



Does having a certified occupational health and safety management system lead to a greater injury rate reduction? An evaluation of the Certificate of Recognition program in Ontario, Canada

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ABSTRACT

Introduction: Occupational health and safety management system (OHSMS) programs are designed to create safer workplaces. However, research on their effectiveness is limited in terms of representation and rigor. This study evaluates whether firms that obtained an OHSMS certification via the Certificate of Recognition (COR) program experienced greater injury rate reductions than similar non-certified firms in Ontario, Canada. **Method:** Using firm and claim-level data from the Workplace Safety and Insurance Board and COR registration data from the Infrastructure Health and Safety Association, the effect of becoming certified on firm-level injury rates was assessed using a matched difference-in-differences study design with population averaged negative binomial regression models. **Results:** A total of 346 certified firms were matched with 310 non-certified firms during the years 2009 to 2020. Firms that became certified were associated with a greater reduction in the lost time injury rate (incidence rate ratio (IRR): 0.72; 95% confidence interval (CI): 0.63–0.84), high-impact injury rate (IRR: 0.80, 95% CI: 0.66–0.97) and no reduction in the no lost time injury rate (IRR: 1.00, 95% CI: 0.92–1.08) relative to the change in similar non-certified firms. The effectiveness of certification was strongest in firms that were recently certified, larger, and in the construction sector. **Conclusions:** The findings suggest that COR can be an effective program in reducing injury rates in construction firms, and among larger and more recently certified firms. It is less effective in smaller and earlier certified firms, and not effective in non-construction firms. Furthermore, the effectiveness in construction firms may be subject to unmeasured selection bias. **Practical Applications:** OHSMS program evaluations can inform decision-makers on when, and under what circumstances programs work and where improvements can be made. In particular, the COR program appears most effective for large construction firms whereas small construction firms may benefit from other tools.

1. Introduction

Globally, an estimated 2.8 million workers die each year from work-related accidents and diseases, with 4% of global gross domestic product lost due to accidents and poor working conditions (International Labour Organization, 2024). One organizational approach with the potential to reduce workplace injuries and illnesses is to develop an occupational health and safety management system (OHSMS). OHSMSs have been around for decades, with internationally recognized standards such as Occupational Health and Safety Assessment Series (OHSAS) 18001 (British Standards Institution, 2023), and its successor, ISO 45001 (International Organization for Standardization [ISO], 2024). OHSMS

certification programs are increasingly implemented across various industry sectors and countries but there is mixed evidence as to whether they are effective or not, with OHSMS adoption being associated with fewer work injury rates in some studies (Abad et al., 2013; McLeod & Macpherson, 2025; Lafuente & Abad, 2018; Viswanathan et al., 2024) but not in others (Dyrborg et al., 2024; Ghahramani & Summala, 2017; Heras-Saizarbitoria et al., 2019).

Definitions of OHSMS vary but generally an OHSMS includes an integrated set of organizational elements involved in the continuous cycle of planning, implementation, evaluation and continual improvement, directed toward the abatement of occupational hazards in the workplace (Robson et al., 2005). In contrast to traditional occupational

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health and safety (OHS) programs, OHSMSs are more proactive, better internally integrated, and incorporate stronger elements of evaluation and continuous improvement (Robson et al., 2007). OHSMSs have been subject to systematic reviews on the barriers and facilitators of their implementation (da Silva & Amaral, 2019) and their evidence of effectiveness (Robson et al., 2007). Despite studies generally identifying positive changes resulting from OHSMS interventions, there has not been enough evidence to conclude that they lead to a reduction in work injuries (Robson et al., 2007). Studies on OHSMS effectiveness are still limited to a few jurisdictions and industries, and characterized by lack of generalizability and methodological limitations, such as a lack of control groups or lack of accounting for selection into OHSMS programs. However, there are some exceptions to this in recent years. For example, Lafuente and Abad (2018) found that OHSAS 18001 adoption in Spain was associated with significant reductions in the work injury rate and that cumulative OHSAS 18001 experience (additional years of certification) was associated with significant reductions in the work injury rate. Viswanathan et al. (2024) used a propensity score-matched difference-in-differences (DiD) model to find that OHSAS 18001 adoption in the United States led to firms experiencing 20% fewer injury and illness cases than matched control firms. Dyreborg et al. (2024) used matched register-based longitudinal data in Denmark to find that firms with certified OHSMSs had a 14% lower risk of severe accidents compared to non-certified firms two years prior to certification but had no further decreased risk during three years of follow-up. Lastly, McLeod and Macpherson (2025), used a coarsened exact matching (CEM) DiD model to find that firms that had certified OHSMSs via the Certificate of Recognition (COR) program in Alberta, Canada, experienced a 14% greater reduction in their lost-time injury rate, relative to the change observed among similar non-certified firms. While the aforementioned study presents the most rigorous evaluation of an OHSMS certification program in Canada to date, there is value in examining whether similar program effectiveness is observed in other provinces where the maturity, implementation, and delivery of the program can differ. Therefore, this study seeks to evaluate the COR program in the Canadian province of Ontario in assessing whether certified firms achieved greater firm-level injury rate reductions compared to similar non-certified firms.

