

Investigation of occupational fatigue and safety climate among nurses using the structural equation model

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Abstract.

BACKGROUND: Nursing is associated with many stressful situations that can lead to fatigue, reduced efficiency, and physical and mental illness. Safety climate is one of the most important indicators of safety management performance assessment that assesses employees' attitudes towards safety issues.

OBJECTIVE: The purpose of this study was to investigate the relationship between safety climate and occupational fatigue in nurses.

METHOD: This descriptive-analytical study was performed on nurses working in hospitals affiliated to Zabol University of Medical Sciences in 2019. 143 nurses were selected by the proportional sampling method and entered the study. Demographic

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questionnaires, Occupational Fatigue Inventory (SOFI), and Nurses' Safety Assessment Questionnaire were used for data collection. Statistical tests, including Independent *T*-Test, ANOVA, Mann-Whitney U, Kruskal-Wallis, and multivariate analysis of variance (MANOVA) were used to analyze the results using SPSS software version 21, and the multivariate structural equation was used for modeling.

RESULTS: The mean scores of safety climate and occupational fatigue were 67.15 ± 12.73 and 85.09 ± 41.49 , respectively. Job and demographic variables except for the second job (P -value = 0.065) had a significant effect on the variables of safety climate and occupational fatigue. There were also higher scores for occupational fatigue and all of its subscales in the group of women compared to the group of men.

CONCLUSION: The results showed that occupational and demographic variables have significant effects on safety climate and occupational fatigue. There was a significant relationship between demographic variables of age, work experience, and education level with safety climate. There was also a significant relationship between education level, job satisfaction, satisfaction with colleagues and work experience with occupational fatigue. Therefore, paying attention to fatigue and safety climate of nurses in workplaces is recommended.

Keywords: Safety culture, burn out, job satisfaction, health care

1. Introduction

One of the most important areas of sustainable health development in human societies is the health care sector, which has the vital task of maintaining and restoring health to the human community. Nurses are one of the largest health care providers in the hospital wards, and patients have more contact with nurses than other caregivers, so the failure of this group due to their important role in improving patients will lead to Irreversible consequences [1].

1.1. Fatigue

According to research on occupational accidents, the nursing staff is the first working group with the highest occupational stress and risk [2]. In the meantime, fatigue has been addressed in terms of the effects that can have on performance and health [3]. Fatigue is an unpleasant mental feeling that forms the spectrum from weakness to burnout and interferes with the ability to play a role and a personal activity. This is a general, multi-causal, multidimensional concept that everyone experiences. Fatigue, despite having different mental, behavioral, and physiological manifestations, has no clear definition [4, 5]. Fatigue can reduce the ability to process hazardous information, can diminish the ability to respond to hazardous conditions, and can increase the incidence of human error [6–8]. Fatigue has a multidimensional structure that includes the physical dimension (lack of energy and need to rest), the cognitive dimension (deficits in mindfulness and attention), and the

emotional dimension (decreasing the motivation or interest) [1, 9]. There are a variety of causes of fatigue, including lack of sleep or inappropriate sleep, long working hours, working in hours with low consciousness (e.g., early morning hours) [10]. In 2010, the Canadian Nurses Association and the Ontario Nurses Association found that nurses experience significant levels of fatigue that act as a major negative factor in nursing occupation, decision making, creativity, and problem-solving ability, all of which are essential aspects of safe patient care in the health care system [11]. Therefore, in order to increase the efficiency and effectiveness of health organizations, paying particular attention to the needs of nurses, and providing their mental and physical health is of particular importance [12].

1.2. Work safety climate

Only managers that have created the appropriate psychological atmosphere (organizational climate) within the organization can provide the possibility for high-level needs of supervised employees in the field [13]. The organizational climate is a multidimensional structure that encompasses a wide range of individual evaluations of the workplace. The safety climate is a special form of organizational climate that describes people's perceptions of safety values in the workplace [14, 15]. Initially, Zohar studied the safety climate in various industrial organizations and identified 8 dimensions for it, such as management's attitude toward safety, the effects of implementing safety guidelines on promotion, work pressure, social

