

Evaluating a new voluntary occupational health and safety management system program in the context of a pandemic¹

by Laksika B Sivaraj, PhD, Robert A Macpherson, PhD, Christopher B McLeod, PhD ²

1. Supplementary material
2. Correspondence to: Dr. Christopher B. McLeod, Partnership for Work, Health and Safety, School of Population and Public Health, University of British Columbia, 2206 East Mall, Vancouver, BC, V6T 1Z3, Canada. [E-mail: chris.mcleod@ubc.ca].

Table S1. Cohort inclusion/exclusion criteria

Exclusion criteria	Year 1 participants		Year 2 participants		Total	
	Cases	Controls	Cases	Controls	Cases	Controls
None	1405	452 189	846	452 748	2251	904 937
Firms with no firm data	1388	323 610	840	335 939	2228	659 549
Control to Treatment crossover firms	1388	320 242	840	331 874	2228	652 116
Schedule-2/self-insured firms	1386	319 648	839	331 279	2225	650 927
Firms with <1 FTE for the pre-intervention years	1311	139 684	781	138 852	2092	278 536
Firms with <=0 FTE for the 1st post-intervention year	1302	133 492	779	132 748	2081	266 240
Firms with missing sector/region information	1302	133 487	779	132 744	2081	266 231

Notes: The term “FTE” refers to full-time equivalent.

Table S2. Detailed description of variables used for matching

Variable	Description
Firm size	Firms were categorized based on the FTE workers employed by the firm (FTE <20, 20 to <50, 50 to <100, 100 to <500, >=500) in the baseline year.
NAICS sub-sector (3-digit level)	The baseline NAICS sector was defined at the 3-digit level based on the predominant class.
NAICS group (1-digit level)	Baseline NAICS sectors were grouped based on their first NAICS digit (NAICS-1xx, -2xx, -3xx, -4xx, -5xx, -6xx, -7xx/8xx/9xx).
Safety Groups experience	Since Safety Groups ended in 2019, participation for all cohorts was assessed based on the years 2017 to 2019. Firms with participation for at least one year during this period were classified as having some Safety Groups experience. All others were considered to have no experience.
COR status	Firms that are COR-certified or registered on or before the baseline year, dated back to 2000, were identified as COR-associated.
Pre-intervention lost-time injury history	Firms were classified as having no, one or more lost-time claims in the 3-year pre-intervention period

Notes: “NAICS” refers to the North American Industrial Classification System. “FTE” refers to full-time equivalent. “COR” refer to the Certificate of Recognition program.

Table S3. Pre- and Post-matching baseline lost-time injury rates per 10 000 FTEs

	Year 1 participants				Year 2 participants			
	Pre-match (N=1302) mean (Q1-Q3)		Post-match (N=1056) mean (Q1-Q3)		Pre-match (N=779) mean (Q1-Q3)		Post-match (N=756) mean (Q1-Q3)	
	Cases	Controls	Cases	Controls	Cases	Controls	Cases	Controls
Overall sample	11.35 (0-0)	8.27 (0-0)	11.72 (0-0)	12.00 (0-0)	12.16 (0-0)	8.11 (0-0)	12.10 (0-0)	13.72 (0-0)
Stratified by firm size								
<20 FTE	13.74 (0-0)	7.98 (0-0)	15.56 (0-0)	19.67 (0-0)	13.30 (0-0)	7.78 (0-0)	12.71 (0-0)	24.72 (0-0)
20 to <50 FTE	10.98 (0-0)	9.26 (0-0)	11.80 (0-0)	10.87 (0-0)	13.18 (0-0)	9.38 (0-0)	13.26 (0-0)	12.57(0-0)
50 to <100 FTE	13.63 (0-0)	10.29 (0-0)	13.20 (0-0)	11.71 (0-0)	15.84 (0-0)	10.35 (0-0)	15.84 (0-0)	14.33 (0-0)
100 to <500 FTE	10.92 (0-0)	9.45 (0-0)	10.44 (0-0)	10.59 (0-0)	10.51 (0-0)	9.98 (0-0)	10.80 (0-0)	10.10 (0-0)
>=500 FTE	6.88 (0-11.47)	6.30 (0-9.10)	7.86 (0-12.41)	8.47 (0-12.09)	8.75 (0-13.30)	6.12 (0-8.63)	7.72 (0-12.84)	7.33 (0-11.14)

Notes: The term “FTE” refers to full-time equivalent.

