a citywide registry including 154528 calls from March 21, 2013 to March 20, 2014. All the data are classified in four equal time intervals including 00:00 to 06:00, 06:00 to 12:00, 12:00 to 18:00, and 18:00 to 24:00. The privacy of the data was considered by eliminating the names and phone numbers of the patients. Exclusion criteria were those calls that their need was solved on phone, and those calls that had the wrong number and there was no need for ambulance dispatch. To recognize the approximate location of calls for the analysis, all the recorded addresses were mapped into a single number representing the municipality district of the address (the latitude and longitude of the addresses were not available at the time). For this an algorithm was designed and implemented using java programming language in which it uses two databases. In the first database, there are municipality region divisions and in the second database there are the addresses of the people who had called the emergency department. By comparing these two databases we implemented the algorithm. P-value<0.05 was considered statistically significant.

Socioeconomic factors including active population, occupational status, income level, home ownership, economic

status of people, quality of life, satisfaction with the place of residence, history of residence, educational level, family size, social status of citizens, and economic and social status of people [9] were compared to ambulance requests in Mashhad using Pearson Correlation Coefficient. Response time for each district is calculated (Response time is described as the interval of the request call by the arrival of the ambulance to the request position). Factors representing the association between socioeconomic status and ambulance requests are listed in Table 1.

Trauma and medical related ambulance calls were examined in this period. Trauma related ambulance calls include burn, traffic and non-traffic accidents, nature caused accidents, suicide and homicide, poisoning, and biting. 5 most frequent demands for ambulance requests in Mashhad were obtained from the data.

## 3 Results

The average of age was 42.43 years (S.D. 21.7) with 50.5% male, 40.7% female and 8.8% were not registered in the database and 28231 (18.3%) of the recorded calls belonged to 65 years and older people. Table 2 represents the number of people who needed an ambulance according to their age. 145791 (94.35%) of records had valid age and other 8737 (5.65%) had invalid age registered and were removed. 64% of the calls were for medical related and the remaining 36% were for trauma related requests.

Traffic accident is the first reason for ambulance calls in all regions with different socioeconomic status, but it is less in regions with higher socioeconomic status compared to lower socioeconomic status. 5 most frequent demands for ambulance requests are listed in Table 3. The trauma related ambulance requests are the highest call reasons from 12:00 to 18:00 for all the time especially August and September when many pilgrims travel to this city (Figure 1). But medical related ambulance requests are high from 18:00 to 24:00 in August and September (Figure 2). There is a smooth reverse relationship between trauma related ambulance requests and occupational status of people ( $r=-0.33$ ,  $P<0.27$ ).

The socioeconomic status of people in the center and southwest of Mashhad is higher than the others [9]. Table 4 represents the regional EMS request comparative density. In one region the ambulance request is 2.5 times more than the average ambulance request in the entire city. Some socioeconomic factors [9] are compared with the ambulance requests. There is a weak and not statistically significant relationship between the educational levels and the frequency of ambulance requests ( $r=0.1$ ,  $p<0.7$ ). The ambulance requests are slightly more frequent in regions with higher education (university studies) than the regions with lower education considering the population density.

The Pearson Correlation Coefficient matrix between socioeconomic factors and ambulance requests rate and also trauma and medical related calls is demonstrated in Figure 3. (The matrix is generated using R, RStudio Version 1.1.456).

Table 1: Factors representing the association between socio-economic status and ambulance requests

