Original Article

Understanding the Role of Job Stress in Safety Climate in a Dairy Industry using Structural Equation Modeling

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Abstract

***Background and purpose*:** The safety climate refers to employees' perception of safety which can be affected by job-related stress in the workplace. This study aimed to assess the safety climate and investigate the relationship between job stress factors and safety climate dimensions in a dairy industry.

***Materials and Methods*:** This was a cross-sectional study. The data was collected using two self-report questionnaires including the Nordic Safety Climate Questionnaire (NOSACQ-50) and the Health and Safety Executive (HSE) indicator tool. After removing the incomplete questionnaires, 164 questionnaires were selected for statistical analysis. Structural Equation Modeling (SEM) was used to investigate the association of the study variables.

***Results*:** Most job stress factors and all were correlated to the safety climate dimensions. The highest correlation was detected between job stress factors and dimension of management safety priority, commitment, and competence. Among job stress factors, role (r=0.522, P<0.001) and managerial support (r=0.452, P<0.001) had the highest relationship with this dimension. SEM showed job stress had a significant effect on safety climate (B = 0.52, P < 0.001).

***Conclusion*:** The job stress dimensions could be effective in the safety climate. Besides, management and peer support as well as high job demands could decrease stress. Thus, improvement of job stress could promote employees' safety behaviors and improve their perception of the organization's safety management system.

***Keywords*:** Dairy Industry; Job Stress; Safety Climate; Structural Equation Modeling
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1. *Introduction*

Job accidents and unsafe behaviors result in a considerable number of deaths and injuries at the workplaces, causing employers to suffer from significant losses (1, 2). According to the International Labor Organization (ILO), 13.7% of work-related deaths result from occupational accidents (3). The industrial safety literature has indicated safety climate as a valuable concept related to the minimization of unsafe behaviors and the occurrence of occupational accidents in the workplace (4, 5). Zohar defined safety climate as "a summary of molar perceptions that employees share about their work environments" (6). In other words, safety climate shows the extent to which employees behave in accordance with safety principles (7). Neal and Griffin argued that managers' attention to the well-being of employees (the results of the social exchange theory) and individuals' motivation for following safety instructions (the results of the expectancy-valence theory) could explain the relationship between safety climate and safety behavior. Due to the relationship between safety climate and safety behavior, the detriments variables of safety behavior can affect the safety climate and occupational accidents. Job stress is defined as an imbalance between job demands and human resources that can have consequences for managers, employees and organizations (8). The scientific literature has mentioned a wide range of job stress factors, such as job control, conflict at work, mental demand, physical environment, social support, and workload (9, 10). In general, studies have listed two types of stress: physical stress and psychological stress. Physical stress is explained as physiological responses, such as hormone secretion, which can result in insomnia and headaches. Psychological stress refers to a severe trauma that can cause discomfort or anger (11, 12). Many studies have suggested the association of job stress with health outcomes including musculoskeletal disorders, mental well-being, burnout, depression, and dissatisfaction (13-16).

Evidence has confirmed the effect of job stress on safety climate and safe behavior as the consequence of safety climate (17-19). Goldenhar et al. showed that job stress affected 37% of occupational accidents and injuries (20). Leung et al. proposed a model for expressing the effect of job stress on accidents through safety behaviors. The findings of their study showed that job stress was involved in the occurrence of unsafe behaviors by reducing concentration, decision making power, distraction, and memory impairment. These changes can affect employees' perceptions of their regulations and environment, which is known as a safety climate (21).

Dairy industries operators encounter with a high level of job demand the consequences of which are reflected as unsafe behaviors. The production process of dairy products is very vulnerable to pollution, and therefore employees must implement a high level of preventive measures that can be considered as a job demand. In addition, the process as a long production chain with mechanical machines has created a risky environment. This study aimed to assess the safety climate and investigate the relationship between multiple job stress factors and safety climate dimensions in a dairy industry.

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2. *Materials and Methods*

This was a cross-sectional study conducted among the employees of a dairy production complex in Iran with at least one year of working experience (n = 231). The data collection procedure was carried out from February to June 2021. In the first step, a workshop was held to explain the goals and used tools. Then, anonymous questionnaires were distributed to gather data. A total of 185 individuals agreed to participate in the study. After reviewing the questionnaires and removing the one with missing information, 164 questionnaires were selected for statistical analysis. The Scientific and Medical Ethics Committee of Shiraz University of Medical Sciences approved the ethical standards of the study (IR.SUMS.REC.1399.248).