Table S4. Intervention effects of HSEp participation on injury rates by Safety Groups experience

		Lost-time claim rates		Non-COVID lost-time claim rates	
Follow-up		IRR (95%CI)	p-value	IRR (95%CI)	p-value
Some experience	<i>Combined</i>	1.02 (0.88-1.17)	0.829	0.93 (0.85-1.02)	0.118
	Year 1	1.13 (0.91-1.40)	0.278	0.95 (0.86-1.06)	0.375
	Year 2	0.90 (0.76-1.07)	0.225	0.90 (0.80-1.01)	0.062
	Year 3	1.05 (0.89-1.25)	0.554	0.94 (0.84-1.05)	0.248
	Year 4	1.00 (0.85-1.17)	0.974	0.93 (0.81-1.07)	0.302
No experience	<i>Combined</i>	0.91 (0.80-1.04)	0.156	0.89 (0.80-1.01)	0.063
	Year 1	1.00 (0.82-1.21)	0.978	0.96 (0.85-1.08)	0.520
	Year 2	0.90 (0.77-1.07)	0.226	0.91 (0.79-1.05)	0.186
	Year 3	0.90 (0.75-1.07)	0.238	0.89 (0.75-1.05)	0.173
	Year 4	0.84 (0.71-0.99)	0.038	0.83 (0.71-0.97)	0.023

Notes: Estimates derived from matched adjusted population-averaged negative binomial regression models. IRR refers to the incidence rate ratio, and confidence levels are based on a 95% significance level.

Table S5. Type III test results for the covariates and the Quasi-likelihood Information Criterion (QIC) for preferred models of the main analyses

	Lost-time injury rates				Non-COVID lost-time injury rates			
	DF	ChiSq Statistic	Pr > ChiSq	QIC	DF	ChiSq Statistic	Pr > ChiSq	QIC
Combined follow-up analysis								
Year 1 participants				29 593.89				64 427.93
HSEp	1	0.11	0.742		1	0.93	0.334	
Follow-up	1	102.65	<0.0001		1	0.63	0.428	
Calendar year	.	.	.		8	84.38	<0.0001	
Calendar month	.	.	.		11	196.10	<0.0001	
Year 2 participants				7707.97				27 344.29
HSEp	1	0.41	0.522		1	0.28	0.598	
Follow-up	1	90.98	<0.0001		1	0.39	0.532	
Calendar year	.	.	.		8	56.78	<0.0001	
Calendar month	.	.	.		11	88.55	<0.0001	
Construction				20 162.89				20 398.87
HSEp	1	0.47	0.495		1	0.67	0.412	
Follow-up	1	2.64	0.104		1	0.72	0.395	
Calendar year	.	.	.		8	18.10	0.021	
Calendar month	.	.	.		11	45.72	<0.0001	
Manufacturing				22 241.73				33 992.67
HSEp	1	0.07	0.789		1	0.00	0.965	
Follow-up	1	10.02	0.002		1	4.43	0.035	
Healthcare				-8416.93				6917.97
HSEp	1	2.02	0.155		1	0.98	0.322	
Follow-up	1	0.03	0.867		1	6.46	0.011	
Calendar year	8	203.56	<0.0001		.	.	.	
Calendar month	11	225.40	<0.0001		.	.	.	
Firm size	4	99.53	<0.0001		.	.	.	
Region	3	10.46	0.015		.	.	.	
Services				11 271.41				19 326.91
HSEp	1	0.02	0.877		1	0.07	0.794	
Follow-up	1	7.19	0.007		1	2.61	0.106	
Calendar year	8	63.42	<0.0001		8	90.25	<0.0001	
Calendar month	11	97.32	<0.0001		11	132.45	<0.0001	
Small and medium firms (<100 FTE)				37 528.84				47 742.38
HSEp	1	0.31	0.578		1	1.24	0.265	
Follow-up	1	9.17	0.003		1	1.06	0.303	
Calendar year	.	.	.		8	21.38	0.006	
Calendar month	.	.	.		11	65.47	<0.0001	
Large firms (100+ FTE)				11 476.91				49 522.42

