Sociodemographic Differences in Perceptions of Occupational Safety Climate

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ABSTRACT

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Objective: To examine the impact of race, ethnicity, gender, and nativity (country of birth) on worker perceptions of occupational safety climate.

Methods: A cross-sectional analysis was performed on 182 worker self-report questionnaires administered across six metals processing industries. Questionnaires surveyed occupational safety climate, as measured by 50-item Nordic Occupational Safety Climate scale (NOSACQ-50). The NOSACQ-50 tool addresses how workers perceive their management and co-worker's commitment to safety through seven subscales (management safety priority, empowerment, justice and worker safety commitment, safety priority/risk-non acceptance, safety communication and trust in safety ability). Respondents were also asked additional demographic information, and self-reported injury experience. Means comparisons were performed to determine significant differences in associations between sociodemographics and the seven NOSACQ-50 subscales as outcome measures. Age, education, and injury experience are identified as potential effect modifiers, and were adjusted for multiple regression models.

Results: Ethnicity and nativity were associated with significant outcome differences for six out of seven safety climate (NOSACQ-50) subscales. Black workers ranked their climate perceptions more favorably than White workers. Hispanic and foreign-born workers had the least favorable perceptions of their occupational safety climate compared to non-Hispanic and native-born workers. Educational attainment and company, while significant predictors, were not shown to substantially influence climate perceptions relative to workers' ethnicity and nativity. The results underscore the importance of developing diagnostic tools sensitive enough to capture potential safety barriers experienced by diverse worker populations and companies.

Table of Contents

INTRODUCTION

The occurrence of non-fatal, work-related accidents and injuries is associated with how a worker perceives their management's commitment toward safety, or safety climate [1]. Safety climate can be thought of as the shared group beliefs, values and perceptions about workplace safety at a point in time [1]. A positive safety climate is thought to influence the adoption of individual and co-worker safety behavior, fostering a safer work environment, which leads to decreased accident and injury occurrence, along with greater production and increased employee morale. Often used interchangeably, safety climate is different from safety culture in that it the latter provides a historical perception of now safety is operationalized in the workplace. Additionally, safety climate perceptions, as "snap shot" measures, are sensitive to workplace incidents (i.e., fatalities, job loss), fluctuations in production, and changes in managerial structure. Safety climate can be measured by the use of employee surveys, and are particularly useful for high-hazard, injury prone industries.

The changing workplace has provided numerous challenges to achieving optimum safety climate. In response to increasing costs of production and overall decreases in demand, firms are pressured to use cost-cutting measures, often to the health and safety detriment of their employees. Lower income minorities, immigrants, and other disadvantaged groups make up a sizable percentage of impacted workers, and are often the most burdened by changes in organizational structure and company downsizing. These experiences may include decreases in wage, job insecurity, increases in the severity and duration of job tasks, higher risk of accidents and injuries, less access to adequate healthcare services and unpredictable shift scheduling, including night work.

Underserved workers, particularly Hispanics, are disproportionately employed in more hazardous trades and experience higher rates of fatal occupational injuries [2]. Hispanic workers have the highest fatality rates in the construction industry, comprising every 1 and 4 construction deaths. Additionally, Hispanic workers have a 20% higher risk of dying from

an occupational injury. The risk is higher for Hispanic workers who were born outside of the United States.

Discrimination, sexism, lack of worker empowerment, job insecurity and other psychosocial demands of work can account for these disparities, and have been explored in the literature [3-7]. Additional factors can be linked to 1) low understanding of legal rights 2) accident and injury underreporting and 3) job insecurity and control. It is also argued that the high occupational injury rate experienced by underserved workers is a direct consequence of their disproportionate employment in hazardous industries.

This paper attempts to bridge the gap between worker sociodemographics and perceptions of their safety climate, which is underexplored in the literature. It is commonly understood that a positive safety climate is associated with higher worker safety performance. Higher safety performance is also linked to reductions in workplace accident and injury occurrence. Since minority and immigrant workers are statistically injured more on the job, it is important to explore if these workers perceive their firm's safety climate positively or negatively, as the magnitude of these perceptions can serve as potential indications for their occupational and injury risk.

Background: Sociodemographic Differences in Occupational Health and Safety

Race

The racial and ethnic makeups of workers are primary predictors of disparities in occupational illnesses and injuries. Hispanic workers are more likely than their white counterparts to experience work-related illness, injury and assault [8]. There have been attempts to explore if other characteristics, independent of race, hold more predictive value in determining likelihood of injury. Particularly differentiating race from other demographic characteristics, Oh and Shin show no association between race and non-fatal work injury; citing human capital in the form of education and work experience as the primary determinant [9]. They argue the more formal education the worker receives, the more likely they are to exhibit and adhere to safe behaviors, regardless of their race. In contrast, Murray [4] and Robinson [10] mention that even with the same level of education and work experience, minorities, particularly Blacks, are disproportionately exposed to more dangerous job tasks compared to their White counterparts.

Ethnicity and Nativity

Hispanic workers are often referred to as a single group, however, the experiences of native or U.S. born Hispanics compared to those foreign born are quite different. Native-born Hispanics are more closely assimilated with U.S. customs regarding rights, liberties, laws, education and English proficiencies. A study by the Pew Research Hispanic Center found that 88 percent of native-born Hispanics have completed high school, compared to 67 percent that are foreign-born [11]. Roughly 54 percent of Hispanic workers are foreign-born, but make up 66 percent of all Hispanic fatal occupational injuries [2]. Differing cultures and attitudes regarding safety in the birth countries of foreign-born Hispanics is also said to be a factor their increased occupational exposure and injury risk.

Gender

The extent to which men and women differ in their occupational exposures could be a function of work task, rank, security and other work organizational attributes. As to why men and women have different occupational exposures, Quinn provides three reasons: 1) men and women work in different jobs, 2) men and women report their experience of occupational exposures differently, and 3) Men and women actually do experience different exposures within the same job task. A population-based telephone survey of workers 20-64 years old, reported that males are two to four times as likely to report dust and chemical exposures, whereas women are 30 percent likely to report repetitive tasks, awkward postures, and working at high speeds [12]. Gendered differences in assignment tasks play a role in exposures, salary, and ease of job promotions.

Language and Communication

Safety communication remains a concern for multilingual workers, particularly those absent English speaking proficiencies. The question remains whether these barriers account for the disproportionate injury rates among Hispanic workers. Roelofs and co-authors concluded in a focus group study of unionized and non-unionized Hispanic construction workers that cultural and language differences were not perceived to be causative reasons behind higher injury and death rates [13]. Alternatively, Alsamadani and colleagues determine that unilingual work crews have 51% greater safety performance relative to multilingual crews [14].

General Study Aims, Hypotheses and Significance

Our principal aim in this study is to determine if there is evidence of climate differences among a cohort of workers by sociodemographic group. If such climate differences are present, we examine how, and in which ways those perceptions may be modified by a worker's educational attainment, and employer (management). In general, we anticipated less favorable climate perceptions among minority, foreign-born Hispanic, and female workers. Additionally, we hypothesized that a worker's educational attainment and employer will modify associations between our primary sociodemographic predictors and safety climate outcomes. Specifically, we expected workers without a high school diploma/GED, and workers employed in smaller, ethnically diverse companies to negatively modify the associations between our predictors and outcomes. Lastly, among our covariates (educational attainment and company) we anticipated that company more substantially influences climate perceptions relative to individual worker educational attainment.

Our work is particularly novel in a few respects. First, we use safety climate in association with occupational health and safety disparities, which deviates from the traditional use of safety climate as solely a predictive tool for accidents and injuries. Second, since safety climate is considered a group phenomenon we argue that the literature falls short in addressing meaningful "in-group" differences in worker climate perceptions. Sociodemographic differences in perceptions of safety climate can underscore important structural and institutional inequalities and other barriers to workplace safety. Lastly, this work differentiates safety climate from psychosocial factors experienced by workers. There is nominal overlap, but generally psychosocial dynamics are described by the various stressors/strains, job security and work-life balance issues which result from the work environment and perhaps the job task itself. Both psychosocial safety climate and managerial safety climate have been explored as separate constructs [15].

SPECIFIC AIMS

In the workplace environment, does a worker's race, ethnicity, gender or nativity influence their perception of their firm's occupational safety climate?

