Published in final edited form as:
J Occup Environ Med. 2017 December ; 59(12): 1172–1179. doi:10.1097/JOM.0000000000001166.

Findings from the National Machine Guarding Program: Safety climate, hazard assessment, and safety leadership in small metal fabrication businesses

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Abstract

Objectives—This manuscript assesses safety climate data from the National Machine Guarding Program (NMGP) – a nationwide intervention to improve machine safety.

Methods—Baseline safety climate surveys were completed by 2161 employees and 341 owners or managers at 115 businesses. A separate onsite audit of safety management practices and machine guarding equipment was conducted at each business.

Results—Safety climate measures were not correlated with machine guarding or safety management practices. The presence of a safety committee was correlated with higher scores on the safety management audit when contrasted with those without one.

Conclusions—The presence of a safety committee is easily assessed and provides a basis on which to make recommendations with regard to how it functions. Measures of safety climate fail to provide actionable information. Future research on small manufacturing firms should emphasize the presence of an employee-management safety committee.

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Conflicts of Interest:
The authors do not have any competing interests/conflicts of interest.

Introduction

Numerous studies discuss the importance of measuring safety climate in order to improve workplace safety.[1–5] Safety climate has been defined as workers' shared perceptions of safety policies, procedures, and practices as well as the overall importance attributed to safety by an organization.[4,6] Factors influencing safety climate may include management's commitment to safety, return-to-work policies, post-injury administration, and safety training.

Data are needed to clearly describe the nature of safety practices within small-scale enterprises and how they are reflected in the knowledge and beliefs of both employees and owners.[7] Data from large corporations indicate that, as worker perceptions of health and safety increase, they are correlated with lower injury rates.[8] However, it is unclear if and how findings from large companies are applicable to small enterprises.[9] In addition, we can find few studies that assess safety climate within small enterprises.[10] Rather, most studies have focused on the qualitative assessment of small businesses using focus groups or key informant interviews.[11,12]

Our previous work showed that small businesses with safety committees performed better on an independent assessment of hazard control on a wide range of metal fabrication machines than businesses without one.[10,13] We also demonstrated that even modest investment of resources on the part of businesses facilitated the improvement of machine-related hazards and substantially improved lockout and tagout (LOTO).[10,14] Neitzel et al found that measures of safety climate were at times negatively correlated with safe work practices; however, their work was conducted in large manufacturing facilities.[15]

The National Machine Guarding Program (NMGP) was a nationwide intervention designed to improve machine safety in small-scale enterprises. Safety climate data were collected at baseline as a means of guiding site-specific interventions. This manuscript examines the relationship between safety climate as reported by workers and owners and an independent business safety assessment conducted by insurance safety risk consultants. Our hypothesis was that safety climate measures would be a useful guide in developing site-specific recommendations to improve machine-related safety.

Methods

The institutional review board (IRB) of the Park Nicollet Institute approved all study methods and materials. Informed consent was obtained from each business owner before enrollment. The IRB exempted the safety climate survey from signed consent because identifying information was not obtained. An information sheet was included with each survey advising employees of their right to decline participation.

Overview of the NMGP

The NMGP was designed to help small metal fabrication businesses prevent injuries by developing safety leadership practices linked to reduced risk of injury. These include demonstrating management commitment to safety, writing and communicating shop policies and programs, encouraging employee participation, and providing sufficient resources. Safety climate was assessed at baseline as a potential means of guiding site-specific intervention recommendations.

Safety consultants employed by 2 insurance companies recruited businesses from their workers' compensation client base. Businesses were eligible to participate if they had 3 to 150 employees, earned at least 75% of revenue through metal fabrication, and maintained a workers' compensation policy with a participating insurer. Once enrolled in the machine guarding intervention, owners were given the choice of having their company participate or not participate in the safety climate survey.

Measures of safety climate

Insurer A requested that the survey be limited to 2 pages to ensure completion and ease of use. Safety climate was measured using an abbreviated version of a survey developed by the British Health and Safety Executive and comprehensively described by Cheyne et al.[16,17] The survey had 9 constructs, with 2 questions per construct (Table 1). Questions were answered on a scale of 1 (strongly disagree) to 5 (strongly agree). Demographic data included age, gender, education, language preference, and primary job activity. The initial survey was written in English, subsequently translated into Spanish, and reviewed for accuracy and back translation.

