The Association Between Safety Climate and Musculoskeletal Symptoms in the U.S. Logging Industry

Elise Lagerstrom and John Rosecrance(✉)

Colorado State University, Fort Collins, CO 80523, USA
John.Rosecrance@colostate.edu

Abstract. The purpose of this research was to assess the association between safety climate and musculoskeletal symptoms (MSS) among workers and management in the logging industry. The Nordic Safety Climate Questionnaire, NOSACQ-50 and modified Standardized Nordic Questionnaire were administered to 743 loggers. Five safety climate dimension scores were assessed. The disparity between management's views of their own safety priority versus workers' views of management's safety priority indicates a need to focus on safety interventions in those specific dimensions. The relationship between these measures can be used to identify possible areas and opportunities for future interventions.

Keywords: Logging · Safety · Safety climate · Musculoskeletal symptoms

1 Introduction

The construct of safety climate has been developing since 1980 in response to the need for leading, rather than lagging, indicators of occupational safety performance, including the prevention of occupational injuries and incidents (Zohar 1980). Zohar (1980) developed one of the first measures of safety climate, which was designed to discriminate between companies with high and low accident rates by measuring different dimensions of organizational climate (Zohar 1980). Based on the compilation of ideas and research regarding safety climate and culture, Zhang et al. (2002), defined safety climate as: "the perceived state of safety at a particular place at a particular time, making the definition relatively unstable, and subject to change depending on the features of the current environment or prevailing conditions" Zhang et al. (2002).

Safety climate researchers have determined that it was important to measure safety climate before beginning an intervention to ensure an adequate climate for change (Neal et al. 2000). While studying the link between organizational climate and safety climate, researchers indicated that interventions aimed at improving the safety of an organization would be more successful if they occurred in a positive climate (Neal et al. 2000). The authors of the same study found that safety climate had an effect on worker motivation and compliance, which was important for determining safe work behavior and performance (Neal et al. 2000). Assessment of safety climate is a critical and

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underutilized tool for occupational groups with a history of and/or high risk for worker injury.

Inherent dangers of the logging industry are induced by environmental conditions, heavy machinery, manual labor, and can vary based upon season, regional logging practices, and terrain (Fig. 1). For example, in the Southeastern United States, logging is highly mechanized, the terrain flat, and the weather mild in comparison to logging in the Pacific Northwest or Intermountain regions of Montana and Idaho, where logging is characterized by harsh conditions, steep terrain, severe weather, and remote work locations (Lagerstrom et al. 2017; United States Department of Labor (OSHA) 2017).

Fig. 1. Professional logger operating heavy equipment (loader/processer) in the mountains of Montana, USA.

There is a scarcity of published studies that specifically assess safety climate and musculoskeletal symptoms (MSS) in the logging industry. The purpose of this cross-sectional study was to quantify safety climate and prevalence of MSS in the logging industry of the intermountain states of Montana and Idaho. The secondary aim was to investigate the association between MSS and five dimensions of safety climate.

2 Methods

Surveys were administered to loggers participating in a required emergency first-aid training workshop. The training sessions are held annually at different locations across the state of Montana. The surveys consisted of three questionnaires: demographic questionnaire, a MSS questionnaire, and a safety climate questionnaire. Participation in the survey was voluntary and anonymous. Compensation was not provided to participants. All workers in attendance at the workshops were eligible for participation.

Demographic information collected as a part of the survey included age, gender, and education level. Job information collected by the survey included logging system type, supervisory status (leader v. worker), whether the logger was an accredited logging professional (designation requiring continuing education on safe and environmental logging practices) and years spent employed in the logging industry.

To determine the presence of musculoskeletal symptoms, a modification of the Standardized Nordic Questionnaire (SNQ) was administered. The modified questionnaire included three questions in reference to nine anatomical regions of the body as follows: (1) "During the last 12 months have you had a job-related ache, pain, or discomfort?"; (2) "During the last 12 months has this ache, pain, or discomfort prevented you from doing your day's work?"; (3) "During the last 12 months have you seen a physician or physical therapist for this pain, ache or discomfort?" For each question, participants checked either yes or no for each of the nine anatomical region.

