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Reliability and Validity of an Employer-Completed Safety Hazard and Management Assessment Questionnaire

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Abstract

Introduction: Managing and improving occupational safety and health requires evaluating performance. Organizations are encouraged to use both lagging indicators (such as injury rates and costs) and leading indicators (such as questionnaire-assessed safety hazards and management practices) for this purpose, but the association between types of indicators over time can be complex. Longitudinal data can assist in clarifying these associations and increasing indicator utility.

Method: Employer data were used to evaluate the reliability and predictive validity of a safety management questionnaire. Employers' longitudinal questionnaire responses and workers' compensation (WC) claims data were analyzed using a marginal model with time-dependent covariates. Multivariable Poisson and linear regression analyses with claim rate and logarithmic cost, respectively, as dependent variables were carried out after adjusting for industry sector and size. Questionnaire data were used to evaluate questionnaire scaling properties and to assess generalizability of results.

Results: One safety management scale was associated with a better WC outcome as predicted and two scales were unexpectedly associated with poorer WC claim outcomes. Analyses assisted in interpreting the latter results, suggesting that WC outcomes were a stimulus for change in some cases. Twelve hazards assessed on the questionnaire were associated with poorer WC claim outcomes as predicted.

Conclusions: This study extends leading indicator research using longitudinal questionnaire and WC claims data from employers. Analyses provided insight into associations between leading and lagging indicators, emphasizing the importance of both for safety improvement. Safety management questionnaire scales were predictive of WC claim outcomes, although support for hazard assessments as leading indicators was stronger.

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Practical Applications: This study supports the use of employer-completed hazard assessment questionnaires for targeting and prioritizing improvement efforts. Employer-completed safety management scales may be useful for directing improvement efforts, although the conditions under which they are completed, including submission to insurers, require additional consideration.

Keywords

Leading; lagging metrics; predictor; workers' compensation

1. Introduction

Managing and improving occupational safety and health (OSH) requires evaluating organizational safety performance. Lagging indicators such as injury rates and costs have been the most used measures for this purpose (Center for Safety & Health Sustainability [CSHS] & American Industrial Hygiene Association [AIHA], 2020; Reiman & Pietikainen, 2012; Sinelnikov et al., 2015). However, the use of injury outcomes as the only safety performance measure is a barrier to safety improvement. Companies with few injuries may have insufficient information to identify injury trends (Amick & Saunders, 2013). This is particularly true for smaller companies. Further, low injury or disability rates occur for reasons other than an absence of hazards, including under-reporting of injuries and chance (Health & Safety Executive [HSE], 2001). Even in situations in which lagging indicators effectively signal a need for safety improvement, they are not effective as sole indicators of safety performance (Sheehan et al., 2016; Wurzelbacher & Jin, 2011) because they provide little information on injury causes and offer little guidance for improvement activities. As noted by Erikson (2009) and Wurzelbacher and Jin (2011), lagging metrics are necessary but not sufficient for guiding safety efforts.

Ideally, multiple safety measures are used that together provide "information on both the level of performance and why the performance level is as it is" (HSE, 2001, p. 8). As such, safety practitioners and researchers are increasingly expanding their focus to include factors that occur in advance of lagging indicators. These factors, termed leading indicators, include activities, practices, and programs for preventing injuries and minimizing duration and severity of injuries when they do occur. Selecting organizational leading indicators is not always straightforward, however. For example, while some practices may be implemented to increase safety and can be easily measured, they may be ineffective for improving safety outcomes (HSE, 2001). The expectation is that leading indicators enable detection of deficiencies which if improved, will prevent injury and loss and lead to an overall improvement of lagging indicators (Amick & Saunders, 2013; Pawlowska, 2015; Sinelnikov et al., 2015) and increase overall organizational performance (CSHS & AIHA, 2020). As noted by several investigators (Robson et al., 2017; Wurzelbacher & Jin, 2011), the effectiveness of leading indicators may lie in the strength of their association with lagging indicators.

To identify effective leading OSH indicators, researchers have examined the association of organizational safety policies and practices with previous, concurrent, and future OSH outcomes, primarily in cross-sectional studies (Amick et al., 2011; Amick et al., 2000; Amick et al., 2004; Autenrieth, Brazile, Douphrate, et al., 2016; Fernandez-Muniz et al., 2007; Habeck et al., 1998; Habeck et al., 1991; Hunt & Habeck, 1990; Hunt et al., 1993; Robson et al., 2017; Shea et al., 2016; Tang et al., 2011; Wurzelbacher & Jin, 2011). They have found injury prevention and severity-reduction policies and practices to be associated with lower claim rates (Habeck et al., 1991; Hunt & Habeck, 1990), better return-to-work (RTW) status (Amick et al., 2000), a higher level of work-role functioning (Amick et al., 2004), and lower workers' compensation (WC) claim rates and lost workday rates (Habeck et al., 1998; Hunt et al., 1993). These results suggest that the identified policies and practices influenced outcomes and functioned as predictors of and means for improving injury outcomes.

In several studies, an interpretation of associations between policies and practices and OSH outcomes was not as clear, however. For example, researchers found that disability monitoring and management activities were associated with longer disability durations (Cullen et al., 2005) and a higher lost workday case rate (Hunt et al., 1993). Robson et al. (2017) found significant positive associations between RTW practices and claim rates. While it is possible that safety practices and procedures negatively affected outcomes, a more likely explanation is that poor safety performance spurred efforts to improve practices and procedures (Hunt et al., 1993). The direction of influence of these variables is difficult to disentangle in cross-sectional research, yet understanding this sequence is key to identifying and using leading indicators.

Studies with both longitudinal leading and lagging measures afford more insight on cause-and-effect since the sequence of changes in variables of interest can be observed. Although longitudinal outcomes were used in several studies, few studies were found that also involved multiple leading indicators. However, even with a longitudinal design, the issue of causality remains complicated because of feedback between variables (Arreola et al., 2020). Research with repeated collections of predictor and outcome variables paired with a statistical method for unraveling the direction of influence of these measures is needed. Such research may advance the understanding of these indicators.

In addition to predictive validity, effective measurement scales display sound scaling properties. Several researchers evaluated and found support for these properties among OSH program evaluation surveys. Amick et al. (2000) evaluated their organizational policies and practices (OPP) scales. Using Cronbach's alpha values, they found support for internal consistency and determined that each item made a unique contribution to its own scale. Item-total correlations indicated a higher correlation of each item to the scale to which it was purported to belong than to other scales, thereby supporting the discriminant validity of the scales. Tang et al. (2011) evaluated the measurement properties of their OPP scale and found support for internal consistency, discriminant validity, and known-groups construct validity, with no evidence of significant floor/ceiling effects. These studies exemplify the evaluation of scaling properties of organizational safety assessment instruments.