Region	1	2	3	4	5	6	7	8	9	10	11	12	13
Population	167013	513365	417950	262184	175603	232616	253236	92543	327061	296823	200161	105263	13861
No of Calls	13053	14136	22685	10449	8490	9150	13156	8247	16294	14396	11437	968	5624
Response Time	9.68	9.71	9.61	9.57	9.19	9.6	9.55	9.68	9.48	9.57	9.64	9.67	9.53
Trauma Related Calls	3574	4456	6783	3375	2981	2956	3787	2271	4390	4202	3423	296	1202
Medical Related Calls	9479	9680	15902	7074	5509	6194	9369	5976	11904	10194	8014	672	4422
Requests of City %	8.45	9.15	14.68	6.76	5.49	5.92	8.51	5.34	10.54	9.32	7.4	0.63	3.68
Income Level	750	562	320	391	365	459	490	601	650	490	670	510	694
Quality of Life	0.91	0.69	0.31	0.41	0.42	0.45	0.52	0.74	0.85	0.51	0.88	0.49	0.81
Satisfaction With The Place of Residence	0.62	0.57	0.39	0.32	0.42	0.41	0.48	0.5	0.59	0.52	0.64	0.55	0.57
Educational Level	0.67	0.51	0.42	0.43	0.41	0.53	0.49	0.62	0.64	0.63	0.65	0.45	0.55
Family Size	3.1	3.4	3.5	3.6	3.9	3.6	3.4	3.2	3.3	3.4	3.5	3.5	3.3
Economic And Social Status of People	0.92	0.67	0.18	0.28	0.16	0.39	0.47	0.65	0.83	0.53	0.8	0.39	0.68
Occupational Status	0.81	0.79	0.63	0.73	0.71	0.71	0.76	0.74	0.8	0.72	0.81	0.75	0.77
Active Population	0.91	0.87	0.83	0.83	0.8	0.83	0.85	0.87	0.87	0.84	0.87	0.83	0.85
Home Ownership	0.89	0.77	0.58	0.67	0.55	0.67	0.68	0.79	0.85	0.69	0.82	0.72	0.7
Economic Status of People	1	0.66	0.09	0.33	0.13	0.34	0.47	0.64	0.8	0.42	0.81	0.46	0.62
History of Residence	21	40	28	29	23	35	29	20	38	32	28	10	35

Table 2: The age category, adapted from <http://www.ncbi.nlm.nih.gov/pubmed/>

Age category	Infant (Birth-2)	Pre-school Child (3-5)	Child (6-12)	Adolescent (13 - 18)	Adult (19-45 )	Middle aged (46-64)	Aged (65-80)	Golden Oldie (81-120)
No.	1536	1587	3620	8523	71903	30391	20280	7951
Accumulative No.	1536	3123	6743	15266	87169	117560	137840	145791
Percentage of total (%)	1	1.02	2	5.5	46.5	19.7	13.1	5.14
Accumulative Percentage	1	2.02	4.02	9.52	56.02	75.72	88.82	93.96

#### 4 Discussion

In this study, we investigated the relationship between socioeconomic status of people and their ambulance requests. The results represent that for some socioeconomic factors, there is a relationship between the ambulance requests of people and their socioeconomic status.

There are some criteria that describe socioeconomic status of people including active population, occupational status, income level, home ownership, economic status of people, quality of life, and satisfaction with the place of residence, history of residence, educational level, family size, social status of citizens, and economic and social status of people. This study demonstrates the relationship between the socioeconomic statuses of people with

Table 3: Five most frequent ambulance requests in Mashhad in regions with different socio-economic status.

Economic level of regions	Population	1st top most	2nd top most	3rd top most	4th top most	5th top most	Summation of top 5
Regions with higher socio-economic status	732794	Traffic accident (15.87%)	Weakness (7.15%)	Seizure (7.14%)	Unconsciousness (6.89%)	Nervous stress (6.68%)	43.83%
Regions with middle socio-economic status	1150771	Traffic accident (19.28%)	Unconsciousness (7.62%)	Seizure (7.3%)	Nervous stress (7.14%)	Dyspnea (6.21%)	47.55%
Regions with lower socio-economic status	694227	Traffic accident (17.81%)	Nervous stress (7.59%)	Seizure (8.86%)	Unconsciousness (6.75%)	Weakness (6.45%)	47.86%

Table 4: Regional EMS request comparative density. Other ambulance requests were out of the city ambulance dispatch. Normalized request per area shows that regions with higher economic status request more ambulances compared to regions with lower economic status.

Economic level of regions	Requests (%) of city	Request per person	Request per area (km2)	Average Population Density#
Regions with higher socioeconomic status	35.41	0.54	4363.78	0.97
Regions with middle socioeconomic status	42.17	0.27	3645.24	0.98
Regions with lower socioeconomic status	18.29	0.14	474.64	1.08
Overall	95.87*	0.95	8483.66	-

\*Other 4.13% belong to the calls outside of the city

#Population density in regions with higher and average socioeconomic status is lower than regions with lower socioeconomic status

