

Individual, Occupational, and Workplace Correlates of Occupational Health and Safety Vulnerability in a Sample of Canadian Workers

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Objective *To describe OH&S vulnerability across a diverse sample of Canadian workers.*

Methods *A survey was administered to 1,835 workers employed more than 15 hrs/week in workplaces with at least five employees. Adjusted logistic models were fitted for three specific and one overall measure of workplace vulnerability developed based on hazard exposure and access to protective OH&S policies and procedures, awareness of employment rights and responsibilities, and workplace empowerment.*

Results *More than one third of the sample experienced some OH&S vulnerability. The type and magnitude of vulnerability varied by labor market sub-group. Younger workers and those in smaller workplaces experienced significantly higher odds of multiple types of vulnerability. Temporary workers reported elevated odds of overall, awareness- and empowerment-related vulnerability, while respondents born outside of Canada had significantly higher odds of awareness vulnerability.*

Conclusion *Knowing how labor market sub-groups experience different types of vulnerability can inform better-tailored primary prevention interventions.* Am. J. Ind. Med. 59:119–128, 2016. © 2015 The Authors. American Journal of Industrial Medicine Published by Wiley Periodicals, Inc.

KEY WORDS: *health and safety; vulnerability; epidemiology*

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INTRODUCTION

Occupational injury, illness, and workplace fatalities are important public health concerns. Globally, 2.3 million deaths a year can be attributed to occupational injury or work-related diseases, and many more millions suffer from non-fatal work-related injury and illness [International Labour Organization, 2014]. Annually in Canada, an average of just under a million lost time occupational injury claims are accepted by provincial workers' compensation agencies, representing one in 46 full-time workers being compensated for an injury severe enough to miss one or more days of work [Gilks and Logan, 2010]. The consequences of work-related injury and illness extend beyond individual workers, exacting important social and economic costs from families, businesses, and economies [Boden et al., 2001].

It is well documented that the burden of occupational injury and illness is not equally distributed across the labor force. Research has identified higher rates of occupational injury and illness among new immigrants [Smith and Mustard, 2009, 2010], younger workers [Breslin and Smith, 2005; Guest et al., 2014], workers with lower levels of education [Breslin et al., 2008; Oh and Shin, 2003], and individuals in temporary employment relationships [Benavides et al., 2006; Quinlan, 1999]. As a result, these labor market sub-groups are often labeled as “at risk” [Webster, 2014] or “vulnerable” [Law Commission of Ontario, 2012].

The practice of identifying and labeling workers at elevated risk of workplace injury or illness based exclusively on individual characteristics has a number of important consequences. First, it suggests that risk is inherent to an individual or population group [Weil, 2009]. Second, it places blame for injury and illness on individuals, attributing negative health outcomes to carelessness or accident proneness. The result is a presumption that education and behavior change alone can overcome environments and workplaces where hazards are poorly managed [DeJoy, 2005]. Thirdly, the act of grouping various population groups who experience higher risk OH&S risk together under the moniker of “vulnerable” obscures important differences between these groups of workers. While young and new workers, new immigrants, or less educated workers may share higher risk of injury or illness, this risk may result from different factors. To examine these diverse groups together overlooks how different sub-populations may require different strategies to ensure safety on the job.

Defining vulnerability based on individual demographic characteristics does not adequately consider how the particular circumstances of workers contribute to their occupational health and safety (OH&S) risk. Recognizing that the factors affecting injury and illness risk are broader than simply unsafe actions by workers, this study measures and analyzes how workplace resources and mechanisms such as training, and protective policies and procedures shape OH&S risk for certain labor market sub-groups.

Researchers in the fields of organizational psychology and occupational health have explored contextual factors shaping OH&S risks including management practice and attitude, organizational culture, and task-specific exposures, but many of these studies have limited their focus to singular facets of the workplace context, specific occupational settings [Smith and DeJoy, 2012; Souza et al., 2014], and employer-reported measures of organizational practice. Very few, if any, studies use worker-reported measures to consider how multiple dimensions of workplace OH&S context impact injury risk in an occupationally diverse population.

