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Project title: Work injuries among young people: A prospective study

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List of abbreviations

National Occupational Research Agenda (NORA)
Survey of Labour and Income Dynamics (SLID)
Work Disability Absence (WDA)
Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST)
CEGEP (a French acronym meaning College of General and Vocational Education)

Abstract

This study on young workers 16 to 24 years old had two aims:

1. To examine the relative contribution of individual and job characteristics to work-related disability risk among young workers.
2. To identify any earnings losses that young workers may experience in the year after a work related disability.

Aim #1: Antecedents of youth work-related disability

Issue addressed: This study examined the relative contribution of individual factors and job characteristics to the risk of lost days of work due to a work-related disability among Canadians 16 to 24 years old.

Approach: Our analyses used a representative sample of young workers from a longitudinal survey. Our regression analysis of work-related disability included the following predictors: age, gender, physical demands of the job (manual, non-manual, and mixed), hours worked, highest education achieved, multiple concurrent job, job tenure, school activity, and living in a rural or urban area.

Key findings: Young workers holding manual jobs were at increased risk for a work disability absence compared to young workers with non-manual jobs. Low education level was associated with the increased likelihood of a work disability absence. Other demographic factors such as gender were not independently associated with work disability absences.

Implications: This is the first longitudinal study on young workers that found that job characteristics are the predominant risk factors for work disability absences for young workers, and individual factors such as gender were not independently associated with the outcome. Young workers with less education appear to be particularly vulnerable, possibly due to inadequate job skills or particularly dangerous jobs.

Aim #2: Economic consequences of youth work-related disability

Issue addressed: Our primary objective in this part of the study was to evaluate the earnings losses that young workers may experience in the year after a work disability absence. Assessing the short-term economic losses of young people after a work injury would provide an indication of whether work injuries do influence the initial trajectory of one's work life.

Approach: Our sample consisted of workers aged 16 to 24 years from a longitudinal survey on a representative sample of Canadians. Young workers who lost 5+ days of work due to a work disability/illness (i.e., work disability absence) were matched to uninjured controls based on age, gender, pre-absence earnings, and student

status. This matching procedure resulted in 173 cases and 795 controls. The outcome measure was the difference between earnings in the year after the work disability episode and those of the uninjured controls.

Key findings: Our analyses indicated that injured young workers earned $1113.00 less than their uninjured controls, a statistically significant difference ($p < .05$). This earnings loss was not due to between-group differences in school activity or work hours in the year after the work absence.

Implications: This is the first study to estimate the impact of work-related disability on earnings losses among young workers. Our findings indicate that earnings losses beyond the immediate event can occur to young workers. This is important because earnings losses early in the work life may affect one's overall earnings trajectory later on. Documenting the economic impacts of work injuries early in one's work life can inform policy debates on the allocation of resources to control workplace hazards where teenagers and young adults work and on the determination of fair and adequate benefits for young workers.

Highlights/significant findings

Our first aim was to examine the relative contribution of individual and job characteristics to work-related disability. Job characteristics were the strongest independent predictor of work-related disability among young people. In particular, the most physically demanding jobs more than doubled their risk of a work injury.

In contrast, individual factors such as gender and age were not associated with work-related disability when job characteristics were controlled. This means, for example, that young men and women who work similar jobs have similar injury risks.

Young workers with higher education levels had a decreased risk of a work-related disability. This finding suggests that different educational experiences (e.g., not completing high school) may be the most salient individual difference with regard to injury risks.

Our second aim was to identify any earnings losses that young workers may experience in the year after a work related disability. Our findings show that a work-related disability led a young worker to earn on average 7.3% less than uninjured controls in the year following the event.

We also examined a few possible explanations for these post-disability earnings losses. We did not find a change in educational activity among those young workers who experienced a work disability compared to their controls. Also, young workers who experienced a work disability absence reported working similar number of hours as their non-disabled counterparts. The lack of differences on these factors seems to suggest that young workers who experienced a disability earned less per hour in the year after their disability.