A demographic questionnaire was developed by the researchers to collect the participants' characteristics including questions on age, gender, marital status, education level, job experience, and status of shift work.

To measure job stress factors, the Persian version of stress indicator tool developed by the Health and Safety Executive (HSE) Management of the United Kingdom was used. This questionnaire consists of limited items and include multiple job-related stress factors. Also, the results of the studied psychometrics suggested that this instrument robustly measured job stress. This tool contained 35 questions divided into seven dimensions of demands, control, managerial support, peer support, relationships, role, and changes (22). A five-point Likert scale (never, seldom, sometimes, often, or always) was also used for scoring system. The psychometric properties of the Persian version of the questionnaire were verified by Azad Marzabadi and Gholami Fesharaki. The reliability of the questionnaire was found to be 0.78 and 0.65 using the Cronbach's Alpha and split-half method, respectively (23).

The Nordic Safety Climate Questionnaire (NOSACQ-50) was designed by a team of researchers from the Nordic occupational safety based on the safety climate theory, psychological theory, previous experimental studies, and experimental results obtained through international studies. This questionnaire consisted of 50 questions divided into seven dimensions; i.e., 1) Management Safety Priority, Commitment, and Competence (MSPCC), 2) Management Safety Empowerment (MSE), 3) Management Safety Justice as well as Shared Perceptions (MSJ), 4) Workers' Safety Commitment (WSC), 5) Workers' Safety Priority and Risk Non-Acceptance (WSPRNA), 6) Safety Communication, Learning, and Trust in Co-workers' Safety Competence (SCLTSC), and 7) Workers' Trust in the Efficacy of the Safety Systems (WTESS). The scoring system was a four-point Likert scale (strongly disagree, disagree, agree, and strongly agree) (24). NOSACQ-50 has been found to be a valid tool for measuring the safety climate, predicting the safety motivation, and perceiving the safety level. The validity of the instrument was determined by detecting significant differences in safety climate at different organizational levels (25). The reliability and validity of the Persian version of NOSACQ-50 was approved by Yousefi et al. The Cronbach's alpha coefficient for all items of the questionnaire was 0.94 (26).

The SPSS and AMOS 21 were used for data analysis and Structural Equation Modeling (SEM), respectively. Descriptive statistics were used to compare the

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demographic data. Pearson's correlation coefficient was also employed to determine the correlation between the scores of safety climate and job stress dimensions. In this study, a model was defined as the relationship between job stress and safety climate, and SEM was used to assess this model. SEM is known as the analysis of covariance structure, latent variable analysis, Confirmatory Factor Analysis (CFA), and linear structural relations (27). In SEM, model fit is assessed using a series of fit indices. In the present study, Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and chi-square/degree of freedom ratio (χ^2/df) together with its 90% Confidence Interval (CI) were used to measure the final model fit. Considering RMSEA, values less than 0.05, less than 0.08, and greater than 0.1 are considered close, reasonable, and poor fits, respectively (28). Moreover, CFI values more than 0.9 are considered reasonable (29). Finally, χ^2/ df ratios more than 2 are considered acceptable (30).

3. *Results*

Most of the participants aged 30-39 years and had worked for 6-10 years (86.5%). In terms of education level, the participants were properly distributed in the sample. Additionally, most of them were shift workers in two 12-hour shifts or three 8-hour shifts (morning, evening, and night). The majority of the participants also had to work for extra hours due to the high workload. Among the participants, 47% of the employees reported work-related injuries in the past two years. Other demographic and job-related factors are presented in Table 1.

