National Machine Guarding Program: Part 2. Safety Management in Small Metal Fabrication Enterprises

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Background *Small manufacturing businesses often lack important safety programs. Many reasons have been set forth on why this has remained a persistent problem.*
Methods *The National Machine Guarding Program (NMGP) was a nationwide intervention conducted in partnership with two workers' compensation insurers. Insurance safety consultants collected baseline data in 221 business using a 33-question safety management audit. Audits were completed during an interview with the business owner or manager.*
Results *Most measures of safety management improved with an increasing number of employees. This trend was particularly strong for lockout/tagout. However, size was only significant for businesses without a safety committee. Establishments with a safety committee scored higher (55% vs. 36%) on the safety management audit compared with those lacking a committee ($P < 0.0001$).*
Conclusions *Critical safety management programs were frequently absent. A safety committee appears to be a more important factor than business size in accounting for differences in outcome measures.* Am. J. Ind. Med. 58:1184–1193, 2015.

KEY WORDS: safety committee; small business; lockout; tagout; manufacturing

INTRODUCTION

Small enterprises represent a significant portion of the United States economy. Nearly 98% of the 4.9 million U.S. businesses have fewer than 100 employees; those account for 36% of all employment. Businesses with 100–499 workers comprise an additional 14% [US Department of Commerce, 2002].

Approximately 2.5 million U.S. workers are employed in metal manufacturing [Census, 2010], of whom 1.3 million are employed in fabricated metal products (North American Industry Classification System NAICS 332). In related industrial sectors, more than 900,000 are employed in machinery manufacturing (NAICS 333) and approximately 350,000 in primary metal manufacturing (NAICS 331) [Census, 2010]. Metalworking machinery is also used in a wide range of industries for tool and die making as well as the fabrication and repair of parts.

The large size of the workforce engaged in metal fabrication, in combination with the high rates of both injuries and OSHA citations for machine guarding and lockout/tagout (LOTO) [BLS, 2015; OSHA, 2015a], highlights the importance of hazards and the potential benefits of injury prevention programs. In addition, the majority

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of U.S. metal-manufacturing establishments have fewer than 50 employees [Census, 2010] a size range that is often lacking occupational health and safety (OHS) expertise and comprehensive safety management programs [NIOSH, 1988; Leviton and Sheehy, 1996; Lentz et al., 2001; Champoux and Brun, 2003; Eakin et al., 2010; Parker et al., 2012].

Several studies have shown that employees in small workplaces have an increased risk of injury and fatality when compared with workers in large establishments (e.g., Oleinick et al., 1995; Leviton and Sheehy, 1996; DOL, 2004; Mendeloff et al., 2006). However, the nature and causes of increased risk are not well understood. Contributory factors are thought to include a lack of safety personnel, the failure of regulatory agencies to affect a sufficient number of enterprises, the absence of readily available and easy-to-use information, and employer and employee time constraints [Leviton and Sheehy, 1996; Lentz, 2001; Okun et al., 2001; MacEachen et al., 2010; Parker et al., 2012].

These problems are compounded by an absence of data on the structure of health and safety in small enterprises with the exception of limited information from focus groups and key informant interviews [Eakin, 1992; Hasle et al., 2011; Parker et al., 2012]. Data are lacking on the presence of safety committees, injury investigations, and worker training, all of which are thought to be important to worker safety and health. Data are also absent on how health and safety practices change as the business size increases from extremely small (e.g., $<$10 employees) to small (11–50) to moderate-size (50–150) establishments.

The Minnesota Machine Guarding Study (MN-MGS) tested the effectiveness of an intervention conducted in small metal fabrication businesses in the Twin Cities metropolitan area. In the MN-MGS, enterprises with a safety committee had better safety practices compared to those without. Businesses that lacked a safety committee at the outset but added one during the intervention made greater improvements in machine safety practices than other shops. However, the study was constrained by a small sample size. [Munshi et al., 2005; Samant et al., 2007; Parker et al., 2009].