To assess safety climate, we used a modification of the English translation of NOSACQ-50 that was modified for this study to fit within survey time and space requirements. The modifications included using five of the seven dimensions: (1) management safety priority and ability, (2) workers' safety commitment, (3) workers' safety priority and risk non-acceptance, (4) peer safety communication, learning, and trust in safety ability, and (5) workers' trust in efficacy of safety systems. The 38 items that pertained to the five dimensions were answered with a Likert scale (1–4) ranging from strongly disagree (1), to strongly agree (4). Multiple studies have validated this measure in various industries, countries, and languages. The NOSACQ-50 was developed by a team of Nordic researchers trying to determine reasons why different occupational groups have higher accident and injury rates than other groups performing the same work (Kines et al. 2011). The definition of safety climate is a measure of "a workgroup members' shared perceptions of management and workgroup safety related policies, procedures, and practices" (Kines et al. 2011).

2.1 Statistical Analysis

Means, standard deviations, and frequency statistics were calculated for all demographic variables. The continuous variable, years of experience in the logging industry, was transformed into a categorical variable by decades of experience. Two binary variables were created based on the results of the modified SNQ, to identify workers who experienced MSS in any anatomical area (Yes/No), or missed work due to MSS in the past 12 months (Yes/No).

Dimension scores for NOSACQ-50 were analyzed and interpreted in accordance with published guidelines. A score for each dimension was calculated. Scores for negatively worded items were reversed when calculating mean dimension scores. Safety climate dimension scores were analyzed separately for leaders (owners/supervisors) and workers.

T-tests were performed to determine if there was a significant difference in safety climate dimension scores based on leader-worker status and MSS status, i.e. whether the respondent had experienced any MSS (Yes/No), or had missed work due to MSS (Yes/No).

A categorical response variable was created for safety climate scores corresponding to recommended levels published by the National Research Centre for the Working Environment in Denmark as soft guidelines for interpretation (Kines et al. 2011). Safety climate dimension scores above 3.30, on the scale of 1–4, indicate that the safety climate level of the workplace is good, dimension scores from 3 to 3.30 correspond to a fairly good safety climate, and scores below 3.00 correspond to fairly low or low safety climate dimension scores.

Multinomial logistic regression was performed to determine which demographic, workplace, and injury variables were associated with the categorical interpretation of the safety climate dimension scores. Separate logistic regression models were run for each of the five safety climate dimensions. Variables in the model included logging system type, supervisory status, if the worker was certified as an accredited logging professional (ALP), education level, age, years of experience in logging, and whether the respondent had reported any MSS.

Data analysis was performed using SAS 9.4 (SAS Institute Inc, 2012). Significance was based upon $p < 0.05$. The study protocol and consent was approved by the university's Research Integrity and Compliance Review Office.

3 Results

One thousand fifty-nine workers attended the training workshops and 743 surveys were returned for an overall response rate of 70.2%. Mean age of respondents was approximately 46 (SD: 13.67); mean number of years employed in the logging industry was 22 (SD: 14.11). The mean number of hours worked per week in logging was 47.1 (SD = 15.5), while the mean number of months worked each year in logging was 9.2 (SD: 2.6). Ninety-four percent of participants identified as male.

Most workers indicated that their primary logging system type as mechanical (84%), with 16% of respondents identifying that they primarily use a conventional logging system (chainsaw).

Overall, 48% of the respondents reported experiencing musculoskeletal symptoms due to their work in the past year, and 6% of the respondents reported missing work in the past year due to MSS (Table 1). The anatomical area with the highest 12-month period prevalence of MSS for all loggers was the low back (38.1%), followed by the shoulders (27.6%), neck (24.8%) and the knees (24.7%).

The results of the safety climate survey indicated that when all responses were considered, the dimension of "Management safety priority and ability" had the highest mean overall score (3.40), followed by the dimension "Workers' safety commitment" (3.39), "Workers' trust in the efficacy of safety systems" (3.34), and "Peer safety communication, learning and trust in safety ability" (3.34). The dimension "Workers' safety priority and risk non-acceptance" had the lowest mean score (3.10) and, when interpreted, was the only dimension found to not fall into the "good" category. Across all five dimensions assessed, leaders had higher dimension scores survey than workers. In dimensions "Management safety priority and ability" and "Workers' safety commitment", the difference between leader ratings and worker ratings was significant ($p < 0.05$).

