RESEARCH ARTICLE

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Developing a Questionnaire to Assess Safety Climate at Universities of Medical Sciences

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Background & Aims of the Study: The implementation of safety principles in work environments can directly benefit both employees and the organization by reducing the mental and physical strain, reducing the risk of work-related injuries, and performance improvement. Thus, with the consideration and implementation of safety principles, and the creation of a positive safety climate, organizations can improve their performance and the welfare and safety of their employees. The purpose of this study was to design and provide a domestic questionnaire of safety climate assessment at universities of Health Ministry in 2018-19.

Materials and Methods: This descriptive-analytical study was carried out with the participation of health and safety specialists, methodologists and personnel of the universities of medical sciences. Universities and people were selected randomly. The validity of the questionnaire was measured by CVI and CVR analysis and then the structural validity was studied by factor analysis using R ,MPLUS and SmartPLS softwares. Also, to test the reliability of the questionnaire, test-retest test and Cronbach's alpha coefficient used. The analytic methods T and Mann–Whitney were used in SPSS V20 software to measure predictive value.

Results: By forming a group, the Focus Group methodology was used and reached to 37 questions. The test-retest showed a correlation of 0.96 with a one-week interval. Then, data from 265 people were analyzed for exploratory factor analysis. Two questions were deleted. Therefore, a final questionnaire includes 35 questions with five-point Likert scale responses, was obtained. The output of this analysis identified seven subscales for the questionnaire. The reliability of the questionnaire was tested with Cronbach's alpha and was 0.909. The analysis of predictive validity of difference in safety climate and its components between two groups of with and without experience of occupational accident indicated that commitment and performance of management in the field of safety, and environment and conditions of work was significant (P<0.05).

Conclusion: The findings indicated that the questionnaire was acceptable. Since human resources are the main and vital part of organizations, recognizing the status of the organization from their viewpoint is important to them. In the area of safety, it is also necessary to have an instrument for assessing its available atmosphere. This instrument can help managers to plan for the future. It is worth noting that other factors and places can also be investigated in future studies.

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Background

An effective way to achieve the goal of identifying hazards before the occurrence of events is to measure the overall state of safety,

as well as safety climate and culture (1). It has to be said that extensive activities have been carried out in various industries in the field of safety climate assessment, but so far no substantial research has been conducted on the safety of the educational centers especially in the universities, and this is the importance and novelty of the study. Obviously, the human resources of the educational centers, if they take into account the issues of safety and constructive thinking in this field, can play a special role as an important contributing factor in promoting the safety of society through influencing learners. Based on this, the researchers believe that by determining the safety status in these organizations, the culture of safety can be greatly improved. Since each change requires its own infrastructure, as well as the acquisition of the necessary infrastructure also needs its own tool; by providing a valid questionnaire for educational environments, safety-centered plans can be developed by comprehensive data at national level. The subject of this study is development of a questionnaire on the study of safety in universities as an educational indicator. As a complex and diverse environment, the university can be the focal point for events. The existence of different colleges brings to mind the range of activities from administrative to laboratory and technical activities. Activity in the lab creates a range of ergonomic, chemical, and even biological hazards. How people look at these issues is critical and directly affects the way in which operational programs are planned and how they are managed. Several questionnaires have been provided by various researchers regarding the status of occupational/safety status and the type of systems thinking in the organization (2). One of the most important factors in determining these factors is the type of organization's activity. Undoubtedly, scientific and educational environments like universities are different from industrial environments such as process, automotive or nuclear industries. Therefore, we need to use a questionnaire that assesses items related to activities in these environments. Since safety climate is in fact the attitude of individuals towards the safety and the existing conditions, it also affects the safety behavior of individuals. Hence, by assessing and improving the level of safety in the organization, it is possible to improve safety behaviors (2). Considering the existing deficiencies, this research can open up a number of issues in the area of safety in educational centers and provide a basis for future research in this area. In fact, safety climate is one of the tools that can be used to examine the management's performance in terms of safety, and ultimately, based on the results try to planning and correction (2). Improving safety climate is one of the most important factors in preventing dangerous conditions and incidents in the universities, and encourages the managers and employees to adhere to the safety standards.

Aims of the study:

The aim of present study was to develop a safety climate assessment questionnaire in universities affiliated to the Ministry of Health in Iran, 2018-19.