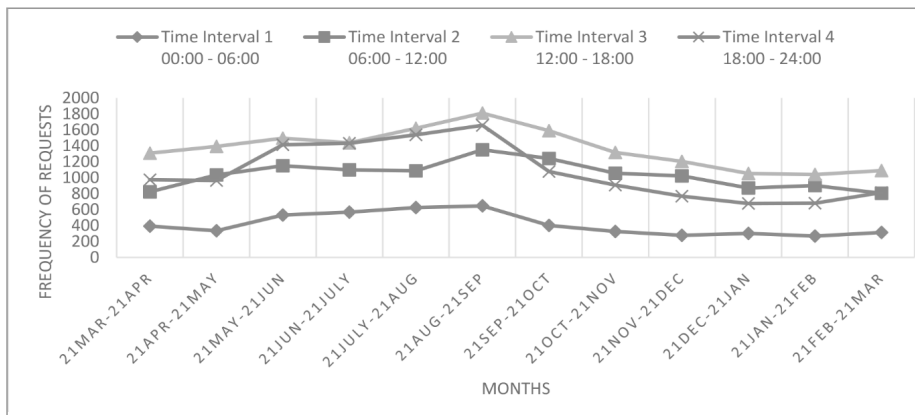


Figure 1: Frequency of trauma related ambulance requests.

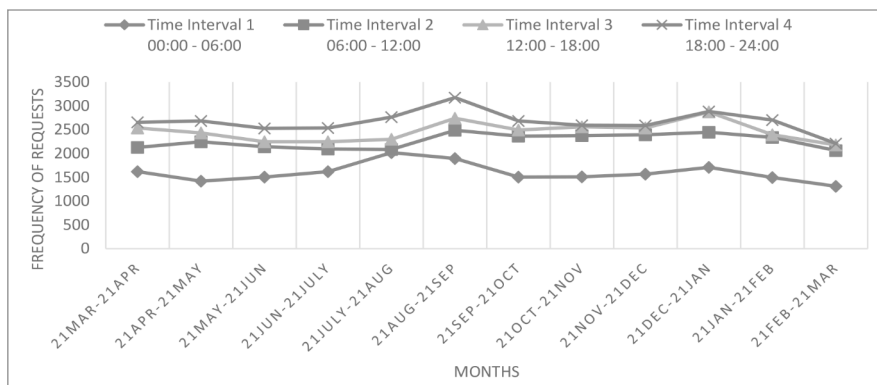


Figure 2: Frequency of medical related ambulance requests.

their ambulance requests frequency. Different regional patterns of trauma or medical related ambulance requests as well as different socioeconomic factors associated with EMS needs were observed. The results show that in the center of the city, there is high risk of both trauma and medical related events where might be because of high population concentration.

Figure 4 represents the current ambulance stations in Mashhad. It is recommended that there could be a location rearrangement in ambulance stations. The number of stations in zone 13 of

Mashhad could be increased due to high need of ambulances. On the other hand the number of stations could be decreased in zone 2 because of low number of recorded ambulance calls in this region which could be added to zone 3 because of their need that is more than zone 2. Figure 5 shows different zone's need for ambulances which seems there should be a change in the current ambulance locations.

The rate of medical related ambulance requests (64%) in this study is higher than the rate of trauma related ambulance requests

