Geographic variation in work injuries: a multilevel analysis of individual-level and area-level factors within Canada

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Overview of presentation

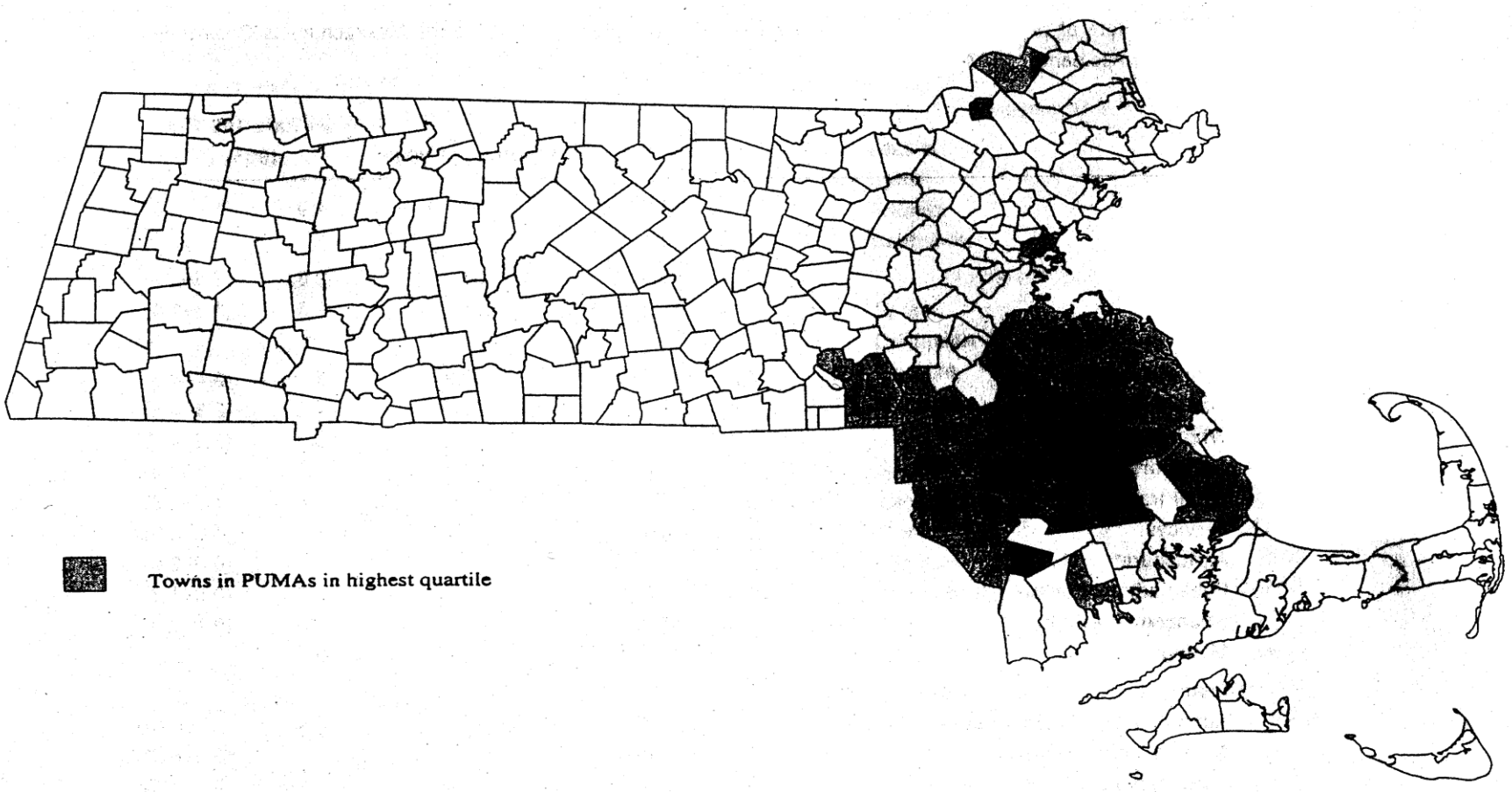
- Burden of occupational injuries in Canada
- Review of evidence
- Framework for geographic variation
- Methods and Results
- Significance of findings
- Future considerations

Burden of occupational injuries in Canada

- In Canada, occupational injuries account for substantial source of illness burden and disability in working-age population
  - **1 million workers** Number of Canadian workers who experienced nonfatal injuries that led to time off work
  - **17 billion dollars** Total estimated economic cost of occupational injuries in Canada per year
  - **Canada ranks poorly** relative to some other OECD member countries in rates of occupational injuries