Table 1. Percentage of workers reporting musculoskeletal symptoms (one-year period prevalence).

Anatomical region	Percent (n = 649)
Neck	24.8%
Upper back	17.8%
Lower back	38.1%
Shoulders	27.6%
Elbows	14.5%
Wrist/Hands	21.0%
Hip/Thighs	17.1%
Knees	24.7%
Feet	13.8%
Symptoms in any area	48.1%
Missed work due to symptoms in any area	6.0%
MSS Score (Mean number of MSS categories reported)	1.8

Leaders who experienced MSS had a significantly lower score on the safety climate dimension "Workers' safety priority and risk non-acceptance" ($p = 0.05$) than leaders who did not experience MSS. Workers who reported MSS had significantly lower scores on the dimension "Management safety priority and ability" ($p = 0.03$), and dimension "Workers' safety priority and risk non-acceptance" ($p = 0.013$), in comparison to workers who did not report MSS. No significant differences in safety climate dimension scores were found with leaders nor workers who did or did not miss work due to MSS.

4 Discussion

This study conducted a quantitative evaluation of the determinants of safety climate within the logging industry, and provided a baseline measure of the safety perceptions for this population. While not significant in the regression model, the disparity between leaders' and workers' safety climate scores is of interest. Across all five dimensions, leaders (owners/supervisors) of logging companies had higher safety climate scores than workers, and in two dimensions, when workers were compared directly to leaders, workers had significantly lower responses. The significant differences were found in dimensions one (management safety priority and ability) and four (workers' safety commitment).

In the safety climate dimension of "workers' safety priority and risk non-acceptance", workers who reported work-related MSS were nearly three times more likely to be assigned to the low category of safety climate than the high category, meaning, loggers who experienced MSS in the past year were more likely to have low safety priorities and accept risks in the workplace than loggers who did not report MSS.

As indicated in the results of the study, the authors provide a quantitative evaluation of the current safety climate in the logging industry. The data and subsequent results

obtained during this study provide a baseline measure of both musculoskeletal symptoms and safety climate, which can be used as a standard of comparison after the application of safety interventions.

This research indicated that injury prevention efforts in the logging industry should focus on sustaining the relatively high level of safety climate within the logging industry. This can be accomplished efficiently by specifically targeting the mismatch between leaders (owners/supervisors) versus worker's safety perceptions, and the association between MSS and safety climate.

Quantifying the current safety climate of the logging population and investigating determinants of safety climate is needed to identify possible areas and opportunities for future interventions. Measuring leading indicators, such as safety climate, is a step toward proactive injury surveillance and control.

References

Kines P, Lappalainen J, Mikkelsen KL, Olsen E, Pousette A, Tharaldsen J, Törner M (2011) Nordic Safety Climate Questionnaire (NOSACQ-50): a new tool for diagnosing occupational safety climate. Int. J. Ind. Ergonomics 41(6):634–646

Lagerstrom E, Magzamen S, Rosecrance J (2017) A mixed methods analysis of logging injuries in Montana and Idaho. Am J Ind Med 60(12):1077–1087

Neal A, Griffin MA, Hart PM (2000) The impact of organizational climate on safety climate and individual behavior. Safety Sci 34(1):99–109

United States Department of Labor OSHA (2017). Safety and health topics: logging. https://www.osha.gov/SLTC/logging/

Zhang H, Wiegmann DA, Von Thaden TL, Sharma G, Mitchell AA (2002) Safety culture: a concept in chaos? In: Paper presented at the proceedings of the human factors and ergonomics society annual meeting

Zohar D (1980) Safety climate in industrial organizations: theoretical and applied implications. J Appl Psychol 65(1):96

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Sara Albolino
Centre for Clinical Risk Management and Patient Safety, Tuscany Region
Florence, Italy

Thomas Alexander
Fraunhofer FKIE
Bonn, Nordrhein-Westfalen
Germany

Yushi Fujita
International Ergonomics Association
Tokyo, Japan

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