Materials & Methods

Study area and sampling points

This analytical and cross-sectional study was carried out among the staff and faculty members of nine medical universities in Iran, according to the territorial planning map. The design of the instrument to assess the safety climate was carried out in three steps. In the first stage, using the literature review and also studies on the safety climate in other organizations, with the advice of experts in the field of occupational health and safety, the primary pattern and content scope of the questionnaire were determined (3,4). Then, analysis was carried out using a focused group approach and an interview in order to ensure greater consistency and comprehensiveness of the domains as well as the maximum fit with the working environment. The analysis team included health and safety experts

and methodologists. In order to better match, the views of some people from the target community were gathered through interviews. Then the initial version of the questionnaire was prepared and reviewed according to the general principles of designing the questionnaire presented in various sources (4-7). Then, face and content validity (12 experts) of the designed questionnaire was studied. The validity of the questionnaire was assessed in four items: simplicity, relevance, clarity and necessity, and analyzed by CVI and CVR indices. Totally, considering that the number of questionnaires in the preparatory phase was 37, 315 questionnaires were distributed among the universities and sample members (faculty members, staff at the faculty and university central part and in units such as laboratories, libraries, facilities, etc.) from the university(s) selected randomly. People with one year or more work experience who were better informed about their organization's circumstances were included in the study. Meanwhile, participants had the discretion to leave the study at any stage if they did not want to continue. Reliability of the questionnaire was assessed by test-retest within one week among the subjects and the internal consistency analysis of the instrument through the Cronbach's alpha. After confirming the validity and reliability of the questionnaire, Exploratory Factor Analysis was used to investigate structural validity in R software and Confirmatory Factor Analysis using MPLUS and SmartPLS softwares and final version of the questionnaire was provided. In addition, analytical tests of T, and Mann-Whitney were used in SPSS V20. It should be noted that answers were in five-point Likert form (very agree, agree, no opinion, disagree, very disagree) and rated in 1-5. Furthermore, a demographic questionnaire including age, work experience and number of completed training courses was used.

Results

After reviewing the texts, 37 questions were obtained and examined by a panel of 12 specialists. The validity of the questionnaire showed that some of the questions are not favorable. Therefore, the questionnaire was revised and relevant questions were rewritten or modified. Subsequently, face and content validity of the re-evaluated instrument was tested and conditions were acceptable at this stage. The average agreement rate of people in relation to the simplicity the questionnaire was 0.88. The minimum agreement rate was 0.58. The average agreement rate of experts regarding necessity of questions was 0.99, while the minimum agreement rate was 0.92. The ratio of agreement in each question based on simplicity, clarity and relevance is presented in table 1. According to the obtained results from CVR and CVI, the questions will remain in the questionnaire. Then, the reliability of the questionnaire was measure by test-retest in a university within one week. Correlation coefficient within the group was equal to 0.96, indicates that the questionnaire has stability (repeatability power).

Table 1) Results of CVR and CVI indices of the corrected version of questionnaire

	Item-level Content Validity Index				$CVR_{relaxed}$	Expert mean
Question	**simplicity**	**necessity**	**clarity**	**relevance**	**necessity**	**necessity**
1	0.92	1.00	0.75	0.92	1.00	2
2	1.00	1.00	1.00	0.92	1.00	1
3	0.92	1.00	0.83	0.92	1.00	2
4	0.92	1.00	0.83	1.00	1.00	2
5	0.92	1.00	0.92	1.00	1.00	2
6	0.83	1.00	0.92	0.92	1.00	2

7	0.83	1.00	0.75	0.92	1.00	2
8	0.83	0.92	0.58	0.92	0.83	2
9	0.75	1.00	0.75	0.92	1.00	2
10	0.67	1.00	0.75	0.83	1.00	2
11	0.92	1.00	1.00	1.00	1.00	2
12	0.58	1.00	0.58	0.83	1.00	2
13	0.75	0.92	0.67	0.92	0.83	2
14	0.83	0.92	0.92	0.75	0.83	2
15	0.75	1.00	0.75	1.00	1.00	1
16	0.92	1.00	0.92	0.92	1.00	1
17	0.92	1.00	1.00	0.92	1.00	1
18	0.83	1.00	0.92	0.92	1.00	2
19	0.75	1.00	0.75	0.83	1.00	2
20	0.92	1.00	1.00	1.00	1.00	1
21	1.00	0.92	1.00	1.00	0.83	2
22	1.00	1.00	1.00	0.92	1.00	1
23	1.00	1.00	1.00	1.00	1.00	1
24	0.92	1.00	0.92	0.92	1.00	2
25	0.92	1.00	0.83	0.83	1.00	2
26	0.92	1.00	0.92	0.83	1.00	1
27	0.92	1.00	0.92	0.92	1.00	2
28	0.83	1.00	0.83	0.83	1.00	1
29	0.92	0.92	0.92	0.92	0.83	2
30	0.67	1.00	0.67	0.83	1.00	2
31	1.00	1.00	1.00	1.00	1.00	2
32	0.75	1.00	0.75	0.92	0.83	2
33	0.92	1.00	0.92	0.75	1.00	1
34	1.00	1.00	1.00	0.83	1.00	2
35	1.00	1.00	0.92	0.75	1.00	2
36	1.00	1.00	0.83	1.00	1.00	1
37	1.00	1.00	1.00	1.00	1.00	2
S-C213VI	.88	.99	.93	.89	.97	