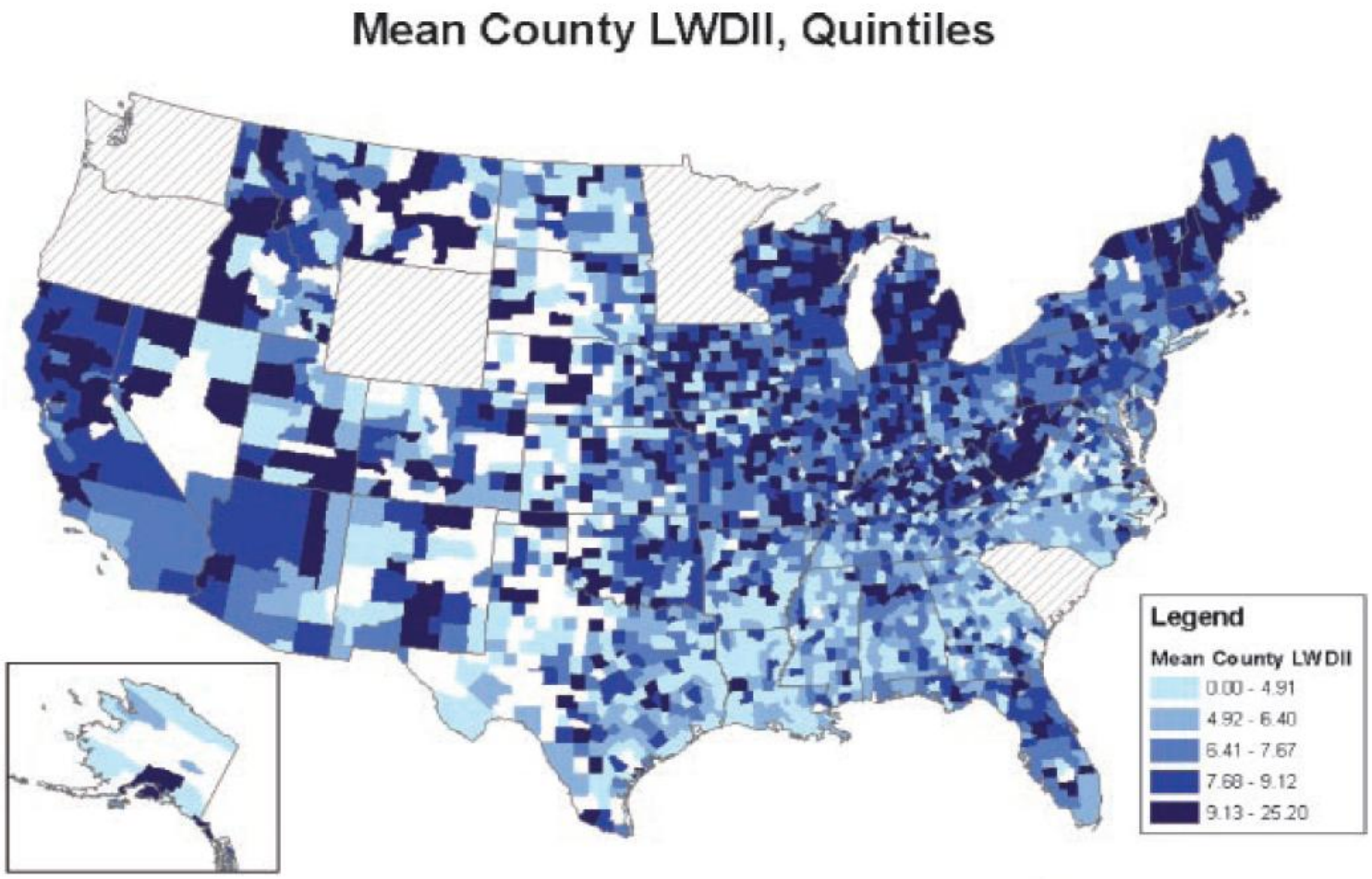
Sources: AWCBC, 2010; Gilks and Logan, 2010; Mustard et al, 2003; Osberg and Sharpe, 2004