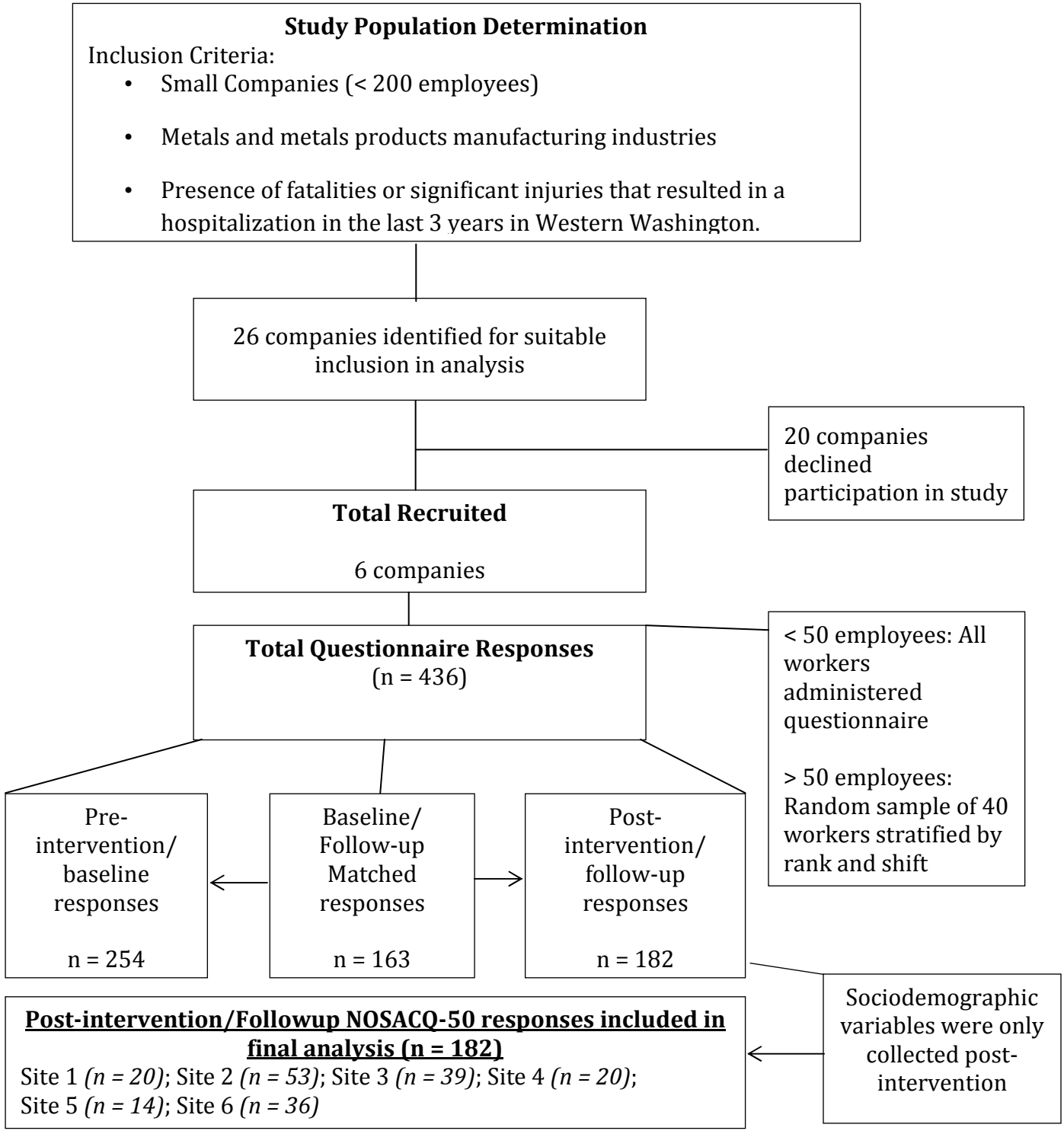
Specific Aim 1: To examine and compare in a cross-sectional study:

1. Means of overall safety climate scales and subscales from a cohort of metals products manufacturing workers
    a. Testing Procedure - Differences in Means (ANOVA)
    H_0: There will be no difference in perception of safety climate among workers of varying race, ethnicity, or nativity.

Specific Aim 2: To evaluate the association between a worker's race, ethnicity, or nativity and a safety climate dimension (management safety priority) in the presence or absence of educational attainment and employer.

2. Testing Procedure – Multiple Regressions
    H_0: There is no relationship between race, ethnicity, or nativity and worker's perceptions of management safety priority, regardless of a worker's educational attainment and employer.

Figure 1: Process Flow Chart



Study Design

This work is a sub-component of a larger study assessing the effectiveness of health and safety committees in small scale metals and metals products manufacturing industries in Washington State [16]. While employers with more than 11 workers are required to have health and safety committees in Washington State, the effectiveness of these committees in addressing, implementing and thereby reducing safety barriers remain unclear.

A total of 26 companies were determined suitable for study inclusion, with a final recruitment of 6 companies (Figure 1). Worksite characteristics are below.

Site 1 – This site is a large foundry with approximately 260 non-unionized workers. This foundry is the site for numerous United States military nuclear defense contracts. English makes up the large language proficiency in this workplace.

Site 2– This site is a large forge employing 150 non-unionized workers. This workforce is largely comprised of English speakers with varying native speaking proficiencies.

Site 3 – This site is a large scrap metal recycling facility with roughly 100 workers working two shifts. Union representation varies by job task (cranes, mechanics). The organizational hierarchy is comprised of a general manager, department/area manager and direct shift supervisors. The workers are mostly native English speakers with some native Spanish speakers with various English proficiencies.

Site 4– Site 4 is a small, non-unionized scrap metal recycling facility with roughly 25 employees. The majority of workers are native English speakers with a small portion of Spanish speakers with various English-speaking proficiencies. Organizational hierarchy is mostly confined to the direct supervisor, although the site has a general manager. Safety concerns expressed at this site include ergonomic stressors, potential cuts and scrapes and mobile traffic. This site has not had an OSHA recordable injury in the past three years.

Site 5 – Site 5 is a small foundry with 28 non-unionized workers over two shifts. The primary speaking proficiencies are English and Somali. Some workers were employed directly through a service for refugees. There are two foremen and the site's owners, which handle most safety and production issues.

Site 6 – This foundry is composed of roughly 120 non-unionized workers. The primary speaking proficiencies are English.

Employees at each site were surveyed at baseline (pre-intervention) for chemical, physical and ergonomic exposures, musculoskeletal constraints and safety climate. Post-intervention surveys were also administered to assess changes in responses. Questionnaire responses were collected on a tablet, utilizing mobile data input platform (ODK) software. Questionnaires were administered to all workers on each site, if less than fifty workers. If more than fifty workers were present, a random sample of forty workers was taken, stratified by department and shift. Average duration of each questionnaire was roughly 30 minutes. The same questionnaire was used in both pre- and post-intervention surveys.

436 study questionnaires were administered in total. 254 employees were surveyed at baseline/pre-intervention, 182 post-intervention/follow-up and 163 workers had both baseline and follow-up matched responses. Since the demographic information was only collected at follow-up, only the 182 post-intervention/follow-up responses were included for analysis.

Questionnaire included broad sections addressing workers':

- Health and safety committee experiences
- Exposures (chemical, physical)
- Musculoskeletal/ergonomic constraints
- **Safety Climate (NOSACQ-50)**

Safety Climate Questionnaire– NOSACQ-50

The Nordic Safety Climate Questionnaire (NOSACQ-50) is a 50-item assessment of worker and management commitment toward prioritizing, empowering and understanding safe behaviors. The Nordic model has been validated across multiple industries, and thus do not directly take into account the nature of work or the variability in safety and health hazards among specific job tasks. Particularly relevant to this paper's focus of sociodemographics as a source of variable attitudes toward safety climate, the questionnaire also gauges aspects of safety justice, risk acceptance, and trust in safety establishment and systems.

The Nordic Safety Climate Questionnaire (NOSACQ-50) assesses safety climate through seven dimensions:

1) Management safety priority **(9 items)**
2) Management safety empowerment **(7 items)**
3) Management safety justice **(6 items)**
4) Worker safety commitment **(6 items)**
5) Worker safety priority and risk non-acceptance **(7 items)**
6) Safety communication **(8 items)**
7) Trust in the efficacy of safety systems **(7 items)**

Examples include "Management encourages employees here to work in accordance with safety rules – even when the work schedule is tight" or "We who work here have confidence in the management's ability to deal with safety". Full questionnaire items are found in the appendix.