The National Machine Guarding Program (NMGP) was designed to help fill a gap in translational research by disseminating the MN-MGS to a broader set of businesses across the United States [Yamin et al., 2014]. This was done in partnership with two workers' compensation insurers. Data were collected as part of a national intervention, the objectives of which were to assist businesses with establishing a safety leadership structure as a basis for improving machine safety and related programs such as lockout/tagout (LOTO), and thereby reduce employee risk for injury.

This paper is the second of two reporting baseline results for the NMGP [Parker, 2015]. It focuses on shop-wide safety management programs in businesses ranging in size from 3 to 150 employees.

METHODS AND MATERIALS

Park Nicollet Institute (PNI) and University of Illinois at Chicago institutional review boards (IRBs) approved study methods and materials. Informed consent was obtained from each business owner prior to enrollment.

Research Partnership and Intervention Design

The National Machine Guarding Program was a translational research initiative designed to lower the incidence of machine-related trauma. Intervention activities were focused on motivating businesses to adopt best practices for safety management, machine guarding, lockout/tagout (LOTO), and regulatory compliance. Program evaluation and intervention materials were originally designed for the MN-MGS [Parker et al., 2009]. They were then redesigned and pilot tested with a large workers' compensation insurer (Insurer A). The intervention was implemented in partnership with insurer A. One year after the intervention was launched, a second regional insurer (B) joined the study.

Training

A total of 50 safety consultants (38 from insurer A and 12 from insurer B) participated in an applied 2-day in-person training course. Four groups of 10–15 consultants attended separate 2-day sessions held at technical colleges with metal fabrication training programs. Safety consultants were trained to conduct a safety management audit, assess machine hazards, review LOTO programs and practices, and use study software to enter and transmit data. Safety consultants participated in periodic conference calls and web-based courses to review study methods and discuss issues arising during the course of their field work [Yamin et al., 2014].

Sample Frame and Recruitment

After training, safety consultants were then expected to enroll as many metal fabrication businesses as possible. Recruitment targets varied by region and were based on the number of eligible businesses served by each safety consultant. Participating businesses were recruited from the insurers' client base. Eligible businesses had between 3 and 150 employees, 75% or more of their revenue from metal fabrication, and carried workers' compensation coverage from the participating insurer.

Safety Management Audit

An audit of business-wide safety programs and policies was developed and tested in conjunction with insurer A

[Parker et al., 2009; Samant et al., 2006; Yamin et al., 2014]. The audit tool was reviewed by an advisory panel of machine safety experts and two business owners, pilot-tested in four Minnesota businesses, and then revised prior to use. The final *safety management audit* consisted of 33 questions addressing four areas (Table I):

- Safety leadership: 12 questions assessed the safety management structure, written safety programs, and workplace safety policies.
- Job hazard analysis (JHA): 8 questions determined the presence and completeness of a program for conducting JHAs and integration of findings from JHAs into regular work practices.
- Machine maintenance: 8 questions assessed the documentation of periodic inspection to ensure machines were effectively guarded on an ongoing basis.
- LOTO: 5 questions assessed key elements of a LOTO program and related employee training and record keeping.

TABLE I. Safety Management Audit

	Yes	No	N/A
Safety leadership program			
Is one employee or manager designated as responsible for safety issues?			
Is there a committee that discusses safety? *If yes, answer the next 2 questions*:			
If present, does this committee meet at least quarterly?			
If present, 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?			
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?			
Job hazard analysis program			
Is a program in place for conducting JHAs? *If yes, answer the next 7 questions*:			
Is there a written record of each JHA? (verify)			
Is each job broken into successive steps or activities?			
Are hazards and safe work practices/controls identified for each step?			
Are ergonomic considerations (e.g., lifting and materials handling) included in each JHA?			
Are JHAs reviewed and updated at least annually?			
Are results of JHAs used in training employees before assigning new job tasks?			
Are employees disciplined for failing to follow the control measures identified in the JHAs?			
Machine maintenance program			
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)			
Is there a brief audit checklist for setup of each machine? (verify)			
Does the shop have written machine guarding policies/procedures? (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 (LOTO) program			
Does the shop have a written LOTO program? (verify)			
Does the LOTO 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 LOTO? (verify)			
Are there records of annual audits verifying the effectiveness of written LOTO procedures for each machine? (verify)			