Claim rates among 16/17 yr olds by town of residence in MA

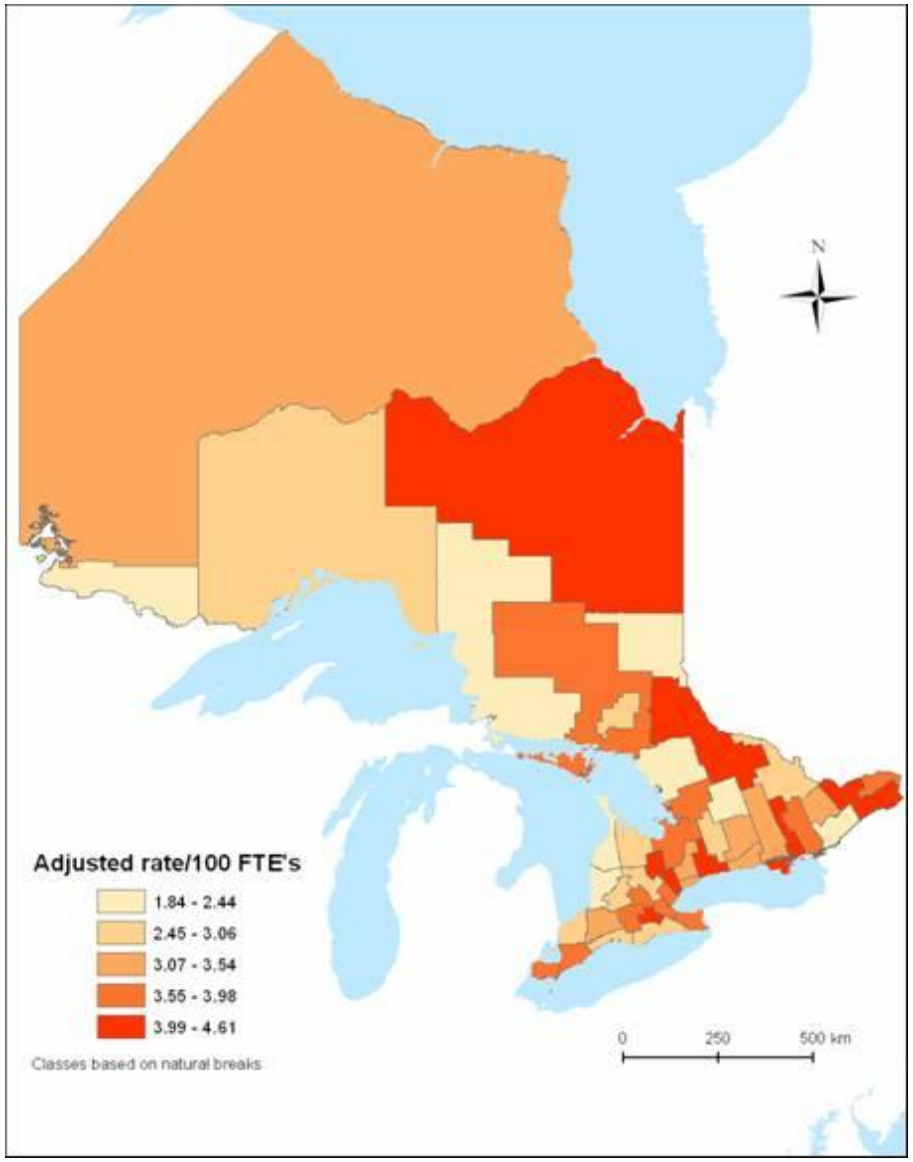


Source: Brooks & Davis, 1996

Lost workday Injury/Illness rate, OSHA survey 1997-2001



LT claim rates per 100 Full-time equivalents by census division among 15 to 24 year old workers adjusted for gender and occupation

