

Original research

Is precarious employment an occupational hazard? Evidence from Ontario, Canada

Faraz Vahid Shahidi ^{1,2}, Qing Liao,¹ Victoria Landsman,^{1,2} Cameron Mustard ^{1,2},
Lynda S Robson ^{1,3}, Aviroop Biswas ^{1,2}, Peter M Smith ^{1,2}

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¹Institute for Work and Health, Toronto, Ontario, Canada
²Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada
³School of Occupational and Public Health, Toronto Metropolitan University, Toronto, Ontario, Canada

Correspondence to

Dr Faraz Vahid Shahidi, Institute for Work and Health, Toronto, ON M5G 1S5, Canada; fsahidi@iwh.on.ca

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ABSTRACT

Objectives To examine the association between precarious employment and risk of occupational injury or illness in Ontario, Canada.

Methods We combined accepted lost-time compensation claims from the Workplace Safety and Insurance Board with labour force statistics to estimate injury and illness rates between January 2016 and December 2019. Precarious employment was imputed using a job exposure matrix and operationalised in terms of temporary employment, low wages, irregular hours, involuntary part-time employment and a multidimensional measure of 'low', 'medium', 'high' and 'very high' probabilities of exposure to precarious employment. Negative binomial regression models examined exposure to precarious employment in relation to risk of occupational injury or illness.

Results After adjusting for age, sex and year, all indicators of precarious employment were associated with increased risk of injury or illness. Workers with 'high' and 'very high' exposure to precarious employment presented a nearly threefold risk of injury or illness (rate ratio (RR): 2.81, 95% CI 2.73 to 2.89; RR: 2.82, 95% CI 2.74 to 2.90). Further adjustment for physical demands and workplace hazards attenuated associations, though a statistically and substantively significant exposure–outcome relationship persisted for workers with 'high' and 'very high' exposures to precarious employment (RR: 1.65, 95% CI 1.58 to 1.72; RR: 2.00, 95% CI 1.92 to 2.08).

Conclusions Workers exposed to precarious employment are more likely to sustain a lost-time injury or illness in Ontario, Canada. Workplace health and safety strategies should consider the role of precarious employment as an occupational hazard and a marker of work injury risk.

INTRODUCTION

Precarious employment is a prominent feature of the labour market in Canada and other high-income countries.^{1–2} Although definitions vary across studies, the term precarious employment generally describes a state of insecurity or uncertainty in the employment relationship.¹ In the field of public and occupational health, precarious employment is often conceptualised as a multidimensional phenomenon characterised by the accumulation of multiple adverse employment conditions within a given job.³ Typical attributes of precarious employment include contractual instability (eg, temporary employment), earnings inadequacy (eg, low wages),

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Evidence concerning the impact of precarious employment on occupational injuries and illnesses is mixed, with some studies reporting weak or negative associations.
- ⇒ These counterintuitive findings may reflect the fact that precariously employed workers spend less time 'at risk' of sustaining an occupational injury or illness—a 'denominator problem' that previous research has not adequately addressed.

WHAT THIS STUDY ADDS

- ⇒ This study examines the relationship between precarious employment and occupational injuries and illnesses, taking better account of the 'denominator problem'.
- ⇒ We find that workers exposed to precarious employment are more likely to sustain an injury or illness resulting in lost-time compensation, even after accounting for underlying differences in the nature of their work.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Occupational health and safety strategies should consider the role of precarious employment as an occupational hazard and a general marker of work injury risk.
- ⇒ Future research should investigate the mechanisms linking precarious employment to occupational injuries and illnesses with the aim of informing effective policy and programmatic interventions.

schedule unpredictability (eg, irregular hours), working-time mismatch (eg, involuntary part-time employment) and a lack of rights and protections (eg, no union representation).^{3,4}

With extensive evidence establishing its role as an 'upstream' social determinant of health, precarious employment has long been hypothesised to present a risk to workplace health and safety.^{5–8} A link between precarious employment and hazardous working conditions is postulated on several grounds. Precariously employed workers may receive inadequate health and safety training, hampering their ability to identify workplace hazards and increasing their likelihood of experiencing an injury or illness at work.^{9,10} A high rate of turnover among