status of individuals, safety compliance by the safety officer, the status of the safety committee, the importance of safety training and the risks involved in the workplace [14, 16]. A safety climate is a subset of the safety culture and is actually a manifestation of the safety culture in practice [17, 18]. The safety climate is a psychological phenomenon that examines employees' attitudes to safety in a cross-sectional manner and is relatively unstable and subject to changes in the components of the current environment or conditions. Whereas the safety culture analyzes the common values of the entire organization or deals with formal organizational safety discussions [19]. Statistics show that more than 300,000 deaths are annually caused by work-related deaths worldwide and occupational injuries are also the cause of many disabilities [20]. The importance of the safety climate is related to its ability to predict safe behavior [21, 22]. Studies have clarified that there is a significant relationship between safety climate and predictions of workplace injuries, so the higher the safety climate, the lower the accident rate [23]. In recent years, the use of preventive indicators such as safety climate and observation of behaviors that emphasize current safety activities have been considered along with reactive indicators such as incident indicators, and the combination of these two preventive and reactive approaches have been able to help organizations to better understand the effects of implemented safety programs. Considering the role of fatigue and its consequences (such as job burnout, increased medication errors, decreased quality of nursing care) and due to the importance of awareness of safety climate in workplaces and limited safety climate studies related to therapeutic settings of the country, this study aimed to investigate the relationship between occupational fatigue and safety climate in hospital nurses at the Zabol University of Medical Sciences.

2. Methods

2.1. Participants

The study population consisted of nurses working in hospitals affiliated to Zabol University of Medical Sciences. The proportional sampling method was used in this study. Thus, after the determination of the number of questionnaires allocated to each hospital, the determined number of questionnaires (out of the total number of 143) was assigned to that hospital. In other words, given the total number of nurses in

each hospital (as the weight of that hospital), a portion of the mentioned number was allocated to that hospital. Trained individuals completed questionnaires through interviewing nurses.

2.2. Measurements

This cross-sectional study was carried out in Zabol Hospitals in 2019. Determination of safety climate was carried out using the Nurses Safety Climate Assessment Questionnaire, and occupational fatigue was measured by Occupational Fatigue Inventory (SOFI) [24] (questionnaires are provided in the Appendix). Accordingly, data were collected from people who were willing to participate in the study and who had completed the consent form. Having at least a bachelor's or upper degree in nursing was considered as the inclusion criterion, and individuals could leave the study if they did not wish to cooperate.

A three-part questionnaire was used for data collection. The first part of the questionnaire included demographic and occupational characteristics (e.g. age, gender, shift work).

Nurses' safety climate: The Nurses Safety Climate Assessment Questionnaire was used to assess nurses' safety climate. This 22-item questionnaire examined 6 factors of nurse's safety climate including cumulative burnout (5 questions), training (5 questions), communication with physicians (3 questions), communication with nurses (3 questions), supervisor's attitude (3 questions), and reporting errors and mistakes (3 questions). The responses of the questions were designed based on a 5-point Likert scale (score of 1 for strongly disagree, score of 2 for disagree, score of 3 for neither agree nor disagree, score of 4 for agree, and score of 5 for strongly agree). The mean of the responses of the questions for each factor is considered as the score of that factor, and according to the scale used, the score of each factor is in the range of 1 to 5. Given all the positive aspects of the questionnaire, higher safety climate scores indicated better safety status. In addition, the validity and reliability index of this questionnaire is approved.

Swedish Occupational Fatigue Inventory (SOFI): The SOFI questionnaire is a multidimensional tool for measuring the quality and severity of perceived acute fatigue. This questionnaire has an 11-item Likert scale (0 = not at all, 10 = very high agreement) and has five dimensions including lack of energy, physical effort, physical discomfort, lack of motivation, and drowsiness; each of these dimensions consisted of 4 questions, and the scores of each dimension were

Table 1
Descriptive statistics of occupational fatigue and safety climate in hospital nurses

Variable	Subscale	Mean	Standard deviation	Min	Max
Fatigue	Occupational fatigue	85.09	41.49	14.00	200.00
	Lack of energy	20.17	9.65	2.00	40.00
	Physical effort	13.57	9.24	0.00	40.00
	Physical discomfort	15.73	9.97	0.00	40.00
	Lack of motivation	16.87	9.09	0.00	40.00
Safety climate	Drowsiness	18.96	9.37	3.00	40.00
	Safety climate	67.15	12.73	35.00	96.00
	Cumulative burnout	13.47	4.40	5.00	25.00
	Nursing education	15.07	4.54	5.00	25.00
	Communication with physician	8.76	2.54	3.00	15.00
	communication with nurses	9.79	2.83	3.00	15.00
	Supervisors attitude	9.73	2.59	4.00	15.00
	Reporting	10.31	2.39	4.00	15.00

between 0 and 40. Total occupational fatigue also ranged from 0 to 200, and the higher scores of occupational fatigue and its dimensions indicate a higher level of occupational fatigue. The SOFI questionnaire has been studied in several surveys on different occupations and has been identified as a reliable tool [18].