1.1. OHSMS certification in Ontario, Canada

In Canada, OHS legislation outlines the general rights and responsibilities of the employer, the supervisor and the worker through an Act or statute and related regulations. Each of the 10 provinces, 3 territories, and the federal government, has its own OHS legislation (Canadian Centre for Occupational Health and Safety, 2025). In the province of Ontario, the Ministry of Labour, Immigration, Training and Skills Development oversees and coordinates the provincial occupational health and safety system (Government of Ontario, 2024) and creates and leads a workplace health and safety strategy to prevent illnesses and injuries. More specifically, the role of the ministry is to:

- Develop laws on OHS and workplace insurance
- Communicate and enforce occupational health and safety law in Ontario workplaces
- Set standards for health and safety training
- Measure and evaluate the effectiveness of the provincial workplace health and safety strategy
- Measure and evaluate the impact of occupational health and safety system's programs and initiatives

The Workplace Safety and Insurance Board (WSIB) is the provincial organization responsible for providing no-fault collective liability insurance and access to industry-specific health and safety information (Workplace Safety and Insurance Board, 2026). COR is a voluntary audit-based OHSMS certification program available to firms across different industries in Canada. In construction and related industries,

COR® is nationally registered, trademarked, and endorsed by the Canadian Federation of Construction Safety Associations (CFCSA) and is delivered through member associations to grant COR® in their respective provinces/territories (The Canadian Federation of Construction Safety Associations, 2024). For brevity, we refer to both the CFCSA endorsed COR programs and other COR programs as COR throughout the rest of the manuscript. The Infrastructure Health & Safety Association (IHSA) is the only organization with the authority to grant COR in Ontario.

COR was first introduced in Ontario in 2012 and has increasingly become a pre-bid requirement for publicly funded construction projects (IHSA, 2016). At the time of this study, in contrast to other provinces, the IHSA COR audit tool included more elements (19 compared to 14) and a higher score threshold to pass each element (65% or above compared to 50% or above) (Infrastructure Health & Safety Association, 2017) (see Supplementary Table 1).¹ While some other provinces offer a Small Employer COR (SECOR) or Small COR that does not require external auditors for certification, maintenance or recertification audits, all baseline and recertification audits for IHSA COR require an external auditor. Once a certification has been issued, it is typically valid for a three-year period provided that all maintenance requirements are met. The firm is responsible for completing internal audits for each of the next two years. When the certification expires after three years, another external audit must be conducted to renew the certification. Usually, a firm will renew their certification near the end of the three-year period; however, a firm may renew their certification at any time by conducting another successful external audit. During the time of this study, certified firms were not offered financial incentives via reduced WSIB premium rates. However, if COR is successful in creating safer workplaces, certified firms should experience cost savings via reduced claim costs and experience ratings.

2. Materials and methods

2.1. Study design

This study used a matched DiD research design to identify the intervention effect of COR certification on changes in firm-level injury rates, similar that used in an evaluation in Alberta (McLeod & Macpherson, 2025). This approach compares changes over time in a group without the program intervention and attributes the “difference-in-differences” to the effect of the program by accounting for difference in the baseline or pre-intervention level of the outcome. DiD can provide an unbiased effect estimate of the intervention if changes over time between the control and intervention group would otherwise have been the same in the absence of the intervention. Due to the fact that COR is a pre-bid requirement for most publicly funded infrastructure projects in Ontario, firm participation is not random and interpretation of the program outcomes from DiD analysis could be incorrect if the control and intervention groups are not comparable, given that changes over time in the outcome may differ independently from the intervention. Comparisons at baseline showed that, on average, certified firms were much larger, in higher risk industries or subsectors, registered with the WSIB longer, and had lower lost time injury rates. To balance certified firms and non-certified firms on observable characteristics, Coarsened Exact Matching (CEM) was used (Blackwell et al., 2009).

2.2. Data

This study used employer and claim-level data from the WSIB and COR registration data from IHSA for the years 2009 to 2020. WSIB data were linked to create a dataset at the level of the employer account-year

¹ As of October 1, 2022, all new external audits are completed using the 14-element COR 2020 audit tool.

(firm-year). Firm characteristics such as classification unit, North American Industrial Classification (NAICS), rate group were assigned based on the account classification unit with the largest insurable earnings. Insurable earnings, assessable payroll, and full-time equivalent (FTE) employees were summed at the level of the account number. Experience rating adjustments were available at the account number, including dollar amount discounts/surcharges from the Council Amendment to Draft #7 (CAD-7) program and New Experimental Experience Rating (NEER) program, and percentage change in insurance premiums according to the Merit Adjusted Premium Plan (MAP) (Workplace Safety and Insurance Board, 2024a).

2.3. Study cohort

The study cohort was defined as all firms with WSIB accounts in classification units identified among COR certified firms, with at least one FTE and positive earnings for at least three consecutive years between 2009 and 2020. Firms that did not meet the criteria were excluded, as firms with short tenure with the WSIB would likely have been unable to achieve a certification. In order to measure the first difference in the DiD model, the intervention group had to have an observable pre-intervention baseline. Therefore, the intervention group was defined as all firms that became certified between 2012 and 2019. Certified firms with no pre-certification baseline (yearly observations prior to their first year of certification) were excluded, as were certified firms with only one year of certification (firms first certified in 2020). The control group (non-certified firms) was defined as firms meeting the above conditions but never becoming certified during the study period. A summary of the cohort restrictions is shown in Table 1.