Table 1. Socio-demographic characteristics of the participants

Characteristics	n	%
Gender		
Male	121	73.8
Female	43	26.2
Marital status		
Single	24	14.6
Married	140	85.4
Education level		
Elementary	28	17.1
High school	33	20.1
Diploma	64	39.0
University degree	39	23.8
Work schedule		
Day work	16	9.8
Two shifts	6	3.7
Three shifts	142	86.6
Overtime		
Yes	101	61.6
No	63	38.4
Job accident		
Yes	47	28.7
No	117	71.3

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Descriptive data associated with stress factors are also shown in Table 2. Accordingly, role and relationships factors had the highest scores in the study population. The mean score of the items for this scale was calculated to be 3.26 out of 5. According to the results of the internal correlation analysis, peer support and managerial support had the highest correlation coefficients. Additionally, the role and demand dimensions had the highest correlations with the safety climate. The results also revealed a significant relationship between the factors of the HSE indicator tool.

Table 2. Mean, standard deviation, and Pearson's correlation coefficients between the factors of the HSE indicator tool

Factors	Mean	SD	1	2	3	4	5	6	7
Demands	2.31	0.49	-						
Control	3.21	0.47	0.178*	-					
Managerial support	3.66	0.46	0.332**	0.201**	-				
Peer support	3.92	0.50	0.274**	0.152	0.712**	-			
Relationships	4.59	0.44	0.542**	0.092	0.379**	0.275**	-		
Role	4.02	0.66	0.575**	0.043	0.566**	0.454**	0.492**	-	
Change	3.69	0.60	0.023	0.563**	0.320**	0.398**	0.072	0.100	-

*** Correlation is significant at p<0.05.**
**** Correlation is significant at P <0.001**

The descriptive and correlation analysis of the safety climate dimensions are presented in Table 3. Accordingly, MSE and MSPCC showed the highest correlation with other safety climate dimensions. The results also indicated a positive association between various dimensions of the safety climate scale. Based on descriptive analyses, WSPRNA and WTESS had the highest scores. The mean score of safety climate was 3.25 out of 5.

Table 3. Mean, standard deviation, and Pearson's correlation coefficients between the NOSCAQ-50 dimensions

	Mean	**SD**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. MSPCC	3.15	0.35	-						
2. MSE	3.27	0.37	0.560**	-					
3. MSJ	3.19	0.36	0.293**	0.537**	-				
4. WSC	3.52	0.43	0.401**	0.514**	0.509**	-			
5. WSPRNA	2.83	0.36	0.249**	0.262**	0.222**	0.301**	-		
6. SCLTSC	3.31	0.34	0.266**	0.343**	0.319**	0.371**	0.196**	-	
7. WTESS	3.53	0.35	0.459**	0.453**	0.241**	0.385**	0.284**	0.301**	-

* Correlation is significant at p<0.05; ** Correlation is significant at p<0.05; MSPCC: Management Safety Priority, Commitment, and Competence; MSE: Management Safety Empowerment; MSJ: Management Safety Justice; WSC: Workers' Safety Commitment; WSPRNA: Workers' Safety Priority and Risk Non-Acceptance; SCLTSC: Safety Communication, Learning, and Trust in Co-workers' Safety Competence; WTESS: Workers' Trust in the Efficacy of the Safety Systems.

The correlations between the dimensions of safety climate and stress-related variables are shown in Table 4. The highest correlation was detected between job-related stress and MSPCC. There was also a significant correlation between the

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HSE indicator tool factors and NOSACQ-50. Moreover, roles and managerial support had the highest loading factors. WSPRNA and SCLTSC were at an acceptable level and MSPCC, MSE, MSJ, WSC, and WTESS were at a favorable level. Overall, the results suggested the good status of the organization's safety climate (mean = 3.25).

Table 4. The correlation between the stress-related factors and safety climate dimensions

	MSPCC	MSE	MSJ	WSC	WSPRNA	ACLTSC	WTESS
Demands	-0.372**	-0.210**	0.045	-0.015	-0.174*	-0.103	-0.148
Control	0.102	0.241**	0.267**	0.335	0.016	0.271**	0.258**
Managerial support	0.452**	0.275**	0.221**	0.310	0.325**	0.200*	0.393**
Peer support	0.253**	0.253**	0.267**	0.298	0.343**	0.120	0.291**
Relationships	0.348**	0.224**	0.107	0.119	0.171*	0.224**	0.233**
Role	0.522**	0.258**	0.148	0.252**	0.289**	0.254**	0.335**
Change	0.146	0.186*	0.162*	0.299**	0.180*	0.180*	0.295**

*Correlation is significant at p<0.01; ** Correlation is significant at p<0.05; MSPCC: Management Safety Priority, Commitment, and Competence; MSE: Management Safety Empowerment; MSJ: Management Safety Justice; WSC: Workers' Safety Commitment; WSPRNA: Workers' Safety Priority and Risk Non-Acceptance; SCLTSC: Safety Communication, Learning, and Trust in Co-workers' Safety Competence; WTESS: Workers' Trust in the Efficacy of the Safety Systems.