HSEp	1	0.25	0.620	1	0.83	0.362
Follow-up	1	137.44	<0.0001	1	0.00	0.965
Calendar year	.	.	.	8	97.91	<0.0001
Calendar month	.	.	.	11	226.46	<0.0001
Region	.	.	.	3	2.28	0.516
Industry	.	.	.	20	426.83	<0.0001
Longitudinal follow-up analysis						
Year 1 participants	33 946.83			66 901.62		
HSEp	1	0.26	0.613	1	0.93	0.334
Follow-up year	5	154.26	<0.0001	5	89.90	<0.0001
Year 2 participants	10 689.03			31 188.01		
HSEp	1	0.51	0.477	1	0.29	0.593
Follow-up year	5	132.05	<0.0001	5	41.16	<0.0001
Construction	20 306.16			20 469.99		
HSEp	1	0.57	0.452	1	1.10	0.294
Follow-up year	4	1.36	0.852	4	4.47	0.347
Calendar year	8	20.83	0.008	.	.	.
Calendar month	11	32.26	0.001	.	.	.
Manufacturing	23 751.77			36 933.78		
HSEp	1	0.26	0.611	1	0.37	0.545
Follow-up year	4	43.73	<0.0001	4	1.99	0.738
Calendar year	.	.	.	8	37.86	<0.0001
Calendar month	.	.	.	11	97.09	<0.0001
Healthcare	-8414.74			6953.88		
HSEp	1	3.70	0.054	1	1.76	0.184
Follow-up year	4	41.51	<0.0001	4	42.29	<0.0001
Calendar year	8	221.98	<0.0001	.	.	.
Calendar month	11	181.13	<0.0001	.	.	.
Firm size	4	100.57	<0.0001	.	.	.
Region	3	10.27	0.016	.	.	.
Services	11 240.56			19 298.39		
HSEp	1	0.19	0.660	1	0.32	0.574
Follow-up year	4	12.76	0.013	4	22.34	0.000
Calendar year	8	49.14	<0.0001	8	57.66	<0.0001
Calendar month	11	92.04	<0.0001	11	132.32	<0.0001
Small and medium firms (<100 FTE)	37 901.59			50 093.28		
HSEp	1	0.02	0.877	1	0.91	0.340
Follow-up year	4	17.53	0.002	4	5.62	0.229
Calendar year	.	.	.	8	6.96	0.541
Calendar month	.	.	.	11	65.64	<0.0001

Region	.	.	.	3	18.25	0.000
Industry	.	.	.	19	121.17	<0.0001
Large firms (100+ FTE)	11 839.22			49 454.06		
HSEp	1	0.17	0.677	1	1.51	0.219
Follow-up year	4	211.83	<0.0001	4	16.16	0.003
Calendar year	.	.	.	8	55.78	<0.0001
Calendar month	.	.	.	11	212.86	<0.0001
Region	.	.	.	3	2.28	0.517
Industry	.	.	.	20	425.22	<0.0001

Notes: The term “DF” refers to the degrees of freedom. “Pr > ChiSq” provides the probability of obtaining a greater Chi-square statistic than that observed, assuming the null hypothesis is true.