Demographic factors

After co-ordination at different universities in the amateur areas, the participation of universities in the two regions 1 and 4 was not possible. On the other hand, the staff of the two universities in the 3rd district cooperated in the study (table 2). Finally, 265 cases out of 315 distributed questionnaires, were returned and used in analyzes. Of these, 147 people (55.5%) were male and the rest were women. Also, 204 (77%) were married. Regarding the level of education of the participants, most of them had a doctorate or higher degree (43%), while those with associate degree or less was 6.4%. Table 3 shows additional information in this regard. Respondents had mean age of 39.45(±8.19) years. Descriptive information about quantitative demographic variables is showed in table 4.

Table 2) Number and percentage of people regards studied universities (N=265)

University	Iran	Sabzevar	Zahedan	Esfahan	Qom	Shiraz	Hamedan	Kurdistan	Ardebil
Territorial part	10	9	8	7	6	5	3	3	**2**
Number	30	27	14	25	72	30	30	18	**19**
%	11.3	10.2	5.3	9.4	27.2	11.3	11.3	6.8	**7.2**

Table 3) Description of demographic variables (N=265)

Factor		Frequency	%
Marital status	Married	204	77.0
	Single	61	23.0
Education Level	Associate Degree or Lower	17	6.4
	Bachelor	64	24.2
	Master	70	26.4
	Ph.D. or higher	114	43.0
Gender	Male	147	55.5
	Female	118	44.5
Job Type	Scientific member	125	47.2
	Administrative member	140	52.8
Employment type	Definitive hiring	89	34.8
	Semi-Definitive hiring	17	6.6
	Contractual (Long form)	40	15.6
	Service commitment	64	25.0
	Contractual (Short form)	46	18.0
Location	Central part of university	12	4.6
	Faculty	209	79.8
	Laboratory	33	12.6
	Others	8	3.1
Work system	Shift work	14	5.3
	Day work	249	94.7
Occupational accident	Yes	33	12.5
	No	231	87.5

Exploratory Factor Analysis

Given that the KMO index is higher than 0.05 (0.792), it can be said that the sample size was sufficient. Also, the probability of testing the Bartlett symmetry index is 0.000, which is lower than 0.05 so, this model is not faced with the problem of linear multiplicity. The exploratory factor analysis revealed that the software extracts 9 factors for 37 questions. Some questions were in two or three factors; given their nature, matched questions fell into one category. After this stage, two questions 3 and

19, which were based on software analysis in only one factor, remained alone, and since one question for a factor could not be sufficient; these two questions were left out of the questionnaire. Seven remained factors were identified under the heading of management commitment and performance in the field of safety, training, knowledge, workplace and conditions, personnel commitment and participation in the field of safety, emergency response and emergency preparedness. Table 5 lists the questions for each factor. By deleting questions 3 and 19, the final version of the questionnaire has 35 questions with total score of 35 to 175.

Table 4) Describing quantitative demographic variables

Factor	Mean	Standard Deviation	Max.	Min.
Age	39.45	8.15	61	**23**
Work experience	11.07	8.74	31	**1**
Duration in university	10.44	8.53	31	**1**
Number of occupational accidents	0.25	0.78	5	**0**

Table 5) Questions related to each factor respect to factor load, based on the results of exploratory factor analysis

	Rotated Component Matrix[a]								
	Component								
	Workplace and conditions	Training	Personnel participation and commitment in the field of safety	Knowledge	Management commitment and performance in the field of safety	Factor 6	Emergency preparedness	Emergency response	Factor 9
q29	.816								
q31	.812								
q37	.805								
q33	.773								
q32	.755								
q28	.753								
q20	.747								
q21	.706								
q27	.693								
q25	.659								.339
q14	.648								
q24	.606								
q30	.595			-.436					
q34	.580						.319		

q6	.521						.309				.348									
q36	.508												.460							
q11			.849																	
q12			.817																	
q13			.806		.330															
q10			.477				.305						.320							
q17					.852															
q16					.844															
q18			.388		.755															
q15			.422		.647															
q5			.416				.735													
q1							.677													
q4							.655													
q8									.835											
q9									.789											
q7									.710											
q3											.859									
q2							.376				.691									
q35	.339												.686							
q26											.310		.451							
q22															.822					
q23															.760					
q19																			.845	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 12 iterations.

Confirmatory Factor Analysis

The output from exploratory factor analysis was verified by confirmatory factor analysis and was re-evaluated by WLSMV estimation method.