Translation of findings

Our findings on the etiology of young worker injuries fit well into the public health approach to prevention (1). Etiological research can help occupational health and safety practitioners to identify modifiable risk factors and guide intervention development. Accordingly, our findings suggest that an important supplement to current school- and community-based education programs on work safety would be reducing the

physical hazards youth encounter at work, potentially through technical safety improvements in the equipment and work environment. The practical implications of finding that young workers with low education are at risk is that job training and injury prevention programs targeting this subgroup of workers may be warranted.

Our findings on the consequences of work injuries also figure into a public health approach to prevention in that it is important to document the burden of work injury on young workers. Our finding of substantial earnings losses among injured young workers can raise awareness among employers, workers, OHS practitioners and policy makers that injuries potentially can have more than a health cost for the individual.

This finding is also relevant to workers' compensation systems. If such earnings losses are found to be persistent among injured young workers, this information can be used to revise compensation policies so that they are more equitable to those injured while their earnings trajectories are still increasing.

In addition to dissemination of the findings through the scientific literature, the Institute for Work & Health has had a dedicated department for knowledge transfer and exchange since 1999. With assistance from the Institute for Work & Health knowledge exchange specialists, dissemination opportunities for the research will include web-based and print newsletters, media releases, research summaries, and stakeholder meetings. These dissemination strategies will allow us to network with interested researchers, stakeholder organizations, and labour/employer groups in North America.

Outcomes/relevance/impact

With regard to the first aim, our findings support the notion that an important supplement to current school- and community-based education programs on work safety would be reducing the physical hazards youth encounter at work, potentially through technical safety improvements in the equipment and work environment.

Also, young workers with less education appear to be a particularly vulnerable population, possibly due to inadequate job skills or particularly dangerous jobs (i.e., residual confounding of hazard exposures). Consequently, job training and injury prevention programs targeting this subgroup of workers may be warranted.

With regard to the second aim, these findings about the economic impact of young worker injuries supplement research documenting the health impacts of such injuries. Accordingly, the possibility that there are persistent earnings losses early in the work life strengthens the case for disproportionately targeting prevention resources on young workers.

Earnings losses associated with work disability absences among young workers also suggest that compensation based simply on their current pay at an entry level job does not adequately take into account the income trajectory observed in this age group. From an equity perspective, workers' compensation programs need to take into account the fact that young workers are transitioning into the labor market.

Scientific Report

Overview

The proposed secondary data analyses sought to make contributions to three priority areas in the original National Occupational Research Agenda (NORA). First, the longitudinal data provided information on health disparities in a special population in the workforce, young workers (i.e., adolescents and young adults). In the U.S. and Canada, population-based data show work injury rates to be 1.5 to 2.0 times higher among workers 15 to 24 years of age as compared to their adult counterparts (2-4). Second, young workers are considered by NORA to be a high-risk group for traumatic injuries (e.g., overexertion, contact with objects or equipment, and trips/slips) (5). Young people are overrepresented in the industries that have the largest number of traumatic injuries such as eating and drinking places, hospitals and grocery stores (6). Finally, the economic consequences of work injury and illness on young workers will also be examined in this study. For adolescents alone, the economic burden of work injuries in the U.S. was estimated to be at least $5 billion dollars in 1993 (7). In terms of the research agenda for the second decade of NORA, young workers' concentration in the service sector suggest that these findings are most relevant to the service sector research area.

The research project had two specific aims:

1. To better define the nature and magnitude of injury risk experienced by young workers. In particular, the proposed multivariate analysis of longitudinal data will overcome the threats to causal inference associated with cross-sectional studies such as the confounding of individual differences and working conditions.
2. To evaluate the labor market outcomes of injured young workers. We focus specifically on the earnings losses that young workers may experience in the 12 months after returning to work. Assessing the short-term economic losses of young people after a work injury would provide an indication of whether work injuries do influence the initial trajectory of one's work life.

Aim #1: Antecedents of youth work-related disability

Background for Aim #1

Work injuries and illnesses among American and Canadian young people 15 to 24 years old are a public health concern. In developed countries, both teenagers and young adults have consistently higher rates of work injury than older workers (8-10). For U.S. teenagers alone, the economic cost of work injuries was estimated at $5 billion in 1993 (11). The purpose of the current study was to examine the relative contribution of individual and job factors to injury risk in a prospective study.