In many leading indicator studies, investigators used data collected for research purposes. These studies increased understanding of leading indicators and demonstrated that employer representatives and employees can meaningfully rate aspects of their organizations (Habeck et al., 1998; Hunt et al., 1993; Westmorland et al., 2005; Williams et al., 2005; Wurzelbacher & Jin, 2011). To determine the utility of indicators in other contexts, several researchers evaluated OSH leading indicators using data collected in consultation programs (Akbar-Khanzadeh & Wagner, 2001; Autenrieth, Brazile, Douphrate, et al., 2016; Autenrieth, Brazile, Sandfort, et al., 2016) and audit programs (Robson et al., 2017). Researchers (Akbar-Khanzadeh & Wagner, 2001; Autenrieth, Brazile, Douphrate, et al., 2016; Autenrieth, Brazile, Sandfort, et al., 2016) obtained support for the predictive validity of a form used in the voluntary United States Occupational Safety and Health Administration's (OSHA) On-Site Consultation Program. Robson et al. (2017), however, obtained mixed results in their evaluation of an audit tool used by the Workplace Safety and Insurance Board (WSIB), the exclusive provider of WC coverage in Ontario, Canada. The tool was used to evaluate OSH management elements in companies with elevated losses. Researchers found that the audit tool had high internal consistency, but overall scores were not predictive of future WC claim outcomes. Robson et al. (2017) suggested additional research prior to using audit assessments as leading indicators of OSH performance.

In summary, numerous OSH leading indicator scales have been developed and many display predictive validity and sound scaling properties. However, many were evaluated using cross-sectional data collected for research purposes. Cross-sectional data limit the extent to which the influences between leading indicators and injury outcome variables can be deciphered. Further, while data collected for research purposes provide information about leading indicators, evaluating leading indicator instruments in the practical context in which they will be used is also beneficial.

2. Method

2.1 Study Purpose

This study was conducted to examine the scaling properties and effectiveness of the Ohio Bureau of Workers' Compensation (OHBWC) SH-26 Safety Management Self-Assessment Questionnaire (OHBWC, no date, c [n.d.] c) for predicting WC claim outcomes. This was the first assessment of the questionnaire in a research study. The questionnaire, provided in Table 1, contains 30 statements and 32 hazards that employers use to identify safety program management elements and hazards for improvement. Employers' questionnaire responses and the same employers' WC claims data from 2012 – 2015 were used to evaluate the questionnaire. The OHBWC collects both types of data and provided them to the National Institute for Occupational Safety and Health (NIOSH). Predictive validity of the data was analyzed using a marginal model incorporating a generalized estimating equations (GEE) method with a first-order autoregressive working correlation structure and time-dependent covariates. Multivariable Poisson regression analysis with claim rate, and linear regression analysis with logarithmic claim cost as dependent variables were carried out after adjusting for industry sector and size. This was a novel application of this statistical method that advances understanding of associations between leading indicators and WC claim outcome measures.

2.2 Survey Development and Leading Indicators

The OHBWC is the state's exclusive WC insurer, providing coverage to approximately 250,000 companies. The OHBWC covers all employers in the state except those that elect to self-insure and meet associated requirements, and self-employed workers who have the option to decline coverage. Consultants in OHBWC's Division of Safety and Hygiene provide safety and health guidance to policyholders, with 1.8% of employers receiving onsite assistance.

In 2010, OHBWC sought to provide policyholders (with whom consultants do not necessarily have direct contact) with an assessment questionnaire to facilitate safety management self-improvement (R. Gaul, personal communication, April 15, 2020). In their search for a questionnaire, OHBWC staff reviewed safety programs, assessments, and standards and included common injury prevention elements from these documents in the new instrument. In addition, recognizing the importance of minimizing injury severity and associated costs, they included items on WC claims management and RTW practices, in line with Amick et al. (2000) and Habeck et al. (1991). Lastly, consistent with research supporting people-oriented culture/safety climate (Amick et al., 2011; Amick et al., 2000; Tang et al., 2011) and employee wellness (Habeck et al., 1991; Wurzelbacher & Jin, 2011) as leading indicators of OSH performance, OHBWC designed the instrument to address these elements also. These efforts produced the SH-26 questionnaire (OHBWC, n.d.c), which contains a unique combination of injury prevention and severity reduction elements not found in OHBWC's search for an assessment instrument.

The SH-26 questionnaire addresses ten OSH program elements with three statements per element. It also contains 32 hazards found in a variety of sectors. Hazards were selected from those addressed in OSHA regulations, associated with OHBWC claims, and related to safety, industrial hygiene, and ergonomics concerns. Examples include confined spaces, airborne contaminants, and repetitive awkward work postures. The person in each company most familiar with the safety and claims management process completes the questionnaire. This requires rating the extent to which program element statements describe their organization's programs and practices, and indicating which hazards are present in their work operations.

Employers submit questionnaire responses electronically. To ensure questionnaire completion, submission cannot occur unless employers rate each statement. Although developed to facilitate employer OSH self-improvement, when OHBWC consultants provide employers with on-site assistance, employers' SH-26 ratings are a catalyst for engagement.

2.3 Study Participants

Ohio policyholders enrolled in any of five OHBWC grant and incentive programs (i.e., drug-free safety program [OHBWC, n.d.a], workplace wellness grant [OHBWC, n.d.d], industry-specific safety program [OHBWC, 2021b], .99 experience modifier construction cap program [OHBWC, 2012], and grow Ohio incentive program [OHBWC, 2021a]) are required to complete the SH-26 assessment annually. SH-26 questionnaires completed by private employers in 2012 – 2015 (the most recent years for which claims data were available to NIOSH researchers) with available NIOSH (2018) National Occupational Research Agenda (NORA) industry sector and size information and that met additional requirements, discussed below, were used in the current study.

Data from public employers were excluded because methods for accessing denominator information needed to calculate injury rates for these employers, which were used as lagging indicators, have not yet been developed. Employer size was based on number of estimated full-time equivalents (FTEs). Methods used to determine numbers of FTEs, employer industry codes, and injury rates have been described previously (Wurzelbacher et al., 2014). Only the first survey was used in the study in cases in which employers submitted more than one survey per year. To enable linking questionnaire data, which originate at the site level, with employers' claims data, only surveys from single-location employers were used in the study. OHBWC claims data are coded to the organizational level, which precludes linking claims to a specific site in a multi-site organization.

Additional criteria for data use included employer completion of the SH-26 questionnaire in at least two years in 2012 – 2015 and experiencing at least one claim in a year of survey completion. These criteria were necessitated by the analytical method used to evaluate predictive validity of the SH-26 questionnaire. (Additional information on the analytical method is provided in Section 2.4.2 below.) These data were also used to evaluate questionnaire scaling properties.

Data from a larger comparison group were used to evaluate the generalizability of results from the main participant group described above. The comparison group met most main group criteria (e.g., private, single-location employers with available size and sector information). However, employers in the comparison group were required to complete a minimum of one questionnaire in 2012 – 2015 (vs. a minimum of two questionnaires for the main participant group) and had no claim requirements. The comparison group, with its less restrictive requirements for questionnaire completion and claims history, included the main participant group. Because not all data from the comparison group met analytical method requirements, only data from the main group were used in the predictive validity assessment.

2.4 Evaluation of the SH-26 Program Assessment

2.4.1 Scaling Properties of the SH-26 Assessment—Ratings from the main participant group were used to evaluate the measurement properties of the SH-26 questionnaire. These included the distribution of scores for each of the 30 scale items to identify potential floor/ceiling effects using a criterion of 15% of scores at scale minimum or maximum (McHorney & Tarlov, 1995).