In this paper a newly developed tool to measure OH&S vulnerability is employed to examine how

demographic, occupational, and workplace groups experience differing types of OH&S vulnerability. This study defines vulnerability as exposure to on-the-job hazards in conjunction with inadequate access to resources to mitigate the effects of these hazards. Specifically, this study explores how three interconnected but conceptually distinct types of vulnerability are associated with socio-demographic and work characteristics. The three types of vulnerability examined arise from inadequate (i) protective OH&S policies and procedures, (ii) awareness of employment rights and responsibilities, and (iii) empowerment to participate in injury prevention.

By examining how diverse sub-populations are differently affected by each type of vulnerability, this work has the potential to contribute to the development of more appropriately tailored primary prevention initiatives.

METHODS

Data

Data used in this study were collected using a newly developed 27-question survey tool designed to improve measurement and evaluation of how workplace context impacts individual risk of workplace injury or illness. Design and development of the tool included a systematic literature review, focus groups, and pilot testing and is described in detail elsewhere [Smith et al., 2015]. Four survey sections captured information on respondents’ exposure to workplace hazards and on the availability of three types of resources designed to mitigate the impact of exposure to these hazards. The three mitigation resources explored were (i) workplace-level policies and procedures (policies and procedures); (ii) worker awareness of occupational hazards and rights and responsibilities (awareness); and (iii) worker empowerment to participate in injury prevention (empowerment). The survey also included questions capturing demographic, occupational, and workplace characteristics.

Survey data used in this study were collected from 1,835 working adults in Ontario and British Columbia (BC) by a commercial survey research provider. Most respondents were recruited by phone and email from an existing panel of approximately 90,000 Canadians who agreed to participate in periodic surveys. A smaller sample was recruited using a random digit dialing (RDD) approach. Phone or online completion of the survey was interpreted as representing informed consent. Individuals were eligible to participate in the study if they were residents of Ontario or BC, and were employed more than 15 hr a week in a workplace with five or more employees. Response rates for the panel and RDD recruitment approaches were 17% and 13%, respectively. Ethics approval was obtained from the University of Toronto Health Sciences Ethics Committee.

Measures

Outcome

In this study, OH&S vulnerability was defined as being both exposed to workplace hazards and experiencing inadequate resources to mitigate the effects of hazard exposure. Four types of vulnerability—three specific, and one overall—were measured.

To determine workplace hazard exposure, individuals were asked nine questions on how often they experience hazards such as excessive noise, repetitive motions, and prolonged standing. The seven-level response scale ranged from never to every day. Individuals were considered exposed if they reported experiencing two or more of the nine hazards weekly or more often, or if they reported weekly or more frequent exposure to either work involving lifting or carrying 20 kg at least 10 times a day, work at heights greater than 2 m, work with hazardous substances such as chemicals, flammable liquids, and gases, or bullying or harassment.

The adequacy of three types of workplace resources designed to mitigate the effects of hazard exposure was measured by level of agreement (strong agree, agree, disagree, strongly disagree) with a series of statements. Seven statements used to evaluate adequacy of OH&S policy and procedures inquired about the existence and implementation of workplace systems such as safety training and accident investigations, and the presence of an OH&S committee or representative. Measurement of the adequacy of worker awareness of OH&S rights and responsibilities used six statements on workers' knowledge of rights and responsibilities and job-specific safety precautions. Five statements measured worker empowerment to engage in health and safety prevention by asking about comfort voicing safety concerns, and participation in health and safety improvements. A complete list of questions for each dimension is available in Table I. Within each of the three types of mitigation resources (policies and procedures, awareness, and empowerment), respondents were considered to have inadequate access if they disagreed (disagree or strongly disagree) with one or more of the survey statements.

Four dichotomous vulnerability outcomes were created based on exposure to hazards and adequacy of mitigation resources. Individuals were defined as having one of three specific types of vulnerability—policies and procedures, awareness, and empowerment—if they were exposed to hazards on the job and were classified as “inadequate” on the corresponding mitigation resource. Overall vulnerability was defined as exposure to hazards plus inadequacy of any of the three mitigation resources.