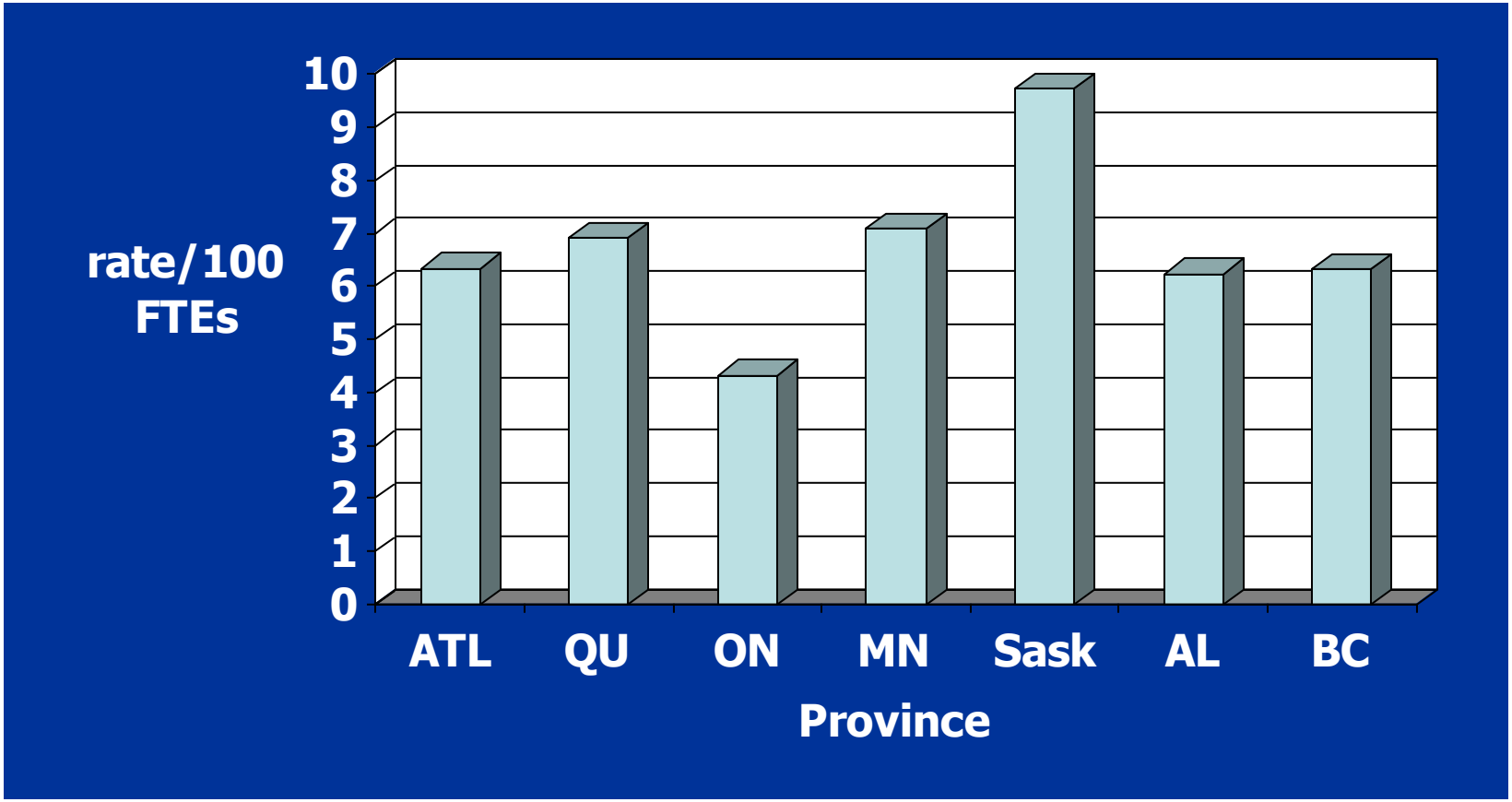


Regional correlates of CD claim rates

- **Regional correlates of claims**
  - Residential stability inversely associated w/ CD claim rates
  - % of small workplaces inversely associated w/ CD claim rates

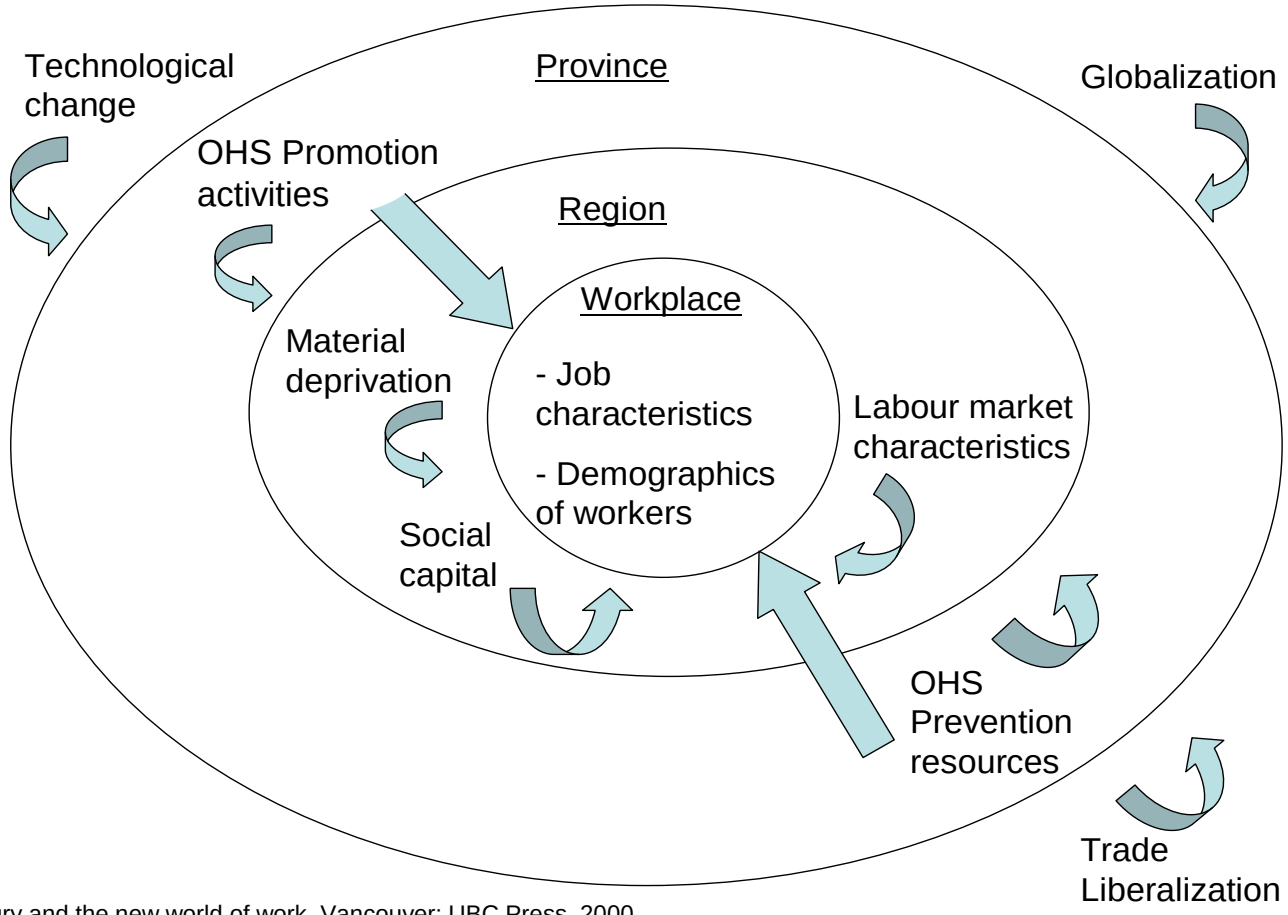
- **Types of injuries**
  - Regions with the lowest claim rates had proportionally fewer cuts and burns than high claim rate regions

Rate of work injuries varies by province for teens/young adults



Source: Canadian Community Health Survey (2000)

Framework for geographic variation in work injuries



T Sullivan. Injury and the new world of work, Vancouver: UBC Press, 2000

How can geographic variation in work injuries occur?