2.3. Structural equation model

Structural equation model was used to test the hypotheses presented in this study. SEM is a robust causal modeling method that simultaneously estimates multiple and related dependencies between variables. SEM was used to investigate the relationship between safety climate and occupational fatigue in nurses. Multivariate linear regression was used to examine the factors related to occupational and demographic variables. Multiple correlation coefficient (R²) was used to evaluate the predictive power of the model.

2.4. Statistical analysis

After data collection, data were entered into Spss software version 21. Then the normality of the data was checked. The analysis of results was carried out by parametric tests (such as two-sample *t*-test and analysis of variance) or nonparametric tests (such as Mann-Whitney U and Kruskal-Wallis). Central inclination and dispersion indices were used to describe the data. Analyzes were performed at a confidence level of 95%.

3. Results

In the present study, out of the 143 participants, 57.3% were women, and 42.7% were men. The mean age was 30.75 ± 6.77 . The lowest work experience was 12 months, and the highest was 360 months; the average work experience was 50.39 ± 62.39 months. 89.51% of the subjects had a bachelor's degree, and 10.49% had a master's degree. 67.1% were single, and 32.9% were married. Individual shifts consisted of the morning (21%), evening (16.8%), night (7.7%), and rotating shift (54.5%). Statistical indices related to occupational fatigue and safety climate of participants as continuous variables were follows:

According to Table 1, the lowest score for the occupational fatigue score was 14, and the highest score was 200. The average occupational fatigue score was 85.09 ± 41.49 . The lowest value for the safety climate score was 35 and the highest score was 96. The average safety climate score was 67.75 ± 12.73 . The following results were obtained to test the effect of occupational and demographic characteristics on the dependent variable, namely, safety climate, using multiple linear regression.

The results of the regression of occupational and demographic characteristics on the dependent variable, namely safety climate, showed that the above variables could justify about 95% of the response variable, i.e., safety climate (Table 2). In order to test the effect of occupational and demographic characteristics on the dependent variable, namely occupational fatigue, multiple linear regression, was used.

The results of the regression of occupational and demographic characteristics on the dependent variable (Table 3), i.e., occupational fatigue showed that

Table 2

Multivariate regression of occupational and demographic characteristics and safety climate variable in hospital nurses

Independent variable	Coefficients of the model			t statistics	P-value	R ²
	Regression coefficient (B)	Standard deviation error	Standardized regression coefficient (β)			
Gender	3.93	2.54	0.087	1.55	0.123	0.95
Marital status	3.02	3.26	0.062	0.927	0.355	
Level of education	11.53	4.17	0.201	2.77	0.006	
Working shifts	0.47	1.07	0.022	0.44	0.663	
Job satisfaction	5.60	2.92	0.114	1.92	0.057	
Satisfaction with colleagues	0.19	2.93	0.004	0.065	0.948	
Second job	2.28	3.28	0.062	0.69	0.489	
Age	1.16	0.26	0.535	4.48	<0.001	
Work experience	-0.1	0.031	-0.118	-3.25	0.001	

Table 3

Regression test of occupational and demographic characteristics and occupational fatigue variable in hospital nurses

Independent variable	Coefficients of the model			t statistics	P-value	R ²
	Regression coefficient (B)	Standard deviation error	Standardized regression coefficient (β)			
Gender	21.82	5.94	0.348	3.68	0.001<	0.87
Marital status	5.01	7.62	0.075	0.658	0.512	
Level of education	-20.45	9.74	-0.258	-2.09	0.038	
Working shifts	-4.49	2.5	-0.15	-1.79	0.075	
Job satisfaction	-14.08	6.84	-0.208	-2.06	0.041	
Satisfaction with colleagues	-13.82	6.85	-0.199	-2.02	0.046	
Second job	14.07	7.68	0.28	1.83	0.069	
Age	0.247	0.61	0.082	0.41	0.684	
Work experience	0.279	0.07	0.236	3.84	0.001<	

the above variables could justify about 87% of the variance of the response variable, namely occupational fatigue. It is noteworthy that the effect of gender on occupational fatigue was about 0.35, which means that, by keeping constant other variables, if gender increases one unit occupational fatigue shows a 35% decrease, in other words, women experience occupational fatigue more than 35%. Also, because the P-value is less than 0.05, there is a significant relationship between gender and occupational fatigue. The effect of education level variable on occupational fatigue was about -0.26, which means that by keeping constant the other variables, if the level of education increases one unit, the occupational fatigue rate will decrease by 26%, in other words, because the P-value is less than 0.05, there is a significant relationship between education level and occupational fatigue. Moreover, the effect of the job satisfaction variable on occupational fatigue was about -0.208, which means that by keeping constant the other variables, if job satisfaction increases one unit, the occupational fatigue rate would decrease by 20.8%.