Covariates

Demographic variables included sex (male or female); age classified into four categories (< 35 years, 35–44 years,

45–54 years, and 55 years and up); country of birth (Canada or outside of Canada); and first language learnt in childhood, which was still understood (English versus non-English). Occupational variables included job tenure in current job (6 months or less, 7–12 months, and longer than 1 year), and employment relationship (temporary versus permanent). Workplace characteristics were limited to workplace size (5–19 employees, 20–99 employees, 100–499 employees, and 500 or more employees).

Analysis

In total, 1,835 respondents completed the survey. Where a respondent was missing a single response within the policy and procedure, awareness, or empowerment sections of the survey, the value was imputed using the mean of the other responses in that section. Values were imputed for 158 policy and procedures statements, 61 awareness statements, and 82 empowerment statements. Respondents missing more than one response within these three survey sections ($N = 162$) or missing any hazard exposure or covariate value ($N = 181$) were removed from the sample. In total, 343 respondents were removed due to missing values leaving a final analytical sample of 1,492 respondents.

Descriptive analysis included calculating the frequency of all categorical covariates. The proportion of the sample defined as exposed to hazards and has having inadequate policies and procedures, awareness, and empowerment was also calculated across all study covariates. To examine relationships between demographic, occupational, and workplace characteristics and OH&S vulnerability, four separate adjusted logistic models were fitted with each of the three specific types of vulnerability and overall vulnerability as outcomes. Models were adjusted for all covariates as well as province of residence (BC or Ontario) and survey administration mode (Online panel, Phone panel, and RDD). Analyses used data weighted to reflect the province-specific age and sex distributions of the labor force from the 2013 Canadian Labour Force Survey [Statistics Canada, 2014].

Two post-hoc sensitivity analyses were completed. The first compared results with and without sampling weights. The second compared the relationship between covariates and OH&S vulnerability outcomes using stricter cut-offs of both hazard exposure and adequacy of policies and procedures, awareness, or empowerment. Using this stricter definition individuals were considered exposed to hazards if they reported three or more hazards on a weekly or more frequent basis, or if they experienced at least weekly exposure to frequent lifting or carrying of 20 kg, work at heights, work with hazardous substances, or bullying or harassment. Inadequate policies and procedures, awareness, or empowerment were defined as disagreeing with at least two—rather than one—related statements.

TABLE I. Hazard and Vulnerability Questions Included in Survey

Hazards: How often do you . . .

1. Have to manually lift, carry, or push items heavier than 20 kg at least 10 times a day?
2. Have to do repetitive movements with your hands or wrists (packing, sorting, assembling, cleaning, pulling, pushing, typing) for at least 3 hr during the day?
3. Have to perform work tasks, or use work methods that you are not familiar with?
4. Interact with hazardous substances such as chemicals, flammable liquids, and gases?
5. Have to work in a bent, twisted, or awkward posture?
6. Work at a height that is 2 m or more above the ground or floor?
7. Work in noise levels that are so high that you have to raise your voice when talking to people less than 1 m away?
8. Have you been bullied or harassed at work?
9. Have to stand for more than 2 hr in a row?

Policies and Procedures: At my workplace . . .

1. Everyone receives the necessary workplace health and safety training when starting a job, changing jobs, or using new techniques.
2. There is regular communication between employees and management about safety issues.
3. Systems are in place to identify, prevent, and deal with hazards at work.
4. Workplace health and safety is considered to be at least as importance as production and quality.
5. There is an active and effective health and safety committee, and/or health and safety representative.
6. Incidents and accidents are investigated quickly in order to improve workplace health and safety.
7. Communication about workplace health and safety procedures is done in a way I can understand.

Awareness: At my workplace . . .

1. I am clear about my rights and responsibilities in relation to workplace health and safety.
2. I am clear about my employer's rights and responsibilities in relation to workplace health and safety.
3. I know how to perform my job in a safe manner.
4. If I became aware of a health or safety hazard at my workplace, I know who (at my workplace) I would report it to.
5. I have the knowledge to assist in responding to any health and safety concerns at my workplace.
6. I know what the necessary precautions are that I should take while doing my job.

Empowerment: At my workplace . . .

1. I feel free to voice concerns or make suggestions about workplace health and safety at my job.
2. If I notice a workplace hazard, I would point it out to management.
3. I know that I can stop work if I think something is unsafe and management will not give me a hard time.
4. If my work environment was unsafe, I would not say anything and hope that the situation eventually improves. (*reverse scored)
5. I have enough time to complete my work tasks safely.