1. *Regions having different composition of workers and industries* *(Diez-Roux, 1998)*

   Examples: Proportion of new workers; different types of jobs or industries

2. *Influence of contextual factors* *(Pampalon and Raymond, 2000)*

   Examples: OHS legislation; or physical, social, and economic aspects of a geographic area -> area-level material and social deprivation

Methodological Gaps

- Ecological fallacy
  - Association with region-level data does not mirror relationship in worker-level data
- Different provincial claim definitions and reporting practices
- Estimating no. of workers at risk for injury
- Statistical techniques to model multiple levels of influence

Study objective

- To examine provincial variation in work injuries among Canadian workers and whether individual and area-level factors are associated with variation

Statistics Canada, 2012

Methods: Data and sample

- Canadian Community Health Survey (2003 & 2005)
  - Multi-staged, stratified random sampling of household residents in Canada
  - Overall person-level response rate: 92% across both cycles
  - Analytic sample was restricted to respondents aged 15-75 who reported working for pay in previous 12 months (89,541 respondents; 53% of total)

Methods: Predictors in multilevel analysis

- Level 1: Individual-level predictors, i.e. respondent
  - Sociodemographic characteristics (e.g. gender, age, education)
  - Work characteristics (e.g. work hours, industry, work stress)

Background characteristics of Canadian workers by frequency and percentage of work injuries

Variables	Sample Distribution, *n* (%)	Work Injury, *n* (%)
Gender		
Female	41,853 (46.7)	878 (2.1)
Male	47,688 (53.3)	2390 (5.0)
Age group (y)		
<25	17,076 (19.1)	635 (3.7)
25–34	18,459 (20.6)	808 (4.4)
35–44	23,219 (25.9)	863 (3.7)
45–54	19,505 (21.8)	666 (3.4)
55+	11,282 (12.6)	296 (2.6)
Marital status		
Married, cohabiting	55,671 (62.2)	2007 (3.6)
Single, widowed, divorced	33,870 (37.8)	1261 (3.7)
Education		
Less than secondary school	12,928 (14.5)	637 (4.9)
Secondary school graduate	17,013 (19.0)	642 (3.8)
Other postsecondary school	8268 (9.2)	318 (3.9)
Postsecondary school graduate	51,332 (57.3)	1670 (3.3)
Minority status		
White	75,681 (84.5)	2932 (3.9)
Other	13,860 (15.5)	336 (2.4)
Immigrant status		
Immigrated to Canada <5 y	1996 (2.2)	52 (2.6)
Immigrated to Canada ≥5 y	15,325 (17.1)	407 (2.7)
Canadian-born	72,220 (80.7)	2809 (3.9)
Population density		
Rural, suburban	16,412 (18.3)	700 (4.3)
Urban	73,128 (81.7)	2568 (3.5)
Ability to converse in English or French		
Yes	88,643 (99.0)	3238 (3.7)
No	898 (1.0)	30 (3.4)

Variables	Sample Distribution, *n* (%)	Work Injury, *n* (%)
Work status		
Full-time	16,161 (82.0)	321 (2.0)
Part-time	73,380 (18.0)	2947 (4.0)
Weeks worked (wk)		
0–26	11,484 (12.8)	292 (2.5)
27–51	15,767 (17.6)	689 (4.4)
≥52	62,290 (69.6)	2287 (3.7)
Work stress		
Low	24,440 (27.3)	792 (3.2)
Medium	37,523 (41.9)	1306 (3.5)
High	27,578 (30.8)	1170 (4.2)
Self-employed		
Yes	14,048 (15.7)	440 (3.1)
No	75,492 (84.3)	2828 (3.8)
Occupation type		
Manual	28,547 (31.9)	1917 (6.7)
Mixed	20,042 (22.4)	678 (3.4)
Nonmanual	40,953 (45.7)	674 (1.7)
Industry		
Agriculture, forestry, mining, utilities	4509 (5.0)	264 (5.9)
Wholesale, transportation, warehousing	7255 (8.1)	314 (4.3)
Finance, real estate, professional, management	11,409 (12.7)	127 (1.1)
Arts, entertainment, accommodation, food service	10,709 (12.0)	355 (3.3)
Administration and support, public administration	12,049 (13.5)	396 (3.3)
Educational services	6433 (7.2)	126 (2.0)
Health care and social assistance	9303 (10.4)	253 (2.7)
Retail trade	10,822 (12.1)	357 (3.3)
Construction	5403 (6.0)	382 (7.1)
Manufacturing	11,649 (13.0)	694 (6.0)

