

ORIGINAL ARTICLE

An Empirical Investigation of Safety Climate in Emergency Medical Technicians in Iran

SHAHRAM VOSOUGHI and MORTEZA OOSTAKHAN*

Department of Environmental and Occupational Health, School of Medicine, University of Tarbiat Modares, Tehran, Iran.

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ABSTRACT

This paper discusses empirical research aimed at investigating the most important dimensions of safety climate from Emergency Medical technician's perspective. Investigation was conducted through the safety climate questionnaire (SCQ) in Tehran Emergency Organization. After a literature review, a 21-item questionnaire was developed and administered to 600 technicians. In order to identify the structure of safety climate Factor analysis was used with varimax rotation method using SPSS 17 software. Data on safety climate were collected by completed questionnaire from 266 technicians with a response rate of 44%. Safety climate attributes were conducted to reduce by Factor analysis and identified five critical safety dimensions which together explained 61% of the total variance. One way ANOVA results show that there were no statistically significant differences for characteristics such as age, experience and job category at the 5% significance level. Employees' perceptions on the five safety climate dimensions differ significantly among the four groups on the basis of their factor scores in safety climate dimensions at the $p < 0.05$ significance level. In order to improve safety climate, based on the study results, more attention should be paid to safety training and management support.

Keywords: *Safety climate, Emergency medical technicians, Factor analysis, Cluster analysis, Iran*

INTRODUCTION

The safety climate of any organization consists of employees' attitudes towards health and safety behavior. Safety climate is the demonstrative of superficial aspects of safety culture [1-3]. Against transient attribute of safety climate, fundamental beliefs, attitudes, values, patterns of behavior and perceptions of individuals and groups within organization will be steady [3]. Then, due to this characteristic of safety climate, the objective measurement tool in an organization is largely needful [4, 5]. Measuring safety climate can be compared to taking the "safety

temperature" of an organization [6], which provides a snapshot of that organization's "state of safety" at a discrete point in time [7, 8]. In the main, safety climate (safety culture) is considered as an important factor affecting the patient safety [9, 10]. Zohar (1980) first defined safety climate as a summary of molar perceptions that employees share about their work environment [11]. Safety climate is typically measured using questionnaires that ask employees to rate their employer's commitment to safety [12, 13]. The underlying concepts of safety climate have been derived from the findings of research in industrial sectors [14]. Much attention has been put on safety climate in some industrial sectors due to the productivity, cost-saving, quality and employee satisfaction, whereas safety climate in these environments has been often taken for

* **Corresponding author:** Morteza Oostakhan, E-mail: morteza_avesta@yahoo.com

granted. Applying the safety climate into the health care field could be regarded as common approach to monitoring and improving the patient safety [15, 16].

Emergency medical technician (EMT) is an educated individual to provide emergency medical services before arriving at hospital [17]. All emergency medical operations are performed in behalf of EMTs principally in order to keep patient in an appropriate situation during transferring to hospital for advanced medical cares [18]. Examples of threats to EMS patient safety include stretchers being dropped, misplaced end tracheal tubes, misdiagnosis of patient signs and symptoms, and deviations from standard treatment protocols.

The Tehran Emergency Organization is a governmental organization which offers certification exams. The TEO recognizes three levels of EMTs: EMT-B (Basic), EMT-I (Intermediate), EMT-P (Paramedic). EMT-B is the entry level of EMS. The procedures and skills allowed at this level are generally non-invasive such as bleeding control, positive pressure ventilation with a bag valve mask, supplemental oxygen administration, and splinting (including full spinal immobilization). EMT-I are the levels of training between EMT-B and EMT-P. EMT-Ps, who are commonly referred to as simply paramedics, represent the highest level of EMT and in general the highest level of pre-hospital medical provider, though some areas utilize physicians as providers on air ambulances or as a ground provider. Poor understanding of organizational and operational factors among EMTs and their viewpoint about patient safety have influenced on safety culture [19, 23].

The purpose of this study was to investigate safety climate dimensions and to classify emergency medical technicians into various groups according to their safety perceptions. Based on the safety climate literature, dimensions such as management support, safety training, minimal conflict/good communication, supervisors' safety leadership and personal protective are assessed in this research.

MATERIALS AND METHODS

Participants

The study population was the emergency medical technicians in the Tehran Emergency Organization in Iran. Of approximately 600 potential respondents, 266 completed the safety climate questionnaire, representing a rate of 44% were retrieved. All respondents were male. The average age of all respondents was 32.3 years (SD=6.42) with a range from 22 to 50 years. The majority of participants (45.9%) were EMT-B, 29.9% were EMT-I and 31.2% were EMT-P. Average experience in their current job was 6.54 years (SD=4.68).