The internal consistency reliability of each of the ten SH-26 scales was evaluated using Cronbach's coefficient alpha (Cronbach, 1951). Recommended values range from 0.70 to 0.90 (Bland & Altman, 1997; Streiner, 2003). Cronbach's alpha values with each scale item removed were calculated to determine whether each item makes a unique contribution to its own scale (Amick et al., 2000). The convergent validity of the SH-26 assessment was evaluated by examining item-total correlations (i.e., the correlation of each item with the scale to which it was purported to belong). Correlations greater than 0.3 were used as support for convergent validity (Hays et al., 1988). Each item was assessed for discriminant validity using a multitrait scaling analysis in which the correlation of items to scales was evaluated (Hays & Hayashi, 1990). With this method, which is an adaptation of the multitrait-multimethod matrix developed by Campbell and Fiske (1959), comparisons were made between the correlation of an item with its own scale (with the item removed from the scale) to the correlations of the item with other scales. Items that correlate more strongly to scales to which they do not belong than to their own scale make interpretation of ratings difficult and are suggested for rewording and retesting (Ware & Gandek, 1998).

2.4.2 Predictive Validity of the SH-26 Program Assessment Scales—To evaluate the predictive validity of the SH-26 instrument, the associations of program ratings and hazard identifications from the main participant group with their WC claim outcomes were assessed. Generalized estimating equations incorporating a first-order autoregressive working correlation structure were used for the longitudinal data with time-dependent covariates (i.e., ratings and hazard identifications) for which employers contributed repeated outcome measurements over time (Chen & Westgate, 2017). Multivariable Poisson and linear regression models with claim rate and logarithmic cost, correspondingly, as dependent variables were carried out after adjusting for industry sector and size information. Four types of time-dependent covariates were presented in previous literature (Lai & Small, 2007; Zhou et al., 2014). Here, we focus on types 2 and 3.

- A type 2 covariate implies that previous and current years' questionnaire management ratings and hazard identifications predict current year WC claim outcome measures.
- A type 3 covariate suggests that previous and current years' questionnaire management ratings and hazard identifications predict current and future years' WC claims outcomes and that current year's WC claims outcomes predict future years' questionnaire covariate values, creating a feedback cycle.

Determining whether a type 2 or a type 3 time-dependency exists between questionnaire predictors and WC claims outcomes assists with interpreting the direction of influence between them if they are found to be associated. This is particularly beneficial for deciphering associations between predictors and outcomes that are in a direction opposite of that expected. An empirical mean-squared-error minimization criterion was used to determine covariate type (Chen & Westgate, 2019).

WC claim rates and costs were used as outcome measures in the predictive validity assessments of program ratings and hazard identifications. Claim rates (number of claims per 100 full-time equivalents [FTEs]), claim cost per FTE, and cost per claim were calculated for total claims (medical-only [MO] and lost-time [LT] claims) from all causes and LT claims from all causes. In Ohio, MO claims are those that require seven or fewer days away from work due to a compensable injury. LT claims require eight or more days away from work due to a compensable injury (OHBWC, n.d.b).

WC claim costs continue to accrue over time, such that older claims tend to be more costly than newer claims. Because the increase in claim costs over time could bias analyses, claim costs were obtained using a 24-month average valuation approach, which OHBWC uses to limit development of claims for comparison purposes. To do this, medical and indemnity claim costs, without reserved amounts (i.e., money set aside for estimated future costs for claims that have not yet been closed), were totaled 30 months after January 1 of the year in which the claims occurred (Wurzelbacher et al., 2013). This approach produced 24-month average paid costs for each of the four years of data (2012 – 2015) used in the study. All statistical tests were two-sided at the 0.05 significance level. Analyses were performed in R version 4.0.3 (R Core Team, 2020).

3. Results

3.1 Study Participants

Of the employers insured by OHBWC in 2012 – 2015, a total of 204,622 were excluded from the study because they did not meet inclusion criteria. Of those excluded, 5,981 were public employers, 6,362 had multiple locations, 9,473 were missing size information, 2,196 were missing sector information, and 191,838 did not participate in an OHBWC grant or incentive program. The sum of these categories exceeds the number of excluded policyholders because some employers were omitted for more than one reason.

Of the remaining 10,920 employers, 2,295 completed the questionnaire two or more times in 2012 – 2015 and experienced at least one claim in a year of questionnaire completion. This main group of 2,295 employers produced 6,362 completed questionnaires (1,045 employers completed the survey twice, 728 employers completed it three times, and 522 employers completed it four times in different years of the study). Data from this group were used to evaluate scaling properties and the predictive validity of the questionnaire. The larger group of 10,920 employers (which included the smaller group of 2,295 employers) with its less restrictive inclusion criteria completed the SH-26 questionnaire at least once and had any number of claims in 2012 – 2015, including zero. Results of the scaling property evaluations from both groups were compared to evaluate the generalizability of results from the main participant group of 2,295 employers.

Numbers and percentages of questionnaires completed by the main participant group (N = 2,295 and 6,362 questionnaires) categorized by employer size for years 2012 – 2015 combined are provided in Table 2. Employers in the 11 – 49 FTE size category completed the most questionnaires.

Numbers and percentages of questionnaires categorized by NIOSH industry sector are displayed in Table 3. Most questionnaires were completed by employers in the construction and manufacturing sectors.

3.2 Evaluation of the SH-26 Program Assessment

3.2.1 Scaling Properties of the SH-26 Assessment—For the main employer group, scale and item means for the combined years of 2012 – 2015 and values associated with scaling properties across these same years are shown in Table 4. Floor effects were not found, but ceiling effects were detected for all 30 program assessment items, with the highest rating selected on more than 15% of the questionnaires. For consistency, employer responses of Not Sure (NS) were not included in the denominator when calculating percentages because they were not used in the regression analyses examining the association of the continuous predictor variable (SH-26 scale ratings) with WC claim outcomes. The NS rating was a separate rating category and not part of the 1 – 4 continuous scale ratings on the SH-26 questionnaire. For reference, the percentage of NS ratings (calculated using all responses [6,362] in the denominator) for each scale item is displayed in Table 4.

The internal consistency reliability of each of the ten program assessment scales was supported by Cronbach's alpha values, shown in Table 4. All values were within the recommended range of 0.70 – 0.90. Nearly all items were found to uniquely contribute to the scale to which they were hypothesized to belong as demonstrated by a decrease in Cronbach's alpha value when each item was removed from the calculation. An exception is Accident Analysis item #3 (see Table 1). When this item was removed, Cronbach's alpha values increased, signaling potential redundancy of the item with other items in the scale. (This item was not removed in subsequent analyses.) Item-total correlations of each item with its own scale indicated convergent validity of the program scales. As displayed in Table 4, correlations ranged from 0.65 – 0.80, exceeding the recommended minimum value of 0.3.