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precariously employed workers could exacerbate this issue, since frequent movement between jobs can lead to limited awareness of site-specific hazards and safety protocols.^{11 12} Fear of job loss and a lack of representation may disempower precariously employed workers and discourage them from reporting hazards, negotiating for better working conditions or refusing unsafe work.^{13 14} These problems are compounded by the fact that precariously employed workers often fall ‘between the cracks’ of legislative and regulatory frameworks governing health and safety at work.^{15 16} Furthermore, economic insecurity arising from low and unpredictable earnings may require precariously employed workers to hold multiple jobs, work longer hours and accept more dangerous work, posing additional health and safety risks.^{17 18} For these reasons and more, precarious employment is increasingly recognised as a pressing occupational health issue.^{19 20}

While research shows that precariously employed workers are disproportionately exposed to adverse physical and psychosocial working conditions,^{21 22} direct evidence on the relationship between precarious employment and occupational injuries and illnesses is more mixed.^{7 23 24} Findings regarding the occupational risks of temporary and part-time employment are particularly ambiguous,⁷ with several high-quality studies demonstrating either no association or an association with lower rates of occupational injury and illness.^{23 25–28} A commonly proposed explanation for this counterintuitive finding is that temporary and part-time employees work fewer hours in a year and therefore spend less time ‘at risk’ of sustaining an occupational injury or illness.^{7 23} To calculate a rate, accurate information is needed on both the ‘numerator’ (ie, the number of new cases) and the ‘denominator’ (ie, total person-time at risk). Failing to account for the fact that precariously employed workers spend on average fewer hours ‘exposed’ to work will inflate the denominator and, by extension, underestimate the true rate of occupational injuries and illnesses in this population. Data limitations, such as a lack of information on individual work histories and total hours of exposure, have prohibited studies from adequately addressing this so-called ‘denominator problem’. Consequently, there are persisting concerns that extant results have significantly underestimated the frequency of injuries and illnesses among precariously employed workers, giving rise to counterintuitive conclusions.^{23 24}

This study explores the relationship between precarious employment and occupational injuries and illnesses in Ontario, Canada, taking better account of the ‘denominator problem’. We do so by combining administrative data on workers’ compensation claims with labour force estimates that provide a more accurate picture of time at risk among precarious and non-precarious workers. Adopting this approach, we ask whether workers exposed to precarious employment are more likely to experience an occupational injury or illness.

METHODS

Data

Data were assembled from two independent sources: a census of lost-time compensation claims registered with the Workplace Safety and Insurance Board (WSIB) and Statistics Canada’s Labour Force Survey (LFS). The WSIB is the public insurance authority responsible for compensating workers who sustain an occupational injury or illness in the province of Ontario. It is the province’s sole provider of workers’ compensation, covering approximately 76% of the workforce.²⁹ WSIB coverage is mandatory in most industries. In other industries, such as finance and

real estate, coverage is optional. From the WSIB census, we identified accepted lost-time compensation claims between January 2016 and December 2019. We excluded more recent years due to the COVID-19 pandemic and its impact on work arrangements. Each claim record described the date and nature of the injury or illness, the sex and age of the claimant, the industry in which they were employed and their occupation at the time of the injury coded according to the National Occupational Classification (NOC).³⁰ To derive accurate claim rates, we combined the claims data from the WSIB (our ‘numerator’) with labour force estimates from the LFS (our ‘denominator’). The LFS is a monthly household survey administered by Statistics Canada. It follows a rotating panel design providing estimates of monthly changes in the Canadian labour force. Respondents are representative of 98% of the household population. The average response rate is approximately 90%. We used the LFS to derive monthly estimates of hours worked (ie, time at risk) using monthly cycles from January 2016 to December 2019 for respondents who were working in Ontario. From both data sources, we excluded self-employed individuals and individuals employed in industry groups with no or incomplete WSIB coverage, given that not all workers in these industries are eligible for compensation insurance. We combined these two data sources into a single dataset where information on the numerator (ie, WSIB claims) and the denominator (ie, LFS estimates of time at risk) was aggregated at a monthly level and stratified across levels of the study variables (see the ‘Covariates’ section). Thus, each observation (or row) in this aggregated dataset described the number of claims and corresponding hours of exposure within a given month and for a given combination of covariate values.