Survey instrument

All technicians were invited to complete a short demographic section, a modified 21-item safety climate survey. From a review of related literature and theory,

25 items questionnaire was developed [20-25]. These questions were reworded and rephrased to suit local working practices and culture. Before using the questionnaire, we distributed it to quality control and technical managers of organization and 20 technicians to for trial. Issues such as appropriate length of the questionnaire, clarity of the questions, difficulty of the question language and vocabulary level used and other suggestions from the participants were taken into consideration. After reviewing each item in detail, some required changes like simplifying, rewording, removing and replacing were made. All participants believed that the questionnaire was made of appropriate, fair, and non-offensive questions. In this stage, the ambiguous items that technicians could not understand clearly, items that could not load at any factors or loading not exceed 0.4 in the factor analysis, items that would substantially increase Cronbach's Alpha coefficient in their, were removed. A total of four items were deleted by the above processes. Content validity of safety climate scale was judged by safety experts. Construct validity was tested by the exploratory factor analysis, and discriminate validity was checked by comparing the safety climate scores among the various groups by ages and years of work experience. For each item, respondents were asked to indicate the extent to which they agreed with the item described in its prospective content domain. Respondents rated their agreement with each item using Likert 5-point scale (1=disagree strongly to 5=agree strongly). Demographic questions were about department, age, sex, and years of working experience in the organization.

RESULTS

Perceptions of safety climate

In general, all questions had a mean score greater than 3 (neutral) and were representative of positive safety climate perceptions. The top 3 ranked items (by mean score 4 or more) included questions 1, 2 and 3. In contrast, respondents showed the lowest agreement (their mean scores were below 3.5) with questions 5, 6, 7, 9, 10, 17, 19 and 20.

Factor analysis

Factor analysis was used to reduce the safety climate attributes in emergency medical technicians into the smaller sets of underlying factors. This was much helpful in detecting the presence of meaningful patterns among the original variables and extracting the main service factors. A varimax rotation was performed to enhance factor interpretability. This procedure finally resulted in five factors with an Eigenvalue of greater than 1 which explained 61% of the total Variance. The data were deemed appropriate for analysis, according to the Kaiser-Meyer-Olkin measure of sampling adequacy value of 0.90 [23]. The Bartlett Test value=2384.469, df =210, $p < 0.0005$. There were a total number of 21 items in the scale. Principal components analyses with VARIMAX rotation to identify key safety climate dimensions are presented in Table 1.

Table 1. Items safety climate factor loadings

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Sharp containers are readily accessible in my work area.	0.306	-0.072	0.186	0.237	0.628
Disposable gloves are readily available in my work area.	-0.126	0.183	-0.006	0.017	0.723
Disposable face masks are readily available in my work area.	0.235	0.277	0.014	-0.046	0.637
Eye protection is readily available in my work area	0.123	0.013	0.303	0.150	0.704
The protection of workers from occupational exposures to respiratory infections is a high priority with management.	0.272	0.176	0.790	0.065	0.135
Employees are encouraged to become involved in employee safety and health matters.	0.248	0.236	0.776	0.086	0.180
Managers on my unit do their part to insure employee protection from occupational respiratory infections.	0.290	0.264	0.714	0.243	0.060
The personnel in this organization take responsibility for patient safety.	0.059	0.167	0.357	0.457	0.217
Unsafe work practices are corrected by supervisors.	0.696	0.252	0.276	0.125	0.134
My supervisor often discusses safe work practices with me.	0.760	0.194	0.238	0.160	0.171
Supervisors encourage us to safe work.	0.758	0.163	0.163	0.301	0.102
Supervisors listen to me and care about my concerns.	0.746	0.231	0.235	0.274	0.045
I have had the opportunity to be properly trained to use personal protective equipment devices so that I can protect myself from respiratory infection exposures.	0.234	0.653	0.155	0.032	0.114
Employees are taught to be aware of and to recognize potential health hazards at work.	0.451	0.576	0.224	-0.055	0.149
I know how to access information about safety.	0.202	0.692	0.123	0.125	0.167
Patient safety is constantly reinforced as the priority in this organization.	0.070	0.467	0.135	0.381	0.098
I know the proper channels to direct questions regarding patient safety.	0.095	0.678	0.253	0.266	0.049
There is open communication between supervisors and staff.	0.392	0.381	0.117	0.523	0.036
The culture of this organization makes it easy to learn from the mistakes of others.	0.107	0.385	0.146	0.647	0.143
I am encouraged by my colleagues to report any safety concerns I may have.	0.311	0.393	0.081	0.579	-0.067
Briefing personnel before the start of a shift (i.e., to plan for possible contingencies) is an important part of safety.	0.221	-0.147	0.019	0.708	0.070