NOSACQ-50 Scoring

NOSACQ-50 responses were assessed in Likert format (1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree) with both positive and reversed, or negated responses [12]. Mean responses for NOSACQ-50 items are analyzed per respondent or group, by dimension. Individual mean scores are a function of the number of positive and reversed responses divided by the number of answered questions.[1]

For example, [17] an individual's mean perception of their management's safety priority (dimension 1) will be calculated by:

$$\text{Mean NOSACQ score(Dimension 1)} = \frac{[\text{Item}_1+\text{Item}_2+(5-\text{Item}_3)+\text{Item}_4+(5-\text{Item}_5)+\text{Item}_6+\text{Item}_7+(5-\text{Item}_8)+\text{Item}_9]}{\text{Total number of unanswered responses}}$$

Individual scores are omitted from calculations if a respondent answers less than 50% of items within a dimension.

Data Analysis

All NOSACQ responses (n=182) were answered within each subscale except for management safety justice (n=178). NOSACQ-50 and additional questionnaire responses were analyzed using STATA/IC version 12.

Student's t-test, or analysis of variance (ANOVAs) tested the association between sociodemographic characteristics (race, ethnicity, nativity, and gender) and perceptions of safety climate, as measured by dimensions 1-7 in the NOSACQ-50 survey.

Multiple regression analyses were performed using a set of covariates based, in part, on established literature and perceived influential modifiers on the association between our primary sociodemographic predictors and the seven NOSACQ-50 dimensions as outcome measures.

[1] Reference Appendix

Models were adjusted for the influence of educational attainment and employer. Educational attainment serves as a significant proxy to socioeconomic status and is commonly adjusted for. Climate research suggests that there are differences in company and management organizational operations even within similar industries. P-values are reported based on a threshold of 0.05, and will be considered meaningful additions to our analysis. P-values of 0.05-0.10 will be regarded as suggestive evidence for statistical inference.

RESULTS

Worker Demographics and Company Characteristics

Summary characteristics are provided for the survey cohort (N=182). Respondents' age range from 22 to 70 years old with a mean age across companies of 42. Site 1 has the highest average worker age (48 years old) and Site 4 has the lowest (36 years old). Site 3 is the only company to have active union representation among workers.

75% of the all respondents are Caucasian, followed by African-American (9%), Asian (8%), and Native American/Pacific Islander/Other (7%). Site 3 has the highest proportion of self-identified White workers (92%), followed by Site 6 (89%), Site 4 (85%), Site 1 and 5 (70%). Slightly over half of the workers at Site 2 are Caucasian. African-American respondents are most represented by sites 2 (23%) and 5 (21%). There are no African-American respondents from sites 1 and 4. Site 1 employs a quarter of Asian respondents. Workers who identified their race as Native American/Pacific Islanders/Other are mostly employed in Site 2. Site 2 is the most racially diverse company with 47% of their employees identifying as a minority race (non-Caucasian).

Approximately 27% of all respondents are foreign-born. Half of workers employed by Site 5 are foreign-born followed by Site 6 (39%), Site 1 (35%), Site 3 (31%), Site 4 (20%), and Site 2 (9%).

The large majority of all respondents have a high school education or higher (90%). Among companies, Site 5 employs the highest proportion of workers without a high school diploma (29%), followed by Site 6 (14%), Site 3 (15%). Sites 1 and Sites 3 have a majority of their workforce with higher than a high school education (vocational school or 4-year college degree).

Table 1: Descriptive Summary of Worker Demographics and Job Characteristics, by Company

		Company							
		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	*All*	**% of Total**
Study Demographics	Number of Employees Surveyed	20	53	39	20	14	36	*182*	-
Hispanic		0	5	12	3	6	13	*39*	21%
Race									
	White	14	28	36	17	10	32	*137*	75%
	African-American	0	12	1	0	3	1	*17*	9%
	Asian	5	2	2	3	1	2	*15*	8%
	Other*	1	11	0	0	0	1	*13*	7%
Foreign Born (outside U.S.)		7	5	12	4	7	14	*49*	27%
Age (years)		47 (11.6)	42 (12.2)	43 (12.3)	37 (9.1)	42 (9.8)	37 (10.9)	*42 (11.9)*	-
Gender (Female)		0	4	2	1	0	3	*10*	5%
Education									
	< High School High School	0	3	5	1	4	5	*18*	10%
	High School/GED Equivalent	6	28	10	10	6	20	*80*	44%
	Some College/Vocational School	13	20	20	8	3	8	*72*	40%
	Finished College	1	2	4	1	1	3	*12*	7%
Self-Reported Injury in Past Year		1	15	9	2	3	4	*34*	19%

**American Indian, Alaskan Native, Native Hawaiian, Pacific Islander, Other*

NOSACQ-50 Response by Sociodemographic Predictors and Company

The 182 post-intervention/follow-up responses were measured in 4-scale, Likert format. Observed values were calculated within each dimension to determine an individual worker's mean response. If a respondent did not answer more than 50% of questions within a certain dimension, these answers were omitted from the total mean. One dimension (Management Safety Justice) has 6 missing worker mean scores (n=176).

A NOSACQ score of more than 3.30 indicates a good level of occupational safety climate, allowing for maintaining and continuing developments. A score of **3.00 to 3.30** results in a fairly good level, with slight need of improvement. A score of **2.70 to 2.99** shows a fairly low level with need of improvement. A score below **2.70** indicates a low level with great need of improvement.

Table 2 presents the descriptive analysis of safety climate response by primary sociodemographic predictors and company. Across all dimensions, African-American workers ranked highest in occupational safety climate perception, with Asians and Whites experiencing the lowest. Hispanic workers regardless of race and nativity experience the lowest overall perceptions of safety climate out of each sociodemographic predictors. Gender is excluded from analysis due to low number of study respondents (n=10).

Safety climate perceptions (scores) differed significantly as a function of: Ethnicity in 6/7 dimensions ($p < 0.05$); Nativity in 4/7 dimensions ($p < 0.01$) and Company in 6/7 dimensions ($p < 0.001$). Specifically, non-Hispanic and native-born workers have 0.23 higher management safety priority score relative to non-Hispanics and foreign-born workers. Each NOSACQ-50 subscale (low, fairly low, fairly good, good) is separated by approximately 0.30 points, so the numeric mean difference in climate responses can potentially indicate close to a unit increase in NOSACQ-50 safety climate categorization

[for example, fairly low → fairly good] for non-Hispanic and native-born workers, relative to Hispanic and foreign-born workers. Nativity, defined by being born in or outside of the U.S. is strongly associated with differences in safety climate perceptions. Foreign-born workers share a less favorable safety climate perceptions compared to native-born workers.

Across all seven dimensions, Site 4 has the highest-ranking safety climate perception among the companies. Site 3 and Site 6 have the lowest overall ranking safety climate perceptions. Worker safety priority and Management safety justice were lowest ranking by site. Management safety priority, Safety communication and learning and Trust in the efficacy of safety systems were the highest-ranking dimensions among workers by company.

Table 2: NOSACQ-50 Mean Safety Climate Scores, by Sociodemographic Predictors and Company (n = 182), p < 0.05