The *safety management audit* was completed during an interview with the owner, manager, or safety director. Responses were verified by auditing documentation for 13 out of 33 questions. The total number of employees, the number of employees working in the shop, and years in business were also recorded. Safety management was defined as a comprehensive, systematic approach to applying standards, and best practices for protecting employees. Safety leadership was defined as the basis for implementing sustainable shop-wide programs. This included a safety committee or similar team comprised of both employees and management whose sole or primary purpose was carrying out safety programs.

Machine Assessment

Safety consultants evaluated 12 randomly-selected machines [Yamin et al., 2015]. Evaluation was performed at machine workstations using one of 26 standardized checklists for metal fabrication machinery and consisting of 25–35 questions [Munshi et al., 2005; Samant et al., 2006; Yamin et al., 2014].

Data Management and Analysis

Safety consultants entered data into software developed for the NMGP. After deleting information identifying the business name and location, data were automatically transmitted to the investigators.

Statistical analysis was performed with SAS [2009]. An overall *safety management audit* score was created as a summary measure for each business using all 33 questions as well as separate scores for *safety leadership*, *JHA*, *machine maintenance*, and *LOTO.* A *machine-level score* was calculated for each machine and a summary *business-level machine score* was calculated by averaging the score for each of the 12 machines assessed in a shop.

Analysis included the computation of means, standard deviations, and χ^2. *T* tests, ANOVA, and Pearson correlations were used to explore the relationship between the percentage of missing items on machine safety checklists and shop demographics. Multiple regression was used to determine the relationship between overall *safety management audit scores* and *business-level machine scores*.

RESULTS

Evaluation was completed at 221 metal fabrication businesses between January 2012 and August 2013. Businesses were recruited from 31 states. Among clients of insurer A, 192 were non-unionized, 1 was unionized, and union status was unknown for 5. For insurer B, none of the 23 businesses was unionized. Businesses ranged in size from 3 to 150 employees (mean = 29; median 18; SD = 28). Shops from Insurer A had an average of 26 (SD = 24) compared with an average of 63 (SD = 42) employees from insurer B ($P < 0.0004$).

There were no significant differences in years in business (30 vs. 32, $P = 0.71$) between businesses represented by the two insurers. There were no significant differences between the insurers' client shops in the *safety management score* (42% vs. 48%, $P = 0.22$), nor was there a difference after adjusting for business size (43% vs. 39%; $P = 0.37$). There was a statistically significant difference in *safety leadership program scores* (58% vs. 70%, $P = 0.02$). Mean *business-level machine score* did not differ between insurers (74% vs. 71%, $P = 0.26$), but did differ slightly between the two insurers when adjusted for business size (74% vs. 69%; $P = 0.02$). At the national level, overall s*afety management scores* were not significantly different between participants located in states with (n = 98) and without (n = 123) a state-based OSHA program ($P = 0.07$). After examining differences between insurers, union status, and OSHA compared with non-OSHA states, all shops were combined for analysis.

The overall *safety management audit score* improved with increasing shop size ($P = 0.0001$; Table II). The trend was particularly strong for the *LOTO program score* where there was a 30% difference between the smallest and largest shops ($P < 0.0001$). For the *safety leadership program score,* the difference between the smallest and largest shops was

TABLE II. Business Size and Baseline Safety Management Audit Scores (n = 221)

	Business size by number of employees (Mean % score in each program)					
Program	**All (n = 221)**	**3–10 (n = 60)**	**11–29 (n = 82)**	**30–49 (n = 36)**	**50–150 (n = 43)**	***P* value for trend**
Safety leadership	59	48	57	66	73	<0.0001
Job hazard analysis (JHA)	9	6	6	16	13	0.04
Machine maintenance	42	34	42	46	48	0.008
Lockout/tagout (LOTO)	57	40	58	65	70	<0.0001
Overall safety management audit score	43	34	42	49	53	<0.0001

25% ($P < 0.0001$). Using simple linear regression to evaluate the relationship between the *safety leadership score* and shop size, for each additional employee in a shop, the safety leadership score increased by 0.3% ($P < 0.0001$). Few shops reported regularly conducting JHAs regardless of size.

