ORIGINAL ARTICLE

Trial by fire: a multivariate examination of the relation between job tenure and work injuries

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Aims: This study examined the relation between months on the job and lost-time claim rates, with a particular focus on age related differences.
Methods: Workers' compensation records and labour force survey data were used to compute claim rates per 1000 full time equivalents. To adjust for potential confounding, multivariate analyses included age, sex, occupation, and industry, as well job tenure as predictors of claim rates.
Results: At any age, the claim rates decline as time on the job increases. For example, workers in the first month on the job were over four times more likely to have a lost-time claim than workers with over one year in their current job. The job tenure injury associations were stronger among males, the goods industry, manual occupations, and older adult workers.
Conclusions: The present results suggest that all worker subgroups examined show increased risk when new on the job. Recommendations for improving this situation include earlier training, starting workers in low hazard conditions, reducing job turnover rates in firms, and improved monitoring of hazard exposures that new workers encounter.

For nearly a century, studies have consistently shown that newly hired workers are more likely to be injured than those with longer job tenures.[1–7] For example in 1917 a steel company reported that the injury rate among employees with less than 30 days' experience was 12 times higher than the company average.[7]

Even though the increased risk of new workers has always been a concern, recent structural changes in labour markets have heightened these concerns. For example, in developed countries the proportion of 16–19 year olds employed in temporary jobs increased from 31.1% to 42.2% between 1983 and 1994, an increase not matched by any other age group.[10] With more workers moving from job to job,[8 9] it is increasingly important to accurately estimate the relation between risk of work injury and time on the job (that is, job tenure). The present study examines the relation between job tenure and work injuries, with an emphasis on age related differences.

Complicating the estimation of the job tenure and injury association, several demographic and work related characteristics could confound the job tenure/injury association. Inexperience and age are highly correlated.[3 6] Root and Hoefer also noted that manual labourers had the lowest average age and the highest percentage of workers injured in the first year of work, suggesting potential confounding of age, occupation, and job tenure.[6] In addition, women are more likely to work in temporary jobs than men.[11] One large US survey showed an inverse relation between job tenure and self reported work injury among ''blue collar'' workers, even after controlling for demographic variables such as age and sex.[4]

The strength and direction of the job tenure/injury association may also differ in certain subgroups, a phenomenon referred to as effect modification.[12] New male workers appear to be an especially high risk group compared with new female workers.[3] Using workers' compensation claims from three US states, Root and Hoefer reported that the construction industry, compared with all other industries, had the highest proportion of workers injured in the first three months on the job.[6] For occupations, manual labourers had the highest proportion of workers injured in the first three months, and managers the lowest proportion of new workers injured.[6]

Using workers' compensation data, the primary goal of this study was to examine the relation between job tenure and claim rates. Specifically, we sought to estimate the degree of risk of work injury associated with being new on the job after adjusting for potential confounders such as age, sex, industry, and occupation. We also examined the extent to which these factors modified the job tenure/injury association.

METHODS

This study used claims data from the Ontario Workplace Safety and Insurance Board (WSIB) in the year 2000. The WSIB is the principal provider of workers compensation in Ontario and covers approximately 65% to 70% of labour force participants.[13] The remaining 30% to 35% not covered included those self employed, domestic workers, federal government workers, the majority of the finance industry, and workers associated with interprovincial commerce. Ethics approval was obtained from the University of Toronto.

Description of lost-time claims

The WSIB requires lost-time claims to be submitted for any injury occurring during paid employment that results in: (a) an absence from regular work past the day of the accident, (b) loss of wages/earnings, or (c) a permanent disability/impairment. Lost-time claim records also contain the following sociodemographic and work related information:

Age and sex

Age at the time of the injury was computed based on the employee's date of birth which was provided in the claim record. Sex of the worker was obtained from each claim record.