Exposure: precarious employment

We examined four dimensions of precarious employment: contractual instability (ie, temporary employment), earnings inadequacy (ie, low wages), schedule unpredictability (ie, irregular hours) and working-time mismatch (ie, involuntary part-time employment). WSIB electronic claim abstracts do not contain direct information on these or any other dimension of employment quality. We addressed this gap by developing a novel job-exposure matrix describing a claimant’s probability of exposure to precarious employment conditions according to their detailed occupational title. We developed this matrix based on an approach described in greater detail elsewhere.³¹ Briefly, we first tabulated the proportion of workers exposed to a given employment condition (ie, the proportion exposed to temporary employment, low wages, irregular hours and involuntary part-time employment) within each of the 500 unique occupations specified in the 2011 NOC. Proportions were estimated using the LFS, which contains information on these employment characteristics. We used LFS data on the Ontario labour force between 2016 and 2019. Exposure to temporary employment was assessed using the question: ‘Is your job permanent?’ Exposure to low wages was assessed using the question: ‘What is your hourly rate of pay?’ and Statistics Canada’s definition of low wages as earning less than two-thirds of the median wage. Exposure to irregular hours was assessed using the question: ‘Does the number of paid hours you work vary from week to week?’ Exposure to involuntary part-time employment was assessed using the pair of questions: ‘How many paid hours do you usually work per week?’ and ‘Did you want to work 30 or more hours per week?’ We rank ordered all 500 occupations according to the proportion of workers exposed to a given employment condition. We then grouped them into four quartiles of exposure,

with the first quartile (Q1) representing the occupations with the lowest probabilities of exposure and the fourth quartile (Q4) representing the occupations with the highest probabilities of exposure. Absolute quartile ranges (ie, minimum and maximum probabilities of exposure within each quartile) are presented in online supplemental table A1. We also created a multidimensional index providing an overall summary of exposure to precarious employment, which we assessed in terms of the number of times a given occupation was assigned the highest possible exposure level (ie, Q4), distinguishing between occupations with 'low' (ie, never assigned to Q4), 'moderate' (ie, assigned to Q4 once), 'high' (ie, assigned to Q4 twice) and 'very high' (ie, assigned to Q4 three or more times) overall exposures. In a final step, individual claimants in the WSIB claims dataset were assigned exposure values (eg, Q1, Q2, etc) based on their reported occupations through a process of one-to-one matching.

Covariates

Covariates included sex (male or female), age (15–24, 25–34, 35–44, 45–54 or 55 and above), year (2016, 2017, 2018 or 2019), physical demands (limited, light, medium and heavy) and exposure to other workplace hazards (unexposed or exposed). Physical demands and exposure to other workplace hazards were operationalised using the NOC Career Handbook.³² Physical demands describe the strength requirements of a given occupation. Every NOC code was assigned one of four strength requirements based on the minimum strength required in the handling of loads: limited, referring to loads weighing less than 5 kg; light, referring to loads weighing between 5 and 10 kg; medium, referring to loads weighing between 10 and 20 kg; and heavy, referring to loads weighing more than 20 kg. Exposure to other workplace hazards describes whether any of the following hazards are likely to be present in the workplace environment of a given occupation: (a) dangerous chemical substances; (b) biological agents; (c) equipment, machinery or tools; (d) electricity; (e) radiation; (f) flying particles or falling objects; (g) fire, steam or hot surfaces; and (h) dangerous locations. We distinguished between occupations exposed to none of these workplace hazards and occupations exposed to one or more of them.

Analyses

Initial descriptive analyses estimated crude claim rates and rate ratios (RR) across levels of the predictor variables. Rates were calculated in terms of full-time equivalent (FTE) hours of work, with one FTE equating to 1950 hours (ie, 37.5 hours/week across 52 weeks of the year). We then estimated a series of negative binomial regression models examining the relationship between exposure to precarious employment and occupational injury and illness rates. Models were estimated using data aggregated at the monthly level, with claim counts as the outcome and log-transformed hours of work exposure as the model offset. Additional details concerning the modelling approach are provided elsewhere.²⁹ We examined each exposure indicator (ie, temporary employment, low wages, irregular hours, involuntary part-time employment and the multidimensional exposure) separately. Models were first adjusted for sex, age and year as potential confounders (model 1). Models were then further adjusted for physical demands and other workplace hazards (model 2). We took this approach to ascertain the role of the physical work environment in explaining the relationship between precarious employment and occupational injuries and illnesses—that is, Are precariously employed workers more likely to sustain an