All analyses were completed in SAS 9.4 (SAS Institute Inc. Cary, NC).

RESULTS

A majority of the final analytical sample ($N = 1,492$) was recruited from the panel (online [55.50%] or by phone [23.65%]), while the remaining 20.85% was recruited using RDD. Table II presents the weighted distribution of demographic, occupational, and workplace characteristics. Also presented are the proportion of individuals who were exposed to hazards, and the proportion with inadequate mitigation resources related to policies and procedures, awareness, or empowerment across all covariates. Hazard exposure was statistically more prevalent in men (59.78%) compared to women (47.63%), among those in temporary (62.31%) rather than permanent jobs (52.44%), and in the

youngest group of respondents (61.18%) compared to other age groups (48.91%). Statistically significant associations between hazard exposure and workplace size, and job tenure were also observed. The highest prevalence of hazard exposure was reported among workplaces with 5–19 employees and among those in their jobs for less than 6 months.

In total, 46.14% of the sample reported inadequate policies and procedures-related protections. Sub-optimal access to OH&S policy and procedures was statistically more prevalent among respondents born in Canada (47.54%) compared to those not born in Canada (36.15%), among temporary (59.17%) versus permanent employees (44.22%), in younger employees, and in respondents employed at smaller workplaces.

Inadequate awareness of workplace rights and responsibilities was experienced by 25.21% of the sample and was significantly more common among those born outside of Canada (31.11%) compared to Canadian-born respondents

TABLE II. Distribution of Hazard Exposure, Inadequate Policies and Procedure (PP), Inadequate Awareness (AW) and Inadequate Empowerment (EM) Across Demographic, Occupational and Workplace Characteristics (N = 1,492)

	% of sample	Exposure to hazards		Inadequate PP		Inadequate AW		Inadequate EM	
		%	P-value	%	P-value	%	P-value	%	P-value
Overall		53.71		46.14		25.21		34.33	
Sex			<0.0001		0.1		0.21		0.08
Male	50.03	59.78		48.26		23.80		36.49	
Female	49.97	47.63		44.03		26.62		32.17	
Age			<0.0001		0.0004		0.14		0.15
< 35 years	38.98	61.18		52.17		27.34		34.87	
35–44 years	21.31	47.57		45.65		25.07		36.8	
45–54 years	22.67	49.1		43.13		25.81		35.64	
55 or more years	17.04	50.45		36.98		19.70		28.26	
Location of birth			0.93		0.004		0.05		0.50
Canadian	87.75	53.67		47.54		24.39		34.02	
Outside of Canada	12.25	54.02		36.15		31.11		36.54	
First language			0.82		0.28		0.82		0.001
English	87.90	53.82		45.62		25.12		32.88	
Not English	12.10	52.94		49.93		25.89		44.88	
Employment relationship			0.01		0.0001		0.04		0.15
Permanent	87.12	52.44		44.22		24.13		33.65	
Temporary	12.88	62.31		59.17		31.28		38.92	
Workplace size			<0.0001		<0.0001		0.40		0.005
5–19 employees	20.78	56.99		55.45		24.63		27.61	
20–99 employees	27.47	58.96		50.01		25.62		36.58	
100–499 employees	27.49	58.95		37.83		22.75		32.25	
500 or more employees	24.27	39.04		43.23		28.02		39.89	
Job tenure			0.0005		0.01		0.63		0.24
6 months or less	15.11	49.06		52.78		27.48		38.48	
7 months to 1 year	12.23	42.31		38.07		23.44		30.62	
Greater than 1 year	72.66	56.6		46.15		25.03		34.09	

(24.24%). Respondents in temporary jobs also reported statistically higher prevalence of inadequate awareness (31.28%) than their permanently employed counterparts (24.13%).

In total, 34.33% of the sample experienced inadequate OH&S empowerment. Inadequate empowerment was statistically more prevalent among individuals whose first language was not English (44.88%) compared to native English speakers (32.88%). Smaller workplaces reported statistically lower levels of inadequate empowerment.