2.4. Model specification

Changes in pre- and post-intervention firm-level injury rates were compared using population-averaged negative binomial regression models with a log of firm FTEs included as an offset variable and an exchangeable correlation matrix. These models were chosen for their ability to estimate over-dispersed count data (i.e., the presence of many zero injury counts and few extreme high injury counts) and to account for correlation across years at the firm-level. Three work-related injury claim rates were examined: (1) lost time claim rate; (2) high-impact claim rate; and (3) no lost time claim rate. A lost time claim is created when a worker suffers from a work-related injury/disease that results in: being off work past the day of accident, loss of wages/earnings, or a permanent disability/impairment. High-impact claims are allowed lost time claims that have large health and financial impacts on employees and businesses: low back, shoulder, and fracture claims (WSIB, 2022). No lost time claims are defined as accepted claims from work-related injury where no time is lost from work, other than on the day of accident, but where health care is required. The health care costs resulting from the injury are paid by the WSIB.

A baseline indicator measured the pre-intervention differences in the

Table 1
Firms with and without COR certification by cohort restriction.

	Certified firms	Non-certified
No restriction	411	305,124
Firms with 3 + consecutive years of WSIB registration, assessable payroll and at least 1 FTE	392	167,020
Firms with pre-certification baseline and 1 + year of certification	390	
Matched firms	346	310*

Note: Certified = Certificate of Recognition (COR) certified; FTE = full-time equivalent employee. * As non-certified firms could be matched to certified firms more than once, 310 non-certified firms were matched during 346 non-certified firm-years.

injury rate between firms that would become certified in the following year and firms that would not become certified during any of the study years. An intervention indicator measured the combination of the baseline indicator and the years the firm was certified. COR firm-years were included until their certification lapsed or there were no more years of follow-up. Certified firms were matched with non-certified firms on the following four characteristics during their first year of certification: industry classification unit (54 categories based on the WSIB account), firm size (7 categories derived from the FTE at the account-year level: 1–4 FTEs, 5–9 FTEs, 10–19 FTEs, 20–49 FTEs, 50–99 FTEs, 100–499 FTEs, 500 + FTEs), assessment year (12 categories from 2009 to 2020), and pre-baseline lost time injury rate (lagged three-year average). A multivariate imbalance measure of covariate combinations was used to select the most effective matching attributes. In addition to matching certified and non-certified firms, the negative binomial regression models also adjusted for the firm NAICS class/subclass (10 categories indicating the primary sector/subsector of the firm), firm size, premium rate adjustment (3 categories indicating whether the firm received an industry premium surcharge, discount or no adjustment), OHS program (whether the firm was participating in one of the following WSIB OHS programs: Small Business, Safety Groups, Workwell, Health and Safety Excellence), and whether the employer head office was located in Ontario or elsewhere (see Table 2 for summary). Models were used to estimate the overall effect of certification (2012–2019), by time period (2012–2015, 2016–2019), by firm size (<100 FTEs versus 100 + FTEs) and by industry sector (construction vs. non-construction). The number of firms by study cohort and restriction are shown in Table 1. The intervention variables and covariates used in the models are shown in Table 2.

3. Results

3.1. Cohort characteristics

Prior to matching, certified firms were more likely to be classified in construction NAICS subclasses than non-certified firms (Table 3). Certified firms were more likely to be large firms, with firms with 20 + FTEs making up 85% of certified firms compared to only 10% of non-certified firms. Certified firms made up increasingly larger proportions

Table 2
Variables used in the statistical models.

Intervention variables	Description
Baseline	Measures the difference in baseline injury risk between intervention (COR certified) and control (non-certified) firms
Intervention	Measures the effect of the intervention (becoming COR certified)
Covariates	Description
NAICS class/subclass*	10 categories indicating the primary sector/sub-sector of the firm
Premium rate adjustment	3 categories indicating whether the firm received an industry premium surcharge, discount or no adjustment
OHS program	Binary variable indicating whether the firm was participating in one of the following WSIB OHS programs: Small Business, Safety Groups, Workwell, Health and Safety Excellence
Province	Binary variable indicating whether the firm head office was located in Ontario or elsewhere
Firm size	6 categories identify whether the firm had less than 1 FTE, 1–4 FTEs, 5–9 FTEs, 10–19 FTEs, 20–99 FTEs, or 100 + FTEs
Firm years	4 categories indicating the years of operation at the level of the WSIB account: <5 years, 5–9 years, 10–19 years, 20 + years
Year	12 categories from 2009 to 2020, indicating the year of assessment

Note: COR = Certificate of Recognition; FTE = full-time equivalent employee. * Classification unit (54 categories) was used for matching whereas NAICS class/subclass was used for statistical models.

Table 3
Baseline characteristics of COR and non-COR firms, unmatched and matched cohorts.