occupational injury or illness because they do more physically dangerous work? Since physical working conditions may be on the pathway from the exposure to the outcome (eg, precariously employed workers are less likely to be able to organise and advocate for safer working conditions), model 2 may be overadjusted. We present both sets of results so that readers can select the one they believe to be the least biased. All analyses were completed using PROC GENMOD in SAS V.9.4. Model estimates are presented with corresponding 95% CIs.

RESULTS

Table 1 presents the number of accepted loss-time injury and illness claims, FTE hours of exposure, crude claim rates per 1000 FTEs and unadjusted RRs across main study variables. Between January 2016 and December 2019, there were 231 307 accepted lost-time compensation claims for occupational injuries and illnesses. Claim rates were generally similar across sex and age groups. Claim rates increased across levels of physical demands, ranging from 6.9 per 1000 FTEs among occupations with limited physical demands to 37.3 per 1000 FTEs among occupations with heavy physical demands. Claim rates were also higher among those exposed to one or more other workplace hazards (21.8 vs 9.4 per 1000 FTEs). Across all four dimensions of precarious employment, claim rates were highest in Q4 (ie, occupations assigned the highest level of exposure) and next highest in Q3 (ie, occupations assigned the second highest level of exposure). For temporary employment and irregular hours, we observed the lowest claim rates in Q1 (ie, occupations assigned the lowest level of exposure). For low wages and involuntary part-time employment, on the other hand, claim rates were lowest among Q2 occupations (with Q1 occupations next). The same overall pattern was reflected in the multidimensional indicator describing overall exposure to precarious employment. The claim rate among occupations with 'high' overall exposure exceeded that of occupations with 'very high' overall exposure (22.1 per 1000 FTEs vs 21.1 per 1000 FTEs), though both of these groups reported substantially higher claim rates than occupations with 'low' overall exposure (8.0 per 1000 FTEs).

Table 2 presents adjusted RRs for accepted loss-time injury and illness claims across levels of exposure to precarious employment, first adjusted by sex, age and year, and then further adjusted by physical demands and other workplace hazards. After adjustment for sex, age and year (model 1), workers with the highest level of exposure to temporary employment, low wages, irregular hours and involuntary part-time employment presented the greatest risk of injury and illness. Compared with workers in Q1, the age, sex and year-adjusted RRs for workers in Q4 ranged from 1.84 (95% CI 1.79 to 1.89) for low wages to 7.37 (95% CI 7.08 to 7.67) for irregular hours. Relationships were generally graded, such that Q3 exposures presented the next highest relative risks across all four dimensions of precarious employment. We observed the same pattern for multidimensional (ie, overall) exposure to precarious employment. Compared with 'low' overall exposure, 'medium' overall exposure was associated with a 105% elevated risk (RR: 2.05, 95% CI 1.99 to 2.11), 'high' overall exposure was associated with a 181% elevated risk (RR: 2.81, 95% CI 2.73 to 2.89) and 'very high' overall exposure was associated with a 182% elevated risk (RR: 2.82, 95% CI 2.74 to 2.90). Further adjustment for physical demands and other workplace hazards (model 2) substantially attenuated observed associations. In most cases, however, higher exposure (ie, Q3

Table 1 Number of accepted loss-time claims, full-time equivalent (FTE) hours of exposure, claim rates and unadjusted rate ratios across study variables: Ontario, Canada (2016–2019)