For the safety leadership program, scores improved significantly with increasing shop size for 7 out of 12 checklist items (Table III). Businesses with 50–150 employees typically had the most program components in place. There was a significant trend between the smallest and largest shops for the presence of a safety committee ($P < 0.0001$); its presence went from 21% in the smallest shops to 77% in the largest. Larger shops were also significantly more likely than their smaller peers to have written policies for reporting injuries, discipline for failing to follow safety procedures, and formalized methods for obtaining employee input on safety issues, and they were also more likely to conduct injury investigations. Regardless of size, most shops had designated an individual to whom injuries must be reported. Few shops conducted investigations of "near misses" for injuries regardless of size.

For all shops combined, as the number of employees increased, shops were increasingly likely to have individual components of a *LOTO program* in place (Table IV). This trend was statistically significant for 4 out of 5 components of the *LOTO program* score. For example, the largest shops were over two-fold greater than the smallest shops in being able to provide records verifying that all employees were trained in LOTO (67% vs. 28%; $P < 0.0001$). Although larger shops were much more likely than smaller ones to have a safety committee, when it was present, there were no significant differences between the smallest and the largest shops in any of the five program components.

When small shops with a safety committee were compared with larger shops without one, smaller shops had higher scores for most measures. However, the differences were not statistically significant. For example, 92% of shops with 3–10 employees and a safety committee had a written LOTO program compared with 80% of shops with 50–150 employees and no safety committee ($P = 0.42$). Similarly, 83% of small shops with a safety committee had designated authorized employees compared with 80% of larger shops without a safety committee ($P = 0.84$).

There was a significant difference in safety leadership programs in small versus large (>50 employees) shops (mean = 56% vs. 73%; $P < 0.0001$). There was also a significant difference in the overall *safety management audit score* between small and large shops (41% vs. 53%; $P = 0.003$).

For all businesses, establishments with a safety committee scored 19% higher (55% vs. 36%) on the *safety management audit (*with items on safety committee removed) compared with those without ($P < 0.0001$; Table V). Those having a safety committee also scored

TABLE III. Safety Leadership Program Components Stratified by Business Size

	Business size (total # of employees)					
	All (n = 221)	**3–10 (n = 60)**	**11–29 (n = 82)**	**30–49 (n = 36)**	**50–150 (n = 43)**	***P* value for trend**
Safety leadership program components	% yes	% yes	% yes	% yes	% yes	
Is one employee or manager designated as responsible for safety issues?	89	88	90	94	84	0.64
Is there a committee that discusses safety?	37	21	26	42	77	<0.0001
If present, does this committee meet at least quarterly?	39	20	29	39	74	<0.0001
If present, arre minutes from committee meetings posted?	17	9	13	23	28	0.008
Are safety issues discussed at least quarterly at meetings that include all employees?	54	45	55	51	64	0.1
Is there a formal method for obtaining employee input on safety?	48	34	47	54	65	0.002
Is there a written policy stating the consequences of failing to follow safety procedures?	66	42	65	83	86	<0.0001
Is there a designated employee to whom injuries are reported?	98	95	100	97	98	0.55
Is there a written policy requiring that employees promptly report all injuries?	74	52	72	94	93	<0.0001
Is a written investigation conducted for each injury?	64	46	62	83	77	0.0002
Is a written investigation conducted for near-misses?	28	24	27	25	37	0.17
Is there a policy requiring that everyone wear safety eyewear in the shop?	86	77	87	94	88	0.052