	Unmatched		Matched	
	COR	Non-COR	COR	Non-COR
NAICS class/subclass				
C: Utilities	1.5	0.2	1.7	1.9
E: Manufacturing	3.1	4.5	2.9	3.2
G1: Building construction	22.8	20.1	24.0	23.6
G2: Infrastructure construction	31.0	2.5	28.6	25.8
G3: Foundation, structure and building exterior construction	7.2	9.7	6.9	7.1
G4: Building equipment construction	16.4	23.6	16.8	17.7
G5: Specialty trade construction	9.0	16.6	10.1	11.3
L: Professional, scientific and technical	4.1	5.7	4.3	4.5
M: Administrative, services to buildings, dwellings and open spaces	2.1	8.8	2.3	2.3
P: Other services	2.8	8.4	2.3	2.6
Firm size				
1–4 FTEs	2.1	66.1	2.3	2.6
5–9 FTEs	3.3	15.2	3.8	4.2
10–19 FTEs	10.0	9.1	11.3	12.6
20–49 FTEs	21.3	6.2	23.1	24.8
50–99 FTEs	22.6	2.0	24.0	23.6
100–499 FTEs	31.3	1.2	30.6	27.7
500 + FTEs	9.5	0.2	4.9	4.5
Firm years				
<5 years	8.5	39.1	9.0	11.6
5–9 years	8.7	18.7	8.1	11.0
10–19 years	24.9	21.1	26.6	25.8
20 + years	58.0	21.1	56.4	51.6
Premium rate adjustment				
Surcharged	21.5	4.9	22.8	19.4
Unadjusted	4.4	41.0	4.9	8.4
Discounted	74.1	54.2	72.3	72.3
OHS program				
Yes	23.9	1.8	22.5	9.7
No	76.2	98.2	77.5	90.3
Province				
Ontario	89.7	96.7	90.5	93.6
Other	10.3	3.3	9.5	6.5

Note: Classes F (Transportation and warehousing), H (Wholesale), K (Finance, management and leasing) were grouped with class P (Other services) due to small sample sizes. Column percentages for COR and non-COR firms in the matched cohort are not identical due to some non-certified firms being eligible to match with multiple certified firms across different years.

of the total number of firms as the firm size thresholds increased, representing one tenth, one fifth, and one third of all firms with 50–99, 100–499, and 500 + FTEs, respectively. In addition to the differences in sector and firm size, certified firms were older, more likely to have received a premium rate discount, participated in WSIB OHS programs, and have had a head office outside of Ontario. Following matching, the observable characteristics at baseline were balanced.

3.2. Impact of certification, overall

The main effect estimates of the matched DiD analysis for the three firm-level injury rate outcomes are presented in Table 4. The first coefficient represents the baseline difference in the injury rate between

Table 4
Negative binomial regression results for the matched cohort, lost time, high-impact, and no lost time injuries.

	Lost time		High-impact		No lost time	
	IRR	95% CI	IRR	95% CI	IRR	95% CI
Baseline	0.88	(0.75–1.03)	0.87	(0.74–1.03)	1.07	(0.94–1.22)
Intervention	0.72	(0.63–0.84)	0.80	(0.66–0.97)	1.00	(0.92–1.08)
Firm years	7,255		7,255		7,255	
Firms	656		656		656	

Note: IRR = incidence rate ratio. CI = confidence interval. Estimates from fully adjusted, population-averaged models with offsets of logged FTEs, including non-COR firms and COR firms.

certified and non-certified firms. The second coefficient represents the intervention effect, or in other words, the change in the injury rate for certified firms had they never been certified. The estimates suggest that certified firms were associated with greater reductions in the lost time and high-impact injury rates and no difference in the no lost time injury rate, compared to similar non-certified firms. More specifically, when firms became certified, the change in their lost time injury rate was 28% lower (IRR: 0.72; 95% CI: 0.64–0.84), and their high-impact injury rate was 20% lower (IRR: 0.80, 95% CI: 0.66–0.97), compared to the change among non-certified firms. Further, the estimates of the baseline indicator suggest that, following matching, the firms were no different than one another at baseline.

When comparing the effectiveness of certification across two separate time periods, there was very little change for lost time and no lost time injury rates (Fig. 1). In terms of the high-impact injury rate, certified firms experienced a larger and more precisely estimated reduction between 2016 and 2019. When stratifying the cohort by firm size, the impact of certification was greater for large firms (100 + FTEs) than small firms (<100 FTEs) (Fig. 2). For lost time injury rate, certified firms experienced a reduction of 24% among small firms and 32% among large firms, compared to the change in non-certified firms. The effect of certification among the high-impact injury rate did not differ between small and large firms but was only precisely estimated for the latter. There was no difference in the change of the no lost time injury rate for small firms but a 12% reduction for certified firms when compared to non-certified firms among large firms. When using alternative firm size thresholds (<50, 50–99, 100 + FTEs), the overall pattern of findings was the same (Supplementary Table 2). Stratifying the analysis by sector (Fig. 3), the majority of the overall intervention effect was driven by construction sector firms whereas no effect was observed for non-construction sector firms.

4. Discussion

4.1. Main findings

The overall finding from this study was that firms that became certified with a COR were associated with greater injury rate reductions than similar non-certified firms. However, the degree of this association varied due to the type of injury claim outcome being measured, the period of time, and the size of the firm or sector being examined. Certification was associated with a 28% reduction in the lost time injury rate, 20% reduction in the high-impact injury rate, and no reduction in the no lost time injury rate, relative to the change in non-certified firms. The overall reductions in the lost time and high-impact injury rates were driven by more recently certified and larger firms, particularly construction sector firms.