As shown in Table 5, the discriminant validity of most items was supported. For these, the correlation between each item and the scale to which it belongs is significantly higher ($p \leq .05$, $p \leq .01$ and $p \leq .0001$ as denoted) than the correlation of the item with other scales. Items #2 and #3 in the Accountability scale, Items #1 and #2 in the Safety Culture scale, Items #1, #2, and #3 in the Hazard Prevention and Control scale, and Item #3 in the Accident Analysis scale exhibited probable scaling errors (see Table 1). The correlation of these items with their own scale is not significantly higher than their correlations with other scales. (These items were not removed in subsequent analyses.)

Ratings from the main employer group (N = 2,295) were evaluated and compared to ratings from the larger comparison group (N = 10,920). Results from the comparison group largely mirrored those of the main group for ceiling effects, scale and item means, internal consistency reliability, convergent validity, and contribution of items to their own scales. Discriminant validity results differed somewhat between the two groups. (Comparison group results not shown.)

3.2.2 Predictive Validity of the SH-26 Program Assessment Ratings—

Higher ratings from the main employer group on Employee Health Promotion/Wellness were significantly associated ($p \leq 0.05$) with a lower WC outcome as predicted. This is denoted with a negative regression coefficient in Table 6. Employee Health Promotion ratings were found to be type 2 time-dependent covariates using an empirical mean-squared-error minimization criterion (Chen & Westgate, 2019). This indicates that practices in previous and current years predict the current year WC claim rates.

Ratings from the same group on Safety and Health Training and Education and RTW practices were significantly associated ($p \leq 0.05$) with higher claim outcomes as indicated by positive regression coefficients in Table 6. These findings were in the direction opposite of that predicted. Ratings for both leading indicators have a feedback cycle due to type

3 time-dependency. As such, previous and current years' Safety and Health Training and Education and RTW practices predict current and future years' WC claim outcomes shown in the table. In addition, current year WC claim outcomes predict Safety and Health Training and Education and RTW practices in the future.

3.3.3 Predictive Validity of Hazard Identifications—Twelve hazards identified by the main employer group were significantly associated ($p \leq 0.05$) with higher WC claim outcomes as predicted. This is indicated with positive regression coefficients in Table 7. Among these 12 hazards, nine were associated with one claim outcome and were found to have a feedback cycle due to type 3 time-dependency. Two hazards (i.e., confined spaces and welding, brazing, soldering molten metal) were associated with more than one claim outcome and were type 3 time-dependent covariates. The remaining hazard (i.e., powered tools and/or power actuated tools) had a type 3 time-dependent feedback impact on two WC claim outcomes and demonstrated a type 2 time-dependency with a third WC claim outcome.

As shown in Table 7, three hazards (i.e., prolonged work at a computer; temporary traffic/roadside worksite hazards; and high-pressure gas cylinders, and propane) were significantly associated with lower claim outcomes, as indicated with negative regression coefficients. This was in the direction opposite of that predicted. A feedback cycle corresponding to a type 3 time-dependency was found for high-pressure gas cylinders and a type 2 time-dependency was detected for temporary traffic/roadside hazards and the claim outcomes with which the hazard was associated. Prolonged work at a computer was found to have both type 2 and type 3 time-dependencies with the claim outcomes with which it was associated.

4. Discussion

4.1 Size, sector, and scaling properties

Main group employers in the 11 – 49 FTE size category and in the construction and manufacturing sectors completed the highest percentage of questionnaires. Differences in representation in size categories and sectors indicate that some groups were over-represented and some were under-represented in the SH-26 questionnaire assessment. Further examination of differences between size categories and between sectors in SH-26 questionnaire scale ratings and hazard identifications is needed in future research.

An examination of scale ratings indicated strong ceiling effects potentially caused by social desirability bias. Knowing that OHBWC could view their SH-26 assessments, participants may have elevated their ratings to create a favorable impression of their companies. The high percentage of ratings at scale maximum may have attenuated associations between program elements and claims outcomes, thereby reducing the number of significant associations between these indicators. It may be possible to reduce social desirability bias by eliminating the requirement to submit assessments to OHBWC. A drawback to this, however, is that OHBWC safety consultants would not be able to use program ratings to assist with policyholder safety improvement. Another option is to enable frontline employees to anonymously submit assessments. Employee ratings could then be compared with management or safety and health leader ratings to determine differences in ratings and the presence of social desirability bias.

Analyses of the main and comparison groups' ratings support the scaling properties of the SH-26 questionnaire. In addition, similarities between the groups' scaling property assessments support the generalizability of the main group's ratings to Ohio employers that may use OHBWC resources, including the SH-26 assessment. This lends credence to the utility of the SH-26 assessment for Ohio employers, particularly those enrolled in OHBWC grant and incentive programs.

4.2 Predictive Validity

4.2.1 Program Ratings—Higher ratings on the Employee Health Promotion/Wellness scale were associated with lower WC claim rates. This is consistent with previous studies in which promotion of employee health and wellbeing were associated with better WC outcomes (Habeck et al., 1991; Wurzelbacher & Jin, 2011). Type 2 time-dependencies were found between employee health promotion practices and claim outcomes. This suggests that previous and current years' practices may have led to lower current year claim frequencies, but that claim outcomes did not influence current and future years' practices in a feedback loop as occurs with Type 3 covariates.

In the current study, higher ratings on safety and health training and education and RTW practices were unexpectedly associated with higher claim rates. Others have also found severity-reduction practices to be associated with higher frequency and severity measures (Cullen et al., 2005; Hunt et al., 1993; Robson et al., 2017; Wurzelbacher & Jin, 2011). In an interpretation of their findings, Wurzelbacher and Jin (2011) and Hunt et al. (1993) suggested that companies with low OSH performance may have implemented or strengthened their safety policies and practices, leading to higher assessment ratings. As such, the influence between leading and lagging indicators was not in the expected sequence. Performance outcomes tagged as "lagging indicators" may have served as "a stimulus to action rather than a response, thus reversing the causation" (Hunt et al., 1993, p. 4–7). The use of prospective longitudinal data and the unique application of a statistical method in the current study provide support for and extend this interpretation. Specifically, a type 3 time-dependency was found between training and education ratings and RTW ratings and claim outcomes, indicating that these practices and claim outcomes affected each other in a feedback cycle. Higher claim rates may have been a catalyst for employers to develop or strengthen their training and RTW practices. Because these practices encourage early reporting of discomfort and injuries as a means for reducing injury severity, they may have led to higher claim rates during the period of the study. They were not, however, associated with claim severity measures.

In sum, only the Employee Health Promotion/Wellness scale was associated with WC claim outcomes in the predicted direction. While associations between Safety and Health Training and Education and RTW Practices and WC claim outcomes were in the direction opposite of that predicted, these findings align with previous research. The analytical method provided insight on these associations, indicating that outcomes may have served as a catalyst to action. Lagging indicators may have signaled a need for improvement while leading indicators provided direction for improvement. These findings underscore the benefit of using both leading and lagging indicators in OSH improvement efforts.