TABLE IV. LOTO Program Components, Business Size, and Safety Committee

		Business size (total # of employees)					
		All (n = 221)	3–10 (n = 60)	11–29 (n = 82)	30–49 (n = 36)	50–150 (n = 43)	
LOTO program components	Safety committee status	% yes	% yes	% yes	% yes	% yes	*P* value for trend
Does the shop have a written LOTO program?	Present	90	92	81	100	91	0.54
	Absent	60	42	69	67	80	0.006
	Total	71	52	72	81	88	<0.0001
Does the LOTO program designate authorized employees?	Present	86	83	81	100	85	0.68
	Absent	53	44	57	48	80	0.11
	Total	66	53	63	69	84	0.001
For each lock issued to an authorized employee, is there just one key that opens that lock?	Present	85	91	75	87	88	0.67
	Absent	64	49	70	67	80	0.03
	Total	71	57	72	75	86	0.003
Are there records verifying that all employees are trained in LOTO?	Present	73	55	76	80	73	0.46
	Absent	38	22	46	48	50	0.02
	Total	51	28	54	61	67	0.0001
Are there records of annual audits verifying the effectiveness of written LOTO procedures for each machine?	Present	34	36	38	40	27	0.47
	Absent	23	13	23	40	30	0.03
	Total	27	18	27	40	28	0.12

significantly higher in three of the four programs comprising the *safety management audit,* the exception being *JHAs.*

Shops were stratified by the presence or absence of a safety committee within each of the four size ranges (Table V). For all but the largest size category (50–150) shops with a safety committee had a significantly higher *safety management audit* score when compared to those without. Scores for the overall audit and for each program component increased with increasing business size for shops without safety committees. Shops with a safety committee did equally well regardless of size for safety leadership ($P = 0.98$ for trend), job hazard analysis ($P = 0.35$ for trend), machine maintenance ($P = 0.68$ for trend), and LOTO ($P = 0.85$ for trend). Further, the smallest (3–10 employees) shops with safety committees scored higher in the total audit and in each program area than the largest (50–150 employees) shops without safety committees, although the difference in scores was statistically significant only for safety leadership program ($P = 0.001$).

Pearson correlation coefficients were used to determine the relationship between *safety leadership program* scores and the other three *safety management program scores* at each business (Table VI). A significant correlation ($r = 0.527$; $P < 0.0001$) was found between *safety leadership* and *LOTO* program scores. Correlations found between *safety leadership* and the other safety management program scores ranged from a low for *JHAs* ($r = 0.294$; $P < 0.0001$) to moderately high for machine maintenance ($r = 0.462$; $P < 0.0001$) and LOTO ($r = 0.429$; $P < 0.0001$).

S*afety leadership*, *LOTO*, and *machine maintenance* scores were combined into a summary measure and entered into a stepwise regression model with *business-level machine score* as the dependent variable. The *business-level machine score* increased by 0.14% for each percent increase in the summary measure. JHAs were excluded from this model because they were conducted in so few shops. For each percent increase in *machine maintenance* scores there was a 0.12% increase in the *business-level machine score* ($P < 0.0001$). Similarly, as seen in Table VI, *machine maintenance* was the only safety management program having at least a moderately high correlation with *business-level machine score* ($r = 0.388$; $P < 0.0001$).

DISCUSSION

The NMGP provides an important perspective on safety management within small enterprises. The large sample, in combination with data on both hazards and management practices, permits stratification to determine the impact of business size on the presence and quality of safety programs. The presence of a safety committee mitigated the impact of size on all measures. This included risk management programs and policies, systematically conducting inspections of machines and machine safeguards, and carrying out