4.2. Interpretation of findings

Comparing the results of the present study with previous studies is challenging due to differences in the composition of firms by size and sector. Nonetheless, the finding of overall effectiveness in reducing firm-level injury rates is consistent with findings from other OHSMS program

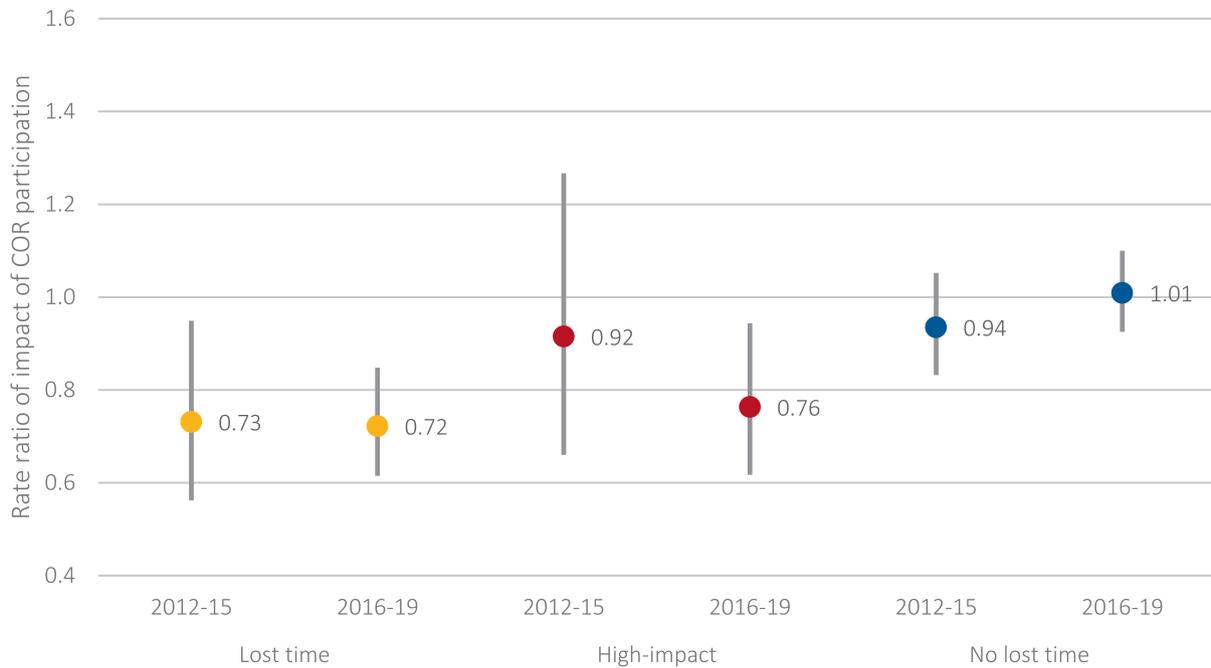


Fig. 1. Intervention effects of COR certification on lost time, high-impact, and no lost time injuries over time.

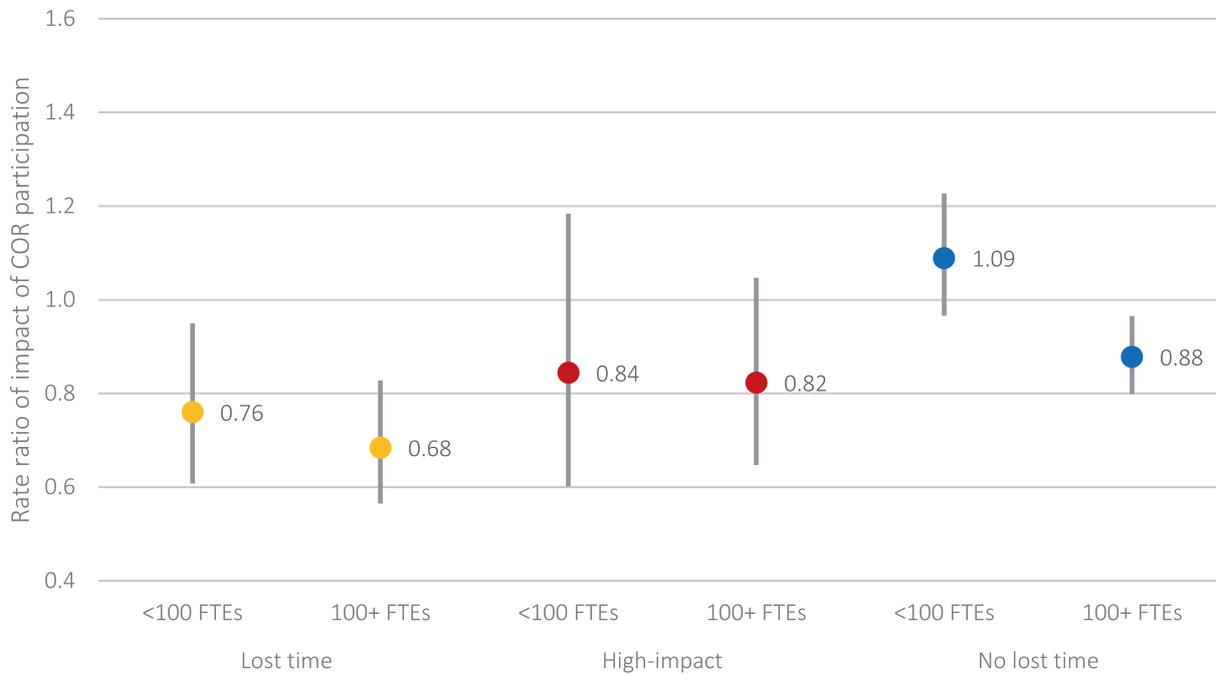


Fig. 2. Intervention effects of COR certification on lost time, high-impact, and no lost time injury rates, by firm size.