4.2.2 Hazard Identifications—

In the current study, 12 hazards, including elevated noise levels, power tools, and confined spaces, were associated with higher claims outcomes as predicted. Similarly, Wurzelbacher and Jin (2011) found that employer reports of worker exposure to noise and projectiles were associated with higher WC rates and costs. These findings also are consistent with those obtained by Akbar-Khanzadeh and Wagner (2001). Researchers found that hazard identification was among the top three of 25 leading indicators on a form used in an OSHA consultation program for their influence in reducing safety violations. These findings align with the practice of using hazard checklists to identify exposures for intervention. Hazard identification is a main component of many OSH programs, including the NIOSH (2017) Elements of Ergonomics Programs and OSHA's (2016) Recommended Practices for Safety and Health Programs.

Because they were included in the SH-26 hazards list, all hazards were predicted to be associated with higher claims outcomes. However, the hazards of prolonged work at a computer, temporary traffic/roadside hazards, and high-pressure gas cylinders were found to be associated with lower claims outcomes. In retrospect, lower claims rates and costs associated with prolonged work at a computer may have been anticipated given its relatively lower injury risk relative to non-office work. The reasons that temporary traffic/roadside hazards and high-pressure gas cylinders were associated with better claim outcomes are unclear and warrant additional study.

In sum, these findings suggest that hazard identifications may be useful for improving workplace safety. Support for this idea comes from several researchers (Emery et al., 1995; Colombini, Occhipinti, & Di Leone; 2012; Colombini, Occhipinti, Peluso, & Montomoli, 2012) who developed simple hazard identification methods that were accepted by users. These methods, which researchers found to be efficient and effective for identifying safety and ergonomics concerns, were developed for use by people in various roles within companies and by health and safety practitioners and government representatives. Simple hazard identifications followed by control efforts to reduce associated injury risk may be an effective means for achieving a safer workplace (Emery et al., 1995).

4.3 Study Limitations

A primary limitation of this study is the use of data provided by companies that self-selected enrollment in OHBWC safety programs. In addition, criteria for using data in predictive analyses, including the requirement of at least two questionnaire completions in different study years and one WC claim in a survey year reduced the size of the main employer group. Related to this concern is the under-representation of employers in larger organizations and in several industries. These limitations may have constrained the generalizability of study findings to the general employer population. Support from both the main and comparison groups for the internal consistency reliability and convergent/discriminant validity of the assessment scales provides support for the generalizability and utility of the SH-26 questionnaire for OHBWC policyholders participating in grant and incentive programs.

Lastly, minor scaling issues and program rating ceiling effects were identified. Rewording or eliminating scale items may address these scaling concerns. Depending on the cause of ceiling effects, ratings may be useful in company self-improvement efforts.

4.4 Conclusions

The current study extends leading indicator research by evaluating an assessment instrument using data from employers for whom the instrument was designed to assist. It provides moderate support for the usefulness of employer safety management scale ratings and stronger support for hazard identifications for safety self-improvement. Further, the longitudinal nature of SH-26 responses and claim outcomes together with a novel statistical approach in this area of research provided insight into the inter-relatedness of leading and lagging indicators. Obtaining statistical support for an interpretation discussed by Hunt et al. (1993) and Wurzelbacher and Jin (2011) in which outcomes function as catalysts for safety and health efforts underscores the value of using both leading and lagging indicators, where possible, for improving safety efforts.

4.5 Practical Applications

Study results have implications for the use of the SH-26 questionnaire by employers and WC insurers. Employer hazard identifications appear to have utility for both employers and safety consultants for targeting aspects of safety management in need of improvement. In addition, insurers may find these identifications useful for targeting companies at higher risk for injuries with safety resources. Further, results suggest that employer-completed safety program management scales may be useful in organizational self-improvement efforts. Additional research is needed to assess the source of and means for eliminating ceiling effects on ratings, however. Such research may provide insight into the usability of employer safety management assessments by safety consultants. Lastly, comparing hazard identifications and safety management ratings from a random sample of policyholders divided into high and low injury rate groups, and from employers in different employer sizes and industry sectors may provide additional understanding of the benefits and application of the SH-26 assessment.

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Table 1.

The OHBWC SH-26 Safety Management Self-Assessment Questionnaire.

Ohio | Bureau of Workers' Compensation

Safety Management Self-Assessment

Company name	Policy number
Industry type	Total number of employees

This assessment is intended to help employers evaluate their safety and claims management systems and identify opportunities for improvement. It should be completed by the person(s) in the organization who is most familiar with the current safety andclaims management process. Please read each of the statements below and select the rating that best represents your level ofagreement with that statement. The estimated time to complete this assessment is 15 minutes.

Upon completion of the assessment, please refer to the Resource Guide on the Industry-Specific Safety Program page for a list of suggested activities and BWC Division of Safety & Hygiene resources you can use in the areas you wish to improve. If you would like personal assistance completing the safety review or implementing any of the suggested activities, please call 1-800-644-6292.

Rating scale: I = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree, NS = not sure

A. **Management commitment –** The level of commitment that management demonstrates to the safety and health process
1. A concise, documented policy that establishes safety and health as a core value that is equally important as production, service and quality has been communicated to all employees by top management.
☐1 ☐2 ☐3 ☐4 ☐NS
2. Management allocates adequate time and resources to support the organization's safety and health efforts.
☐1 ☐2 ☐3 ☐4 ☐NS
3. Top management establishes safety and health program goals, and regularly evaluates and communicates the organization's safety performance.
☐1 ☐2 ☐3 ☐4 ☐NS

B. **Accountability –** The process that is used to assign safety and health management responsibilities and to evaluate, recognize and reward performance
1. Safety and health responsibilities are assigned to the appropriate personnel and are specifically addressed in the performance review of each employee.
☐1 ☐2 ☐3 ☐4 ☐NS
2. Individuals with assigned safety and health responsibilities are provided with the skills, knowledge, resources and authority to perform their duties effectively.
☐1 ☐2 ☐3 ☐4 ☐NS
3. Supervisors conduct regularly scheduled safety inspections, safety briefings, observations, coaching and other assigned activities.
☐1 ☐2 ☐3 ☐4 ☐NS

C. **Employee participation** –The extent to which the employees participate in and are encouraged to be involved in the safety and health of the workplace
1. Opportunities are provided for employees to participate in the safety process through activities such as safety committee meetings, safety team projects and safety awareness event planning.
☐1 ☐2 ☐3 ☐4 ☐NS
2. Employees are involved in safety goal setting, strategy development and safety process improvements.
☐1 ☐2 ☐3 ☐4 ☐NS
3. Employees actively participate in safety and health training by identifying needed training topics, assisting with development and delivery of training, and assisting with on-the-job training and mentoring of new employees.
☐1 ☐2 ☐3 ☐4 ☐NS

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Rating scale: 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree, NS = not sure

D. Safety culture –The organizational values, management style, environment and social norms related to safety and health

1. The organization fosters trust and open communication on occupational safety and health issues by encouraging discussion and feedback on all issues that are raised.

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

2. Collaboration and teaming on safety and health projects, activities and goals are used to ensure involvement and support from people in all areas.

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

3. Employee safety and health issues are a standard topic of discussion in all organizational meetings and an essential consideration in all business decisions.

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

E. Hazard prevention and control –The process to identify and correct unsafe acts and unsafe conditions.

1. Employees at all levels are encouraged to promptly report safety and health hazards and unsafe acts to their supervisor and/or safety contacts for follow-up action.