Methods: Predictors in multilevel analysis

- Level 2: Area-level predictors reflecting socioeconomic status, labour market, and workplace features of the area
- Predictors at census division-level
- Sources: 2001 Canadian Census, 2003, 2005 SLID, and 2003, 2005 CCHS
- 12 indicators of area-level material and social deprivation based on previous Canadian studies *(Pampalon and Raymond, 2000; Frohlich and Mustard, 1996)*
- To reduce number of predictor variables and avoid collinearity: principal components analysis was performed which revealed three factor scores that were used as predictors
- Province of residence was included as dummy-coded variable

Principal components analysis with three factors as area-level predictors of material and social deprivation

Variables*	Factor 1	Factor 2	Factor 3
% Movers in past 5 years (residential stability)	**.92**		
% Rent/mortgage > 30% of salary	**.80**	.36	
Average household income	**.69**		
% Residents with less than high school education	**-.73**		
Unemployment rate		**.84**	
Unemployed for more than 26 weeks		**.75**	
% Residents who are lone parents	.38	**.74**	
% Residents with permanent jobs		**-.66**	
Employed in workplaces with less than 100 employees			**.82**
Employed in firms with less than 100 employees			**.76**
% Residents with weak sense of community belonging			**-.48**
% Residents part of union or collective agreement	**-.43**		**-.85**

*Variables are at the census-division level and are based on previous Canadian studies of material and social deprivation.
Variance explained by all three factors = 67%.
Bolding indicates loading of > 0.4 in absolute value.

Methods: Predictors in multilevel analysis

- Level 2: Area-level predictors, i.e. at census division
  - Factor 1 appeared to reflect socioeconomic status of the area, e.g. regions with higher costs of living, highly educated workers, white collar or service jobs, better OHS resources
  - Factor 2 appeared to reflect status of labour market in the area, e.g. regions with higher and more chronic unemployment, more single parent families, fewer careers, or little economic growth
  - Factor 3 appeared to reflect characteristics of workplaces in the area, e.g. regions with more small businesses, greater social cohesion, and fewer unions

Methods: Outcome variable

- Outcome variable: Self-reported medically-attended work injury
- Respondents were asked:
  - If they had been injured in the previous 12 months seriously enough to limit their normal activities?
  - Where did that injury occur? (selected response: workplace)
  - If they had received medical attention?
- Excludes RSI injuries

Analysis

- Multilevel logistic regression was used because data are spatially nested, i.e. unit of observation is individual (level 1) nested within province (level 2)
  - Model was created using MLwiN to calculate odds ratio of work injury
  - Model was fitted using a Markov chain Monte Carlo estimation method
- A random effect term was included at level 2 to account for spatial dependence (e.g. a geographic area being correlated with neighboring areas because of unobserved environmental conditions)

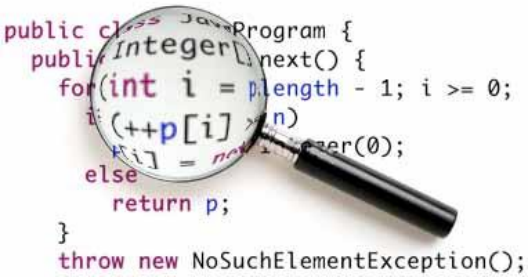


Table 1: Sociodemographic characteristics associated with work injury*†

Variable	Coefficient	AOR	95% CI
Gender			
Female	-0.52	0.60	0.55 - 0.65
Male	ref		
Age group			
< 25	0.25	1.28	1.11 - 1.48
25-34	0.39	1.47	1.30 - 1.67
35-44	0.30	1.34	1.19 - 1.52
45-54	0.18	1.20	1.06 - 1.36
55+	ref		
Minority status			
White	ref		
Other	-0.16	0.85	0.74 - 0.98
Immigrant status			
Immigrated to <5 years	-0.49	0.61	0.40 - 0.93
Immigrated to >= 5 years	-0.21	0.81	0.70 - 0.94
Canadian-born	ref		

AOR = adjusted odds ratio; CI = confidence interval.
* Model is adjusted for all other variables
† Showing significant relationships only

Table 2: Work characteristics associated with work injury*

Variable	Coefficient	AOR	95% CI
Work status			
Full-time	ref		
Part-time	-0.44	0.64	0.57 - 0.73
Weeks worked			
0-26 weeks	-0.41	0.67	0.59 - 0.75
27-51 weeks	0.13	1.13	1.04 - 1.24
>= 52 weeks	ref		
Work stress			
Low	ref		
Medium	0.18	1.19	1.09 - 1.31
High	0.52	1.68	1.53 - 1.84
Self employed			
Yes	-0.14	0.87	0.78 - 0.97
No	ref		
Occupation type			
Non-manual	ref		
Mixed	0.59	1.80	1.61 - 2.02
Manual	1.12	3.06	2.76 - 3.41
Industry			
Agriculture/forestry/mining/utilities	-0.09	0.92	0.78 - 1.08
Wholesale/transportation/warehousing	-0.01	0.99	0.84 - 1.16
Finance/real estate/professional/mgment	-0.67	0.51	0.41 - 0.63
Arts/entertainment/accommodation/food	-0.11	0.90	0.77 - 1.05
Administration	-0.15	0.86	0.74 - 1.00
Educational services	-0.22	0.81	0.65 - 0.99
Health care and social assistance	-0.19	0.83	0.70 - 0.98
Construction	0.14	1.15	0.98 - 1.35
Manufacturing	-0.04	0.96	0.83 - 1.11
Retail trade	ref		