evaluations, such as OHSAS 18001 (Abad et al., 2013; Bottani et al., 2009; Lafuente & Abad, 2018; Viswanathan et al., 2024) whereas other studies found no associations between OHSMS participation and injury rates (Ghahramani & Salminen, 2019; Ghahramani & Summala, 2017; Dyreborg, Thorsen, Madsen, & Hasle, 2024), or only weak associations (Heras-Saizarbitoria et al., 2019). The finding of a reduction in the lost time injury rate in this study is also consistent with the reduction in same injury outcome in an evaluation of the COR program in the Canadian province of Alberta (McLeod & Macpherson, 2025). However, the size of the effect in the present study is larger than that in the Alberta study and several factors may be contributing to this. First, the program in Alberta has been around for a much longer period (since early 1992 compared to

2012) and discussions in the literature suggest that the effectiveness of safety incentive programs can diminish over time and that early adopters can benefit more than late adopters (Gangwar & Goodrum, 2005; Yang et al., 2021). Secondly, the audit used by IHSA during this study period is arguably more rigorous than those used in the Alberta study, including more elements, requiring a higher score threshold to pass elements (65% or above compared to 50% or above), and requiring external auditing for all baseline and recertification audits. Thirdly, the composition of firms enrolled in the program was different to those in the Alberta study, with firms tending to be much larger and predominantly in the construction sector, as opposed to a mix of firm sizes and sectors. Fourthly, the motivation to enroll in the program (e.g.,

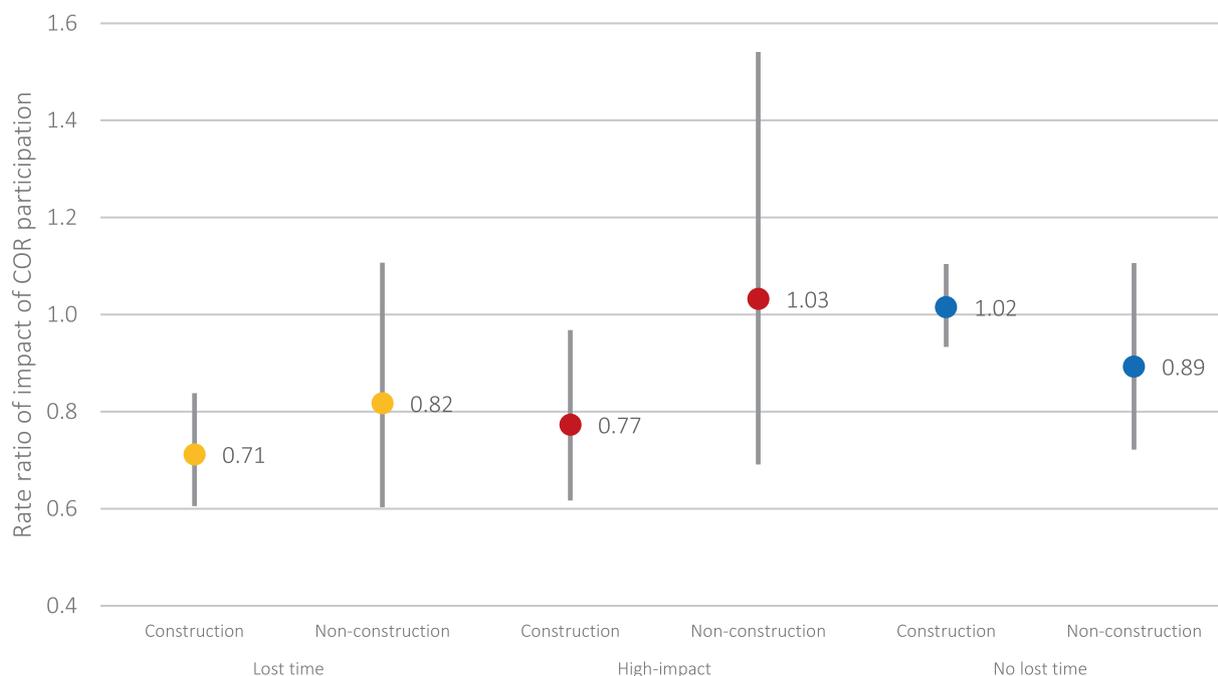


Fig. 3. Intervention effects of COR certification on lost time, high-impact, and no lost time injury rates, by sector.

monetary vs. safety or compliance) may differ between the studies since COR-certified firms in Alberta may receive up to 20% reduction in their workers' compensation premiums if they reduce their claim costs below predicted targets; whereas in Ontario, during the time of this study, there was no direct workers' compensation financial incentive through certification. Again, early adopters of the program in Ontario during this study period may be different and experience different levels of effectiveness than those who have enrolled in more recent years when a financial incentive through WSIB premiums has been available.