Job tenure

As part of filing a claim, employers complete a form which includes both the employee date of hire and the accident

Table 1 Incidence and relative risk for first time and all-claim rates

Variable	First-time claims					All claims						
	Rate/1000 FTE	Lost-time claims		Relative risk	95% CI	Rate/1000 FTE	Lost-time claims		Relative risk	95% CI	FTE	Persons
Sex												
Male	13.49	26047	66.6%	1.19	(1.16–1.21)	25.21	48669	71.4%	1.49	(1.47–1.51)	1930694	1913271
Female*	11.35	13066	33.4%	1.00		16.92	19472	28.6%	1.00		1150789	1336045
Age group (years)												
15–19	25.16	3489	8.9%	2.56	(2.46–2.66)	27.04	3749	5.5%	1.36	(1.31–1.40)	138662	259030
20–24	20.76	6306	16.1%	2.11	(2.05–2.18)	26.54	8060	11.8%	1.33	(1.30–1.37)	303748	349144
25–34	12.71	10164	26.0%	1.29	(1.26–1.33)	22.11	17685	26.0%	1.11	(1.09–1.13)	799978	795721
35–44	10.99	10205	26.1%	1.12	(1.09–1.15)	22.07	20492	30.1%	1.11	(1.08–1.13)	928631	923672
45+*	9.83	8949	22.9%	1.00		19.94	18155	26.6%	1.00		910465	921749
Occupation												
Manual	20.84	28390	72.6%	7.98	(7.67–8.29)	36.99	50379	73.9%	10.07	(9.75–10.41)	1362117	1410205
Mixed	12.13	7941	20.3%	4.64	(4.44–4.84)	21.15	13853	20.3%	5.76	(5.56–5.97)	654864	736741
Non-manual*	2.61	2782	7.1%	1.00		3.67	3909	5.7%	1.00		1064502	1102369
Industry												
Goods	14.76	20892	53.4%	1.35	(1.32–1.38)	27.06	38305	56.2%	1.51	(1.49–1.53)	1415718	1366390
Services*	10.94	18221	46.6%	1.00		17.91	29836	43.8%	1.00		1665765	1882925
Job tenure (months)												
1	57.21	2859	7.3%	6.14	(5.90–6.38)	78.52	3924	5.8%	4.23	(4.09–4.37)	49974	61586
2	28.29	2304	5.9%	3.04	(2.91–3.17)	38.71	3152	4.6%	2.09	(2.01–2.16)	81433	96760
3–4	23.69	3556	9.1%	2.54	(2.45–2.63)	32.70	4908	7.2%	1.76	(1.71–1.81)	150083	174720
5–8	20.88	4731	12.1%	2.24	(2.17–2.31)	29.76	6745	9.9%	1.60	(1.56–1.65)	226609	263104
9–12	19.40	3227	8.3%	2.08	(2.01–2.16)	28.46	4735	6.9%	1.53	(1.49–1.58)	166359	192305
13+*	9.32	22436	57.4%	1.00		18.56	44677	65.6%	1.00		2407025	2460841

*Indicates reference group for relative risk calculations.
FTE, full time equivalents.

date. Job tenure was calculated as the number of months between these two dates.

Industrial sector

Each lost-time claim contains information on the industry in which each claimant's workplace operates and is coded to correspond to the Standard Industrial Classification 1980.[14] Workplaces were grouped into two categories: goods and services. Goods industries included agriculture, forestry, fishing, mining, oil, utilities, construction, and manufacturing. Service industries included trade, management, administrative, accommodation, food and beverage, public administration, health care, social services, education, professional, science, and technical. Collapsing into two industrial groups was necessary to ensure that the claim numerators matched denominators estimated from the Canadian Labour Force Survey (see Statistical methods).

Occupation

The physical demands of work tasks were classified using a system developed by Institut de recherche Robert-Sauvé en santé et en sécurité du travail.[15] This classification system groups standard occupational codes into three categories of physical demands: manual, mixed, non-manual. This classification system was developed using a mixture of observation of occupations and agreement among experts in the occupational health and safety field. Manual occupations included: (a) the handling of heavy or average loads on a regular basis; (b) the handling of lighter loads in static postures; or (c) continuous repetitive work. Mixed occupations included: (a) the handling of heavy or average loads on only an occasional basis; or (b) the handling of light loads, but not in continuous static postures. Non-manual occupations rarely involve the handling of loads or physical activity. As with industrial sector, this aggregation was necessary to ensure that the claim numerators matched the denominators.