Among young workers, the risk of work injuries is often attributed to individual characteristics. For example, young males sustain work injuries at about twice the rate of young females (12). Also, cognitive and physical developmental factors of teenagers are widely believed to increase injury risk, leading to the current emphasis on school- and community-based educational programs in North America (13;14).

The job characteristics can also influence injury risk. Young workers in manual jobs (e.g., stockhandlers, janitors/cleaners), jobs in the goods-producing sectors (e.g., agriculture, manufacturing, and construction) and food service jobs have higher work injury rates than youth in sales jobs or administrative/clerical jobs (12;15;16). In particular, the physical demands of the job have been shown to be associated with the chance of a work injury (17).

With regard to temporal factors, working longer hours is sometimes associated with injury risk (18), possibly due to fatigue or simply a function of increased exposure time (19). Some studies of work injury records find that new young workers are at increased risk of work injury compared to their more experienced counterparts (20-22). However, self-report studies find the opposite relationship (19) or no association between experience and work injury risk (23). These mixed findings may be due to self-report studies not pinpointing when the injury occurred during each worker's job tenure. Had the studies done so, it would have been possible to track the specific risk of injury for each phase of job tenure. Without this detailed analysis, such job tenure findings address cumulative injury risk versus phase-specific risk.

Several methodological limits complicate the risk estimates provided in previous studies. First, most studies of young workers are descriptive and do not adjust for the fact that males are more likely to hold hazardous jobs (e.g., manual work, jobs in industries with higher injury rates) than young females.

Second, for studies using administrative data sources, underreporting may be an issue. For example, studies which rely on workers' compensation claims could fail to capture all work injuries ((24)), especially if filing a claim might affect a firm's insurance premium or increase their risk of being inspected. Underreporting of claims could bias risk factor estimates if the likelihood of reporting injuries to the compensation system differs by industry or by young worker characteristics. Relying on health records (i.e., health care visits) as a data source can also be problematic and lead to reporting bias, since not all injured workers seek health care services. Research shows that only 34 percent of occupational injuries are treated in emergency departments (25).

Finally, virtually no studies have utilized longitudinal data to examine risk of work injury. An exception is Feldman and colleagues' one-year follow-up of high school students on incidence of musculoskeletal pain (26). In this study, jobs such as baby sitting or non-manual work led to more neck/upper limb pain and back pain (respectively) than those not working at all.

Related to the first aim of the project, we used longitudinal data from a nationally representative sample of teenagers and young adults to examine the relationship between individual, job, and temporal factors and self-reported work absence due to a work-related illness or disability.

Methodology for Aim #1

Data and sample

The Survey of Labour and Income Dynamics (SLID) consists of a series of six-year overlapping panels (each of the six years is considered a wave within a panel), with a new panel being introduced every three years to replace the oldest panel (27). Available data from these panels cover the time period from 1993 to 2003 inclusive.

Respondents are interviewed annually about their work experiences over the previous calendar year in up to six jobs and report monthly on the characteristics of each job. These secondary data analyses were approved by the Health Sciences I ethics committee at the University of Toronto.

Population

The target population for SLID is all persons living in Canada, excluding people in the Yukon or Northwest Territories, residents of institutions, persons living on Reserves, and full-time members of the Canadian Armed Forces living in barracks. The initial representative sample of each panel is drawn from respondents of Statistics Canada's Labour Force Survey. For each panel, the sample is approximately 15,000 households, comprising about 31,000 persons aged 16 years and over.

This analysis focused on respondents who were between the ages of 16 and 24 years old and were employed at some point during the observation period.

Outcome, Work Disability Absence

The outcome measure (event) was the first observed occurrence of a work disability absence (WDA) for a person in a given job. A WDA was defined as any absence for one week or greater due to a work related illness or disability. Providing evidence of concurrent validity, this WDA measure showed similar time trends as workers' compensation claim rates in a Canadian province (28).

For each respondent, every job start over the six waves of the panel provided a new person-job episode to be used for the analysis. However, person-job episodes that started prior to the respondent entering the panel were not included in the analysis due to difficulties in determining exposure time and because a WDA could have occurred prior to panel entry.