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

2. Safety inspections are performed regularly to identify unsafe acts, and conditions and hazards are effectively eliminated or minimized in a timely fashion.

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

3. New equipment, tools, materials and methods are evaluated before purchase, implementation and use to ensure that they do not create safety and health hazards

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

F. Safety and health training and education – The process of making sure that safety education and training is provided to people at all levels and that skills are assessed to ensure understanding.

1. Individuals at all levels in the organization receive the appropriate level of job-specific safety training along with all OSHA required training and a thorough explanation of the organization's safety and health management process, opportunities to participate and expectations for performance.

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

2. Supervisors and managers are knowledgeable with regard to the potential hazards and the safe practices for alljobs they oversee and are trained in safety observations, coaching and mentoring techniques to promote safe and healthy work practices.

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

3. Employees are informed of all potential hazards in their jobs, provided with documentation of safe work practices, and periodically evaluated to ensure understanding and compliance.

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

G. Accident analysis –The method of gathering and analyzing information and accident facts, determining root causes, and identifying safety improvements to prevent future accidents

1. Supervisors document accidents, incidents and near misses, and conduct thorough accident analysis in a timely manner.

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

2. Supervisors work with safety coordinators and employees to determine root causes of accidents and near missesto ensure that effective corrective actions are taken.

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

3. Top management regularly reviews accident trends and workers' compensation costs and uses the information to help develop goals and objectives.

   ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **NS**

Rating scale: 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree, NS = not sure

H. Workers' compensation claims management –The management process for ensuring timely filing of claims, care for the injured workers and minimizing the financial impact of claims on the organization

1. A clear and efficient process for reporting injuries/illnesses, obtaining medical treatment and filing the claim is established and communicated to all employees and follow-up contacts are made with injured workers while theyare off work.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ NS
2. The person(s) responsible for managing workers' compensation is knowledgeable about the various BWC rating programs, discount programs and claims-management strategies and use them effectively.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ NS
3. The person(s) responsible for claims management regularly consults with BWC, the MCO and TPA to monitor all openclaims, identify claims needing case management and rehabilitation services, and develop next steps to maximize return-to-work outcomes.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ NS

I. Return-to-work practices – The management process for ensuring a safe, efficient return to work by injured workers to help reduce financial burdens on the employee and employer

1. The organization has developed policies and procedures for bringing an injured worker back to work in a safe and timely manner and communicated them to all managers, supervisors, employees and local health-care providers.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ NS
2. The organization maintains a detailed inventory that quantifies the physical demands of its jobs and educates local health-care providers on modified, transitional duty opportunities and expectations for releasing employees as soon as medically suitable.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ NS
3. The organization collaborates with treating physicians and case managers and uses strategies such as job modi-fications, assistive devices and flexible work scheduling to facilitate placement of injured workers based on their restrictions, capabilities and functional capacities.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ NS

J. Employee health promotion (wellness) –The organization's efforts to encourage personal health improvement and health maintenance among its employees

1. Top management supports and actively participates in health and wellness programs and activities, and regularly communicates the personal and organizational benefits.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ NS
2. Employees are encouraged to complete health risk assessments and are provided with data to help identify potential health risks and improvement opportunities.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ NS
3. The employer provides low-cost/no-cost preventive care services and resources for health maintenance and health improvement (e.g., health coaching, disease management, diet and nutrition counseling, smoking cessation and weight loss programs).
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ NS

K. Hazard identification - Please check all of the items below that apply to the nature of your business or the work operations.

☐ Airborne contaminants (dust, fumes, vapors)	☐ Exposure to electrical hazards	☐ Knives, slitters, shears, other cutting tools	☐ Repetitive forceful exertions
☐ Bloodborne pathogens or other bodily fluids	☐ Exposure to extreme heat or cold	☐ Lifting and transferring patients/residents	☐ Slips/trips/falls
☐ Confined spaces	☐ Exposure to mechanical hazards	☐ Moderate to heavy lifting, carrying, push/pull	☐ Sustained awkward work postures
☐ Cranes, rigging and material lifting operations	☐ Exposure to sunlight or other UV radiation	☐ Needlesticks or other sharps	☐ Sustained forceful exertions
☐ Earth-moving equipment	☐ Flammable or combustible	☐ Power press, brake press,	☐ Temporary traffic/roadside

other powered trucks	materials	forging press	worksite hazards

☐ Elevated noise levels	☐ Forklifts or other powered trucks	☐ Powered tools and/or power actuated tools	☐ Trenching and excavation
☐ Elevated work with potential for falls	☐ High-pressure gas cylinders, propane, etc.	☐ Prolonged work at computer terminal	☐ Vibration or impact forces on the body
☐ Exposure to chemicals or hazardous substances	☐ Insect bites, stings, poisonous vegetation	☐ Repetitive awkward work postures	☐ Welding, brazing, soldering, molten metal

L. Please indicate which BWC safety and health programs and services you would like to learn more about.

☐ Ergonomics consultation	☐ Safety and health training	☐ Safety consultation
☐ Industrial hygiene consultation	☐ Safety and health videos/DVDs	☐ Safety council
☐ Safety and health resource library	☐ Safety Congress & Expo	☐ Safety grants

If you have any questions or would like to request personalized assistance from a BWC representative, call 1-800-OHIOBWC.

Owner/partner; officer name	Title
Signature X	Date

Table 2.

Number and percentage of questionnaires by employer size category in years of the study (2012 – 2015).

Employer Size Category N = FTEs	Questionnaires 2012 – 2015	
	N	%
1 – 10	265	4%
11 – 49	3030	48%
50 – 99	1700	27%
100 – 249	1163	18%
250 – 999	197	3%
> 1000	7	<1%
Totals	6,362	100%

Table 3.

Number and percentage of questionnaires by industry in years of the study (2012 – 2015).

NIOSH Industry Sector	Questionnaires 2012 – 2015	
	N	%
Agriculture, Forestry & Fishing	35	<1%
Construction	1,897	30%
Healthcare & Social Assistance	513	8%
Mining (except oil & gas extraction)	47	<1%
Manufacturing	1,854	29%
Services	882	14%
Transportation, Warehousing & Utilities	486	8%
Wholesale & Retail Trade	648	10%
Totals	6,362	100%

Table 4.

Descriptive statistics, convergent validity, and internal consistency for years 2012 – 2015 combined.