Convergent Validity

This kind of validity indicates that the indices of a structure how much are contributing in explaining the common variance. To assess convergent validity, two criteria are considered simultaneously: factor loading and Average Variance Extracted (AVE), Composite

Reliability (CR) can also be another criterion in this field, which is presented in table 6 for this questionnaire. Also, in the present study, the proportionality indices of Standardized Root Mean squared Residual (SRMR) and Normed Fit Index (NFI) were used and were respectively 0.926 and 0.0579, which are acceptable.

Instrument reliability

Reliability of the questionnaire was analyzed by Cronbach's Alpha and the alpha value was 0.909. The alpha for each of the seven factors is also given in table 6.

Predictive validity

With regard to the close relationship between safety and occupational accidents both in the industry (8) and in academic settings (9,10), the testing differences of safety climate score and its sub-factors between the two groups of people who have experienced and not experienced accidents in the workplace used to assess the predictive validity of the tool, which is commonplace in this field (8). After evaluating the normality of the data by Kolmogorov-Smirnov test it was depicted that only the total safety climate was normal ($P>0.05$) and its sub-scales were not normal ($P<0.05$). Therefore, independent t-test was used for total score and Mann-Whitney test was used in the remaining cases. T-test did not illustrate a significant difference between two groups ($P=0.069$). However, two factors of management commitment in the field of safety, and workplace and conditions had a significant difference ($P<0.05$).

Those who had accident experience in the work environment had a lower average score in the management commitment and performance factor (41.79 vs. 46.33). On the other hand, this group of people had a lower score on participation in the field of safety (14.53) compared to those who did no accident (15.39). In addition, although the difference in total safety score between these two groups was not significant, the safety climate among participants who did not experience accident was better (with an average of 105.82 versus 99.80).

Table 6) Factor load of questions in confirmatory factor analysis, and Cronbach's alpha

Question	Management commitment and performance in the field of safety	Knowledge	Personnel participation and commitment in the field of safety	Training	Workplace and conditions	Emergency preparedness	Emergency response
14	0.573						
20	0.648						
21	0.658						
24	0.699						
25	0.616						
27	0.589						
28	0.795						
29	0.738						
30	0.662						
31	0.761						
32	0.735						
33	0.776						
34	0.568						
36	0.426						
37	0.772						
10		0.748					
11		0.853					

12		0.825					
13		0.898					
15			0.816				
16			0.818				
17			0.834				
18			0.821				
1				0.792			
2				0.552			
4				0.861			
5				0.861			
6				0.778			
7					0.056		
8					0.882		
9					0.859		
26						0.647	
35						0.904	
22							0.889
23							0.874
AVE	0.456	0.694	0.676	0.604	0.506	0.618	0.777
CR	0.925	0.9	0.893	0.882	0.157	0.759	0.874
Alpha	0.912	0.852	0.842	0.830	0.685	0.612	0.713

Discussion

Taking into account the principles of safety in the workplace is critical to achieving the goals of the organization and its productivity growth. Organizational subcultures such as safety culture can play a major role through better involvement of personnel. A definite definition of safety culture has not been stated, but it can be considered as an organizational subculture that affects safety behavior of individuals. It is not unreasonable to consider Dominic Cooper's safety culture model for university safety. This model, presented in 2000 considers culture in three parts: employees: climate, behavior, management (11). In the case of the first element, employees' attitudes will be assessed, it is a perceptual audit that questionnaire is the most important and most used tool in this regard. The second element is employees' behavior, which is evaluated using behavioral sampling. The third component is management of the organization, which reviews the activities of organization's management. The most important of these actions are laws, guidelines, resource allocation, communication, planning and control. The evaluation of this element is externally/objective and the people evaluate the various factors objectively. Hoffmeister et al., quoted from Schneider and Richards, that organizational climate theory states that the climate derived from employees' efforts to understand their work environment so that they can estimate what types actions are supported at work (12). In a series of steps, the safety climate assessment questionnaire in universities in Iran was presented in this study. Then a trial was done and reviewed to find evidence of the initial validity of the tool. The factor analysis confirmed the seven-factor model (management commitment and performance in the field of safety, personnel participation and commitment in the field of safety, training, knowledge, workplace and conditions, emergency preparedness and emergency response).

Utilizing the tool in universities and analyzing data showed that it has a total reliability of 0.92 which is acceptable compared with 0.7, which is considered as a desirable reliability level (13). Also, its subscales were in acceptable condition.

Conclusion

The findings indicated that the questionnaire was acceptable. Since human resources are the main and vital part of organizations, recognizing the status of the organization from their point of view is important. In the area of safety, it is also necessary to have an instrument to assess its climate. This tool can help managers to plan for the future. It is worth noting that other factors and places can also be investigated in future studies.

Footnotes

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Conflict of Interest:

The authors declared no conflict of interest.

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