AOR = adjusted odds ratio; CI = confidence interval.
* Model is adjusted for all other variables

Results: Sociodemographic & work characteristics associated with work injury*

Sociodemographic factors	Significant findings
Gender	Men had higher risk than women
Age	Respondents <54 years old had higher risk than those 55+ (*25-34 had highest risk)
Minority status	White respondents had higher risk than visible minorities
Immigrant status	Canadian-born respondents had higher risk than immigrants to Canada

Work characteristics	Significant findings
Work status	Full-time workers had higher risk than part-time workers
Work stress	Those with high & medium work stress had higher risk than those with low work stress
Self-employment	Self-employed respondents had higher risk than non-self employed
Physical demand	Manual and mixed manual workers had higher risk than non-manual workers
Industry	Retail trade had highest risk than all other industries

*Results are from the fully adjusted model controlling for all other variables

Table 3: Material & social deprivation and province of residence associated with work injury*

Variable	Coefficient	AOR	95% CI
Material and social deprivation predictors†			
Factor 1	-0.02	0.98	0.96 - 1.00
Factor 2	0.01	1.01	0.99 - 1.02
Factor 3	-0.01	0.99	0.97 - 1.01
Province of residence			
NFLD/PEI/Nova Scotia/New Brunswick	-0.05	0.95	0.81 - 1.12
Quebec	0.06	1.06	0.92 - 1.22
Manitoba	0.05	1.05	0.87 - 1.26
Saskatchewan	0.26	1.30	1.09 - 1.55
Alberta	0.27	1.31	1.13 - 1.51
British Columbia	0.38	1.46	1.26 - 1.71
Ontario	ref		

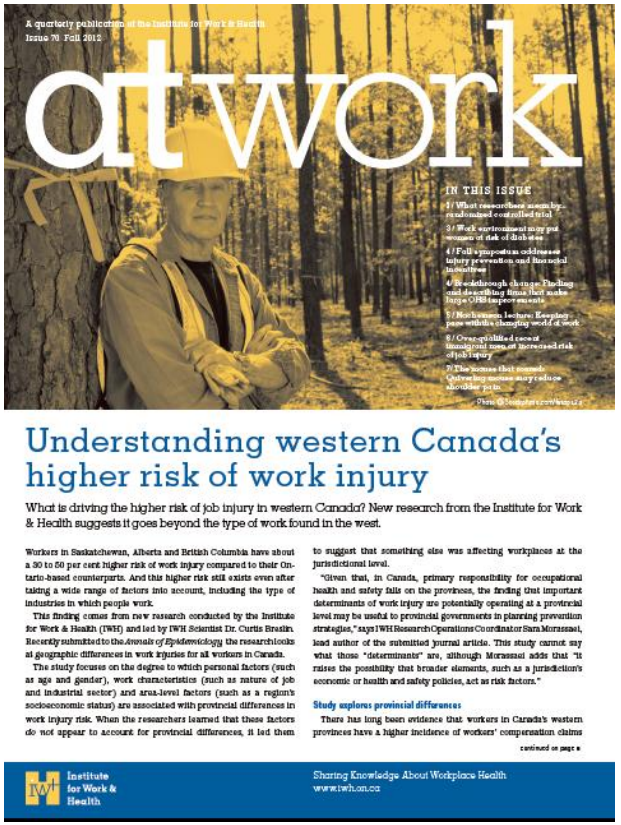
AOR = adjusted odds ratio; CI = confidence interval.

* Model is adjusted for all other variables

† Continuous variable with no reference group. The interpretation of the odds ratio is for one increase in factor.

Summary and conclusion

- Provincial differences in work injuries were found even after controlling for individual-level and area-level factors
- Workers in western provinces – Saskatchewan, Alberta, and British Columbia – had 30% to 46% higher risk of work injury compared with Ontario workers
- Findings suggest that broader factors may be acting as determinants of work injuries operating at a provincial level