TABLE V. Safety Committee, Business Size, and Safety Management Program Scores

				Programs within the safety management audit									
	Safety committee status			Safety leadership[a]		Job hazard analysis		Machine maintenance		Lockout/tagout		Overall safety management audit[a]	
Number of employees		%	n	Mean %	SD	Mean %	SD	Mean %	SD	Mean %	SD	Mean %	SD
All	Present	37	81	79	17	13	27	48	28	73	28	55	18
	Absent	63	140	51	21	7	21	38	26	47	38	36	18
				$P < 0.0001$		$P = 0.0613$		$P = 0.0061$		$P < 0.0001$		$P < 0.0001$	
≤10	Present	20	12	81	20	11	25	47	30	72	33	57	24
	Absent	80	48	43	20	5	20	31	27	33	37	29	20
				$P < 0.0001$		$P = 0.3673$		$P = 0.0934$		$P = 0.0013$		$P = 0.0001$	
11–29	Present	26	21	76	20	19	35	47	30	70	33	54	20
	Absent	74	61	55	20	2	7	41	22	53	36	38	14
				$P = 0.0001$		$P = 0.0329$		$P = 0.3220$		$P = 0.0572$		$P = 0.0023$	
30–49	Present	42	15	80	13	18	25	50	30	81	16	58	15
	Absent	58	21	60	17	15	31	43	29	54	37	44	19
				$P = 0.0005$		$P = 0.7140$		$P = 0.4952$		$P = 0.0050$		$P = 0.0240$	
50–150	Present	77	33	79	16	8	23	50	28	72	27	54	16
	Absent	23	10	50	17	29	33	44	29	64	37	45	20
				$P < 0.0001$		$P = 0.0313$		$P = 0.6007$		$P = 0.4557$		$P = 0.1604$	

[a]Excluding questions on safety committee.

training and documentation required for an effective LOTO program.

This finding is consistent with previous work documenting the importance of worker engagement in health and safety (e.g., Smitha et al., 2001; Mahan et al., 2013). In addition to the safety committee, safety leadership encompasses numerous factors associated with lower injury rates such as management commitment to safety [Simonds and Shafai-Sahrai, 1977; Smith et al., 1978; Habeck et al., 1991; Gilkey et al., 2003], designating person(s) responsible for safety [Shannon et al., 1997], incident investigation and recordkeeping [Simonds and Shafai-Sahrai, 1977; Smith et al., 1978], and effective enforcement of safety policies [Bull, 2007].

In the MN-MGS, regardless of size, businesses with safety committees were found to have better safety practices when compared to those without ($P < 0.004$ for trend) [Samant et al., 2007]. The MN-MGS found that 57% of participating businesses (n = 40) had a safety committee at baseline [Brosseau et al., 2007] compared with 37% in the NMGP. Overall safety audit scores were 55% versus 36% ($P < 0.0001$) in the NMGP and 71% versus 55% ($P = 0.0003$) in the MN-MGS for businesses with and without a safety committee respectively [Samant et al., 2006].

In the NMGP, the presence of safety management programs had a small but positive impact on decreasing physical hazards related to machines. This was largely mediated by the presence of machine maintenance programs. For every 1% increase in a business' *machine maintenance score* there was a 0.14% reduction in machine-related hazards. This represents a 14% difference in machine

TABLE VI. Correlation Between Four Safety Management Program Scores and Business-Level Machine Score

	Business level machine score		JHA program score		LOTO program score		Machine maintenance program score	
	Pearson correlation	*P* value	Pearson correlation	*P* value	Pearson correlation	*P* value	Pearson correlation	*P* value
Safety leadership program score	0.189	0.004	0.294	<0.0001	0.527	<0.0001	0.462	<0.0001
Business-level machine score			0.142	0.03	0.258	<0.0001	0.388	<0.0001
LOTO program score							0.429	<0.0001

safeguarding practices between shops that regularly conduct systematic, written inspections of the conditions of machines and guards and those that do not.

In the MN-MGS, adding a safety committee was the most important factor in shops showing improvement over the course of the intervention. Business that added a safety committee showed a 13% improvement in machine guarding and 23% improvement in safety measures. In the MN-MGS, statistical significance was constrained by the small sample size [Parker et al., 2009]. Although NMGP data show that the presence of a safety committee is likely to result in an overall improvement LOTO and machine safety programs; even among shops with a safety committee, many were missing either LOTO programs (10%), did not designate authorized employees (14%), did not have records to verify employee training in LOTO (27%), or did not conduct machine safety audits on a regular basis (56%). Thus, while having a safety committee may be the best means of addressing important problems, it is not in itself sufficient to ensure many important problems are addressed.