Screen plots and eigenvalues greater than one were used to determine the number of factors in each data set factors with eigenvalues lower than one was not significantly indicated in the first screen plot Fig.1 [23]. In order to better explanation, only variables with a factor loading greater than 0.50 were extracted [22-25]. Items 8 and 16 were removed from further analysis.

The five factors with their names, items in each factor, are described below:

Factor 1, *Supervisors' safety leadership*, consisted of 4 items: unsafe work practices are corrected by supervisors, my supervisor often discusses safe work practices with me, supervisors listen to me and care about my concerns and supervisors encourage us to safe work.

Factor 2, *Training*, consisted of 3 items: I have had the opportunity to be properly trained to use personal protective equipment devices so that I can protect myself from respiratory infection exposures, employees are taught to be aware of and to recognize potential health hazards at work, I know how to access information about safety, and I know the proper channels to direct questions regarding patient safety.

Factor 3, *Management support*, consisted of 3 items: the protection of workers from occupational exposures to respiratory infections is a high priority with management, employees are encouraged to become involved in employee's safety and health matters, managers on my unit do their part to insure employee protection from occupational respiratory infections.

Factor 4, *Minimal conflict/good communication*, consisted of 4 items: there is open communication between supervisors and staff, the culture of this organization makes it easy to learn from the mistakes of others, I am encouraged by my colleagues to report any safety concerns I may have, briefing personnel before

the start of a shift (i.e. to plan for possible contingencies) is an important part of safety.

Factor 5, *Personal protective and engineering control equipment availability*, consisted of 4 items: sharp containers are readily accessible in my work area, disposable gloves are readily available in my work area, disposable face masks are readily available in my work area, and eye protection is readily available in my work area.

Item-total correlation and Reliability

The item-total correlation test is performed to check whether any item is not consistent with the rest of the scale and thus it can be discarded. The analysis is performed to refine the measure by eliminating 'garbage' items prior to determining the factors that represent the construct. This can be done by measuring the correlation between the scores of an individual item and the sum of the scores of the remaining items that form the scale. The total scale's internal consistency is

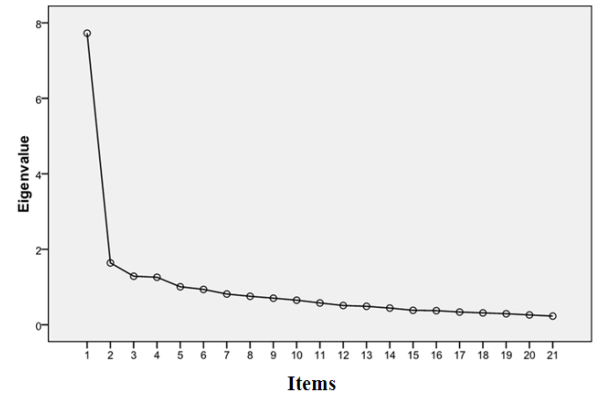


Fig 1. Screen plot of factors

Table 2. Item-total correlations

Items	Corrected item-total correlation
Sharp containers are readily accessible in my work area.	0.455
Disposable gloves are readily available in my work area.	0.202
Disposable face masks are readily available in my work area.	0.401
Eye protection is readily available in my work area.	0.425
The protection of workers from occupational exposures to respiratory infections is a high priority with management.	0.618
Employees are encouraged to become involved in employee safety and health matters.	0.644
Managers on my unit do their part to insure employee protection from occupational respiratory infections.	0.688
Unsafe work practices are corrected by supervisors.	0.654
My supervisor often discusses safe work practices with me.	0.680
Supervisors encourage us to safe work.	0.661
Supervisors listen to me and care about my concerns.	0.712
I have had the opportunity to be properly trained to use personal protective equipment devices so that I can protect myself from respiratory infection exposures.	0.504
Employees are taught to be aware of and to recognize potential health hazards at work.	0.618
I know how to access information about safety.	0.560
I know the proper channels to direct questions regarding patient safety.	0.572
There is open communication between supervisors and staff.	0.631
The culture of this organization makes it easy to learn from the mistakes of others.	0.572
I am encouraged by my colleagues to report any safety concerns I may have.	0.564
Briefing personnel before the start of a shift (i.e., to plan for possible contingencies) is an important part of safety.	0.30