	Predictors	N		Management Safety Priority	Management Safety Empowerment	Management Safety Justice	Worker's Safety Commitment	Worker's Safety Priority	Safety Comm.	Trust in Safety Systems
Race	Asian	15	Mean	3.03	2.98	2.85	3.13	2.77	3.13	3.05
			SD	0.37	0.38	0.59	0.36	0.31	0.34	0.23
	Black	17	Mean	3.13	3.03	2.96	2.98	2.83	3.04	3.15
			SD	0.24	0.29	0.35	0.33	0.23	0.28	0.31
	White	137	Mean	2.93	2.90	2.89	3.02	2.79	3.08	3.13
			SD	0.46	0.40	0.41	0.34	0.37	0.37	0.36
	Other*	13	Mean	3.24	3.06	3.13	3.18	2.95	3.18	3.16
			SD	0.42	0.41	0.39	0.27	0.36	0.41	0.40
	Significance			**0.042**	0.327	0.223	0.213	0.498	0.669	0.797
Ethnicity	Non-Hispanic	39	Mean	2.79	2.73	2.82	2.90	2.66	2.92	3.02
			SD	0.39	0.33	0.28	0.25	0.31	0.22	0.18
	Hispanic	137	Mean	3.02	2.98	2.93	3.07	2.84	3.13	3.16
			SD	0.45	0.39	0.45	0.35	0.36	0.38	0.38
	Significance			**0.003**	**0.000**	0.141	**0.005**	**0.006**	**0.001**	**0.023**
Nativity	Foreign-Born	49	Mean	2.83	2.82	2.82	2.95	2.75	2.95	3.03
			SD	0.35	0.36	0.41	0.28	0.30	0.19	0.20
	Native-Born	133	Mean	3.04	2.97	2.94	3.07	2.83	3.14	3.17
			SD	0.46	0.39	0.42	0.35	0.37	0.39	0.38
	Significance			**0.004**	**0.021**	0.107	**0.036**	0.185	**0.001**	**0.019**
Company	Site 1	20	Mean	3.01	3.01	2.89	3.04	2.84	3.03	3.09
			SD	0.39	0.38	0.41	0.30	0.16	0.25	0.29
	Site 2	53	Mean	3.16	3.07	3.07	3.12	2.89	3.20	3.21
			SD	0.40	0.36	0.36	0.32	0.39	0.37	0.36
	Site 3	39	Mean	2.74	2.77	2.61	2.93	2.65	3.00	3.11
			SD	0.41	0.41	0.46	0.29	0.37	0.30	0.36
	Site 4	20	Mean	3.26	3.15	3.13	3.30	2.98	3.33	3.21
			SD	0.37	0.36	0.33	0.43	0.32	0.45	0.41
	Site 5	14	Mean	2.98	2.91	2.95	2.93	2.84	3.02	3.04
			SD	0.28	0.22	0.34	0.13	0.32	0.26	0.28
	Site 6	36	Mean	2.80	2.74	2.89	2.91	2.74	2.93	3.03
			SD	0.47	0.34	0.35	0.33	0.33	0.33	0.32
	Significance			**< 0.001**	**< 0.001**	**< 0.001**	**< 0.001**	**0.004**	**< 0.001**	0.154

Multiple Regression Analysis

Multiple linear regression models were built to estimate the effects of educational attainment and company on the association between our primary predictors (race, ethnicity, nativity) and the seven NOSACQ-50 dimensions as safety climate outcome measures. Asian (Race), High School diploma/GED equivalent only (Education), and Site 1 (company) serve as our reference values. Full models (adjusted for both company and education) with all predictor coefficients are included in Appendix 3-9.

NOSACQ-50 outcome measures were predicted by sociodemographics, company, and educational attainment, which explains < 10% of the variance in safety climate perceptions, particularly among workers who self-identify as Hispanic and foreign-born.

Adjusting for the effects of educational attainment, and company, Non-Hispanic workers relative to Hispanic workers experience higher perceptions of their management safety priority ($\beta = 0.21$, $p < 0.01$) [Table 3], safety empowerment ($\beta = 0.21$, $p < 0.01$) [Table 4], safety justice ($\beta = 0.12$) [Table 5], co-worker safety commitment ($\beta = 0.15$, $p < 0.01$) [Table 6], priority ($\beta = 0.18$, $p < 0.01$) [Table 7], safety communication ($\beta = 0.19$, $p < 0.01$) [Table 8], and trust in safety systems ($\beta = 0.12$, $p < 0.01$) [Table 9].

Native-born workers relative to foreign-born workers also perceive their safety climate more favorably within dimensions: management safety priority ($\beta = 0.18$, $p < 0.01$) [Table 3], safety empowerment ($\beta = 0.12$, $p < 0.05$) [Table 4], safety justice ($\beta = 0.11$) [Table 5], co-worker safety commitment ($\beta = 0.10$, $p < 0.05$) [Table 6], co-worker safety priority ($\beta = 0.07$) [Table 7], safety communication ($\beta = 0.17$, $p < 0.01$) [Table 8], and trust in safety systems ($\beta = 0.12$, $p < 0.01$) [Table 9].

The coefficient estimates relate to the increase (positive) or decrease (negative) in mean NOSACQ-50 climate scores. As stated, the scoring rubric is divided into 0.30-point intervals (low → fairly low → high → fairly high). Coefficient estimates, particularly as shown in the

management safety priority model of 0.21 can influence a higher or lower categorization of safety climate within those dimensions. The numerical values of beta coefficients are of interest, however, we are particularly interested in the magnitude of change in the coefficients and goodness of fit resulting from the addition of covariates (educational attainment and company) within the model. The addition of both company and education as covariates do not alter the coefficient estimates or goodness of fit in the models (Table 3-7). We determine that management (company) and educational attainment, while significant predictors, does not substantially influence climate perceptions relative to a worker's ethnicity and nativity.

Table 3: Multiple Regression Analysis of the relationship between sociodemographics and **Management safety priority** adjusted for influences of covariates

		Unadjusted	Adj. (Educ.)	Adj. (Educ. & Company)
Race	R^2	0.04	0.05	0.07
	Black	.10(.11)	.08(.11)	.07(.11)
	White	-.10(.10)	-.12(.10)	-.10(.10)
	Other	.21(.15)	.17(.15)	.13(.16)
Ethnicity	R^2	0.05	0.06	0.08
	Non-Hispanic	.24(.07)**	.25(.07)**	.21(.07)**
Nativity	R^2	0.04	0.05	0.08
	Native-Born	.21(.06)**	.21(.06)**	.18(.06)**

$p < 0.01$** $p < 0.05$*

Other - American Indian, Alaskan Native, Native Hawaiian, Pacific Islander

Ref: Race (Asian), Ethnicity (Hispanic), Nativity (Foreign-Born)

Table 4: Multiple Regression Analysis of the relationship between sociodemographics and **Management safety empowerment**, adjusted for influences of covariates

		Unadjusted	Adj. (Educ.)	Adj. (Educ. & Company)
Race	R^2	0.02	0.02	0.06
	Black	.02(.12)	.05(.12)	.03(.12)
	White	-.08(.10)	-.07(.10)	-.05(.10)
	Other	.08(.15)	.10(.15)	.05(.15)
Ethnicity	R^2	0.08	0.07	0.1
	Non-Hispanic	.26(.06)**	.25(.06)**	.21(.06)**
Nativity	R^2	0.03	0.03	0.07
	Native-Born	.15(.06)**	.15(.06)**	.12(.06)*

Table 5: Multiple Regression Analysis of the relationship between sociodemographics and **Management safety justice** adjusted for influences of covariates

		Unadjusted	Adj. (Educ.)	Adj. (Educ. & Company)
Race	R^2	0.02	0.02	0.03
	Black	.12(.17)	.11(.17)	.11(.18)
	White	.04(.16)	.03(.16)	.04(.16)
	Other	.28(.19)	.27(.19)	.26(.19)
Ethnicity	R^2	0.01	0.02	0.02
	Non-Hispanic	.11(.06)	.12(.06)*	.12(.06)
Nativity	R^2	0.01	0.02	0.02
	Native-Born	.12(.07)	.12(.07)	.11(.07)

Table 6: Multiple Regression Analysis of the relationship between sociodemographics and **Worker's safety commitment** adjusted for influences of covariates

		Unadjusted	Adj. (Educ.)	Adj. (Educ. & Company)
Race	R^2	0.02	0.03	0.05
	Black	-.16(.12)	-.16(.12)	-.17(.12)
	White	-.12(.09)	-.12(.09)	-.10(.10)
	Other	.05(.12)	.03(.12)	.004(.12)
Ethnicity	R^2	0.04	0.05	0.06
	Non-Hispanic	.17(.05)**	.18(.05)**	.15(.05)**
Nativity	R^2	0.02	0.03	0.05
	Native-Born	.12(.05)**	.12(.05)**	.10(.05)*

Table 7: Multiple Regression Analysis of the relationship between sociodemographics and **Worker's safety priority** adjusted for influences of covariates

		Unadjusted	Adj. (Educ.)	Adj. (Educ. & Company)
Race	R^2	0.01	0.02	0.02
	Black	-.06(.09)	.05(.09)	.04(.09)
	White	-.02(.08)	.006(.08)	.01(.08)
	Other	.17(.12)	.15(.13)	.13(.13)
Ethnicity	R^2	0.04	0.05	0.05
	Non-Hispanic	.18(.06)**	.19(.06)**	.18(.06)**
Nativity	R-square	0.01	0.02	0.02
	Native-Born	.08(.05)	.08(.05)	.07(.05)

Table 8: Multiple Regression Analysis of the relationship between sociodemographics and **Safety Communication** adjusted for influences of covariates