Barriers to improving workplace safety exist at the owner as well as the worker levels. Social research indicates that small business owners may: (i) see themselves as "one of the guys"; (ii) feel that they lack authority to impose health and safety rules; (iii) believe rules are an infringement of workers' individual rights; (iv) not regard health and safety as part of their everyday management role; (v) discount the severity of health hazards present in their businesses and/or minimize the need for regulation [Eakin, 1992; Hasle et al., 2011; Parker et al., 2012]; or (vi) not be aware of the benefits of safety management [Vaz Junior et al., 2012]. Simultaneously, employees may (i) downplay risk; (ii) see risk as inherent in their job; and (iii) feel they ought to navigate risk primarily through cautious work practices [MacEachen et al., 2010; Parker et al., 2012].

Most studies related to human resource management have focused on large-scale enterprises. There is a tendency to assume that findings from large enterprises may be automatically applied to small enterprises [Wilkinson, 1999]. Management practices shown to increase business performance include, among others, the use of teams and opportunities for training and development. These same practices have also been shown to increase employee effort. However, it is not clear how—or if—findings from large enterprises ought to be applied to small business [Allen et al., 2013].

In small businesses, human resources management and business administration become more structured as business size increases [Barber et al., 1999; Kotey and Slade, 2005; Vaz Junior et al., 2012]. Small firms may lack the technical knowledge necessary to develop and implement formalized human resource practices [Vaz Junior et al., 2012; Allen et al., 2013]. Additionally, autonomous and self-directed work is seen as an important aspect of management commitment to employees of small firms [Allen et al., 2013]. Surprisingly, with regard to health and safety, focus groups indicate that workers prefer formal to informal work practices [Parker et al., 2012].

As firms grow, there are pressures to formalize human resource management practices [Storey et al., 2010]. 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 where employee satisfaction may be low [Wilkinson, 1999; Eakin et al., 2003; Saridakis et al., 2013].

Numerous investigators have reported that small industrial firms lack occupational safety and health programs and infrequently engage the services of an occupational safety and health professional [Leviton and Sheehy, 1996; Bradshaw et al., 2001; Lentz et al., 2001; Champoux and Brun, 2003; Eakin et al., 2010; Parker et al., 2012]. Data from the NMGP indicate that management practices within small firms may be an underlying impediment to the implementation and maintenance of best practices with regard to safety and health. Hasle and Limborg [2006] note the importance of the owner as central in small enterprises. Although the NMGP did not assess the roles of specific individuals, it is clear that if there is shared responsibility for safety leadership, numerous aspects of safety are likely to improve.

To address this problem, the NMGP intervention prioritized establishment of a safety leadership structure as a basis for implementing sustainable, cost-effective programs in LOTO and machine safety. Business safety assessments and intervention delivery were conducted on-site at each business. This was done using a consultative approach customized to each business [Hasle and Limborg, 2006].

Limitations

The principal limitation of this study was inability to determine causality because of its cross-sectional design as well as the high level of correlation between each of the four components of the safety management audit score. A second limitation is that participating sites were not randomly selected. To meet recruitment goals and form a nationwide sample, safety consultants recruited as many shops as possible from the pool of business to which they personally provided services. Owners participated on a voluntary basis, which could potentially have skewed the sample toward higher-performing shops. However, the fact that most shops scored poorly in at least some categories of the safety audit indicates that there remains substantial room for improvement in both safety leadership and machine safety.

Conclusions

NMGP data show that a safety committee is correlated with better safety management program scores even in the smallest shops. These findings are consistent with business management literature noting the importance of worker engagement. On a national basis, data from the NMGP indicate a need for more comprehensive enforcement of the machine guarding and lockout/tagout standards, and to encourage businesses in all size ranges to establish and maintain a safety committee.

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