Descriptive Statistics and Scaling Property Values 2012 – 2015								
Scales	**Items**	**Scale Means**	**Item Means**	**% of NS Ratings**	**Ceiling %**	**Item-Total Correlation**	**Cronbach's Alpha Scale Level**	**Cronbach's Alpha with Item Removed from the Scale**
Management commitment		3.61					0.87	
	A1		3.69	1.0%	73%	0.74		0.82
	A2		3.62	.94%	66%	0.77		0.80
	A3		3.53	1.3%	59%	0.73		0.83
Accountability		3.49					0.82	
	B1		3.44	2.7%	51%	0.69		0.75
	B2		3.58	1.3%	62%	0.70		0.73
	B3		3.47	1.9%	55%	0.65		0.79
Employee participation		3.31					0.85	
	C1		3.37	2.0%	48%	0.69		0.81
	C2		3.23	2.4%	36%	0.77		0.74
	C3		3.33	1.8%	43%	0.70		0.81
Safety culture		3.53					0.84	
	D1		3.65	1.2%	69%	0.71		0.76
	D2		3.40	1.9%	48%	0.69		0.78
	D3		3.53	2.0%	59%	0.69		0.78
Hazard prevention & control		3.66					0.83	
	E1		3.80	.85%	83%	0.68		0.76
	E2		3.58	1.7%	63%	0.68		0.76
	E3		3.60	3.0%	64%	0.68		0.76
Safety & health training & education		3.55					0.88	
	F1		3.56	2.0%	61%	0.76		0.84
	F2		3.58	1.4%	63%	0.79		0.82
	F3		3.51	1.8%	57%	0.76		0.84
Accident analysis		3.53					0.86	
	G1		3.54	1.2%	60%	0.76		0.78
	G2		3.53	1.5%	58%	0.79		0.75
	G3		3.52	2.0%	59%	0.66		0.87*
WC claims management		3.67					0.88	
	H1		3.70	1.0%	73%	0.75		0.86
	H2		3.63	1.3%	67%	0.77		0.84
	H3		3.70	1.5%	73%	0.80		0.81
RTW practices		3.49					0.86	
	I1		3.60	2.0%	66%	0.73		0.82

Descriptive Statistics and Scaling Property Values 2012 – 2015								
Scales	**Items**	**Scale Means**	**Item Means**	**% of NS Ratings**	**Ceiling %**	**Item-Total Correlation**	**Cronbach's Alpha Scale Level**	**Cronbach's Alpha with Item Removed from the Scale**
	I2		3.40	4.5%	51%	0.74		0.81
	I3		3.50	3.3%	57%	0.75		0.80
Employee health promotion (wellness)		3.00					0.88	
	J1		3.09	5.1%	36%	0.78		0.82
	J2		2.96	6.7%	31%	0.80		0.79
	J3		2.92	7.9%	32%	0.71		0.87

*The value of Cronbach's alpha increased when calculated with item #3 removed from the Accident Analysis scale.

Table 5.

Correlations of scale items with their own and other scales for the evaluation of discriminant validity.

Scale Item Correlations 2012 – 2015										
Scale Items	**A. Mgmt. commitment**	**B. Accountability**	**C. Employee participation**	**D. Safety culture**	**E. Hazard prevention and control**	**F. Safety & health trng. & education**	**G. Accident analysis**	**H. WC claims mgmt.**	**I. RTW practices**	**J. Employee health promotion**
A1	0.74‡	0.68	0.56	0.66	0.65	0.65	0.60	0.59	0.53	0.30
A2	0.76‡	0.70	0.57	0.66	0.63	0.63	0.58	0.56	0.50	0.33
A3	0.73‡	0.70 *	0.62	0.67	0.60	0.63	0.61	0.54	0.52	0.37
B1	0.65 *	0.68‡	0.60	0.63 **	0.57	0.59	0.58	0.50	0.50	0.37
B2	0.70 †	0.69‡	0.60	0.66 *	0.63	0.65 **	0.61	0.58	0.51	0.33
B3	0.66 †	0.64‡	0.61 †	0.64 †	0.65 †	0.63 †	0.60 **	0.49	0.47	0.32
C1	0.58	0.59	0.69‡	0.61	0.53	0.56	0.52	0.46	0.47	0.40
C2	0.57	0.62	0.76‡	0.63	0.53	0.57	0.53	0.44	0.47	0.42
C3	0.59	0.64 **	0.69‡	0.66 *	0.56	0.61	0.56	0.47	0.49	0.38
D1	0.67 **	0.65	0.58	0.71‡	0.69 †	0.66 **	0.63	0.61	0.52	0.31
D2	0.63	0.66 *	0.70 †	0.69‡	0.61	0.64 **	0.60	0.52	0.51	0.40
D3	0.66 *	0.65 **	0.60	0.69‡	0.64 **	0.63	0.62	0.53	0.49	0.33
E1	0.62 **	0.57	0.48	0.64 *	0.67‡	0.64 †	0.60	0.64 †	0.51	0.25
E2	0.62 **	0.66 †	0.58	0.64 *	0.67‡	0.68 †	0.63 **	0.57	0.52	0.32
E3	0.58	0.60	0.53	0.64 *	0.68‡	0.68 †	0.61	0.57	0.52	0.29
F1	0.64	0.64	0.57	0.65	0.68	0.76‡	0.60	0.59	0.55	0.32
F2	0.65	0.66	0.59	0.68	0.72	0.79‡	0.65	0.60	0.56	0.32
F3	0.64	0.66	0.61	0.67	0.69	0.76‡	0.65	0.59	0.58	0.37
G1	0.56	0.60	0.51	0.60	0.62	0.60	0.75‡	0.59	0.51	0.33
G2	0.60	0.63	0.56	0.64	0.65	0.65	0.78‡	0.60	0.56	0.36
G3	0.62 *	0.61 **	0.56	0.64 †	0.61 **	0.62 *	0.66‡	0.59	0.54	0.36
H1	0.60	0.57	0.50	0.61	0.65	0.62	0.64	0.73‡	0.62	0.30
H2	0.54	0.52	0.45	0.54	0.58	0.56	0.57	0.76‡	0.58	0.29
H3	0.57	0.54	0.46	0.57	0.62	0.59	0.59	0.80‡	0.62	0.28
I1	0.54	0.53	0.48	0.55	0.58	0.59	0.57	0.66	0.73‡	0.33
I2	0.50	0.50	0.49	0.50	0.49	0.54	0.52	0.55	0.74‡	0.37

Scale Item Correlations 2012 – 2015										
Scale Items	A. Mgmt. commitment	B. Accountability	C. Employee participation	D. Safety culture	E. Hazard prevention and control	F. Safety & health trng. & education	G. Accident analysis	H. WC claims mgmt.	I. RTW practices	J. Employee health promotion
I3	0.51	0.50	0.48	0.53	0.53	0.54	0.54	0.60	0.75‡	0.35
J1	0.38	0.39	0.44	0.41	0.34	0.38	0.39	0.33	0.38	0.77‡
J2	0.36	0.38	0.44	0.38	0.31	0.36	0.37	0.29	0.36	0.79‡
J3	0.29	0.32	0.36	0.31	0.26	0.29	0.31	0.26	0.33	0.71‡

Correlations with no denotation, p-values are ≤.0001

** p≤.01

* p ≤.05

+ Probable scaling error with p >.05

‡ Reference group (also shaded)

Table 6.

Main employer group associations of 2012 – 2015 scale ratings with 2012 – 2015 claims rates and costs.