SEM showed job stress had a significant effect on safety climate (B=0.52, P<0.001). The results of the good-of-fit indices of final model are reported in Table 5.

The loading factors of the safety climate factors and job stress dimensions have been depicted in Figure 1.

Table 5. Acceptable and results values of model fit indices

Indices	χ^2/df	CFI	RMSEA
Acceptable values	> 2	> 0.9	< 0.05
Results	1.78	0.93	0.07

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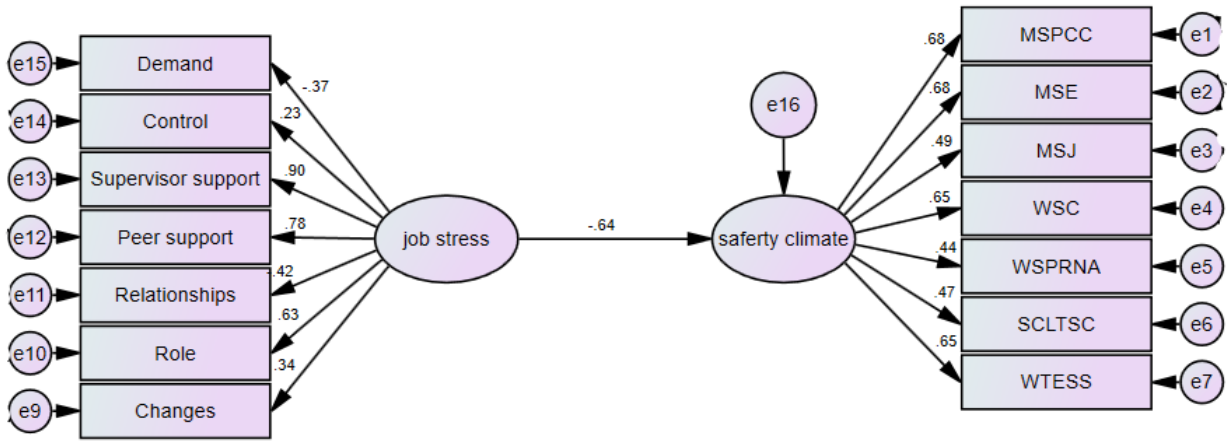

Figure 1. The results of estimation of the study model

MSPCC: Management Safety Priority, Commitment, and Competence; MSE: Management Safety Empowerment; MSJ: Management Safety Justice; WSC: Workers' Safety Commitment; WSPRNA: Workers' Safety Priority and Risk Non-Acceptance; SCLTSC: Safety Communication, Learning, and Trust in Co-workers' Safety Competence; WTESS: Workers' Trust in the Efficacy of the Safety Systems.

4. *Discussion*

The current study aimed to assess the safety climate and investigate the relationship between multiple job stress factors and safety climate dimensions in a dairy industry. The findings showed that this relationship was statistically significant and the structural model was also confirmed. Previous studies demonstrated that job-related stress could harm people's behavioral patterns and increase the likelihood of accidents. In doing so, a theoretical model was developed for the role of job stress in the safety climate among the employees and workers in a dairy production plant. The results revealed the good status of job stress (mean = 3.62). Among the dimensions of job-related stress, relationships and roles received the highest score, which conformed to the research performed by Gharibi et al. to evaluate job stress amongst Iranian workers (31). The scores of managers' and supervisors' support were also at a high level. Studies have emphasized that a high level of managerial support could affect job satisfaction, turnover, and job fatigue (32-35). In the HSE indicator tool, demands, relationships, and change had acceptable loading factors and managerial and peer support had favorable loading factors. These effective factors in stress played a crucial role in the assessment of job stress. In this context, demand covered such features as workload and work environment, while support entailed encouragement, sponsorship, and resources provided by managers and peers (36).