In Table III, the frequency of inadequate policies and procedures, awareness, empowerment, and overall lack of protective resources (inadequate access to any one of the three protective measures) are displayed by hazard exposure category. Shaded cells in the table identify those respondents who meet the two-part definition of OH&S vulnerability: exposed to hazards and classified as having inadequate access to one of the three kinds of mitigation resources. Of the three separate types of OH&S vulnerability, policy and procedure vulnerability was the most common, experienced by 27.40% of the sample, followed by empowerment-related

vulnerability (22.22%), and finally, awareness vulnerability (14.00%). Overall, more than one third of respondents (35.22%) was defined as vulnerable to workplace illness or injury.

Odds ratios (OR) and confidence intervals for all covariates in adjusted logistic models are presented in Table IV. Statistically significant relationships between policy and procedures vulnerability and age, workplace size, and job tenure were observed. Odds of policy and procedure vulnerability were 1.76 times higher (95%CI: 1.25, 2.48) for respondents under 35 years old compared to 45–54 years olds. Compared to respondents in workplaces with 500 or more employees, odds of policy and procedure vulnerability was 3.35 times higher (95%CI: 2.25, 4.99) for those employed in workplaces with 5–19 employees, and 2.75 (95%CI: 1.88, 4.01), and 2.00 (95%CI: 1.36, 2.94) times higher for those in workplaces with 20–99 employees and 100–499 employees, respectively. Shorter job tenure provided a statistically significant protective effect. Compared to respondents at their jobs for more than a year, individuals in their jobs for 6 months or less, or for 7–12

TABLE III. Sample Distribution of Inadequate Policies and Procedure, Inadequate Awareness, and Inadequate Empowerment by Hazard Exposure (N = 1,492)

	Hazard exposure (n (%))		Total
	Unexposed	Exposed	
	691 (46.29)	801 (53.71)	
Policies and procedures			
Adequate	411 (27.54)	393 (26.31)	803 (53.86)
Inadequate	280 (18.74)	409 (27.40)	688 (46.14)
Awareness			
Adequate	523 (35.07)	593 (39.72)	1116 (74.79)
Inadequate	167 (11.21)	209 (14.00)	376 (25.21)
Empowerment			
Adequate	510 (34.17)	470 (31.50)	980 (65.67)
Inadequate	181 (12.11)	331 (22.22)	512 (34.33)
Overall			
Adequate	313 (21.00)	276 (18.49)	589 (39.49)
Inadequate	377 (25.29)	525 (35.22)	903 (60.51)

months experienced lower odds (OR:0.52 95%CI:0.36, 0.76 and OR:0.45 95%CI:0.29, 0.69, respectively) of policy and procedure vulnerability.

Results related to awareness vulnerability include statistically significant OR for age, location of birth, first language, employment relationship, and workplace size. The odds of awareness-related vulnerability were 74% higher for 35–44 year olds (95%CI: 1.03, 2.38) compared to those 45–54 years old and 2.52 times higher for those born outside of Canada (95%CI: 1.59, 4.00) than for Canadian-born respondents. Increased odds of awareness vulnerability were also observed for temporary (OR: 1.85 95%CI: 1.22, 2.82) compared to permanent employees and among those employed at workplaces with 5–19 or 20–99 employees as compared to the reference group (500 or more employees). In comparison to native English speakers, individuals whose first language was not English experienced statistically significant lower odds of awareness vulnerability (OR: 0.44 95%CI: 0.25, 0.77).

Statistically significant relationships were observed between empowerment vulnerability and employment relationship, workplace size, and job tenure. Higher odds of empowerment vulnerability were reported by those in temporary rather than permanent jobs (OR: 1.60 95%CI: 1.12, 2.31). Odds of empowerment vulnerability were higher among all workplace sizes smaller than the reference category (500+ employees) though the differences were only statistically significant for the category 20–99 employees (OR: 1.58 95%CI: 1.10, 2.25). Statistically significant protective effects of shorter job tenure were observed for those at their roles for 7–12 months compared to those with a year-long tenure or more (OR: 0.60 95%CI: 0.39, 0.94).