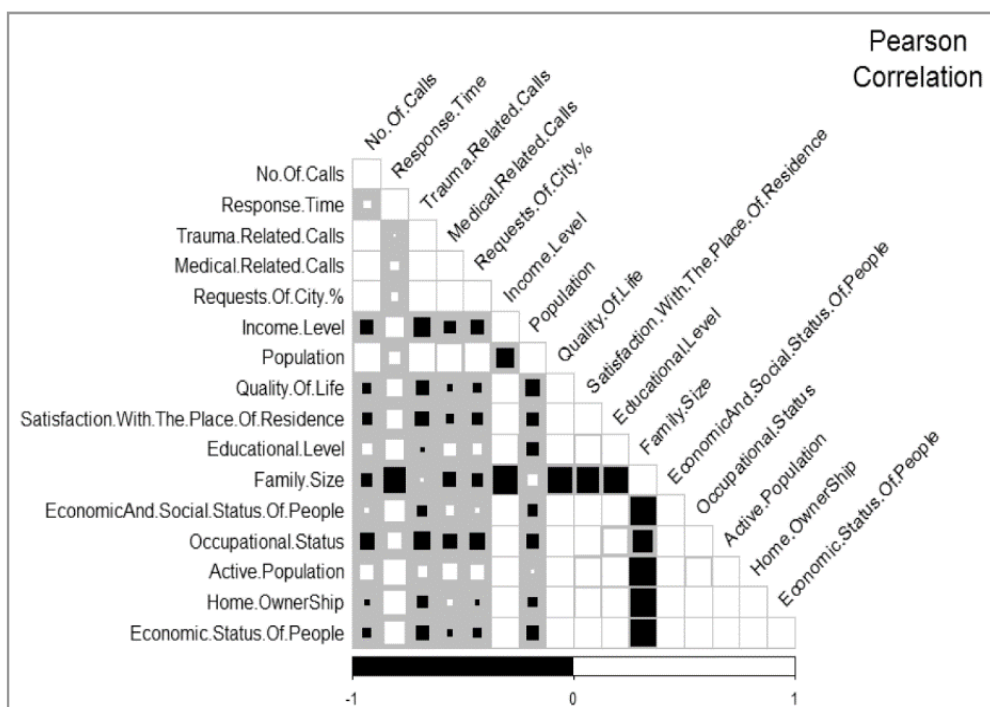


Figure 3: Pearson correlation coefficient between socioeconomic factors and ambulance requests. The color spectrum represents the degree of association.

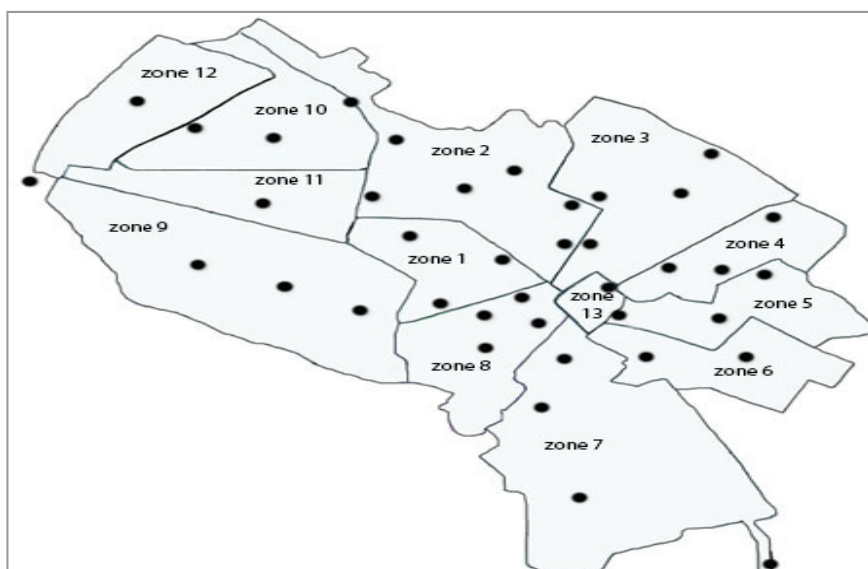


Figure 4: Current ambulance stations in Mashhad.