Survey distribution and data collection

An encrypted identification number unique to each business was embedded into a barcode on the surveys. Surveys were then printed on a machine-readable form and provided to the business by the insurer a week before, and returned no more than 2 weeks after, the baseline visit. The owner or manager was responsible for having shop employees complete the survey and place their individual survey in a sealed envelope. Surveys were returned by employers to the safety consultant in person or via US mail. The insurer then mailed the surveys to research staff. After inspection for errors or damage, surveys were optically scanned.

Onsite business safety audit

At baseline, 12 machines were randomly selected for a standardized onsite assessment of machine safeguarding.[8, 9] Checklists assessed 4 types of hazards: equipment safeguards, LOTO procedures, electrical, and work environment. Checklists varied by machine type and contained 25 to 35 questions, depending on the complexity of the machine.[8–12] All checklists had been validated for inter-rater reliability.[13,18]

A separate safety management audit checklist was completed during an interview with the owner or the owner's representative (Figure 1). The safety management audit addressed safety leadership, machine maintenance, and LOTO. For all checklist items, a "yes" response meant that the presence of a safeguard, policy, or written document was verified by the evaluator. Results from the machine and safety management audits were transmitted electronically from field sites to the research team.

Data analysis

Data collected using the machine safety checklists were used to calculate a business-level machine score. The number of "yes" responses was divided by the number of "yes" plus "no" responses for each machine and scaled to 100%. Next, a business-level machine score was calculated by adding the scores for each machine and dividing by12 — the number inspected in each business.

An overall safety management audit score was created using 25 questions from the safety management audit. In addition, sub-scores were created for safety leadership, machine maintenance, and LOTO. Scores were calculated as the number of items present divided by the total number of items multiplied by 100.

- Safety leadership and risk management: Twelve questions assessed safety leadership practices, programs, and policies. These were defined as a formal, organized structure within which employees and management cooperatively identify, evaluate, and remediate hazards.
- Machine maintenance programs and policies: Eight questions assessed the documentation of periodic inspection of machines to ensure they were effectively guarded for safe operation.
- LOTO program: Five questions assessed compliance with Occupational Safety and Health Administration (OSHA) standard 1910.147 to ensure safe control of hazardous energy, commonly known as the LOTO standard. OSHA requires that each business have a comprehensive written LOTO program. A LOTO procedure is a series of steps to safely shut down and restart machines.

Internal consistency of the safety climate constructs was evaluated using Cronbach's alpha. A score for each of the 9 safety climate constructs was determined by adding responses for both questions within that construct. Each pair of questions had a minimum score of 2 and a maximum score of 10. Scores were summed within shops and then averaged for the number of respondents. Separate analyses were conducted for employees and owner/managers within each shop. Analysis included the computation of means, standard deviations, t-tests, and Chi-squares. Simple multiple regression was used to assess the impact of safety climate scores, the presence or absence of a safety committee, and the overall safety leadership as well as the overall machine guarding scores.

Results

A total of 221 businesses agreed to participate in the baseline assessment. Safety climate surveys were returned by 132 (60%). There were no differences in the overall shop score, business-level machine score, the presence of LOTO programs or procedures, the presence of safety committees, number of years in business, or number of employees between businesses that did and did not participate in the safety climate survey ($P > 0.4$ for all measures).

For the 132 shops that returned surveys, both workers and at least 1 owner/manager completed surveys in 115 and only workers in 17. Analysis was done using these 115 shops.

A total of 47 of 115 (41%) shops had a safety committee. As the number of employees increased from 2–10, 11–29, 30–49, and 50–150, the presence of a safety committee went from 4 of 22 (18%), 12 of 43 (28%), 12 of 23 (52%) to 19 of 27 (68%) (P-trend < 0.001) businesses, respectively.