In addition, the effect of satisfaction with colleagues variable on occupational fatigue was about -0.199, which means that by keeping constant other variables, one unit increase in satisfaction with colleagues leads to decrease occupational fatigue by 19.9%. Finally, the effect of the work experience variable on occupational fatigue was about 0.236, which means that by keeping constant the other variables, one unit increase in work experience increases the occupational fatigue by 23.6%. In general, there is a significant relationship between gender, education level, job satisfaction, satisfaction with colleagues, and work experience with occupational fatigue because the p-value is less than 0.05. Also, there is a significant relationship between education level, age, and work experience with safety climate because the p-value is less than 0.05. The results of the research hypotheses are summarized in the following model. In Fig. 1, black lines indicate a significant relationship between the two variables, and red lines indicate that the relationship between the two variables is not significant.

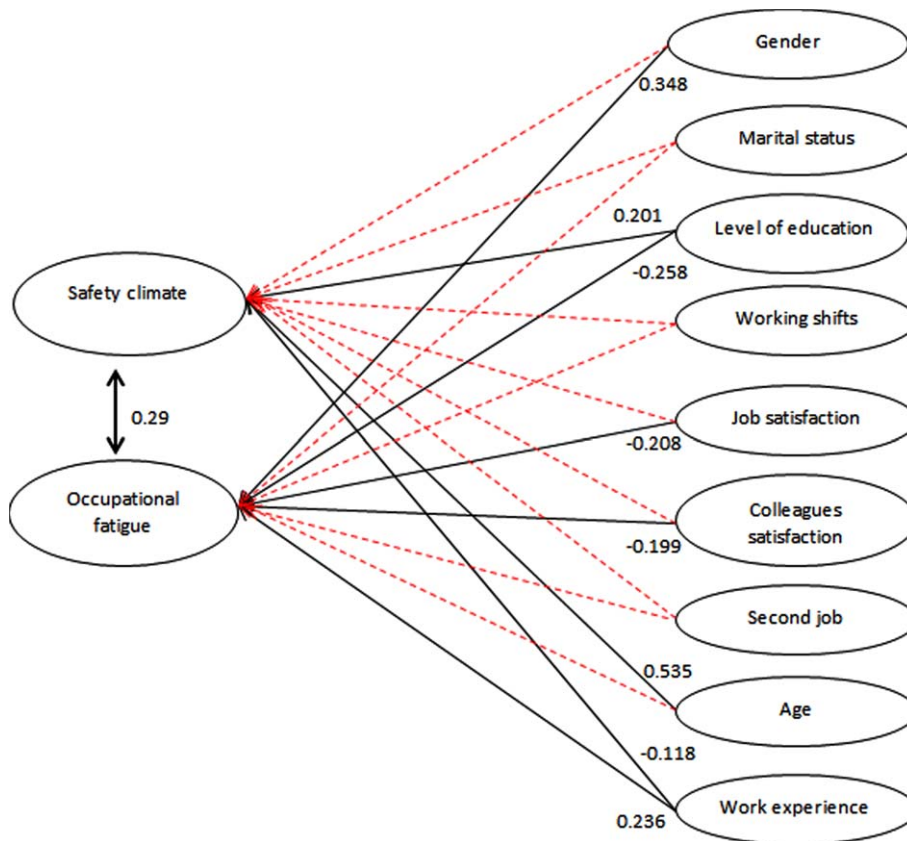


Fig. 1. Relationship between safety climate variables and occupational fatigue among nurses. The black lines indicate a significant relationship between the two variables and the red lines indicate that there is no significant relationship between the two variables.