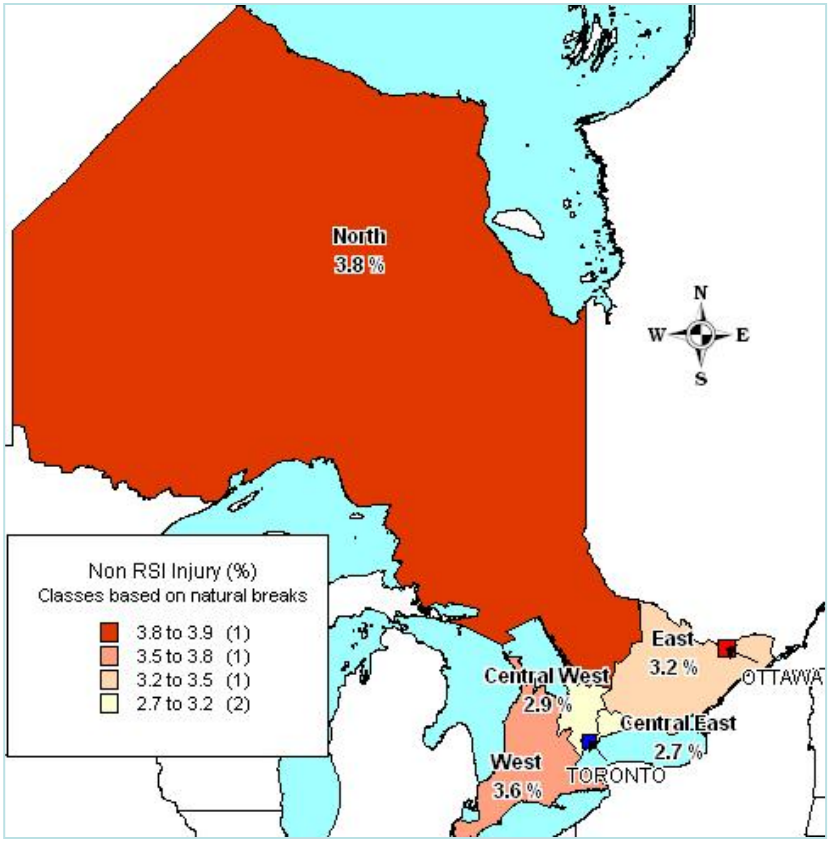


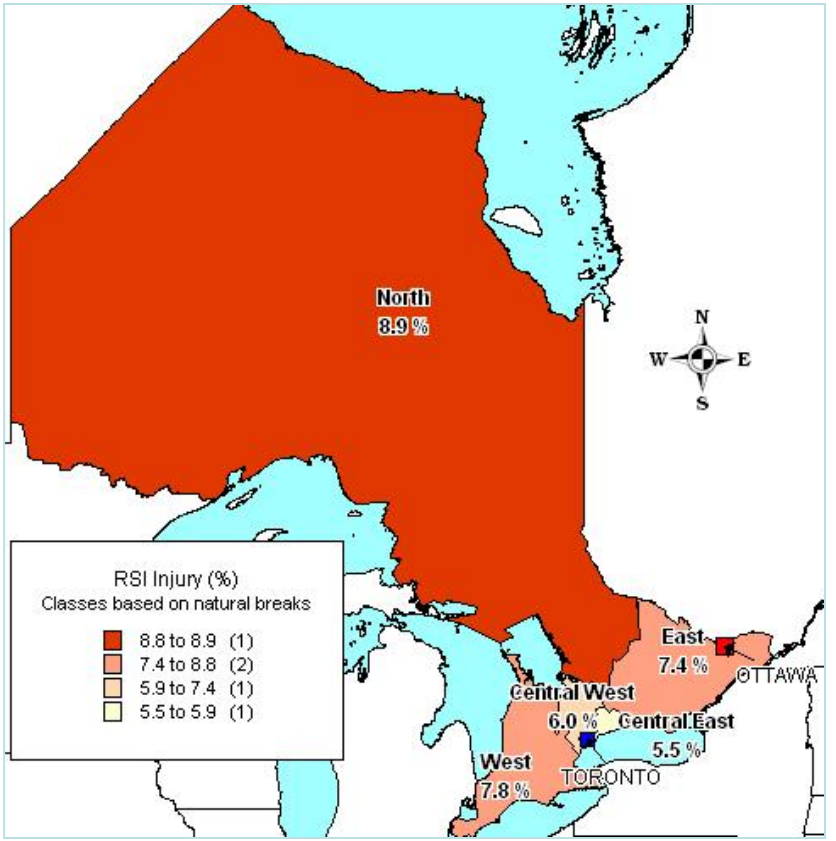
Significance of findings

- Benefits of examining and understanding provincial variation in work injury are significant :
  - Identify geographic “hot spots”
  - Planning prevention efforts that are tailored to needs of a region
  - Useful to provincial governments when planning jurisdictional policies/legislation

- Need for improved monitoring and surveillance at provincial level
- Need for jurisdictions to coordinate this work so that data between jurisdictions can be meaningfully compared

Preliminary map for manufacturing, service and agriculture industries





Future investigations

- Future research needs to identify provincial determinants driving work injuries and whether similar large area-level factors exist in other countries (e.g. at state-level in U.S.)
- Potential avenues of investigations: what could be driving these provincial differences?
  - Compliance and enforcement activities in British Columbia decreased steadily from 2001 until 2005, while Ontario was stable
  - Even broader economic trends, such as rapid economic growth at provincial level, e.g. proportion of new workers entering the workforce

Acknowledgements

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