After eliminating 28 surveys that could not be identified as coming from an owner or employee, the final analysis was completed on 2502 individuals, including 2161 employees (86%) and 341 owners or managers (14%). The response rate for workers was 59% (2164 of 3646) for employees in the 115 shops. A response rate was not calculated for owners and managers, as the denominator could not be obtained, and only 1 survey was sought per business. The intra-class correlation coefficient (ICC) was 0.1 for workers and 0.21 for owners, indicating substantial differences in individual responses within shops. The ICC did not change appreciably between shops with fewer than 10 and 10 or more employees.

As seen in Table 1, for employees, Cronbach's alpha ranged from a high of 0.84 for management commitment and priority of safety to a low of 0.29 for safety training. For owners/managers, it ranged from 0.84 for management commitment to 0.28 for safety training.

Table 2 shows the demographic characteristics for shop workers (N=2161) and owners/managers (N=341) who completed safety climate surveys. Safety climate measures in Table 2 are averaged at the individual level. Sixty-two percent of employees classified themselves as machinists, and most workers and owners had completed high school. For workers, 36% completed at least some college, and 27% graduated from technical school, compared with 46% and 22%, respectively, for owners. For workers, there was no difference in safety climate measures based on level of education. Spanish surveys were completed by 26 workers, most of whom were men (58%) and machinists (81%). Most Hispanic workers had completed high school (15 [58%]), and 2 (8%) had graduated from technical college (data not shown in table).

Owners with less than a high school education had lower safety climate scores than those with more education. However, significance was not calculated due to low numbers (N=7). For both owners and workers, there was no difference in safety climate measures based on age. Further analysis of workers was confined to the 1977 individuals who worked in the shop, the original target population for the safety climate survey. For workers, scores declined from a high of 88% to 84%, 84%, and 83% for those working at the company <1, 1–4, 5–9, and ≥10 years, respectively (P-trend < 0.0001). A minimal but reverse trend was seen for owners whose scores for these same 4 categories were 87%, 88%, 87%, and 90% (P-trend = 0.0003).

Safety climate measures in Tables 3 to 7 were averaged at the shop level, accounting for the small differences in the overall safety climate score in Tables 2 and 3. Table 3 contrasts the safety climate constructs for owners/managers and employees. Owners consistently rated their enterprises more favorably than did workers.

Table 4 shows safety climate scores by business size. As size increased, there was a consistent trend towards lower safety climate measures. A negative and statistically significant downward trend was seen for all constructs except involvement in safety. This trend was consistent across all size ranges. The largest difference was seen for management commitment, which went from 8.8 in the smallest shops to 7.8 in the largest shops. Involvement was the construct that did show significant differences by business size range.

As shown in Table 5, there were slight differences in safety climate measures when stratified by the overall machine score for each shop. Management commitment, priority of safety, and safety discipline were all associated with a slight but statistically significant increase in summary measures ($P < 0.01$).

Table 6 shows the overall safety climate score stratified by quartile of the overall safety management audit, safety leadership, machine maintenance, and LOTO program scores. There were minimal differences in safety climate measures between businesses in the lowest and highest quartiles (P-trend > 0.5 for all measures). As seen in Table 7, the presence or absence of a safety committee made minimal and contradictory differences in safety climate measures.

Multiple regression was used to assess the relationship between the summary safety climate score and summary measures for safety leadership, machine maintenance programs, and LOTO programs. When controlling for shop size and safety committee, an increasing safety climate score was not correlated with the safety leadership score ($P = 0.48$), machine maintenance program score ($P = 0.43$), or LOTO program score ($P = 0.74$).

Next, based on our a priori hypothesis that the presence of a safety committee was associated with an improvement in shop safety, multiple regression was used to assess the impact of the overall safety climate score and the presence or absence of a safety committee.

A total of 47 of 115 (41%) businesses had a safety committee. Using multiple regression with the overall safety audit score as the dependent variable, an increasing safety climate score showed no correlation with the overall safety audit score ($P = 0.47$) while controlling for both shop size and safety committee. However, the presence of a safety committee resulted in a 16% increase ($P = 0.0003$) in the overall safety audit score while controlling for the effect of shop size and overall safety climate score as well as 21% ($P<0.0001$) percentage point increases in safety leadership, 4% ($P = 0.51$) in machine maintenance program score, and 22% ($P = 0.004$) in LOTO program score.