4. Discussion

The purpose of this study was to investigate the relationship between occupational fatigue and safety Climate in nurses. The results showed that the mean scores of occupational fatigue and safety climate were 85.09 ± 41.49 and 67.15 ± 12.73 , respectively. The results showed that there was a significant relationship between education level and safety climate so that those with higher education felt a higher safety climate, which is in line with the results of Yeung et al. [25]. The reason for this similarity is that the participants in the present study had a bachelor's degree and higher. In the study by Haj Aghazadeh, the study population consisted of workers of one of the ports which were not highly educated. Therefore, there was not a strong relationship between safety climate and education level. It can also be stated that people with higher education have a better understanding of safety, and they better follow the policies of the organization and are more aware of the safety climate and its effects. The results of our study showed

that there was no statistically significant difference between gender and safety climate, which was consistent with Kho et al. [26]. But our results were not in line with Wu et al. [27], which can be partly attributed to the gender distribution of the participants. In a study conducted by Basha et al. [28], no significant relationship was found between safety climate and age groups, which was inconsistent with the results of the present study. However, Vinodkumar et al. [29] found an effective relationship between age and dimensions of safety climate, which was consistent with the present study; this could indicate that, by increasing age, people work more cautiously in the hospital and their social and occupational experiences increase, and their risk-taking levels decrease. The results of our study showed that there was no significant relationship between marital status and safety climate, which was in agreement with the results of Mohammadi Zeidi; this indicates that one's marital status does not influence his/her safety climate in the workplace. The results also showed that there is a significant relationship between job satisfaction and

safety climate, which is consistent with the study by Lee et al. [30]. To rationalize this result, it can be expressed that the individual with higher job satisfaction usually feel more safety in their job because these individuals have a more stable employment status than their colleagues, receive more salary and benefits, have better organizational positions, and have a higher education level and their physical activity, workload, and shifts are less. In the studies conducted by Haj Aghazadeh, Mohammadi Zeidi, Sarsangi and Raftopoulos, no significant relationship was observed between safety climate and work experience, which was not in line with the results of the present study. This difference should be sought in the statistical population under study and the type of organization in which employees were employed; so that, in the study conducted by Haj Aghazadeh, 83% of the studied population had less than ten years of experience. Also, his research population was workers, and their low experience and lack of safety training courses for all individuals could lead to a lack of difference in safety climate scores among the work experience groups.

The results of the evaluation of safety climate factors showed that the training factor among nurses had the highest value, which indicates that education is one of the most critical factors influencing safety climate and has been widely and extensively studied by other researchers [31]. On the importance of staff training, it should be stated that trained staff will respond to organizational change as well as community change, compared to employees who do not benefit from this index and will play a more effective and efficient role in organizations. On the other hand, by increasing the levels of information, knowledge, skills, and capabilities of staff, they will be more prepared and equipped to carry out their duties and accept heavier responsibilities. But, in the study by Sarsangi et al. [32], the communication between nurses had the highest score, which the difference in factors can be due to the different working conditions in the hospital; so that, in some hospitals, there is usually an intimate atmosphere among nurses, and they talk about all the issues and problems of work together.

The lowest rank, among the factors of safety climate, was related to communication with physicians, which was not in line with the study by Sarsangi [32]. To justify this, it should be noted that good and close communication is not existed between nurses and doctors in the hospitals studied. It should also be noted that, in these studies, reporting among

nurses was introduced as the least factor, which seems that, in the hospitals under study, there is no well-established system for recording and reporting errors that could cause injury to nurses or patients.

The results of the present study showed that 85.09% of nurses reported occupational fatigue while Saki et al. [33] observed 47.61% occupational fatigue in nurses and Saremi et al. [7] reported 59% occupational fatigue in nurses; based on these results, the occupational fatigue in the present study was higher than the mentioned studies, which seems to be due to long-term dealing with patients, different work divisions, long-term shift work, prolonged physical activity, more stress and anxiety, Low number of personnel needed in hospital wards, and these can be the reasons for the high level of occupational fatigue in nurses in this study compared to other studies.

In the following, the results related to the relationship between occupational fatigue and each of the study variables are presented separately based on the results of Tables and Fig. 1. The results showed that there was a significant relationship between occupational fatigue and educational level, which was consistent with the findings of the study by Choobineh et al. [34]. While a high prevalence of fatigue was reported in a study conducted by Azad et al., for justification of this difference, it can be said that the study population was steel industry workers who were different from our study population in terms of education. The level of education of the nurses studied in this study was the bachelor's and master's degrees. The nurses with higher education levels generally have less work shift, have less workload, and they are mostly working in occupations requiring less physical activity. Thus, their occupational fatigue is lower compared to their lower-educated colleagues.