Type of event

Each lost-time claim reported to the WSIB contains information on the type of event leading to the injury.

Table 2 Regression model with adjusted rate ratios for first time claim rates

Variable	Fully adjusted negative binominal model	
	Relative risk	95% CI
Sex		
Female*	1.00	
Male	1.04	(0.96–1.13)
Age group (years)		
15–19	1.28	(1.12–1.47)
20–24	1.11	(0.97–1.25)
25–34	1.05	(0.92–1.18)
35–44	1.09	(0.96–1.24)
45+*	1.00	
Occupation		
Manual	8.73	(7.84–9.73)
Mixed	4.23	(3.79–4.73)
Non-manual*	1.00	
Industry		
Services*	1.00	
Goods	0.86	(0.79–0.94)
Job tenure (months)		
1	4.08	(3.55–4.68)
2	2.15	(1.87–2.47)
3−4	1.93	(1.69–2.21)
5−8	1.73	(1.52–1.97)
9−12	1.68	(1.47–1.92)
13+*	1.00	

Injuries were grouped into six different categories based on a national classification system:[16] bodily reaction or exertion, repetitive motion, contact with objects or equipment, falls, exposure to harmful substances/environments, and other events or exposures (for example, transportation accidents, fires and explosions, assaults, and violent acts). The first two injury events are usually associated with more chronic injury processes (for example, soft tissue injuries) while the other events are considered as having more of an acute onset.

Excluding workers with previous claims

In workers' compensation systems, it is not uncommon for claimants to have multiple claims over time.[17] To rule out the possibility that a previous injury might increase one's susceptibility for reinjury at a new job, we focused our multivariate analyses on only those workers whose claim in 2000 was their first claim recorded in the workers' compensation database (n = 61 404 claims, 61% of all lost-time claims in 2000). This database includes lost-time claims starting in 1990, so all ''first-time'' claimants had at least a 10 year period where no claim was recorded.

Analyses of missing claim information

Of the 61 404 first-time claims, 6988 (11%) were missing industry information and 10 021 (16%) worked in industrial subsectors without mandatory claim reporting procedures, which meant that claim rate denominators could not be calculated for these industrial subgroups. Of these 44 395 lost-time claims from companies with mandatory insurance coverage, 34 were missing information on age of the worker, 2763 (6%) were missing information on occupation, and an additional 2487 injury reports (6%) were missing information on job tenure, leaving a sample of injury reports with complete information of 39 113.

With regards to the key variable of job tenure, logistic regressions showed that younger claimants (15–19 years, and 20–24 years) were more likely to be missing information on job tenure than claimants over the age of 45 years (odds ratios (ORs) = 1.18, 1.32, respectively). Male claimants were more likely to be missing job tenure information than female claimants (OR = 1.32). Claimants in the goods industry were less likely to be missing tenure information than claimants in the goods industries (OR = 1.34). A similar pattern of missing data led to the final number of ''all claims'' to be 68 141.

Statistical methods

Due to the group level nature of the data, each unique combination of independent variables (that is, age, sex, industry, occupation, job tenure) had a corresponding number of ''events'' (that is, number of claims) and number of full time equivalents that that were used to calculate claim rates.

Estimates of the number of workers and work hours for each subgroup (that is, denominators for claim rates) were derived from the Canadian Labour Force Survey Public Use Files.[18] Further details on the methodology for estimating denominators for the insured Ontario workforce can be found in our previous work.[19 20]

The relative contribution of sociodemographic and work related factors in predicting claims rates were initially modeled assuming a Poisson distribution. Examination of the goodness-of-fit statistics from the Poisson model suggested the poor model fit (deviance/degrees of freedom = 8.44, with a value around one representing adequate model fit). We then used a negative binominal model, which can be viewed as special case of the Poisson distribution in that it includes a random component that reflects the heterogeneity in the true rates of injury.[21] The goodness-of-fit statistics of the negative binomial model indicated a good fit (deviance/degrees of freedom in = 1.20).