Discussion

In the NMGP, safety climate for workers and owners was poorly correlated with workplace hazards or safety management practices such as safeguarding equipment, worker training, or written programs. In contrast, the presence of a functioning safety committee appears to be a good proxy for safety management practices observed during an independent audit of small businesses. This finding is consistent with data from the MN-MGS, in which the presence of a safety committee was a stronger indicator of safety audit performance than safety climate.[20] Similarly, our work in small auto collision repair shops revealed a discrepancy between owners' and workers' perceptions of safety performance and actual conditions documented in site audits.[10]

Few studies have simultaneously measured safety practices and safety climate. Neitzel et al found an inverse relationship between compliance with safety regulations as measured by an outside observer and safety climate.[15] In a review of safety climate in the construction trades, Schwatka et al concluded that safety climate was related to subjective measures of safety behavior rather than measures of ill health or objective safety and health outcomes.[19,20] A notable exception was work from Gershon et al, who found a strong relationship between self-reported work practices and measures of safety climate among hospital healthcare workers.[19]

The difference in the utility of safety climate measures between small and large businesses may, in part, be accounted for by the human resource management practices that facilitate the creation and maintenance of a safe work environment. These practices become more structured as business size increases.[21–23] Survey and focus group data show that many small businesses lack a defined structure for managing health and safety, which parallels — or, in fact, may simply reflect — the lack of technical knowledge necessary to develop and implement formal human resource practices.[9,23–25] Health and safety problems related to a lack of human resources capacity are compounded by a lack of access to good information, as well as unawareness of the scope of regulations with which a business must comply.[14,26]

As firms grow, there is an increasing need to formalize human resource management practices.[27] From the vantage point of business development, formal human resources practices enhance employee perception of fairness and may lead to greater levels of employee commitment, especially in enterprises in which employee satisfaction may be low.[28,29]

Focus groups indicate that owners believe it is their responsibility to ensure they are doing all they can to create a safe work environment.[24] This belief is supported by safety climate data in which owners consistently rate their safety performance quite highly. However, in the NMGP, only 28 of 88 (32%) businesses with < 50 employees had a safety committee. In a Canadian survey of business with ≤ 50 employees ($N = 223$), only 5% had a safety committee.[9] The contrast between what is reported by owners in focus groups and safety climate surveys and what is taking place within businesses may arise because owners often downplay the distinctions between themselves and their employees.[11] This may lead owners to see their commitment to safety in a more favorable light than do employees.

Seen another way, small companies usually have a flat organizational structure in which workers feel some personal responsibility for the success or failure of the business as a whole.[30] A flat organizational structure is likely to diminish as companies grow, with the concomitant result of lower worker perception of safety climate as seen in the NMGP (Table 4). It may be impossible to disentangle the interaction between social relations at work and perceptions of health and safety in small enterprises. If this is the case, while hypothetical, the higher safety climate scores seen in the smallest enterprises in the NMGP when contrasted with their larger peers are more a reflection of interpersonal relationships than they are of health and safety practices.[31]

This paper has several limitations. First, this was not a random sample of businesses. Most owners see receiving a benefit as prerequisite to participation in a study. If there is no perceived benefit, they decline participation. Ethically, we believe it is necessary to provide baseline results to owners and employees, along with materials to help remediate serious hazards. In our previous work, we showed that even a minimal intervention may result in change.[32]

Second, the wide geographic reach in the NMGP necessitated that owners distribute safety climate surveys to employees. It is unknown if this may have impacted employee responses; however, the names of individuals and businesses were not collected, and respondents were provided an envelope in which to place and seal their surveys. Third, there was a low Cronbach's alpha for 3 and a moderate Cronbach's alpha for 2 of 9 constructs. This may stem from having only 2 questions per construct. Regardless, these values draw into question the internal validity of several measures.

Last, our previous work showed a relationship between improving self-reported work practices and improving scores for the safety climate construct for rules and procedures. However, no relationship was found between overall safety climate measures and self-reported work practices.[10] We were unable to measure self-reported work practices in the NMGP because one of our partners felt a survey that exceeded 2 pages would be poorly received by employers.