	Claims	FTE hours of exposure	Rate per 1000 FTEs	RR	95% CI
Sex					
Male	131 999	9 000 503	14.7	Ref	
Female	99 308	6 690 623	14.8	1.01	1.00 to 1.02
Age					
15–24	30 204	1 943 628	15.5	1.07	1.06 to 1.09
25–34	49 170	3 651 536	13.5	0.93	0.92 to 0.94
35–44	49 037	3 385 595	14.5	Ref	
45–54	56 385	3 662 725	15.4	1.06	1.05 to 1.08
55+	46 511	3 047 643	15.3	1.05	1.04 to 1.07
Year					
2016	52 233	3 836 673	13.6	Ref	
2017	56 077	3 867 396	14.5	1.07	1.05 to 1.08
2018	60 904	4 019 557	15.2	1.11	1.10 to 1.13
2019	62 093	3 967 499	15.7	1.15	1.14 to 1.16
Physical demands					
Limited	55 172	8 043 504	6.9	Ref	
Light	55 732	3 341 992	16.7	2.43	2.40 to 2.46
Medium	83 134	3 306 052	25.1	3.67	3.63 to 3.71
Heavy	37 269	999 578	37.3	5.44	5.37 to 5.51
Other workplace hazards					
Unexposed	84 216	8 947 960	9.4	Ref	
Exposed	147 091	6 743 166	21.8	2.32	2.30 to 2.34
Temporary employment					
Q1 (lowest exposure)	25 449	2 850 960	8.9	Ref	
Q2	33 238	3 638 160	9.1	1.02	1.01 to 1.04
Q3	94 726	5 111 806	18.5	2.08	2.05 to 2.11
Q4 (highest exposure)	77 894	4 090 200	19.0	2.13	2.10 to 2.16
Low wages					
Q1 (lowest exposure)	28 233	2 645 349	10.7	Ref	
Q2	38 782	3 959 099	9.8	0.92	0.90 to 0.93
Q3	60 632	3 878 925	15.6	1.46	1.44 to 1.48
Q4 (highest exposure)	103 660	5 207 754	19.9	1.86	1.84 to 1.89
Irregular hours					
Q1 (lowest exposure)	7 726	2 612 215	3.0	Ref	
Q2	54 895	4 634 075	11.8	4.00	3.91 to 4.10
Q3	64 995	3 649 118	17.8	6.02	5.88 to 6.17
Q4 (highest exposure)	103 691	4 795 719	21.6	7.31	7.14 to 7.48
Involuntary part-time employment					
Q1 (lowest exposure)	7 254	872 141	8.3	Ref	
Q2	31 643	4 445 714	7.1	0.86	0.83 to 0.88
Q3	71 211	4 740 074	15.0	1.81	1.76 to 1.85
Q4 (highest exposure)	121 199	5 633 198	21.5	2.59	2.53 to 2.65
Multidimensional exposure					
Low	55 916	7 005 452	8.0	Ref	
Medium	45 280	2 665 678	17.0	2.13	2.10 to 2.16
High	65 599	2 964 276	22.1	2.77	2.74 to 2.80
Very high	64 512	3 055 720	21.1	2.65	2.61 to 2.68

Multidimensional exposure was assessed in terms of the number of times a given occupation was assigned the highest possible exposure level (ie, Q4), distinguishing between occupations with 'low' (ie, never assigned to Q4), 'moderate' (ie, assigned to Q4 once), 'high' (ie, assigned to Q4 twice) and 'very high' (ie, assigned to Q4 three or more times) overall exposures.
Q, quartile; RR, rate ratio.

and Q4) continued to predict higher risk of injury or illness. This was the case for all indicators except low wages. In the model looking at multidimensional exposure to precarious employment, after adjusting for physical demands and other workplace hazards, 'medium' overall exposure was associated

with a 24% elevated risk (RR: 1.24, 95% CI 1.18 to 1.29), 'high' overall exposure was associated with a 65% elevated risk (RR: 1.65, 95% CI 1.58 to 1.72) and 'very high' overall exposure was associated with a 100% elevated risk (RR: 2.00, 95% CI 1.92 to 2.08).

Table 2 Rate ratios describing the association between exposure to precarious employment and occupational injuries and illnesses in Ontario, Canada (2016–2019)