The finding that certification was generally not associated with a reduction in the no lost time injury rate is interesting and not unsurprising given that the evaluation of COR in Alberta found that certification was more effective in reducing lost-time injuries than disabling injuries (McLeod & Macpherson, 2025). While many studies on OHSMS effectiveness only evaluate changes in overall injury rates, some studies have also identified differences by injury type. An evaluation of OHSAS 18001 certification in Spain showed how certified firms had lower rates of minor injuries, no difference in serious injuries, and greater injury rates among fatal injuries compared to non-certified firms (Heras-Saizarbitoria et al., 2019). In the United States, firms achieving OHSAS 18001 certification were associated with 20% fewer injury and illness cases overall than their matched counterparts, 24% fewer injury and illnesses cases associated with job transfers or restrictions (an indication of severity) and 15% fewer "other injury and illness cases" (Viswanathan et al., 2024). The authors also found that OHSAS 18001 certification was associated with reductions in the most severe injuries and illnesses (those that required days off work) by a similar magnitude but the estimates were less precise.

The effectiveness of COR in Ontario appears to be stronger in more recent years, suggesting a maturation of the program. Previous research has shown that for each additional year of OHSAS 18001 experience, there was an estimated annual average reduction in the work injury rate (Abad et al., 2013; Lafuente & Abad, 2018). The effectiveness of COR also appears to be stronger among larger firms as has been seen in evaluations in other provinces too. An important distinction between the firms certified in the program in Ontario compared to other provinces is that they were much larger. This difference is likely a result of the increasing importance of firm certification being a pre-bid requirement for large infrastructure projects in the province. That said, previous

research on COR in Alberta found that the injury reduction as a result of certification was larger for large firms (20 + FTEs) than small firms (<20 FTEs) (McLeod & Macpherson, 2025). Previous research has found that size of firm is a more important factor in terms of explaining injury rates than OHSAS 18001 certification (Heras-Saizarbitoria et al., 2019). Small firms are characterized by management by the owner in a personalized (non-formal) manner, independent, with limited market share, having high resource constraints, operating under extreme financial pressure (with high start-up costs and tight profit margins), and therefore having high changes of failure (i.e., short life-cycles) (Legg et al., 2015). All of these factors play an important role in determining whether a firm can successfully implement an OHSMS. It is also possible that due to employers and employees working more closely together in small firms, that they may be less likely to report work-related injuries and illnesses to workers' compensation boards and therefore the impact of OHSMSs may not be observable using compensation injury rates as opposed to other OHS performance measures.

Due to sample size limitations, it was not possible to examine the effectiveness of COR certification across detailed sectors or subsectors. Nonetheless, a simple comparison of construction versus other sectors showed how the majority of the injury rate reduction associated with certification was being driven by construction sector firms. The majority of OHSMS evaluations focus on manufacturing sector firms (Bottani et al., 2009; Ghahramani & Salminen, 2019; Ghahramani & Summala, 2017), or included multiple sectors in a pooled sample (Abad et al., 2013; Heras-Saizarbitoria et al., 2019). In one of the only studies that did stratify by sector, the authors found an intervention effect of OHSAS 18001 certification on work injury rates in manufacturing and services sector but not in the construction sector (Lafuente & Abad, 2018). In the evaluation of COR in Alberta, intervention effects were observed across all industry sectors, with the exception of the oil and gas, business, and forestry sectors (McLeod & Macpherson, 2025). Compared to other Canadian provinces where various COR programs are available across multiple industries, COR certification in Ontario is mostly for construction-related sectors.

4.3. Strengths and limitations

This study contributes to the literature on the effectiveness of

OHSMS on workplace safety outcomes in a variety of ways. A benefit of this study was the opportunity to link workers' compensation data and COR registration data at the level of individual firms over time. Detailed claim-level workers' compensation data enabled this study to focus on specific types of injury claims (e.g., no lost time, lost time, high-impact claims), and firm-level data enabled the study to characterize the firms in terms of industry sector, size, participation in OHS programs, experience rate, and location. COR registration data from the IHSA enabled cohorts to be created in which pre-certification baselines could be determined. The span of 12 years of data produced sample sizes large enough to conduct stratified analyses (e.g., by time period, industry sector, firm size). Complementing the rich data, the DiD observational research design and matching approach offered a robust methodological approach to evaluate an OHSMS in the absence of a randomized research design. Notably, the matching algorithm in this study matches on pre-certification injury rates and in doing so, does a better job of accounting for the self-selection into the program than other recently published OHSMS evaluation studies (McLeod & Macpherson, 2025; Dyreborg et al., 2024). The DiD enabled comparison of changes between COR certified firms (intervention group) with comparable non-certified firms (control group) to provide an effect estimate of the counterfactual (what the injury rate reduction would be in the absence of the intervention). The population-averaged negative binomial regression model with the log offset of FTEs and exchangeable correlation matrix enabled the model to account for any remaining bias in the covariates and eliminate time-invariant unobservable characteristics. Lastly, to the authors knowledge, only one other peer-reviewed study has evaluated the COR program (McLeod & Macpherson, 2025) and the present study builds on that study by using a more granular matching algorithm and compares more injury outcome measures.