demonstrated by items with a strong positive correlations>0.20 when measured against the total scale [24]. As seen in Table 2, the item-total correlation coefficients ranged from 0.202 to 0.712. A reliability test based on Cronbach’s Alpha was used to test whether these dimensions were consistent and reliable. The alphas of the five factors of our model were 0.88 for SC1 (supervisors’ safety leadership), 0.84 for SC2 (management support), 0.77 for SC3 (training), 0.74 for SC4 (minimal conflict / good communication), 0.68 for SC5 (personal protective equipment). The reliability value of each factor was above the acceptable limit of 0.6, indicating adequate internal consistency [24, 27, 28]. The emergency medical technicians’ perceptions of safety climate in the current situation were shown in Fig. 2. The mean score of total safety climate and its standard deviation (in parentheses) were 3.60 (0.39), and the means (corresponding standard deviation in parentheses) of the five factors were 3.84 (0.63), 3.03 (1.14), 3.58 (1.03), 3.62 (0.88), 4.12 (0.75), respectively.

One-way analysis of variance

To evaluate the relationship between the employees’ perceptions on these factors and personal attributes like age, experience and job category, a series of one way ANOVA tests were conducted. The data used was the one obtained by lumping together the standardized scores. Mean values of safety climate factor scores were calculated for three groups based on age, experience, and job category which are presented in Table 3. As seen in Table 3, respondents were divided into three age groups *a*₁, *a*₂ and *a*₃ based on age (up to 30 years, between 31 and 40, above 41 years, three groups *e*₁, *e*₂ and *e*₃ based on experience (5 years, 6–10 years, above 11 years and three groups *j*₁, *j*₂ and *j*₃ based on job category (basic, intermediate, and paramedic). According to the results of one way ANOVA in Table 4

there were no statistically significant differences found for these characteristics at the 5% significant level.

Cluster analysis

In addition to identifying whether perceived differences existed among groups based on respondents’ characteristics, all respondents were categorized into four groups on the basis of their factor scores in safety climate dimensions; 96 were assigned to Group (1), 75 to Group (2), 40 to Group (3), and 55 to Group (4). A one-way analysis of variance (ANOVA) was used to examine whether the safety climate dimensions differed among the four groups. One way ANOVA results in Table 5 Shows that the employees’ perceptions on five safety climate dimensions differ significantly among the four groups at *p*<0.05 significance level. A comparison of factor score coefficients shows Group (1) had two high centroid scores on the safety management and minimal conflict/good communication dimensions. Group (2) had its highest score on the personal protective dimension. However, it had a negative score on the management support, supervisors’ safety

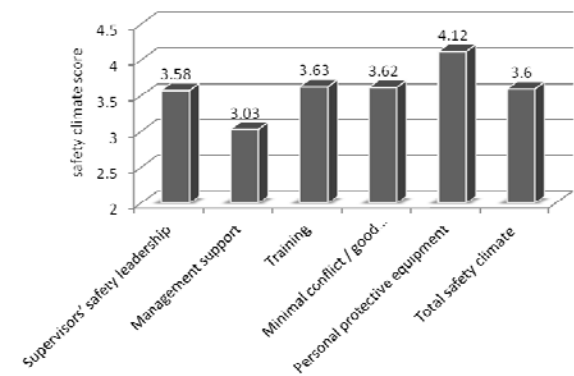


Fig 2. Safety climate in emergency medical technicians

Table 3. Mean safety perception scores for groups based on age, experience, and job category

	Age			Experience			Job		
	a ₁	a ₂	a ₃	e ₁	e ₂	e ₃	j ₁	j ₂	j ₃
F ₁	0.007	-0.041	0.064	0.040	-0.080	0.036	0.047	0.007	-0.074
F ₂	-0.088	0.072	0.167	0.071	-0.065	-0.051	0.032	-0.020	-0.032
F ₃	-0.030	-0.068	0.255	0.050	0.001	-0.104	0.073	-0.077	-0.051
F ₄	-0.058	0.011	0.189	0.027	-0.311	-0.010	0.045	-0.132	0.031
F ₅	-0.113	0.158	0.072	0.081	-0.097	-0.025	-0.098	-0.003	0.146

Table 4. One way ANOVA

	Age		Experience		Job	
	F	Sig.	F	Sig.	F	Sig.
F ₁	2.077	0.127	0.815	0.444	1.477	0.230
F ₂	1.525	0.220	0.466	0.628	0.614	0.542
F ₃	1.317	0.270	0.558	0.573	0.115	0.891
F ₄	0.940	0.392	0.086	0.917	0.690	0.503
F ₅	0.154	0.857	0.402	0.669	0.364	0.695

leadership and minimal conflict / good communication dimensions. Group (3) and Group (4) had negative scores on all dimensions.