	Model 1		Model 2	
	RR	95% CI	RR	95% CI
Temporary employment				
Q1 (lowest exposure)	Ref		Ref	
Q2	1.05	1.01 to 1.08	1.05	1.01 to 1.09
Q3	2.04	1.98 to 2.10	1.45	1.40 to 1.51
Q4 (highest exposure)	2.16	2.09 to 2.22	1.68	1.61 to 1.74
Low wages				
Q1 (lowest exposure)	Ref		Ref	
Q2	0.92	0.89 to 0.95	0.69	0.66 to 0.72
Q3	1.43	1.39 to 1.47	0.72	0.69 to 0.75
Q4 (highest exposure)	1.84	1.79 to 1.89	0.98	0.94 to 1.02
Irregular hours				
Q1 (lowest exposure)	Ref		Ref	
Q2	4.05	3.89 to 4.22	2.27	2.16 to 2.39
Q3	5.89	5.66 to 6.13	2.76	2.62 to 2.91
Q4 (highest exposure)	7.37	7.08 to 7.67	3.30	3.14 to 3.47
Involuntary part-time employment				
Q1 (lowest exposure)	Ref		Ref	
Q2	0.92	0.88 to 0.96	0.84	0.80 to 0.88
Q3	1.74	1.67 to 1.81	1.20	1.14 to 1.25
Q4 (highest exposure)	2.80	2.69 to 2.92	2.13	2.04 to 2.22
Multidimensional exposure				
Low	Ref		Ref	
Medium	2.05	1.99 to 2.11	1.24	1.18 to 1.29
High	2.81	2.73 to 2.89	1.65	1.58 to 1.72
Very high	2.82	2.74 to 2.90	2.00	1.92 to 2.08

Model 1 is adjusted for sex, age and year; model 2 is adjusted for sex, age, year, physical demands and other workplace hazards; multidimensional exposure was assessed in terms of the number of times a given occupation was assigned the highest possible exposure level (ie, Q4), distinguishing between occupations with 'low' (ie, never assigned to Q4), 'moderate' (ie, assigned to Q4 once), 'high' (ie, assigned to Q4 twice) and 'very high' (ie, assigned to Q4 three or more times) overall exposures.
Q, quartile; RR, rate ratio.

DISCUSSION

We combined workers' compensation claims with corresponding labour force estimates to examine the relationship between exposure to precarious employment and risk of lost-time injury or illness in Ontario, Canada. Workers in occupations with a higher prevalence of precarious employment conditions—that is, contractual instability, earnings inadequacy, schedule unpredictability and working-time mismatch—were at increased risk of occupational injury and illness. Taking a more multidimensional view, occupations with a higher proportion of workers with 'high' and 'very high' overall exposures to precarious employment presented a nearly threefold risk of injury or illness compared with those with 'low' overall exposure. These associations were partly explained by differences in exposure to physically demanding and hazardous working conditions. Even after accounting for these differences, however, statistically and substantively significant associations persisted for workers with 'high' and 'very high' exposures to precarious employment, with the latter still presenting a twofold risk of injury or illness.

Our study contributes to the ongoing debate regarding the role and significance of precarious employment as a putative occupational hazard.^{3 7 19 33–35} Mixed findings in this area

have led researchers to conclude that the relationship between precarious employment and occupational injuries and illnesses may not be as straightforward as previously thought.^{7 23 24} For example, in a recent high-quality study using register-based data from Sweden, temporary employment and low earnings were both associated with a lower risk of occupational injury, whereas working multiple jobs and being employed through an agency predicted a higher injury risk.²³ Possible explanations include that precariously employed workers are less likely to report an injury or illness and that those in the most precarious positions are unlikely to be captured by the register data.^{24 36} Our study points to another possible explanation: namely, that various forms of precarious employment—including temporary, part-time and irregular jobs—inherently involve working fewer hours and weeks in the year, and thus imply less time 'at risk' of sustaining an occupational injury or illness. This would explain lower injury and illness rates among precariously employed workers, despite their disproportionate exposure to adverse physical and psychosocial working conditions. In fact, after accounting for this so-called 'denominator problem', our study found that all four measured dimensions of precarious employment—including working temporary, part-time and irregular jobs—were associated with an elevated risk of occupational injury and illness. These results suggest that previous studies may have underestimated injury and illness rates among precariously employed workers, resulting in the inconsistent and counterintuitive nature of extant findings.