Following analytic procedures outlined by Bailer and colleagues,[12] we examined whether the tenure/claim associations were stronger for some worker subgroups by conducting a series of separate regressions on each level of an explanatory variable (for example, a tenure/claim estimate for each sex), adjusted for all other confounding variables. The degree of effect modification was statistically evaluated by comparing coefficients for the risk in the first month of work (relative to 13 or more months of work) across levels of each variable using a χ^2 statistic described by Allison.[22]

RESULTS

Descriptive statistics

All predictors, except for age and job tenure, showed stronger associations with all lost-time claim rates than with first-time claim rates (see table 1). This pattern suggests that workers with previous claims tended to be from older age groups, manual occupations, and goods industries. In addition, workers with previous claims tended to be over-represented in the longer job tenure categories (that is, weaker tenure/claim association among all claims than first-time claims). This suggests that the increased risk in the first few months of first time or all claims was not due to increased vulnerability of previously injured workers changing jobs and then getting re-injured soon after.

Multivariate analyses

The multivariate analysis of first-time claim rates had sex, age, occupation type, industry, and job tenure entered simultaneously as predictors (see table 2). Both sex and industrial sector showed evidence of confounding, with the previously observed increased risk of males and the goods industry being eliminated in the fully adjusted model.

The increased risk for young workers was also reduced. Whereas the unadjusted rates showed that 15–19 year olds had 2.67 times the claim rate of the oldest age group, this changed to 1.28 times the reference rate in the adjusted model. The increased risk of 20–24 year olds was reduced to non-significance in the fully adjusted model.

In the adjusted model, working in manual occupations and short job tenure continued to be strong predictors of lost-time claim rates. The similar strength of association for both

Table 3 Regression models with adjusted* rate ratios (95% CIs) for first-time claim rates by injury event and job tenure

		Relative risk of injury by job tenure category					
	Total claims	1 month	2 months	3–4 months	5–8 months	9–12 months	13+ months
Contact with objects or equipment	13074	5.56 (4.67–6.63)	2.83 (2.36–3.38)	2.42 (2.04–2.87)	2.07 (1.76–2.45)	1.86 (1.56–2.21)	1.00
Falls	6186	6.36 (5.44–7.42)	2.97 (2.25–3.50)	2.63 (2.26–3.05)	2.04 (1.76–2.36)	1.91 (1.64–2.23)	1.00
Bodily reaction or exertion	14067	2.93 (2.48–3.46)	1.73 (1.47–2.05)	1.60 (1.37–1.87)	1.56 (1.34–1.81)	1.70 (1.46–1.98)	1.00
Repetative motions	2252	1.58 (1.12–2.23)	1.08 (0.78–1.51)	1.17 (0.89–1.54)	1.30 (1.02–1.66)	1.43 (1.10–1.84)	1.00
Exposure to harmful substances/environments	2116	5.28 (4.16–6.69)	2.39 (1.86–3.08)	2.09 (1.66–2.63)	1.88 (1.51–2.33)	1.45 (1.13–1.85)	1.00
Other events or exposures	1418	4.99 (3.89–6.39)	2.30 (1.75–3.02)	2.05 (1.63–2.59)	2.07 (1.69–2.55)	1.50 (1.17–1.93)	1.00

*Adjusted for age, sex, industry, and occupation.

Table 4 Regression models for first-time claim rates with adjusted* rate ratios, 95% CIs, and tests for differences in effect of job tenure between subgroups

	Estimate for tenure = 1 month					
Variable	**RR**	**95% CI**	**β**	**SE**	**χ^2 for diff**	**p Value**
Sex						
Male	4.95	(4.21–5.82)	1.600	0.082	10.59	0.001
Female*	3.30	(2.73–3.98)	1.193	0.096		
Age group (years)						
15–19	3.00	(2.52–3.57)	1.100	0.089	8.50	0.004
20–24	2.84	(2.14–3.77)	1.043	0.145	7.23	0.007
25–34	5.06	(3.95–6.49)	1.622	0.126	0.03	0.857
35–44	5.46	(4.13–7.20)	1.697	0.142	0.29	0.588
45+*	4.89	(3.70–6.47)	1.588	0.142		
Occupation						
Manual	4.92	(4.33–5.58)	1.593	0.065	11.36	0.001
Mixed	3.68	(2.98–4.54)	1.302	0.108	1.91	0.167
Non-manual*	2.85	(2.14–3.81)	1.049	0.148		
Industry						
Goods	5.59	(4.71–6.64)	1.721	0.088	15.26	<0.001
Services*	3.24	(2.79–3.76)	1.175	0.076		

*Adjusted for all other covariates.

factors across the unadjusted and adjusted models suggests that their relation with lost-time claim rates is not confounded by the other variables included in these models.