DISCUSSIONS

The aim of this attempt was to characterize EMS organizational safety culture. A growing body of literature highlights the growing problem with medical errors in emergency medical services. Organizational culture refers to the beliefs, attitudes and values of its personnel. There is growing awareness that organizational culture may also have strong ties to patient safety and outcomes in healthcare settings. Safety climate is considered as a subset of organizational climate, therefore understanding of safety climate can help us to reach a healthy and coherent organizational climate. One of the benefits of safety climate measurement is the recognition of weaknesses in organizational structure and its subsets. Proper understanding of factors can strengthen weaknesses in the structure of safety climate and thereby raising the level of safety culture could be very helpful. Safety and health issues for emergency technicians and patient safety should be paid special attention. Safety climate rarely has been performed in emergency centers in Iran and compared other sectors fewer studies about patient safety climate have been done. In organizations like the emergency organization that try to reduce the errors in services, a support system of patient safety and

implementing safety measures in behalf of management is essential. Measuring safety climate in health centers is considered one of the important tools that can help managers in regard to the situation and improvement of safety culture weaknesses.

This study is one of the first studies to evaluate safety climate that has been conducted with the aim of understanding the safety status of emergency technicians. The questionnaire preparation phases were chosen from previous studies used in health care centers. The five safety climate factor were labeled as supervisors' safety leadership, training, management support, minimal conflict/good communication, personal protective and engineering control equipment. According to Table 5 the lowest level agreement is allocated to management support. Safety culture includes organizational trust as an essential element. The respondents have a moderate climate safety and the average score on safety climate is 3.60 in all groups.

Certainly culture is one of the most important factors affecting the reporting of errors. Good relations among technicians, as based on the above statistical results has a relatively acceptable level, can also reduce the possibility of mistakes and errors of others during operations and raising the level of patient safety is very important. Therefore, this important position with regard to the organizational values must be strengthened more than ever. Training in addition to raising the level of work force capabilities can help technicians to report errors and encourage the expression of their culture to achieve patient safety. Safety leadership by supervisors also is an important factor. A proper link between technicians and managers in promoting safety and health programs must always be established. This means that they play an important role in the safety of technicians and patient safety and of course to strengthen safety rules and procedures. One way ANOVA revealed there were no statistically significant differences found for respondents' characteristics such as age, experience and job category. Cluster analysis

Table 5. One-way ANOVA analysis of safety climate differences among the four groups

Safety climate dimensions	Groups				F	Sig
	1(96)	2(75)	3(40)	4(55)		
Personal protective equipment	0.74	0.16	-0.14	-1.41	144.344	0.000
Management support	0.85	-0.06	-0.98	-0.70	90.634	0.000
Training	0.83	0.05	-1.44	-0.48	137.836	0.000
Supervisors' safety leadership	0.84	-0.06	-1.43	-0.35	125.239	0.000
Minimal conflict / good communication	0.85	-0.33	-1.18	-0.18	91.634	0.000

1. The description of groups is based on factor scores with a mean of zero and standard deviation of one.
2. Significance level $p < 0.01$.

categorized respondents into four groups on the basis of their factor scores in safety climate dimensions. The five safety climate dimensions differed significantly among the four groups.

The limitations of this study are as follows, first according to that the major studies of safety climate conducted in medical centers and hospitals, as we know almost little research has been done in emergency medicine. Due to limited resources, the comparison with other studies is impossible. For example, in a study of a Canadian intensive care unit maximum safety score was 3.4 that is different in the type of work with the emergency medicine department and comparison between them may not seem very logical, although the issue of patient safety share with each other.

The second limitation is that the findings require further evaluation. Our data cannot be easily generalized. The survey findings should be reviewed carefully, because this study was conceived as an experimental project and was not designed to facilitate research. Our measure of safety climate may be biased.

Future research should include the evaluation of existing items, as well as the inclusion of additional items to enhance interpretation and internal consistency of the instrument's dimensions. Furthermore future studies should survey more and various multidisciplinary health care organizations. Investigators should also consider mechanisms for establishing a body of benchmark data for comparison purposes across a range of healthcare settings.

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