Conclusions

Based on data from the NMGP, it is more important to assess the presence or absence of programs and policies than worker or owner perceptions of their effectiveness. From a practical perspective, the presence of a safety committee is easily assessed and provides a clear basis on which to make recommendations with regard to how it functions (e.g., frequency of meetings, membership), whereas measures of safety climate fail to provide actionable information. Safety, much like productivity, improves with employee participation. For example, regular employee meetings, self-management teams, profit sharing, and skill development have been shown to increase productivity.[33]

To our knowledge, the NMGP is the single largest assessment of safety climate in small businesses. We were able to stratify findings over businesses ranging from 3 to 150 employees. The failure to find useful relationships between safety climate and more robust measures of safety leads us to conclude that safety climate assessment is unlikely to provide small business researchers with helpful information and/or a framework with which to guide research and/or intervention efforts. Future research should emphasize the presence of a well-functioning safety committee — a practical intervention point that is readily assessed.

Acknowledgments

Source of Funding:

Dr. Parker, Mr. Yamin, Dr. Xi, Dr. Brosseau, Mr. Gordon, and Dr. Most received funding support through U.S. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH) grant 5R01 OH003884-10.

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Business Name: ______________________ Today's Date: __________

Yes	No	N/A	
			Safety leadership practices
			Is one employee or manager designated as responsible for safety issues?
			Is there a formal committee that discusses safety?
			If "yes", answer the next 2 questions:
			Does this committee meet at least quarterly?
			Are minutes from committee meetings posted? (Verify by seeing documentation.)
			Are safety issues discussed at least quarterly at meetings that include all employees?
			Is there a formal method for obtaining employee input on safety?
			Risk management programs and policies
			Is there a written policy stating the consequences of failing to follow safety procedures? (Verify.)
			Is there a designated employee to whom injuries are reported?
			Is there a written policy requiring that employees promptly report all injuries?
			Is a written investigation conducted for each injury?
			Is a written investigation conducted for near-misses?
			Is there a policy requiring that everyone wear safety eyewear in the shop?
			Machine safeguarding programs and policies
			Are machine safety audits conducted at least annually? (Verify by seeing documentation.)
			Are machine maintenance inspections conducted at least every 60 days?
			Is power outage (anti-restart) protection in place for each machine?
			Are records kept showing that emergency stops are regularly inspected and tested? (Verify.)
			Does the shop have written machine guarding policies/procedures? (Verify.)
			Is there a brief audit checklist for setup of each machine? (Verify.)
			Are light curtains or other presence-sensing devices used anywhere in the shop for machine safeguarding?
			If "yes", answer the next question:
			Is there documentation that blanking is compliant with OSHA table 0-10, or that stop-time analyses are performed, or both? (Verify.)
			Lockout/tagout (LO/TO) program
			Does the shop have a written LO/TO program? (Verify.)
			Does the LO/TO program designate "authorized" employees? (Verify.)
			For each lock issued to an "authorized" employee, is there just one key that opens that lock? (Verify.)
			Are there records verifying that all employees are trained in LO/TO? (Verify.)
			Are there records of annual audits verifying the effectiveness of written LO/TO procedures for each machine? (Verify.)

National Machine Guarding Program
August 2011

Figure 1.

Safety Management Audit Form

Table 1

Cronbach's alpha for nine safety climate constructs

Construct	Definition	Cronbach's alpha		
		All respondents (n=2502)	Workers (n=2164)	Owners (n=338)
Management commitment	Perceptions of management's commitment to addressing health and safety issues.	0.84	0.84	0.81
Communication	Perception about how well safety information is communicated within a business.	0.75	0.75	0.66
Priority of safety	The importance of health and safety issues within the business.	0.83	0.83	0.86
Safety rules and procedures	Views on the efficacy and necessity of rules and procedures.	0.61	0.62	0.58
Work environment	Perceptions of the nature of the physical environment.	0.74	0.74	0.73
Supportive environment	The nature of the social environment at work and the support derived from it.	0.64	0.64	0.44
Safety training	Employee understanding of personal risks and responsibilities.	0.29	0.28	0.30
Safety discipline	Employee understanding of expectations and rules for safety.	0.56	0.56	0.50
Involvement	The extent to which safety is a focus for everyone, and all are involved.	0.51	0.52	0.34