WDAs were not linked to a specific job when multiple concurrent jobs were being held. Given this, we attributed the work accident of respondents who held multiple concurrent jobs and experienced a WDA to the job identified as the main-job for that month (the job with highest usual hours for that month). A sensitivity analysis was undertaken to assess the impact of assigning the WDA to the respondent's main-job.

For person-job episodes with a WDA, all months of observation after the month of the WDA were excluded. For respondents who held multiple concurrent jobs at the time of a WDA, observed months in all concurrent jobs after the month of the WDA were excluded.

Covariates

Covariates for each person-job episode included in the model were age, gender, job type, hours worked, highest education achieved, having multiple, concurrent jobs, job tenure, school activity, living in an urban versus rural area, and a flag indicating what panel the person-job episode arose.

Age was considered a time-varying covariate, calculated in months and updated each month.

Jobs were classified into three categories of physical demands: manual, mixed, non-manual using the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST) occupation coding system (29). The coding system is based on observations in workplaces and agreement among experts in the occupational health and safety field on the typical frequency of handling loads and the weight of the load.

Hours worked in a given month for a particular job were assessed by multiplying the average number of paid hours in weeks by the number of weeks worked in that month. Total hours were categorized into four groups (0 to 60, 61 to 120, 121 to 160 and 161 or more hours per month).

Highest education achievement was identified with a three category variable (no secondary degree, secondary degree, post secondary degree) in December of each year of observation.

Job tenure was calculated as the number of months between the start date of the person-job and the current month of observation.

A flag indicating current full time school activity in a given month of observation was used to assess the differences between those respondents who were balancing work and school commitments compared to those who were not.

Given the potential differences in employment patterns and the varying types of jobs held by youth living in urban environments compared to living in rural environments, a flag indicating urban residence was used in the model.

An indicator of the panel (1-4) from which the data arose was also used in the model to control for any difference that may exist between the different cohorts.

Analysis

The complementary log-log model for continuous time processes, as described by Allison (30), was employed. This model is based on the assumption that events are generated by a proportional hazards model with an exponential hazard within a particular time period, but makes no assumptions are made about the overall shape of the hazard across time periods. The analysis was undertaken on a month by month basis. Therefore, a single person-job episode could contribute a maximum of 72 months of observation over the six year observation period. This modelling framework allows for time-dependent covariates.

A list-wise deletion was employed, deleting any observation that did not provide complete responses to all covariates. All covariates were entered in the analysis model simultaneously.

Given the complex nature of the survey and the non-independence that arises due to the clustering of person-job episodes within individuals (respondents may hold more than one job over the six-year period of observation either consecutively, concurrently or both) we calculated robust variance estimates using a weighted bootstrap method with 1000 replicates to adjust variance estimates. The bootstrap technique assumes independence across respondents when estimating the coefficients but accounts for the true non-independence of respondents when estimating the variance of coefficients (31). The weights take into account sampling probabilities and non-response. The weight from the first wave of each panel was used for all subsequent waves of data.

Potential for bias due to sample selection and proxy responses

To assess the potential impact of a person-job episode due to exclusion or non-response, an analysis of those jobs selected for analysis compared to those jobs not selected for analysis was undertaken. A job-based logistic regression model was developed where the outcome was whether or not the job was included in the analysis with the independent variables being the job holder's age (at the start of the job) and gender.

The SLID allows one household member to answer questions on behalf of any or all other members of the household, provided he or she is willing and able to do so (i.e., proxy response). Given this study examines 16 to 24 year old respondents (and that the younger a respondent the greater the potential to have responses through proxy) an estimate of the impact of proxy reporting was undertaken. A logistic regression model was estimated with the job holder's age (at the start of the job) and gender as predictors and whether or not the job was reported through proxy response as the outcome.

Results for Aim #1

Background characteristics

The 16 to 24 year old respondents who had complete covariate information and met the study inclusion criteria provided 360,808 person months of observation from 45,125 jobs. During the observation period there were a total of 281 WDAs observed. The number of jobs, person-months of observation, number of WDAs and the WDA rate per 1000 person-months is provided in Table 1 for each covariate.