With respect to the mechanisms linking precarious employment to occupational injuries and illnesses, existing hypotheses suggest that precariously employed workers face greater exposure to workplace hazards and greater vulnerability to their associated harms (eg, because they receive less training, are afforded fewer protections and have less power in the workplace).^{9 12 19 20} In the present study, differential exposure to high physical demands and other workplace hazards explained a substantial portion of the association between precarious employment and occupational injuries and illnesses. For the most part, however, sizeable associations persisted even after adjustment for these working conditions, suggesting that while greater exposure to hazards might explain some of the relationship, there are likely other factors—such as greater vulnerability—linking precarious employment to increased risk of injury or illness. While it was not within the scope of this study to examine these mechanisms in any detail, research to that effect is lacking and could help inform the design of effective interventions.

The study findings highlight a persisting need for policy and programmatic focus on precarious employment as a structural or 'upstream' cause of occupational injuries and illnesses.^{19 35} Efforts to address the precariousness of contemporary employment arrangements may yield substantial improvements to workplace health and safety, including a reduction in occupational harms and associated costs to workers, employers and governments. Such efforts could include legislative reforms to improve and enforce regulatory standards governing the minimum terms and conditions of employment (eg, stronger employment protection legislation, stricter scheduling requirements and updated minimum wage legislation).¹⁶ Employers can also design workplace policies and practices to address these issues and associated health and safety concerns at an organisational level (eg, by improving the employment and working conditions of their employees). Other interventions could aim to address specific aspects of work that are less favourable for precarious workers (eg, training, representation and empowerment), with a targeted focus on those occupations and industries characterised by a

high prevalence of precarious employment. Our findings do not speak to the effectiveness of such interventions for preventing injuries and illnesses. This represents a potentially promising avenue for future research.³⁷

Our findings should be interpreted in light of the following key limitations. Precarious employment was assessed indirectly using a job exposure matrix describing the probability of exposure to adverse employment conditions. Use of a job exposure matrix was necessary due to the absence of direct measures of employment quality in the compensation claims data. Misclassification error arising from heterogeneous exposure levels *within* a given occupation may have biased our results. For future research to overcome this problem, such information will either have to be collected directly from workers on their contact with the compensation system or indirectly through administrative linkages across multiple government registers, akin to those available in some European countries.^{23 24} The under-reporting of occupational injuries represents another important limitation of our study. Previous research suggests that a sizeable proportion of compensable injuries go unreported, and that precariously employed workers are on balance less likely to report injuries.^{36 38} These insights point to a source of differential misclassification of the outcome which would underestimate the frequency of injuries and illnesses incurred by workers exposed to precarious employment, implying that the results presented in this paper are biased towards the null. Third, while we controlled for key aspects of the physical work environment (ie, physical demands and other workplace hazards), we did not account for a comprehensive list of physical and psychosocial work environment factors, suggesting residual and unmeasured differences in job-level exposures between study groups. The work environment factors we controlled for are nevertheless among those that most strongly predict occupational health and safety risks.³⁹ Furthermore, we were not able to account for factors such as race and immigration status, which are likely to differ across our study groups and potentially confound the association between precarious employment and health and safety outcomes. This information is not presently collected by the workers' compensation system. Finally, our findings are specific to a high-income country with relatively robust occupational health and safety standards. They may not generalise to other contexts where health and safety standards and compliance are substantially different.

CONCLUSIONS

In this study of 231307 compensable injuries and illnesses in Ontario, Canada, we found that workers exposed to precarious employment are more likely to sustain an occupational injury or illness resulting in lost-time compensation. With the prevalence of temporary, irregular and other 'non-standard' jobs rising in Canada and other high-income countries,⁴⁰ precarious employment appears to pose a significant and potentially increasing risk to workplace health and safety. Legislative and organisational strategies to improve health and safety at work should consider the role of precarious employment as an occupational hazard and a marker of work injury risk.

Contributors FVS and PMS developed the study idea. QL performed the analysis with assistance from FVS, PMS and VL. FVS wrote the first draft of the manuscript. All authors discussed and interpreted the study findings, provided substantive comments and suggestions and have reviewed and approved the final version of the manuscript for submission. FVS is the guarantor for the study.

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ORCID iDs

Faraz Vahid Shahidi <http://orcid.org/0000-0002-2789-1515>
Cameron Mustard <http://orcid.org/0000-0002-0747-8870>
Lynda S Robson <http://orcid.org/0000-0003-4418-0042>
Aviroop Biswas <http://orcid.org/0000-0002-0393-6280>
Peter M Smith <http://orcid.org/0000-0001-8286-4563>

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