Effect of job tenure by injury event

Table 3 shows the tenure/claim associations by the type of event that led to the injury. As would be expected, more acute injury processes such as contact with objects/equipment, falls, and exposure to harmful substances showed particularly increased risk for workers in their first month (rate ratio (RR) = 5.56, 6.36, and 5.28, respectively) than more chronic injury processes such as repetitive motion (RR = 1.58).

Modifying the effect of job tenure

To investigate the degree to which the effect of job tenure differed among subgroups of workers, we estimated a series of negative binomial models and examined in particular the rate ratio between the first month and 13+ month job tenure groups (see table 4). The separate regressions for men and women exhibited significant increase in first month claims rates (RR = 4.95 and 3.30, respectively). Further, the increased risk in the first month was significantly higher among men than women ($\chi^2 = 10.59$, $p<0.001$).

All occupations showed a marked elevation in the newest compared to the most experienced workers, with manual jobs having the highest first month increases ($\chi^2 = 11.36$, $p<0.001$). Both industries showed marked first month increases from the first to the 13+ month groups, with the goods producing sector showing a significantly higher first month increases ($\chi^2 = 15.26$, $p<0.001$).

With regard to age, all age groups exhibited a significant first month increase in claim rates. However, the degree of first month risk for 15–19 year olds ($\chi^2 = 8.50$, $p<0.001$) and 20−24 year olds ($\chi^2 = 7.23$, $p<0.001$) was significantly different than for older age groups. To further examine this modifying effect of age, we calculated claim rates per 100 full time equivalents by age and job tenure groups, using direct standardisation techniques described by Hennekens and Buring.[23] Figure 1 shows that adults 25 years and older show a greater risk for new workers than teenagers or young adults. This difference in the tenure/claim association by age group noted in table 4 was due to the most experienced adult workers having lower claim rates than the most experienced young workers, as well as new young workers having lower claim rates than older workers in their first or second month.

DISCUSSION

The vulnerability of newly hired workers was demonstrated in our finding that unadjusted claim rates for workers in their first month of a job were four to six times higher than those with more than one year on the job. The present study makes two important contributions to understanding the relation between job tenure and work injury. Firstly, our analyses showed a strong inverse association between job tenure and claim rates beyond any potential confounding due to sex, age, industry, and occupation.

Secondly, part of the increased injury risk of young workers was accounted for by job tenure. Although job inexperience is often cited as a risk factor for young workers,[24] this is one of the first studies to quantify job tenure's contribution relative to other known risk factors such as occupation. In addition, our examination of effect modification provided additional nuances to the observation that being new on the job is a risk factor regardless of age. We observed that increased risk for new workers was more pronounced among older workers compared with their younger counterparts.

With regard to aetiological processes underlying these patterns, the general effect of job tenure across age groups is consistent with research showing increased injury risk when workers perform new or unusual tasks.[25] The increased risk

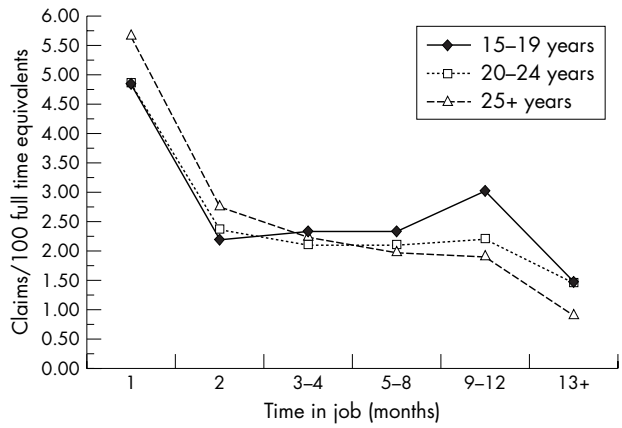

Figure 1 First-time claim rates per 100 full time equivalents by age and job tenure adjusting for occupation, industry, and sex.