		Unadjusted	Adj. (Educ.)	Adj. (Educ. & Company)
Race	R^2	0.01	0.01	0.04
	Black	-.09(.10)	-.10(.11)	-.11(.11)
	White	-.05(.09)	-.06(.09)	-.05(.09)
	Other	.05(.14)	.04(.14)	.003(.14)
Ethnicity	R^2	0.06	0.06	0.08
	Non-Hispanic	.21(.05)**	.22(.05)**	.19(.05)**
Nativity	R^2	0.06	0.06	0.07
	Native-Born	.19(.04)**	.19(.04)**	.17(.04)**

Table 9: Multiple Regression Analysis of the relationship between sociodemographics and **Trust in Safety Systems** adjusted for influences of covariates

		Unadjusted	Adj. (Educ.)	Adj. (Educ. & Company)
Race	R^2	0.01	0.01	0.03
	Black	.10(.09)	.12(.10)	.11(.09)
	White	.08(.07)	.10(.07)	.12(.07)
	Other	.12(.12)	.15(.13)	.12(.13)
Ethnicity	R^2	0.03	0.03	0.04
	Non-Hispanic	.12(.04)**	.14(.04)**	.12(.05)**
Nativity	R^2	0.03	0.03	0.04
	Native-Born	.14(.04)**	.13(.04)**	.12(.05)**

DISCUSSION

Results Summary

- Safety climate perceptions (scores) differed significantly as a function of:
  - **Ethnicity** in 6 / 7 dimensions ($p < 0.05$)
  - **Nativity** in 4 / 7 dimensions ($p < 0.01$)
  - **Company** in 6 / 7 dimensions ($p < 0.001$)
- Black respondents (n=17) have the highest perceptions of safety climate among all dimensions with Caucasians having the lowest (n=137).
- Adjusting for the effects of age, educational level, and company, Hispanic workers experience lower perceptions of both their management and co-worker's safety priority ($\beta = -0.10$, $p < 0.05$).
  - Foreign-born workers experience lower perceptions of their management safety priority ($\beta = -0.09$, $p < 0.05$).
- A worker's managerial structure (company) or educational attainment does not substantially influence their climate perceptions independent of their ethnicity and nativity.

Selected NOSACQ-50 Dimensions

Dimension 1: Management Safety Priority

Management safety priority yielded the strongest differences in ethnicity and nativity coefficient estimates (Table 3). This dimension exemplifies workers' perceptions of how their management's safety promotion, reaction to unsafe behavior and overall competence in handling and communication of safety issues[12]. We expect these deviations since management safety priority and commitment are the most influential components of safety climate research [18]. In the initial inception of safety climate scales; management safety commitment and involvement were two significant features to safety operationalization identified by Zohar (1980) [19]. Since safety priorities are largely communicated through managers, we determine that management behavior and priority would be a main source of influence on individual safety behavior [19].

Dimension 3: Management safety justice

Management safety justice relates to workers' perceptions of management treating workers who are involved in accidents fairly[12]. Worker's NOSACQ-50 responses were considered suitable for scoring purposes (n = 182) with the exception of Management safety justice (n = 178) with six worker's scores omitted. Questions asked within this dimension are: "Fear of sanctions (negative consequences) from management discourages employees here from reporting near-miss accidents" and "Management treats employees involved in an accident fairly".

We determined Management safety justice to be one of the more central dimensions in measuring sociodemographic influences, in particular, on safety climate outcomes. Six respondents did not self-identify their ethnicity (either Hispanic or non-Hispanic). Those same six respondents who declined to self-identify their ethnicity also answered less than 50%, or less than 3 questions within this dimension, and their mean response was omitted. This raises the question of whether the questions within this dimension were particularly sensitive for certain subsets of workers. The realm of "justice" can supersede safety in that workers face unjust situations such wage theft, lower pay, unsafe conditions, racism and discrimination. It's difficult to determine if this is the experience of the six workers who declined to self-identify their ethnicity and respond sufficiently to the items within this dimension. The metals industries being relatively job insecure, there is caution that workers maybe reluctant to self-identify as Hispanic as it is a presumed proxy to undocumented status.

Dimension 5: Workers' safety priority and risk non-acceptance

This dimension relates to workers' perceptions of how they and their co-workers prioritize safety before production goals, ability not resign to hazardous conditions nor accepting risk taking[12].

A significant finding relates to the discrepancy in how workers perceive their co-workers safety commitment in relation to that of their management. Workers perceive their management's safety priority much higher than that of their co-workers. Although the literature suggests management safety prioritization is key to safety performance, the collective safety attitudes and behaviors of co-workers can also greatly influence individual safety climate perceptions. For example, some workers may have a high, internal commitment for safety, regardless of their management's safety prioritization. Other workers are potentially more acceptable to taking risks on the job. The latter individuals may be more influenced by management's prioritization of safety because their safety performance depends on the perceived safety values of to which the organization (management) upholds.

Dimension 6: Safety communication & trust in co-workers safety competence

Safety communication generally relates to how worker's and their co-workers discuss safety issues when they emerge, learn from experience, generally help each other to work safely and attempt to come with solutions, along with trust in ensuring safety at work[12]. An example item includes "We who work here can talk freely and openly about safety".

This dimension was among the highest ranking in aggregate safety climate perceptions, even among our sociodemographic predictors. It demonstrates that while there maybe individual worker constraints with management (production, managerial style/disputes), workers still hold strong safety efficacy beliefs regarding their co-workers, which is in contrast with the lower ranking response for worker safety priority. Specifically, if there is

confidence and acceptance in seeking information, this could in turn result in higher climate perceptions and greater risk mitigation.

Dimension 7: Trust in the efficacy of safety systems

This dimension is the highest ranking out of NOSACQ-50 subscales averaged by all respondent groups. Trust in the efficacy of safety systems describe perceptions of how workers see the benefit in safety officers, safety representatives, committees, rounds, early planning see benefit in safety training see benefit in clear safety goals and objectives[12]. Example question is "We who work here consider that safety rounds have no effect on safety". There is encouragement that while some groups, particularly Hispanics and foreign-born workers share lower perceptions of their safety climate overall, safety systems are still concepts and practices that translate to healthy safety climate perceptions.

Influence of Covariates-Education

Education is a well-known confounder of the influences of race, ethnicity and gender. Company is also a potential confounder in association with safety climate outcomes. We expected to see both covariates as influential modifiers in the regression models, as they were significant predictors in the univariate models. There is concern that adjusting for these covariate had a stronger effect than one sociodemographic predictor of interest (i.e., race) and potentially lead to further underestimations of the true effect of race.

Table 10: Educational Characteristics of Workers, by Race, Ethnicity, Nativity, Gender (n=182)

	Less Than High School	High School/GED Equivalent	Some College / Vocational School	Finished College	Total
N =	18	80	72	12	182
Race					
White	10%	46%	37%	7%	137
Black	6%	41%	47%	6%	17
Asian	13%	13%	60%	13%	15
Other*	8%	62%	31%	0%	13
Ethnicity					
Hispanic	31%	38%	28%	3%	39
Non-Hispanic	4%	44%	44%	8%	137
Nativity					
U.S.	4%	47%	41%	8%	133
Foreign	27%	35%	35%	4%	49
Gender					
Male	10%	44%	40%	6%	172
Female	0%	50%	30%	20%	10

Table 10 displays the percentages of educational status among each sociodemographic group. A larger proportion of Hispanic and foreign-born workers did not complete high school. While we expected to see Blacks with among the lowest occupational safety climate perception, this experience may have been modified by presence of a comparatively educated sample, although these differences were not statistically significant. The proportion of Blacks who have some college or vocational training is higher than those of Whites. Interestingly, Asians make up the largest share of educated groups, and yet experience more negative perceptions of occupational safety climate.

NOSACQ-50 Mean Score and Company Influence

Overall, study participants within each company perceive their respective firm's occupational safety climate favorably. Whether this is the experience of most metals and metals products manufacturing workers in WA State remains unclear. The sites participating in the study did so on a voluntary basis, so we could not rule out likelihoods of established safety cultures.

Workers in Site 3 have the lowest ranking safety climate perception among all sites. Site 3 is the only company in the study with union representation. Most are native English speakers, along with several Spanish-speaking workers at varying English proficiencies. Employees at Site 3 are also more comparatively educated than workers at other companies with more favorable climate perceptions. There was an initial cooperation with this site during the questionnaire and HSC intervention process. However, reportedly due to production constraints, there was difficulty in getting time to survey workers. Significant layoff of junior employees delayed training for several months. The follow-up assessments therefore have a high likelihood of reflecting a less than positive occupational safety climate [16]. This coincides with the notion that safety climate measures are highly sensitive to the occurrence of workplace events.