Associations of Scale Ratings with WC Outcomes												
	All Claims						LT Claims					
Claim metrics	Claim rate/100 FTEs		Claim cost/FTE		Cost/claim		Claim rate/100 FTEs		Claim cost/FTE		Cost/claim	
Scale Ratings	CT[+]	RC[++]	CT	RC	CT	RC	CT	RC	CT	RC	CT	RC
Management commitment	2	0.0176	1		1		1		1		1	
Accountability	-	-	3	−0.0524	3	0.0138	1		1		1	
Employee participation	-	-	3	−0.0255	3	0.0188	1		1		1	
Safety culture	-	-	2	−0.0775	2	−0.0151	1		1		1	
Hazard prevention & control	3	0.1356	3	−0.0422	3	−0.0022	-	-	1		1	
S&H training & education	3	0.1348↑	1		1		1		1		1	
Accident analysis	3	0.0554	3	−0.0841	3	−0.0237	-	-	3	−0.0240	1	
WC claims management	1		3	0.0154	3	0.0090	-	-	3	0.1147	3	0.1031
RTW practices	3	0.0935↑	3	−0.0179	3	−0.0221	1		1		1	
Employee health promotion	2	−0.0435↓	2	−0.0624	2	−0.0138	3	−0.0028	3	0.0915	3	0.1299

[+] CT = Covariate Type

[++] RC = Regression Coefficient

↓ = Significant associations (p≤.05) of scale ratings with lower WC outcomes as predicted.

↑ = Significant associations (p≤.05) of scale ratings with higher WC outcomes, which is in the direction opposite that predicted.

Note: Dashes indicate that the model fitting for the item is not convergent due to a linear algebra issue (the inverse covariance matrix is not solved). Blanks signify that the scale items are time-independent covariates and therefore cannot predict outcome variables.

Table 7.

Main employer group associations of 2012 – 2015 identified hazards with 2012 – 2015 claim rates and costs.

Associations of Hazards with WC Claim Outcomes												
	All Claims						LT Claims					
Claim metrics	**Claim rate/100 FTEs**		**Claim cost/FTE**		**Cost/claim**		**Claim rate/100 FTEs**		**Claim cost/FTE**		**Cost/claim**	
Hazards	**CT**[+]	**RG**[++]	**CT**	**RG**	**CT**	**RG**	**CT**	**RG**	**CT**	**RG**	**CT**	**RG**
Elevated work with potential for falls	2	0.0459	1		1		1		1		1	
Repetitive forceful exertions	2	−0.0701	1		1		2	0.2596	3	0.0700	3	0.0242
Power press, brake press, forging press	3	0.1026**↑	3	0.0876	3	0.0107	1		2	0.1716	3	0.0633
Sustained forceful exertions	1		1		1		3	−0.0426	3	−0.0891	3	−0.0113
Trenching and excavation	3	0.1939**↑	3	0.0300	3	−0.0317	1		3	0.1352	2	0.0840
Confined spaces	3	0.1585***↑	3	0.1316*↑	3	0.0427	1		1		1	
Earth-moving equipment other powered trucks	3	0.0605	1		1		3	0.0666	1		1	
Knives, slitters, shears, other cutting tools	1		1		1		2	0.1336	2	0.0906	2	0.1125
Forklifts or other powered trucks	3	−0.0438	3	−0.0816	2	−0.0495	2	−0.0211	1		1	
Cranes, rigging and material lifting operations	1		3	−0.0281	1		3	−0.0033	3	−0.2420	3	−0.1898
Powered tools and/or power actuated tools	3	0.1317***↑	3	0.1359*↑	3	0.0157	2	0.2536**↑	1		3	−0.0937
Vibration or impact forces on the body	2	0.0642	3	0.0640	1		1		1		1	
Lifting and transferring patients/ residents	2	−0.0085	1		2	−0.0381	1		1		1	
Repetitive awkward work postures	3	−0.0821	1		1		3	−0.0060	3	0.0726	3	0.1557
Temporary traffic/ roadside worksite hazards	2	−0.0522	2	−0.0823	2	−0.1028*↓	1		2	−0.0246	2	−0.1773

Associations of Hazards with WC Claim Outcomes												
	All Claims						LT Claims					
Claim metrics	Claim rate/100 FTEs		Claim cost/FTE		Cost/claim		Claim rate/100 FTEs		Claim cost/FTE		Cost/claim	
Hazards	CT+	RG++	CT	RG	CT	RG	CT	RG	CT	RG	CT	RG
Exposure to electrical hazards	3	0.0819 *↑	1		1		1		1		3	−0.1049
Exposure to chemicals or hazardous substances	3	0.2153 ***↑	3	0.0921	3	−0.0594	1		3	0.2488	3	0.0618
Welding, brazing, soldering, molten metal	1		3	0.1663 **↑	3	0.0876	3	0.2794 **↑	3	0.2507	3	0.0142
Slips/trips/ falls	3	0.1359 **↑	3	0.0959	3	0.0616	1		1		3	−0.2572
Flammable or combustible materials	2	0.0308	3	0.0327	1		3	0.1607	3	−0.0619	1	
Airborne contaminants (dust, fumes, vapors)	2	0.0417	1		1		3	0.2834 **↑	2	0.0554	2	−0.2510
Prolonged work at computer terminal	3	−0.0863 **↓	2	−0.1119 *↓	2	−0.0564	1		3	−0.2586	3	−0.1200
Elevated noise levels	3	0.0931 *↑	1		1		3	0.0530	3	−0.3325	3	−0.3118
Exposure to mechanical hazards	1		1		1		1		2	−0.0693	2	0.0163
High-pressure gas cylinders, propane, etc.	2	−0.0155	3	−0.0452	3	−0.0915 *↓	1		3	0.0849	3	0.0165
Exposure to extreme heat/ cold	3	0.0344	1		1		1		2	−0.0281	1	
Sustained awkward work postures	3	0.1525 ***↑	3	0.0368	3	−0.0561	3	0.1346	2	−0.0595	2	−0.2032
Exposure to sunlight or other UV radiation	3	0.0597	3	0.0020	3	−0.0464	1		3	−0.1174	3	−0.1057
Needle sticks or other sharps	2	−0.0504	2	−0.0076	2	−0.0131	3	−0.0159	1		1	
Bloodborne pathogens or other bodily fluids	2	0.0097	1		1		3	−0.0511	1		1	
Insect bites, stings, poisonous vegetation	3	0.1072 **↑	3	0.0641	3	−0.0129	2	−0.0033	2	−0.2319	2	−0.1941

Associations of Hazards with WC Claim Outcomes												
	All Claims						**LT Claims**					
Claim metrics	**Claim rate/100 FTEs**		**Claim cost/FTE**		**Cost/claim**		**Claim rate/100 FTEs**		**Claim cost/FTE**		**Cost/claim**	
Hazards	**CT**[+]	**RG**[++]	**CT**	**RG**	**CT**	**RG**	**CT**	**RG**	**CT**	**RG**	**CT**	**RG**
Moderate to heavy lifting, carrying, push/ pull	-	-	3	0.0941	1		-	-	1		1	

[+]CT = Covariate Type

[++]RC = Regression Coefficient

P-values:

*≤.05

**≤.01

***≤.001

↑= Significant associations of scale ratings with higher WC outcomes as predicted.

↓= Significant associations of scale ratings with lower WC outcomes, which is in the direction opposite that predicted.

Note: Dashes indicate that the model fitting for the item is not convergent due to a linear algebra issue (the inverse covariance matrix is not solved). Blanks signify that the scale items are time-independent covariates and therefore cannot predict outcome variables.