The findings showed a correlation between the dimensions of safety climate. This revealed the usefulness of the NOSACQ-50 for describing the safety climate in an organization, which has been noted in other studies, as well (24, 37). For instance, Schwatka et al. indicated that general management's commitment to safety, safety policies, resources, and training and supervisor's commitment to safety had the highest frequency among the safety climate assessment tools (38). Employees' commitment to safety is an important issue that has been emphasized

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in the safety climate studies. Working groups can also play a pivotal role in the safety climate. According to Clark, people relied more on working groups compared to the organization (39).

Based on the current study results, the correlation coefficients between the dimensions of safety climate and job stress ranged from -0.372 to 0.522, which indicated changes between the positive and negative aspects of safety climate and work-related stress. Moreover, an indirect relationship was observed between the dimensions of job stress and safety climate, except for the MJS. This implied an increase in job demands in case of a significant decrease in the safety climate score. Furthermore, the results demonstrated that managers' support, roles, and changes had the highest correlations with the dimensions of safety climate. The effect of stress on the safety of an organization can be explained by the impact of job stress on the behaviors of the organization's members. Too low or too high stress levels can harm the safety of employees, eventually leading to accidents. In case of normal stress levels, however, the staff can be expected to perform their duties more safely. In these situations, the personnel are more likely to meet work needs and follow safety participation, warnings, and safe working practices. Therefore, they will have a greater control over their behaviors, which will reduce the unhealthy behaviors that may result in occupational accidents (12). Occupational fatigue is one of the variables referred to as a mediator in several studies on safety and stress. It is worth mentioning that stress has been introduced as a predictor in these studies.

In the current research, SEM was used to evaluate the relationship between the factors and dimensions of each of the safety and health stress variables. In this regard, each dimension was considered an observable variable used to measure a latent variable, such as job stress or the safety zone (40). The model showed that there was a significant relationship between the observed factors and the study variables. However, this relationship was not significant in the control. The work environment is such that people have different control over their jobs. For example, managers can stop and restart their tasks, which is not the case for workers.

Limitation

The sample size and data collection using self-reported questionnaires were the most substantial limitations in cross-sectional studies. This study was carried out in a dairy production plant, thus generalizing the results to other contexts should be done with caution. It is necessary to mention that mostly participants (also in this study) are men; hence we had a homogenous sample.

The current research investigated the association of safety climate and job stress. In future studies, we propose that other safety aspects, such as safety behavior and performance, be investigated as outputs of safety climate. Although the known factors of job stress were used in this study, other psychosocial factors can also be considered as the objectives of future studies. The model examined in this study was based on the dimensions of the tools; therefore, based on new dimensions and aspects, structural models can be tested to examine the relationship between factors.

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5. *Conclusion*

This study indicated that job-related stress factors could have a significant effect on safety. It highlighted the importance of role and managerial support for improving safety climate. Determining the tasks of each worker and supporting supervisors during work time can prevent occupational accidents. As a result, people can be expected to have more control over their occupation and less insecure behaviors. It should be noted that occupational stress is lower than the normal level. In this case, people with excessive self-esteem, regardless of warning points, increase the likelihood of unsafe behaviors and incidents.

Abbreviations

NOSACQ-50: Nordic Safety Climate Questionnaire; HSE: Health and Safety Executive indicator tool; SEM: Structural Equation Modeling; ILO: International Labor Organization; CFA: Confirmatory Factor Analysis; CFI: Comparative Fit Index; RMSEA: Root Mean Square Error of Approximation.

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Authors' Contributions

Two authors read and approved the final manuscript. They contributed to the conceptualization, project administration, formal analysis and writing –original draft, writing – review and editing.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study protocol was reviewed and approved by the Research Ethics Committee of Shiraz University of Medical Sciences (IR.SUMS.REC.1399.248). All procedures are in accordance with the ethical standards of the institution, the research committee, the Declaration of Helsinki and its later amendments. The participants completed the survey anonymously after providing informed consent. They were aware of the purposes and hypotheses of the study.

Consent to publications

Not applicable

Conflicts of Interest

The authors declare that they have no conflict of interests.

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