Site 6 also has comparatively lower NOSACQ scores. This site is non-unionized, and has the second-highest percentage of Hispanic and foreign-born workers. Although most are native English-speakers, several speak Spanish and Vietnamese as their first language. The combination of recent layoffs, and language, culture and other communication barriers posed a challenge within this workforce with worries about job security being prominent.

LIMITATIONS

The data was not collected in order to directly facilitate our intended research question, thus our principle limitation of this study lies within the structure of a secondary analysis. We share a concern for the sample size, particularly with the breakdown of sociodemographic groups serving as our primary predictors. The underrepresentation of female subjects (workers) is an additional limitation to addressing the sociodemographic differences, in particular, on perceptions on occupational safety climate.

An underexplored feature that we did not assess is the impact of ethnicity as a potential confounder. One of our main objectives was to determine ethnicity as a primary predictor variable; however, it is possible that the influence of the "white Hispanic" could have significantly modified the association between race and NOSACQ-50 outcomes. Roughly 25 percent of white respondents self-identify as Hispanic. White respondents experienced the lowest perception of safety climate, particularly management safety priority. The extent that could have been modified by the presence of Hispanic ethnicity is a significant limitation.

There are potential that biases could cause a distortion in our analysis. Non-random response bias, as outlined in a review of safety climate limitations [20], is of importance. The subjects were interviewed within work-shifts, which could possibly facilitate fatigue and attitudes of indifference toward the survey. The concern for non-modal responses are heightened given the 50 item safety climate responses were assessed after 20 minute questioning of self-reported exposures, ergonomic hazards and injury experience. By analyzing safety climate perceptions in cross-lingual and cultural contexts, we share a concern for information bias; particularly in translating questionnaires from English to Spanish.

CONCLUSIONS

Determining occupational safety climate has, and will continue to face numerous challenges to measurement validity, and overall effectiveness in reducing occupational illnesses and injuries. We determined that there are substantial, statistically significant differences in perceptions of occupational safety climate among certain sociodemographic groups, particularly ethnicity and nativity.

Although significant predictors, when adjusting for the independent effects of education, and the combined effects of educational attainment and company, climate perceptions were not substantially determined by either of these predictors relative to a worker's ethnicity and nativity. We conclude that there are underlying, and potentially measurable variables that can better explain climate perceptions independent of worker ethnicity and nativity. Examining the influence of culture and privilege as unexplained components in these associations is worth further analysis. The question arises if expectations what safety climate should be, and not necessarily what it is, modifies occupational safety climate perceptions. We part with the question: what is the influence of background, upbringing, general culture and institutional mores on perceptions of safety climate? Our results present a need to develop more sensitive climate instruments to adequately answer these broader scope questions.

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APPENDIX

Appendix 1: NOSACQ-50 Questionnaire Distribution

Element	Dimensions	Number of Items	Positve Questions (#)	Negated/Reversed Questions (#)
Managerial (22 items)	Management Safety Priority	9	1,2,4,6,7	3,5,8,9
	Management Safety Empowerment	7	10,11,12,14,16	13,15
	Management Safety Justice	6	17,19,20,22	18,21
Worker (28 items)	Worker's Safety Commitment	6	23,24,27	25,26,28
	Worker's Safety Priority	7	33	29,30,31,32,34,35
	Safety Communication & Learning	8	36,37,38,39,40,42,43	41
	Trust in Safety Systems	7	44,46,48,50	45,47,49

Likert Format Distribution

Item	Strongly Disagree	Disagree	Agree	Strongly agree
Positive	1	2	3	4
Reversed	4	3	2	1

Appendix 2: NOSACQ-50 Safety Climate Questionnaire

In the following section, please describe how you perceive safety at your workplace. Although some questions may appear very similar, please answer each one of them.

		Strongly Disagree	Disagree	Agree	Strongly Agree
1.	**Management encourages employees here to work in accordance with safety rules – even when the work schedule is tight**	☐	☐	☐	☐
2.	**Management ensures that everyone receives the necessary information on safety**	☐	☐	☐	☐
3.	**Management looks the other way when someone is careless with safety**	☐	☐	☐	☐
4.	**Management places safety before production**	☐	☐	☐	☐
5.	**Management accepts employees here taking risks when the work schedule is tight**	☐	☐	☐	☐
6.	**We who work here have confidence in the management's ability to deal with safety**	☐	☐	☐	☐

		Strongly Disagree	Disagree	Agree	Strongly Agree
7.	**Management ensures that safety problems discovered during safety rounds/evaluations are corrected immediately**	☐	☐	☐	☐
8.	**When risk is detected, management ignores it without action**	☐	☐	☐	☐
9.	**Management lacks the ability to handle safety properly**	☐	☐	☐	☐
10.	**Management strives to design safety routines that are meaningful and actually work**	☐	☐	☐	☐
11.	**Management makes sure that each and every one can influence safety in their work**	☐	☐	☐	☐
12.	**Management encourages employees here to participate in decisions which affect their safety**	☐	☐	☐	☐
13.	**Management never considers employees' suggestions regarding safety**	☐	☐	☐	☐
14.	**Management strives for everybody at the worksite to have high competence concerning safety and risks**	☐	☐	☐	☐
15.	**Management never asks employees for their opinions before making decisions regarding safety**	☐	☐	☐	☐
16.	**Management involves employees in decisions regarding safety**	☐	☐	☐	☐
17.	**Management collects accurate information in accident investigations**	☐	☐	☐	☐
18.	**Fear of sanctions (negative consequences) from management discourages employees here from reporting near-miss accidents**	☐	☐	☐	☐
19.	**Management listens carefully to all who have been involved in an accident event**	☐	☐	☐	☐
20.	**Management looks for causes, not guilty persons, when an accident occurs**	☐	☐	☐	☐
21.	**Management always blames employees for accidents**	☐	☐	☐	☐
22.	**Management treats employees involved in an accident fairly**	☐	☐	☐	☐

		Strongly Disagree	Disagree	Agree	Strongly Agree
23.	**We who work here try hard together to achieve a high level of safety**	☐	☐	☐	☐
24.	**We who work here take joint responsibility to ensure that the workplace is always kept tidy**	☐	☐	☐	☐
25.	**We who work here do not care about each other's safety**	☐	☐	☐	☐
26.	**We who work here avoid tackling risks that are discovered**	☐	☐	☐	☐
27.	**We who work here help each other to work safely**	☐	☐	☐	☐
28.	**We who work here take no responsibility for each other's safety**	☐	☐	☐	☐
29.	**We who work here regard risks as unavoidable**	☐	☐	☐	☐
30.	**We who work here consider minor accidents as a normal part of our daily work**	☐	☐	☐	☐
31.	**We who work here accept dangerous behavior as long as there are no accidents**	☐	☐	☐	☐
32.	**We who work here break safety rules in order to complete work on time**	☐	☐	☐	☐
33.	**We who work here never accept risk-taking even if the work schedule is tight**	☐	☐	☐	☐
34.	**We who work here consider that our work is unsuitable for cowards**	☐	☐	☐	☐
35.	**We who work here accept risk-taking at work**	☐	☐	☐	☐
36.	**We who work here try to find a solution if someone points out a safety problem**	☐	☐	☐	☐
37.	**We who work here feel safe when working together**	☐	☐	☐	☐
38.	**We who work here have great trust in each other's ability to ensure safety**	☐	☐	☐	☐
39.	**We who work here learn from our experiences to prevent accidents**	☐	☐	☐	☐

		Strongly Disagree	Disagree	Agree	Strongly Agree
40.	**We who work here take each other's opinions and suggestions concerning safety seriously**	☐	☐	☐	☐
41.	**We who work here seldom talk about safety**	☐	☐	☐	☐
42.	**We who work here always discuss safety issues when such issues come up**	☐	☐	☐	☐
43.	**We who work here can talk freely and openly about safety**	☐	☐	☐	☐
44.	**We who work here consider that a good safety representative plays an important role in preventing accidents**	☐	☐	☐	☐
45.	**We who work here consider that safety rounds/evaluations have no effect on safety**	☐	☐	☐	☐
46.	**We who work here consider that safety training is good for preventing accidents**	☐	☐	☐	☐
47.	**We who work here consider early planning for safety meaningless**	☐	☐	☐	☐
48.	**We who work here consider that safety rounds/evaluations help find serious hazards**	☐	☐	☐	☐
49.	**We who work here consider safety training to be meaningless**	☐	☐	☐	☐
50.	**We who work here consider it important to have clear-cut goals for safety**	☐	☐	☐	☐