Nurses with higher levels of education have fewer work shifts and workloads and are more likely to work in jobs that require less physical activity, so their occupational fatigue is lower than their lower-educated colleagues. Bultmann et al. [35] reported that the possibility of a perception of fatigue in people who do not have a university education is more significant.

The findings also showed a significant relationship between occupational fatigue and job satisfaction. Usually, people who are satisfied about their job have a good job based on their knowledge, skills, experience, interest, and personal ability; these individuals are also highly motivated to work. On the other hand, these staffs usually have higher occupational levels

and do less physical activity. Therefore, fatigue is lower in these individuals.

The findings of our study showed that there was a significant relationship between work experience and occupational fatigue, which was consistent with the study conducted by Habibi et al. [36]. This relationship indicates that staff with more work experience are naturally older and do not have enough mobility and energy to perform physical activity, so their occupational fatigue is higher compared to their colleagues who have less work experience.

Habibi et al. [36] showed that the level of occupational fatigue was significantly related to gender, so that the rate of occupational fatigue was higher in men than women, which is consistent with the present study in terms of the meaningfulness of occupational fatigue and gender. However, in the present study, occupational fatigue in women was higher than in men which one of the reasons is the higher number of women participating in the study compared to men. It should also be noted that working women, in addition to working in the hospital, should be involved in housekeeping at home, which will double their occupational fatigue.

The results showed that there is no significant relationship between age and occupational fatigue, which is thought that older people have higher job satisfaction and better morale to their job and that socioeconomic factors have a more significant impact on young people in society, and they find themselves under pressure. Akerstedt et al. [37] stated that workloads are likely to be higher in younger staff, and on the other hand, older staff can choose jobs with less fatigue. The results of the evaluation of occupational fatigue factors showed that, among the nurses, the lack of energy had the highest values, and the physical effort factor had the lowest values, indicating the importance of energy in the nurses' occupational fatigue.

4.1. Limitations of this study

Since the present study was a cross-sectional study, the researcher is always concerned about losing exposure to research samples that could lead to a decrease in the statistical power of the study. In addition, because the study population was nurses of hospitals affiliated to Zabol University of Medical Sciences, so its generalizability to other hospitals in the country should be done cautiously.

5. Conclusion

The results of this study showed that demographic variables such as education level, age, and work experience had a significant effect on safety climate, and education level, job satisfaction, satisfaction with colleagues, and work experience had a remarkable effect on occupational fatigue. Individual factors, such as age, gender, work experience, education level, and safety climate, also seem to be influential.

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Conflict of interest

There are no conflicts of interest.

Ethics approval

Ethical approval for this study was obtained from the Zabol University of Medical Sciences (IR.ZBMU.REC.1398.153). It should be noted that the information of the individuals was kept confidential by the researcher and an anonymous and coded questionnaire was used.

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Appendix A: Nurses Safety Climate Assessment Questionnaire

The answers to the questions are based on a 5-point Likert scale (number 1 for strongly disagree, number 2 for disagree, number 3 for neither agree nor disagree, number 4 for agree, and number 5 for strongly agree) Average answers to questions related to each factor The factor is considered as the score.

Questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					

The questionnaires used in this study were in Persian. The validity and reliability of each of them have been confirmed.

Appendix B: Occupational Fatigue Inventory (SOFI)

Think of how it felt when you were most tired. To what extent do the expressions below describe how you felt? For every expression, answer spontaneously, and mark the number that corresponds to how you feel right now. The numbers vary between 0 (not at all) and 6 (to a very high degree).

	Not at all						To a very high degree
Palpitations	0	1	2	3	4	5	6
Lack of concern	0	1	2	3	4	5	6
Worn out	0	1	2	3	4	5	6
Tense muscles	0	1	2	3	4	5	6
Falling asleep	0	1	2	3	4	5	6
Numbness	0	1	2	3	4	5	6
Sweaty	0	1	2	3	4	5	6
Spent	0	1	2	3	4	5	6
Drowsy	0	1	2	3	4	5	6
Passive	0	1	2	3	4	5	6
Stiff joints	0	1	2	3	4	5	6
Indifferent	0	1	2	3	4	5	6
Out of breath	0	1	2	3	4	5	6
Yawning	0	1	2	3	4	5	6
Drained	0	1	2	3	4	5	6
Sleepy	0	1	2	3	4	5	6
Overworked	0	1	2	3	4	5	6
Aching	0	1	2	3	4	5	6
Breathing heavily	0	1	2	3	4	5	6
Uninterested	0	1	2	3	4	5	6

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