There are, however, several study limitations that should be acknowledged. The study relies on data that were collected primarily for administrative purposes, such as workers' compensation registration, payment of insurance premiums, and the adjudication of work-related injuries and illnesses claims. Such data may introduce bias due to errors and misclassification. Workers' compensation claims data underestimate the true rate of work injuries. Previous research has shown that while the majority of work-related fatalities and injuries are found in workers' compensation data, additional work-related fatalities and injuries can be found in coroners' reports and hospitalization records (Koehoorn et al., 2015). In any case, in order for underreporting to bias the results away from a null effect (or no effect of certification on injury rate reduction), certified firms would need to have had a greater underreporting rate than when they were not certified.

How FTEs are calculated also introduces limitations. FTEs are calculated using annual estimates of assessable payroll/insurable earnings and industry average earnings. There is a limit to the total earnings that can be insured by injured workers, which influences the total insurable earnings an employer may report. Due to the inconsistencies between the industry of the firm and the industry estimate in which the average wages are obtained, FTEs can be fractional and underestimate the true number of employees a firm may employ. Nonetheless, in the absence of hours worked, FTEs remain the only measure available in the data to conduct this type of evaluation study.

Due to data access limitations, this study was restricted to examining the impact of COR on lost-time, high-impact, and no lost-time injury claims. Using more granular data and larger samples through additional years of data, it is possible that excluding claims with longer latency periods, such as occupational diseases, may result in more precisely estimated and larger intervention effects. Nonetheless, the fact that high-impact claims, which exclude occupational diseases, show smaller and less precise estimates than lost time claims suggests that additional restrictions may not necessarily result in stronger intervention effects.

The representation of the COR certified firms should be carefully considered in the interpretation of the findings. Due to the selective nature of firms into the COR program in Ontario, certified firms are not

representative of other construction and related sector firms in the province. Approximately two thirds of non-COR firms in the unmatched sample were considered micro firms with less than five employees. Statistics Canada estimates show that in Ontario and other provinces, the majority (97%) of firms in the construction sector have less than 20 employees and 86% have less than 5 employees (Statistics Canada, 2024a, 2024b).

The study was able to account for whether certified and non-certified firms were part of existing WSIB-provided OHSMS (such as Small Business, Safety Groups, Workwell, and Health and Safety Excellence). However, the study was unable to account for whether non-certified firms were certified via alternative OHSMS such as ISO 45001. Nevertheless, it is likely that if any of the non-COR certified firms were certified by such programs, their presence would be reducing the intervention effect of COR certification as they would more likely be larger and safer firms. Therefore, by adjusting for, or removing such firms, the overall effectiveness of COR could be even greater. Furthermore, during this study period, COR was the industry standard in Ontario, whereas only this year have COR and ISO 45001 been legally recognized as equivalent standards under the Occupational Health and Safety Act (Mercer, 2025). Therefore, it is likely that the number of potential ISO 45001 firms during this study period was less than it would be in a study using more recent data.

Given that COR became a pre-bid requirement for many publicly-funded infrastructure projects towards the latter end of the study period and beyond (IHSA, 2016), it is challenging to disentangle the positive impacts of becoming COR certified due to developing an OHSMS that meets industry standards versus the positive impacts due to of having access to publicly-funded projects that may be characterized by safer and more accountable work practices. To address this, future research should link WSIB and IHSA data with external data on procurement (e.g., Infrastructure Ontario, 2025), to control for this selection process and produce even more robust intervention effect estimates. Furthermore, future research should explore COR audit properties and firm performance in the audit as well as other survey-based measures like those collected in other studies (e.g., Uhrenholdt Madsen et al., 2022), to investigate heterogeneity in the effort and effect of COR certified firms on OHS outcomes.

5. Conclusions

Overall, this study showed that construction firms and larger firms that had OHSMS certified through the COR program achieved a greater injury rate reduction than similar non-certified firms, particularly in more recent years. There were smaller and less precise effects in smaller firms and earlier years, and no effects in non-construction firms. The difference in effectiveness of certification on lost time and high-impact injury rates compared to no lost time injury rates indicates that other work-related injury measures need to be examined. The difference in effectiveness of certification by size of firm suggests that smaller firms do not benefit from the program to the same degree as larger firms. While effectiveness was observed in the construction sector, the findings may be subject to unmeasured selection bias due to the increasing role that COR has had as a pre-bid requirement for publicly-funded infrastructure projects.

6. Practical applications

Analyses of OHSMS certification programs can inform decision-makers, such as owners of firms, health and safety associations, and OHS regulators, on when, and under what circumstances do existing programs work and where improvements can be made. In particular, the COR program in Ontario shows promise in its effectiveness of reducing injury rates in more recent years, and for large firms in the construction sector. Given that the vast majority of construction firms in Ontario and the rest of Canada are small in size, the IHSA and other health and safety

associations should develop alternative options for small firms in order to improve the workplace health and safety in the construction sector and other related sectors.

CRedit authorship contribution statement

Robert A Macpherson: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Christopher B McLeod:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jsr.2026.01.017>.

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