Table 2

Demographic characteristics and average safety climate measures for all respondents

Characteristic		All Employees			Owner/manager		
		Number	%	Summary safety climate score (SD)	Number	%	Summary safety climate score (SD)
All workers		2164		84.6 (11.9)	338		89.2 (9.4)
Gender	Male	1834	86.6	84.3 (11.9)	304	92.1	89.2 (9.5)
	Female	284	13.4	86.5 (11.0)	26	7.9	88.6 (9.5)
Job title	Machinist	1346	62.2	84.1 (12.2)			
	Engineer/electrician	97	4.5	87.0 (11.5)			
	Other shop duties	534	24.7	84.6 (11.4)			
	Does not work in shop	187	8.6	87.2 (10.5)			
	Owner	---		---	145	42.9	90.7 (8.7)
	Manager	---		---	193	57.1	88.1 (9.8)
Education	< High school	122	5.7	85.3 (11.6)	7	2.1	80.6 (9.0)
	High school	1252	58.2	84.4 (11.9)	167	49.6	89.2 (9.8)
	At least some college	777	36.1	84.6 (11.9)	163	48.4	89.7 (8.9)
Technical education	No technical school	1133	52.7	84.6 (11.7)	145	42.9	88.9 (9.6)
	Some technical school	435	20.3	84.9 (11.8)	73	21.6	89.1 (8.3)
	Technical graduate	580	27.0	84.2 (12.2)	120	35.5	89.7 (9.9)
Age (years)	< 25	227	10.7	85.8 (10.7)	5	1.5	86.2 (9.1)
	25–40	678	32.0	84.3 (12.4)	89	26.9	88.4 (9.9)
	41–54	798	37.7	84.2 (12.0)	166	50.2	89.0 (9.4)
	≥ 55	414	19.6	85.6 (10.7)	71	21.5	91.0 (7.9)

Table 3

Comparison of average shop-level of safety climate measures between workers and owners/managers

	Mean safety climate score		*P*-value, difference between groups
Safety climate constructs	**Workers mean (SD)**	**Owner/ managers mean (SD)**	
Overall score	86.8 (5.3)	89.5 (7.4)	<0.0001
Management commitment	8.6 (0.9)	8.7 (1.3)	0.053
Communication	8.8 (0.7)	9.0 (1.0)	0.006
Priority of safety	8.6 (0.9)	8.9 (1.3)	0.0005
Safety rules and procedures	7.5 (1.0)	7.5 (1.8)	0.55
Work environment	8.7 (0.8)	8.9 (1.2)	0.001
Supportive environment	8.6 (0.7)	9.3 (0.8)	<0.0001
Safety training [Personal appreciation of risk]	8.6 (0.6)	8.9 (1.0)	<0.0001
Safety discipline	9.4 (0.4)	9.6 (0.6)	<0.0001
Involvement [Personal priorities and need for safety]	9.6 (0.3)	9.8 (0.4)	<0.0001

Table 4

Average shop-level worker safety climate scores by business size

Safety climate constructs	Business size				
	3–10	11–29	30–49	50–150	
	Safety Climate Score				
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	*P*-trend
Overall score	89.3 (5.9)	87.4 (5.1)	87.3 (2.7)	82.4 (4.3)	<0.0001
Management commitment	9 (1)	8.7 (0.8)	8.6 (0.5)	7.7 (0.6)	<0.0001
Communication	9.3 (0.7)	8.8 (0.7)	8.8 (0.4)	8.1 (0.6)	<0.0001
Priority of safety	9.1 (1)	8.7 (0.8)	8.6 (0.5)	7.9 (0.7)	<0.0001
Safety rules and procedures	7.2 (1.4)	7.7 (0.8)	7.6 (0.6)	7.2 (0.6)	0.70
Work environment	9.2 (0.8)	8.7 (0.7)	8.7 (0.5)	8 (0.7)	<0.0001
Supportive environment	8.8 (1)	8.6 (0.7)	8.8 (0.3)	8.3 (0.5)	0.06
Safety training [Personal appreciation of risk]	8.8 (0.7)	8.6 (0.6)	8.5 (0.4)	8.3 (0.5)	0.002
Safety discipline	9.5 (0.6)	9.5 (0.4)	9.4 (0.3)	9.2 (0.3)	0.04
Involvement [Personal priorities and need for safety]	9.5 (0.4)	9.6 (0.3)	9.7 (0.2)	9.5 (0.1)	0.78