for all new workers could also reflect differential exposure to more hazardous conditions than their more experienced counterparts in the same job. Preliminary evidence of such a phenomenon comes from focus group research on young workers who mention that more senior workers assign them more hazardous work.[26] The relative contribution of these two processes—task familiarisation/training and shifts in hazardous work—would be a fruitful avenue for future research.

Returning to the finding that older workers showed a stronger job tenure/injury association than young workers, perhaps the most experienced adults are exposed to fewer hazardous conditions and/or are better at identifying and controlling hazards compared with the most experienced young workers in the same occupation. For the least experienced older workers, their increased risk may reflect an inappropriate assumption that they can already handle hazardous conditions because of their previous work experience.

Even though the effect of job tenure differed by age, this effect modification was modest and was statistically significant partly due to the large sample sizes. Indeed, it was striking how quickly the claim rates dropped as young workers gained experience on the job. This pattern is consistent with the notion that cognitive development factors (for example, perceived invulnerability) are not the predominant reason that adolescent and young adult workers are at increased injury risk. If such development factors were a persistent and predominant factor, we would have expected to see their elevated risk continue even as they gained experience. Although there are slight increases of risk for young workers in some job tenure categories in figure 1, the general trend is for young workers to adapt as quickly as their adult counterparts.

Interpretations of our findings must be made in light of study limitations. The cross sectional nature of the data means that other job characteristics (for example, temporary jobs are more hazardous) and selection processes (for example, low socioeconomic status predisposes people to short tenure jobs and injuries) may still affect our estimates of the job tenure/injury association.

Another limitation is that the occupation and industry categories were kept broad to ensure that the claims (numerators) could be accurately matched to the workforce estimates (denominators). More refined occupational groupings, especially ones that reflect hazard exposures,[27] would improve the assessment of this potential confounder of the tenure/claim association. However, the tenure/claim association appeared to be quite independent of this potential confounder. In our multivariate analyses, occupation was the strongest predictor of claim rates, yet only had a minimal impact on the tenure claim association.

There may have also been some misspecification in defining what was a new job in both the claim records (that is, numerator) and the labour force estimates (that is, denominator). Between the date of hire and the date of injury, some workers may have had sufficient changes in job tasks or title to constitute a ''new job'' in the same employment term within a company. This type of misspecification of job tenure, however, would lead to an underestimate of the influence of job tenure, because workers with job changes within a firm would presumably have a higher risk of injury (due to the unfamiliarity with new tasks), but would be counted among the more experienced workers. Clearly, more detailed descriptions of job tasks and hazards over time would be important for future research.

Our results highlight the need to develop more effective safety management systems for new workers, and create greater awareness among supervisors and employers of this high risk period. To the extent that the initial risk of new workers is due to changes in hazard exposure, employers and equipment/machine manufacturers should not overlook opportunities to eliminate hazards.

In addition, job turnover becomes a potential health and safety issue if frequent job changing continually puts a worker in the ''high risk'' period. Some company practices can reduce turnover rates[28] and, in turn, decrease the number of times a worker is ''new on the job''. This process would be particularly relevant to youth given that it is common early in one's work life to move from job to job.

The present findings also underscore the need for improved monitoring by employers and government regulators of the biochemical, physical, and psychosocial hazards to which new workers encounter. Further, the particularly strong job tenure/injury associations found among certain subgroups of workers (for example, manual occupations) suggest special attention to monitoring of hazards and injury prevention efforts in these areas. In summary, the present findings suggest that all worker subgroups examined show increased risk when new on the job. Recommendations for improving this situation include earlier training, starting workers in low hazard conditions, reducing job turnover rates in firms, and improved monitoring of the hazard exposures that new workers encounter.

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