Table S6. Intervention effects of HSEp participation on injury rates after excluding healthcare firms

		Lost-time injury rates	
Stratification	Follow-up	IRR (95%CI)	p-value
By cohort			
Year 1 participants	<i>Combined</i>	0.88 (0.78-0.99)	0.037
	Year 1	1 (0.83-1.19)	0.957
	Year 2	0.84 (0.71-0.98)	0.031
	Year 3	0.95 (0.8-1.12)	0.509
	Year 4	0.75 (0.65-0.87)	<0.001
Year 2 participants	<i>Combined</i>	0.92 (0.79-1.07)	0.287
	Year 1	1 (0.77-1.31)	0.994
	Year 2	0.91 (0.77-1.07)	0.264
	Year 3	0.83 (0.72-0.96)	0.015
By firm size			
Small and medium	<i>Combined</i>	0.94 (0.79-1.12)	0.510
	Year 1	0.98 (0.72-1.34)	0.912
	Year 2	0.92 (0.72-1.18)	0.530
	Year 3	0.97 (0.8-1.18)	0.771
	Year 4	0.89 (0.72-1.09)	0.257
Large	<i>Combined</i>	0.87 (0.78-0.98)	0.027
	Year 1	1.01 (0.82-1.23)	0.952
	Year 2	0.85 (0.74-0.97)	0.020
	Year 3	0.88 (0.76-1.02)	0.096
	Year 4	0.77 (0.67-0.88)	<0.001
By Safety Groups			
Some experience	<i>Combined</i>	0.88 (0.77-1.01)	0.076
	Year 1	0.99 (0.78-1.27)	0.956
	Year 2	0.83 (0.71-0.98)	0.031
	Year 3	0.91 (0.77-1.07)	0.247
	Year 4	0.8 (0.69-0.93)	0.003
No experience	<i>Combined</i>	0.9 (0.78-1.04)	0.162
	Year 1	1.02 (0.83-1.26)	0.820
	Year 2	0.92 (0.76-1.1)	0.355
	Year 3	0.89 (0.73-1.08)	0.233
	Year 4	0.78 (0.65-0.94)	0.008

Notes: Estimates derived from matched adjusted population-averaged negative binomial regression models. IRR refers to the incidence rate ratio. Lower and upper confidence levels (LCL and UCL) are based on a 95% significance level. “Small and medium” refers to firms with fewer than 100 FTE, whereas “Large” refers to firms with 100+ FTE.

Table S7. Intervention effects of HSEp progression on injury rates

		Lost-time injury rates		Non-COVID-19 lost-time injury rates	
Follow-up		IRR (95%CI)	p-value	IRR (95%CI)	p-value
No completed action plans	<i>Combined</i>	0.91 (0.79-1.06)	0.232	0.94 (0.84-1.05)	0.273
	Year 1	0.93 (0.73-1.18)	0.544	1 (0.87-1.15)	0.985
	Year 2	0.86 (0.71-1.05)	0.132	0.91 (0.79-1.05)	0.188
	Year 3	0.85 (0.7-1.02)	0.083	0.89 (0.76-1.05)	0.159
	Year 4	1.01 (0.83-1.21)	0.979	0.95 (0.8-1.13)	0.574
1+ completed action plans	<i>Combined</i>	1.02 (0.9-1.15)	0.791	0.91 (0.83-0.98)	0.018
	Year 1	1.16 (0.96-1.42)	0.131	0.93 (0.85-1.02)	0.137
	Year 2	0.92 (0.78-1.08)	0.294	0.89 (0.8-0.99)	0.039
	Year 3	1.08 (0.92-1.26)	0.362	0.93 (0.83-1.04)	0.190
	Year 4	0.91 (0.79-1.05)	0.218	0.86 (0.76-0.98)	0.019

Notes: Estimates derived from matched adjusted population-averaged negative binomial regression models. IRR refers to the incidence rate ratio. Lower and upper confidence levels (LCL and UCL) are based on a 95% significance level.