Overall vulnerability was statistically associated with age, employment relationship, workplace size, and job tenure. The youngest respondents experienced twice the odds of overall vulnerability (OR: 1.99 95%CI: 1.45, 2.74) compared to respondents aged 45–54 years. Those in temporary work relationships had 55% higher odds of overall vulnerability (95%CI: 1.10, 2.18) than permanently employed counterparts. Compared to workplaces with 500+ employees, smaller workplaces reported greater odds of overall vulnerability. Odds of overall vulnerability were highest in workplaces with 5–19 employees (OR: 1.99 95% CI: 1.40, 2.83). A statistically significant protective effect of shorter job tenure was also observed; those at a job for less than a year were significantly less likely to report overall vulnerability than those in a job for more than year.

DISCUSSION

The purpose of this study was to develop a more comprehensive understanding of how exposure to workplace hazards and inadequate access to risk mitigation mechanisms differently impact varied labor market sub-groups. Three specific types of workplace vulnerability and overall vulnerability were measured and variations in the types of vulnerability experienced by different sub-populations were described.

Overall, more than half of the study population was exposed to workplace hazards and nearly one third of respondents were vulnerable to a work injury or illness due to hazard exposure in conjunction with either inadequate OH&S policies and procedures, inadequate awareness of workplace rights, responsibilities and hazards, or inadequate empowerment to ensure a safe work setting. This overall vulnerability was significantly more prevalent among younger respondents, temporary employees, and those working in smaller workplaces. These results are consistent with previous research demonstrating elevated risk of both hazard exposure and occupational injury or illness among young workers and individuals in non-permanent employment relationships [Labege and Ledoux, 2011; Smith and DeJoy, 2012; Dragano et al., 2014].

Beyond overall vulnerability, this study also examined three specific types of vulnerability. The labor market sub-groups often grouped together under the label “vulnerable” were differently affected by three types of vulnerability. Vulnerability due to hazard exposure and inadequate access to OH&S policies and procedures was the most common, reported by one in four respondents. While some population sub-groups reported experiencing all types of vulnerabilities, others reported just a single type.

Younger respondents were found to experience higher vulnerability across all four measures (the three specific and one overall measure) of vulnerability. Policy and procedure

TABLE IV. Adjusted Logistic Models for Overall, Policy and Procedure, Awareness, and Empowerment Vulnerability (N = 1,492)

	Vulnerability							
	Policies and procedures		Awareness		Empowerment		Overall	
	Effect	95%CI	Effect	95%CI	Effect	95%CI	Effect	95%CI
Sex								
Male	Ref.		Ref.		Ref.		Ref.	
Female	0.8	0.62, 1.02	1.09	0.80, 1.48	0.98	0.76, 1.26	0.8	0.64, 1.00
Age								
< 35 years old	1.76	1.25, 2.48	1.57	1.03, 2.38	1.42	1.00, 2.02	1.99	1.45, 2.74
35–44 years	1.23	0.85, 1.79	0.93	0.59, 1.49	1.12	0.77, 1.63	1.10	0.78, 1.56
45–54 years	Ref.		Ref.		Ref.		Ref.	
55 or more years	0.73	0.48, 1.10	0.56	0.33, 1.96	0.71	0.46, 1.09	0.76	0.52, 1.10
Location of birth								
Canada	Ref.		Ref.		Ref.		Ref.	
Outside of Canada	0.77	0.50, 1.18	2.52	1.59, 4.00	0.95	0.63, 1.45	1.17	0.80, 1.70
First language								
English	Ref.		Ref.		Ref.		Ref.	
Not English	1.36	0.91, 2.03	0.44	0.25, 0.77	1.30	0.87, 1.93	1.21	0.83, 1.75
Employment relationship								
Permanent	Ref.		Ref.		Ref.		Ref.	
Temporary	1.38	0.96, 1.99	1.85	1.22, 2.82	1.60	1.12, 2.31	1.55	1.10, 2.18
Size								
5–19 employees	3.35	2.25, 4.99	1.79	1.09, 2.94	1.13	0.76, 1.69	1.99	1.40, 2.83
20–99 employees	2.75	1.88, 4.01	1.80	1.13, 2.87	1.58	1.10, 2.25	1.76	1.27, 2.44
100–499 employees	2.00	1.36, 2.94	1.57	0.98, 2.52	1.17	0.81, 1.69	1.59	1.14, 2.22
500 or more employees	Ref.		Ref.		Ref.		Ref.	
Job tenure								
6 months or less	0.52	0.36, 0.76	0.64	0.41, 1.02	0.78	0.54, 1.13	0.58	0.41, 0.82
7 months to 1 year	0.45	0.29, 0.69	0.64	0.38, 1.07	0.60	0.39, 0.94	0.45	0.30, 0.66
Greater than 1 year	Ref.		Ref.		Ref.		Ref.	