Table 5

Average shop-level worker safety climate scores and quartile of business-level machine score

Safety climate constructs	Safety climate scores by quartile of business-level machine score				
	1st (45%–69%)	**2nd (70%–74%)**	**3rd (75%–78%)**	**4th (79%–97%)**	***P*-trend**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	
Overall score	85.9 (5.4)	87.2 (5.6)	86.7 (4.6)	87.9 (5.6)	0.23
Management commitment	8.4 (1)	8.7 (0.9)	8.6 (0.9)	8.8 (0.8)	0.19
Communication	8.7 (0.6)	8.9 (0.8)	8.8 (0.7)	8.8 (0.8)	0.83
Priority of safety	8.4 (0.9)	8.7 (0.8)	8.7 (0.9)	8.7 (0.8)	0.26
Safety rules and procedures	7.6 (0.6)	7.3 (1)	7.1 (1.2)	7.9 (0.9)	0.64
Work environment	8.7 (0.7)	8.7 (0.9)	8.7 (0.9)	8.6 (0.7)	0.74
Supportive environment	8.5 (0.7)	8.6 (0.6)	8.8 (0.6)	8.7 (0.8)	0.29
Safety training [Personal appreciation of risk]	8.5 (0.6)	8.5 (0.6)	8.6 (0.6)	8.6 (0.6)	0.67
Safety discipline	9.3 (0.6)	9.4 (0.4)	9.5 (0.3)	9.4 (0.4)	0.49
Involvement [Personal priorities and need for safety]	9.5 (0.3)	9.6 (0.3)	9.6 (0.2)	9.6 (0.4)	0.28

Table 6

Average shop-level worker safety climate scores by quartile for the overall safety management score and each of its 3 component parts.

Component of the Safety Management Audit Checklist	Quartile for the Overall and Components of the Safety Management Audit Checklist*				
	1st	2nd	3rd	4th	*P*-trend
	Overall Safety Climate Score				
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Overall safety management audit score	86.7 (5.4)	87.3 (5.4)	85.0 (5.3)	88.1 (4.2)	0.87
Safety leadership score	87.6 (5.7)	85.9 (3.7)	85.9 (4.9)	87.6 (5.9)	0.94
Machine maintenance program score	86.1 (6.7)	88.1 (4.2)	85.5 (5.2)	87.0 (5.6)	0.69
LOTO program score	87.4 (3.8)	85.8 (4.3)	84.8 (6.1)	87.3 (4.5)	0.51

* The quartile ranges changes slightly for each of the four measures.

Table 7

Average shop-level worker safety climate scores by safety committee status at baseline

Safety climate construct	Safety committee status at baseline		
	Absent (n = 68)	Present (n = 47)	*P*-value
	Mean (SD)	Mean (SD)	
Overall score	87.3 (5.4)	86.1 (5)	0.25
Management commitment	8.7 (0.9)	8.5 (0.8)	0.34
Communication	8.9 (0.7)	8.6 (0.7)	0.07
Priority of safety	8.7 (0.9)	8.5 (0.8)	0.25
Safety rules and procedures	7.5 (1.1)	7.4 (0.8)	0.65
Work environment	8.8 (0.7)	8.5 (0.8)	0.14
Supportive environment	8.6 (0.8)	8.7 (0.5)	0.86
Safety training [Personal appreciation of risk]	8.6 (0.6)	8.5 (0.6)	0.48
Safety discipline	9.4 (0.5)	9.4 (0.4)	0.57
Involvement [Personal priorities and need for safety]	9.6 (0.3)	9.6 (0.3)	0.66