Appendix 3-9: Multiple Regression Models Fully Adjusted for the Influence of Educational Attainment and Company

Appendix 3. Multiple Regression Analysis of the relationship of sociodemographics and Management Safety Priority adjusted for influence of company and education

		Management Safety Priority		
Predictors		β	P	95% CI
Race				
	African-American	0.03	0.776	-0.19 to 0.25
	White	-0.06	0.536	-0.25 to 0.13
	Other*	0.11	0.469	-0.19 to 0.40
	Asian			Ref.
Company				
	Site 2	0.11	0.372	-0.13 to 0.34
	Site 3	-0.24	**0.044**	-0.47 to -0.01
	Site 4	0.25	**0.050**	0.00 to 0.50
	Site 5	-0.02	0.874	-0.25 to 0.21
	Site 6	-0.22	0.081	-0.47 to 0.03
	Site 1			Ref.
Education				
	< High School	-0.24	**0.002**	-0.38 to -0.09
	Some College/Voc.	-0.12	0.087	-0.26 to 0.02
	College Degree	0.14	0.357	-0.15 to 0.43
	High School			Ref.
Ethnicity				
	Non-Hispanic	0.11	0.190	-0.05 to 0.27
	Hispanic			Ref.
Company				
	Site 2	0.14	0.197	-0.07 to 0.36
	Site 3	-0.23	**0.043**	-0.45 to -0.01
	Site 4	0.25	**0.042**	0.01 to 0.49
	Site 5	0.01	0.898	-0.20 to 0.23
	Site 6	-0.20	0.102	-0.44 to 0.04
	Site 1			Ref.
Education				
	< High School	-0.19	0.023	-0.36 to -0.03
	Some College/Voc.	-0.12	0.082	-0.27 to 0.02
	College Degree	0.12	0.388	-0.15 to 0.39
	High School			Ref.
Nativity				
	U.S. Born	0.09	0.194	-0.05 to 0.23
	Native Born			Ref.
Company				
	Site 2	0.11	0.308	-0.11 to 0.34
	Site 3	-0.26	**0.017**	-0.48 to -0.05
	Site 4	0.22	**0.070**	-0.02 to 0.46
	Site 5	-0.01	0.891	-0.23 to 0.20
	Site 6	-0.23	**0.054**	-0.47 to 0.00

	Site 1		Ref.			
Education						
	< High School	-0.19	**0.025**	-0.36	to	-0.02
	Some College/Voc.	-0.12	0.093	-0.26	to	0.02
	College Degree	0.13	0.350	-0.14	to	0.40
	High School		Ref.			

p < 0.05

Appendix 4. Multiple Regression Analysis of the relationship of sociodemographics and Management Safety Empowerment adjusted for influence of company and education

		Management Safety Empowerment				
Predictors		β	P	95% CI		
Race						
	African-American	0.02	0.850	-0.22	to	0.26
	White	-0.01	0.947	-0.21	to	0.19
	Other*	0.04	0.772	-0.25	to	0.33
	Asian		Ref.			
Company						
	Site 2	0.05	0.663	-0.16	to	0.25
	Site 3	-0.24	0.035	-0.46	to	-0.02
	Site 4	0.14	0.268	-0.11	to	0.38
	Site 5	-0.09	0.404	-0.29	to	0.12
	Site 6	-0.28	0.011	-0.49	to	-0.06
	Site 1		Ref.			
Education						
	< High School	-0.12	0.090	-0.26	to	0.02
	Some College/Voc.	-0.04	0.518	-0.16	to	0.08
	College Degree	0.27	0.054	0.00	to	0.54
	High School		Ref.			
Ethnicity						
	Non-Hispanic	0.15	0.019	0.02	to	0.27
	Hispanic		Ref.			
Company						
	Site 2	0.07	0.474	-0.13	to	0.28
	Site 3	-0.20	0.061	-0.42	to	0.01
	Site 4	0.15	0.205	-0.08	to	0.39
	Site 5	-0.04	0.706	-0.24	to	0.16
	Site 6	-0.23	0.026	-0.44	to	-0.03
	Site 1		Ref.			
Education						
	< High School	-0.06	0.378	-0.21	to	0.08
	Some College/Voc.	-0.04	0.478	-0.16	to	0.08
	College Degree	0.24	0.064	-0.01	to	0.50
	High School		Ref.			
Nativity						
	U.S. Born	0.05	0.422	-0.08	to	0.19
	Native Born		Ref.			

Company						
	Site 2	0.04	0.681	-0.17	to	0.25
	Site 3	-0.25	0.025	-0.46	to	-0.03
	Site 4	0.13	0.298	-0.11	to	0.37
	Site 5	-0.08	0.409	-0.28	to	0.11
	Site 6	-0.28	0.008	-0.48	to	-0.07
	Site 1					
Education						
	< High School	-0.10	0.214	-0.25	to	0.06
	Some College/Voc.	-0.04	0.526	-0.16	to	0.08
	College Degree	0.26	0.049	0.00	to	0.53
	High School		Ref.			

p < 0.05

Appendix 5. Multiple Regression Analysis of the relationship of sociodemographics and Management Safety Justice adjusted for influence of company and education

		Management Safety Justice				
Predictors		β	P	95% CI		
Race						
	African-American	0.05	0.748	-0.27	to	0.37
	White	0.10	0.496	-0.19	to	0.39
	Other*	0.20	0.255	-0.15	to	0.56
	Asian			Ref.		
Company						
	Site 2	0.15	0.179	-0.07	to	0.38
	Site 3	-0.29	0.026	-0.55	to	-0.04
	Site 4	0.24	0.079	-0.03	to	0.50
	Site 5	0.07	0.583	-0.18	to	0.33
	Site 6	-0.03	0.830	-0.27	to	0.21
	Site 1			Ref.		
Education						
	< High School	-0.13	0.114	-0.29	to	0.03
	Some College/Voc.	-0.04	0.492	-0.17	to	0.08
	College Degree	0.26	0.104	-0.05	to	0.57
	High School			Ref.		
Ethnicity						
	Non-Hispanic	0.01	0.911	-0.12	to	0.14
	Hispanic			Ref.		

Company						
	Site 2	0.18	0.143	-0.06	to	0.42
	Site 3	-0.28	0.041	-0.55	to	-0.01
	Site 4	0.24	0.081	-0.03	to	0.50
	Site 5	0.07	0.593	-0.19	to	0.33
	Site 6	-0.01	0.912	-0.27	to	-0.24
	Site 1			Ref.		
Education						
	< High School	-0.13	0.108	-0.30	to	0.03
	Some College/Voc.	-0.05	0.403	-0.18	to	0.07
	College Degree	0.23	0.155	-0.09	to	0.56
	High School		Ref.			
Nativity						
	U.S. Born	0.02	0.766	-0.13	to	0.18
	Native Born			Ref.		
Company						
	Site 2	0.17	0.151	-0.06	to	0.40
	Site 3	-0.28	0.032	-0.54	to	-0.03
	Site 4	0.23	0.078	-0.03	to	0.49
	Site 5	0.07	0.597	-0.19	to	0.33
	Site 6	-0.02	0.895	-0.27	to	0.23
	Site 1					
Education						
	< High School	-0.13	0.148	-0.30	to	0.05
	Some College/Vocational	-0.06	0.365	-0.18	to	0.07
	College Degree	0.23	0.156	-0.09	to	0.55
	High School		Ref.			

p < 0.05

Appendix 6. Multiple Regression Analysis of the relationship of sociodemographics and Worker's Safety Commitment adjusted for influence of company and education

		Worker's Safety Commitment				
Predictors		β	P	95% CI		
Race						
	African-American	-0.18	0.127	-0.41	to	0.05
	White	-0.09	0.312	-0.26	to	0.08
	Other*	-0.01	0.938	-0.24	to	0.22
	Asian	Ref.				
Company						
	Site 2	0.10	0.228	-0.07	to	0.27
	Site 3	-0.08	0.345	-0.25	to	0.09
	Site 4	0.27	0.029	0.03	to	0.50
	Site 5	-0.07	0.440	-0.24	to	0.10
	Site 6	-0.12	0.208	-0.30	to	0.07
	Site 1	Ref.				
Education						
	< High School	-0.08	0.214	-0.22	to	0.05
	Some College/Voc.	-0.04	0.490	-0.15	to	0.07
	College Degree	0.03	0.751	-0.17	to	0.23
	High School	Ref.				
Ethnicity						
	Non-Hispanic	0.11	0.078	-0.01	to	0.23
	Hispanic	Ref.				
Company						
	Site 2	0.08	0.322	-0.08	to	0.25
	Site 3	-0.08	0.347	-0.25	to	0.09
	Site 4	0.27	0.026	0.03	to	0.50
	Site 5	-0.08	0.360	-0.24	to	0.09
	Site 6	-0.11	0.229	-0.29	to	0.07
	Site 1	Ref.				
Education						
	< High School	-0.03	0.703	-0.18	to	0.12
	Some College/Voc.	-0.04	0.469	-0.16	to	0.07
	College Degree	0.02	0.838	-0.18	to	0.22
	High School	Ref.				