Models adjusted for all variables in the table in addition to province of residence and mode of survey administration.

vulnerability and awareness vulnerability displayed significantly higher odds for those under 35 years; their greatest increased odds related to inadequate protective OH&S policies. Respondents in non-permanent positions also experience elevated levels of three types of vulnerability, though these differences were only statistically significant for vulnerability related to awareness of OH&S rights and responsibilities, and empowerment to participate in injury prevention. The vulnerability experienced by those born outside of Canada related exclusively to their inadequate awareness of rights, responsibilities, and hazards. This finding is similar to earlier research that suggests immigrants often have lower levels of OH&S awareness due to receiving less comprehensive workplace training, and language and cultural barriers [Kosny and Lifshen, 2012].

The study also revealed important trends related to the relationship between workplace size and vulnerability. Respondents in the smaller firms reported increased

vulnerability of all three types, but the differences were most pronounced as they relate to policies and procedure vulnerability. The nearly 3.5-fold increase in policy and procedure vulnerability experienced by firms with 5–19 employees may in part reflect provincial legislation in BC and Ontario that requires small workplaces to have an OH&S worker representative rather than the OH&S committees required of larger workplaces [Ontario Ministry of Labour, 2012; WorkSafeBC, 2012]. As a result, OH&S advocates and procedures may be less visible, or less substantive in the smallest work settings [Sorensen et al., 2007]. The increased vulnerability related to workplace policies and procedures may also reflect a lack of capacity to formalize health and safety procedures within smaller staff complements [Hasle and Limborg, 2006].

Two unexpected results emerged in this study. First was the protective effect offered by shorter job tenure. Respondents in their jobs for 6 months or less reported significantly

lower odds of overall, and policy and procedure-specific vulnerability while those with a 7–12 month-long tenure had significantly lower odds of overall, policy and procedure, and empowerment vulnerability. This finding contradicts previous research that describes an inverse relationship between job tenure and occupational injury [Breslin and Smith, 2006; Morassaei et al., 2013]. Sensitivity analyses using unweighted data and stricter definitions of vulnerability revealed no significant relationship between job tenure and any type of vulnerability. As a result, we believe that the observed protective effect may result from sampling whereby the study sample included individuals in shorter tenure jobs with more favorable work conditions than past study populations. In our sample, younger workers in short tenure jobs had more favorable work conditions than older workers in short tenure jobs. As a result of weighting the data to match the Ontario and BC labour markets across age and sex groups, we up-weighted younger respondents and down-weighted older respondents. This weighting may have resulted in a protective effect being observed for job tenure in the weighted sample, which was not present in the un-weighted sample.

The second unexpected finding was that respondents whose first language is not English are at reduced odds of awareness-related vulnerability. This observed relationship differs from previous research suggesting higher rates of workplace injury and illness and lower OH&S knowledge among non-English-speaking respondents or those working in their non-native language [Premji et al., 2008]. The results observed in this study cannot be entirely explained by the weighting of the data as the protective effect persists—albeit no longer at a statistically significant level—in analyses using un-weighted data and continue to be apparent when a stricter definition of vulnerability is adopted. The observed relationship may result from the composition of the survey panel. Self-enrollment in the panel and voluntary participation in the survey may have resulted in a population who, despite English not being their first language, are fluent and, therefore, less affected by language barriers. In the future, a measure of current fluency may provide a more accurate description of the relationships between language competency and the three dimensions of vulnerability.