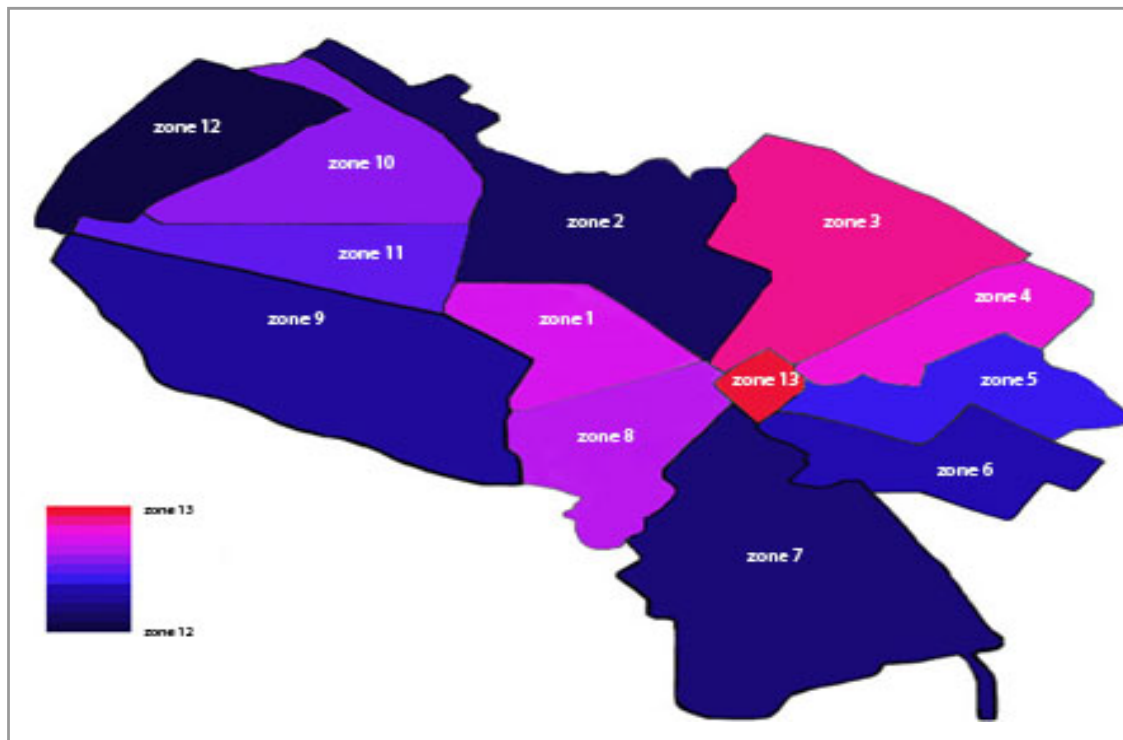


Figure 5: Color spectrum of the need of different zones for ambulances (zone 13 highest need and zone 12 lowest need).

(36%). Previous studies such as the report of Arul et al. have also mentioned the higher medical related reasons of EMS calls (71% vs 29%) and say that the risk of medical related risk decreased by the better socioeconomic status of the region [2]. Ong et al. showed the same pattern (68.8% vs 31.2%) [10] which medical related ambulance requests represent higher frequency. Likewise similar studies in Middle East countries [11] as well as north America [6], it is shown in this research that lower regional socioeconomic status is related to higher cardiac emergency events ( $P < 0.0005$ ). Arul et al. have shown that age, household income and traveling by car are positively associated to ambulance calls [2], which is studied by Kawakami et al. as well [12]. Our study also reveals a positive relationship between the income level of the region and ambulance requests rate.

Chihiro et al. investigated some demographic and socioeconomic factors that affect peoples' decision to call an ambulance. One of these factors is age in which elderly people are shown to prefer to call for an ambulance more than young people. This result is in concordance with our study's result. The other factor that seems to affect the frequency of ambulance calls is owning a private vehicle in which people owning a car prefer to call for an ambulance less frequently than the people who don't [12], but we didn't have these information in our dataset. Our data show that there is almost no relationship between the ambulance requests rate and home ownership ( $r = -0.02$ ).

This study reveals that in one region the ambulance request is 2.5 times more than other regions of the city that the position of this region is special, due to the presence of holy shrine in this

zone. As many pilgrims visit the holy shrine each year, we cannot assure that in this region the relationship between ambulance requests and socioeconomic status of people is as other regions and pilgrims may highly influence it.

Ambulance response time is another factor which is defined as the period of time between receiving of a call by the EMS center and arrival of ambulance at the scene. The ambulance response time is less in the center of the city than other regions. Some people might think that it would be easier and faster to take their patients to hospitals by their personal car than calling an ambulance. So it seems that there is a need to establish ambulance stations in the regions far from the city center and inform people to use ambulances more than their own cars by distributing brochures, sending SMS, and etc. Previous studies agree with the results of this study that owning personal cars affect the ambulance requests. They show that this socioeconomic factor effects medical related calls more [2].

If the location of ambulances changes to an optimum form, the emergency department could get the most of the available ambulances and reduce mortality and morbidity caused by events which happen every day and every time in the whole city. The results of the present study might suggest rearrangement of the ambulances standby locations according to socioeconomic report to reduce the response time. In this study the needs of different regions for ambulance calls are studied and future studies are needed to find the optimum locations of each ambulance to decrease the response time.

## 5 Conclusion

In this study we concluded that there is a relationship between the socioeconomic status of people and their calls for ambulances. The results of this study can help policy makers in finding people potentially in high risk locations and provide facilities that can help them reduce mortality and morbidity.

## 6 Conflict of Interest

The authors declare no conflict of interest.

## 7 Funding Sources/Disclosures

Mashhad University of Medical Sciences

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