Nativity						
	U.S. Born	0.05	0.406	-0.07	to	0.17
	Native Born		Ref.			
Company						
	Site 2	0.06	0.483	-0.11	to	0.24
	Site 3	-0.11	0.178	-0.28	to	0.05
	Site 4	0.24	0.043	0.01	to	0.48
	Site 5	-0.11	0.184	-0.27	to	0.05
	Site 6	-0.14	0.119	-0.32	to	0.04
	Site 1					
Education						
	< High School	-0.05	0.522	-0.20	to	0.10
	Some College/Voc.	-0.04	0.505	-0.15	to	0.07
	College Degree	0.03	0.739	-0.16	to	0.23
	High School		Ref.			

p < 0.05

Appendix 7. Multiple Regression Analysis of the relationship of sociodemographics and Worker's Safety Priority adjusted for influence of company and education

		Worker's Safety Priority				
Predictors		β	P	95% CI		
Race						
	African-American	0.01	0.877	-0.16	to	0.18
	White	0.04	0.598	-0.10	to	0.18
	Other*	0.12	0.347	-0.13	to	0.37

	Asian			Ref.		
Company						
	Site 2	-0.04	0.627	-0.11	to	0.19
	Site 3	-0.16	0.032	-0.31	to	-0.01
	Site 4	0.14	0.064	-0.01	to	0.30
	Site 5	-0.06	0.492	-0.11	to	0.23
	Site 6	-0.08	0.254	-0.23	to	0.06
	Site 1			Ref.		
Education						
	< High School	-0.27	**0.005**	-0.46	to	-0.08
	Some College/Voc.	-0.05	0.439	-0.17	to	0.07
	College Degree	-0.05	0.642	-0.28	to	0.17
	High School			Ref.		
Ethnicity						
	Non-Hispanic	0.10	0.113	-0.02	to	0.22
	Hispanic			Ref.		
Company						
	Site 2	-0.06	0.394	-0.08	to	0.20
	Site 3	-0.13	0.078	-0.28	to	0.01
	Site 4	0.15	0.039	0.01	to	0.30
	Site 5	-0.09	0.319	-0.08	to	0.26
	Site 6	-0.05	0.478	-0.20	to	0.09
	Site 1			Ref.		
Education						
	< High School	-0.23	0.012	-0.41	to	-0.05
	Some College/Voc.	-0.06	0.340	-0.18	to	0.06
	College Degree	-0.08	0.489	-0.31	to	0.15
	High School			Ref.		
Nativity						
	U.S. Born	-0.01	0.886	-0.13	to	0.11
	Native Born			Ref.		
Company						
	Site 2	-0.05	0.451	-0.09	to	0.19
	Site 3	-0.16	0.025	-0.29	to	-0.02
	Site 4	0.14	0.062	-	to	0.30

				0.01		
	Site 5	0.06	0.501	-0.11	to	0.22
	Site 6	-0.08	0.260	-0.22	to	0.06
	Site 1					
Education						
	< High School	-0.28	0.006	-0.47	to	-0.08
	Some College/Voc.	-0.05	0.347	-0.17	to	0.06
	College Degree	-0.06	0.584	-0.29	to	0.17
	High School		Ref.			

p < 0.05

Appendix 8. Multiple Regression Analysis of the relationship of sociodemographics and Safety Communication adjusted for influence of company and education

		Safety Communication				
Predictors		β	P	95% CI		
Race						
	African-American	-0.17	0.117	-0.38	to	0.04
	White	-0.04	0.634	-0.21	to	0.13
	Other*	-0.05	0.733	-0.31	to	0.22
	Asian			Ref.		
Company						
	Site 2	0.19	0.021	0.03	to	0.36
	Site 3	-0.03	0.744	-0.18	to	0.13
	Site 4	0.29	0.020	0.05	to	0.53
	Site 5	0.01	0.912	-0.17	to	0.19
	Site 6	-0.12	0.161	-0.29	to	0.05
	Site 1			Ref.		
Education						
	< High School	-0.12	0.039	-0.23	to	-0.01
	Some College/Voc.	-0.09	0.106	-0.20	to	0.02
	College Degree	0.22	0.115	-0.05	to	0.49
	High School			Ref.		
Ethnicity						
	Non-Hispanic	0.14	0.010	0.03	to	0.25
	Hispanic			Ref.		
Company						
	Site 2	0.17	0.030	0.02	to	0.33
	Site 3	0.00	0.992	-0.15	to	0.15
	Site 4	0.30	0.013	0.06	to	0.53
	Site 5	0.02	0.853	-0.15	to	0.18
	Site 6	-0.09	0.278	-0.26	to	0.07
	Site 1			Ref.		
Education						
	< High School	-0.06	0.351	-0.18	to	0.06
	Some College/Voc.	-0.10	0.077	-0.22	to	0.01
	College Degree	0.19	0.142	-0.07	to	0.45

	High School	Ref.		
Nativity				
	U.S. Born	0.11	0.024	0.01 to 0.21
	Native Born	Ref.		
Company				
	Site 2	0.12	0.116	-0.03 to 0.28
	Site 3	-0.05	0.504	-0.19 to 0.10
	Site 4	0.26	0.027	0.03 to 0.49
	Site 5	-0.02	0.764	-0.19 to 0.14
	Site 6	-0.13	0.095	-0.29 to 0.02
	Site 1			
Education				
	< High School	-0.06	0.317	-0.18 to 0.06
	Some College/Voc.	-0.09	0.098	-0.20 to 0.02
	College Degree	0.21	0.110	-0.05 to 0.47
	High School	Ref.		

p < 0.05

Appendix 9. Multiple Regression Analysis of the relationship of sociodemographics and Trust in Safety Systems adjusted for influence of company and education

	Trust in Safety Systems		
Predictors	β	P	95% CI
Race			
African-American	0.07	0.496	-0.12 to 0.25
White	0.10	0.151	-0.04 to 0.25
Other*	0.07	0.572	-0.18 to 0.33
Asian	Ref.		
Company			
Site 2	0.12	0.176	-0.06 to 0.30
Site 3	0.00	0.988	-0.18 to 0.18
Site 4	0.11	0.336	-0.11 to 0.33
Site 5	-0.04	0.696	-0.23 to 0.15
Site 6	-0.07	0.413	-0.24 to 0.10
Site 1	Ref.		
Education			
< High School	-0.09	0.140	-0.22 to 0.03
Some College/Voc.	0.01	0.873	-0.11 to 0.13
College Degree	0.22	0.105	-0.05 to 0.48
High School	Ref.		

Ethnicity						
	Non-Hispanic	0.08	0.165	-0.03	to	0.19
	Hispanic			Ref.		
Company						
	Site 2	0.15	0.092	-0.02	to	0.31
	Site 3	0.04	0.627	-0.14	to	0.23
	Site 4	0.13	0.248	-0.09	to	0.35
	Site 5	0.00	0.986	-0.19	to	0.18
	Site 6	-0.03	0.744	-0.21	to	0.15
	Site 1			Ref.		
Education						
	< High School	-0.08	0.267	-0.21	to	0.06
	Some College/Vocational	0.00	0.956	-0.12	to	0.11
	College Degree	0.19	0.154	-0.07	to	0.45
	High School		Ref.			
Nativity						
	U.S. Born	0.07	0.184	-0.03	to	0.18
	Native Born			Ref.		
Company						
	Site 2	0.11	0.229	-0.07	to	0.28
	Site 3	0.02	0.852	-0.16	to	0.19
	Site 4	0.11	0.332	-0.11	to	0.32
	Site 5	-0.02	0.782	-0.20	to	0.15
	Site 6	-0.05	0.510	-0.22	to	0.11
	Site 1					
Education						
	< High School	-0.07	0.295	-0.20	to	0.06
	Some College/Vocational	0.00	0.992	-0.11	to	0.11
	College Degree	0.20	0.132	-0.06	to	0.45
	High School		Ref.			

p < 0.05