Findings of this study should be interpreted in light of a number of limitations. Firstly, the population recruited for the study is not representative of all labor-market subgroups in Ontario and British Columbia. Compared to the Ontario and British Columbia labor markets, younger respondents, those in smaller workplaces, and those in the sales and service, and natural or applied science occupations were under-represented in the initial survey sample. While weighting by province, age and sex offered some correction, future studies would benefit from more active recruitment of the labor market groups under-represented in this current study. Second, the choice to exclude individuals who

were self-employed, who work less than 15 hr a week and who were employed in workplaces with fewer than five employees led to a failure to examine these experiences. Precariously and self-employed individuals have been found to be at greater risk of on-the-job hazard exposure and occupational injury [Benavides et al., 2006; Lewchuk et al., 2006]. This selection effect may also have been exacerbated by using an existing survey panel and RDD approach to recruit survey respondents. Additional work to examine the dimensions of vulnerability among the respondents excluded from this study would offer further insights into how workplace context shapes different types of vulnerability among harder to reach respondents.

Finally, the thresholds used to define vulnerability may impact the observed results. Absolute rather than relative thresholds were selected in order to allow for consistent adoption across samples and time points. Sensitivity analyses exploring the impact of setting a higher threshold for defining respondents as vulnerable suggested that some of the relationships between covariates and vulnerability are sensitive to the definition of vulnerability used. Using the more strict definition, the youngest respondents only experience significantly elevated odds of awareness-related vulnerability, no significant differences in vulnerability by location of birth are observed, and men no longer experience significantly higher odds of overall vulnerability. The more strict definition does highlight higher empowerment vulnerability among temporary respondents and smaller workplaces continued to experience significantly higher vulnerability on all three dimensions. Results from sensitivity analysis using a higher threshold highlight population groups and corresponding types of vulnerability where prevention efforts are of the highest priority.

This study also has a number of strengths. Despite noted sampling challenges, respondents were recruited from a wide range of occupational categories, workplace sizes, and employment relationships. Additionally, the measurement of occupational hazard exposure using individually reported experience is an improvement over many studies that use occupational category as a proxy [Oh and Shin, 2003]. Finally, measurement of multiple dimensions of vulnerability allows for the simultaneous study differing aspects vulnerability among varied sub-populations.

Identification of workers at increased risk of work-related injury or illness is an important strategy in the efforts to reduce the burden of workplace morbidity. Alongside the study of individual characteristics of those at risk is the need to study the circumstances and mechanisms associated with this risk. By examining the hazards respondents are exposed to in conjunction with the policies and procedures in place to protect them, worker awareness of health and safety-related rights and responsibilities, and individual sense of empowerment, this study offers a clearer portrait of how labor market sub-groups often captured under the umbrella term

“vulnerable” differ in the types and reasons for their vulnerability. By examining overall vulnerability as well as three distinct types of vulnerability, we are able to identify how sub-populations often grouped together in both research and policy-making environments actually differ in the reasons for their elevated risk of injury or illness. The type and magnitude of vulnerability experienced by non-English-speaking individuals is unique from that experienced by younger respondents or that of temporary employed individuals.

Through examination of three distinct types of vulnerability researchers, policy-makers and workplaces are better able to tease apart the complexity of workplace environment and its impact on individual risk. Because this measure of vulnerability is able to isolate vulnerability due to poor policies and procedures, from vulnerability to lack of worker awareness, from vulnerability resulting from workplace environments that discourage engagement in safety the results of this paper identify areas for more specific and targeted interventions. For example, non-Canadian born individuals might benefit most from tailored awareness materials and awareness raising, while interventions that strengthen health and safety policies and procedures might be the most impactful in small workplaces. Policy-makers and workplaces are better equipped to design programs and policy to meet the greatest needs of their clients or citizens.

The strategy of simultaneously examining multiple specific types of vulnerability has the additional benefit of providing specific measures to isolate the avenues of impact of regulatory or other preventative interventions. For example, pre- and post-implementation measurement could reveal the impact of population- or workplace-wide education initiatives across all three specific types of vulnerability with particular focus on changes to the awareness dimension.

Future research to explore how well the new measures of vulnerability predict workplace injury and illness and continued examination of the differential impacts of all three dimensions of vulnerability on various worker populations will together contribute to the design of appropriate interventions and the successful reduction of occupational injury and illness.

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