Table 1. Number of Jobs, Person Months of Observation and Work Disability Absence Rate for SLID respondents aged 16 to 24 years old. Weighted.

	Jobs	Person Months		Work Disability Absence	
	N	N	%	N	Rate per 1000 PY
Total	45125	360808	100.00	281	0.78
Gender					
Female	22452	184879	51.24	122	0.66
Male	22673	175929	48.76	159	0.91
IRSST Job Type					
Manual	21621	149119	41.33	177	1.19
Mixed	13273	110144	30.53	66	0.60
Non-Manual	10231	101546	28.14	39	0.38
Total Hours Worked (month)					
0-60	9623	86995	24.11	22	0.25
61-120	11525	94391	26.16	40	0.42
120-160	18837	145518	40.33	158	1.09
161+	5140	33904	9.40	61	1.81
Highest Education					
Less than High school	11383	65773	18.23	98	1.49
High school	22711	182894	50.69	126	0.69
Post-Secondary	11031	112141	31.08	57	0.51
Multiple Concurrent Job					
No	36348	293000	81.21	252	0.86
Yes	8777	67808	18.79	30	0.44
Tenure (months)					
0-2	13094	24730	6.85	43	1.75
3-4	10290	37597	10.42	56	1.50
5-6	4624	25254	7.00	43	1.70
7-12	8347	18538	5.14	58	3.11
13+	8770	194689	53.96	81	0.42
School Activity					
No	29702	223634	61.98	236	1.06
Yes	15423	137174	38.02	45	0.33
Living in Urban Area					
No	11805	60139	16.67	66	1.09
Yes	33320	300669	83.33	216	0.72

Multivariate regression results

Results of the fully-adjusted multivariate regression analysis examining the antecedents to WDA are presented in Table 2 including the hazard ratio (HR) and the corresponding 95 percent confidence interval (CI). The final column of the table represents the percentage deviation of the hazard ratio from the null value (1.00).

Manual occupations were 165 percent more likely to experience a WDA compared to non-manual occupations (HR: 2.65, CI: 1.59, 4.41) while mixed occupations had only a 70 percent increase (HR: 1.70, CI: 0.78, 3.68).

Total hours worked per month showed a dose response relationship with increasing hours and increasing risk. Jobs with monthly hours between 61 and 120 hours had a 86 percent increase in the likelihood of a WDA compared to jobs with hours between 0 and 60 (HR: 1.86, CI: 0.89, 3.89). A 381 percent increase was seen for jobs in the 120 to 160 hour range (HR: 4.81, CI: 2.15, 10.76) with a 623 percent increase for jobs working greater than 160 hours per month (HR: 7.23, CI: 3.22, 16.22) compared to jobs with hours between 0 and 60.

Respondents who had completed high school or post-secondary education were seen to decrease their risk of a WDA by 51 to 65 percent (HR: 0.49, CI: 0.27, 0.92 and HR: 0.35, CI: 0.17, 0.73 respectively). Little difference in risk was noted between those who finish high school and those that have finished some sort of post-secondary education.

As noted, when a respondent had multiple concurrent jobs and a WDA, the WDA was assigned to the main-job. In a sensitivity analysis for this treatment of the WDA, the WDA was not re-assigned to the main-job. The full multivariate model was then regenerated with no differences in the direction or relative relationship between the original hazards and the hazards from the sensitivity analysis noted. Given the small number of WDAs that are re-assigned this outcome was expected and demonstrates the minimal effect this decision has on the hazard estimates.

Potential for bias due to sample selection and proxy responses results

The three reasons for not being selected for analysis were examined (job started before the period of observation, missing covariate information and non-response during the first wave of the survey). Overall, gender did not vary greatly between those jobs selected for analysis compared to those jobs not selected for analysis. And, as age increased, the likelihood for selection into the final model decreased.

Proxy responses were 1.47 times more likely to be provided for jobs held by male respondents compared to jobs held by females respondents independent of age (CI: 1.34, 1.60). The likelihood of a proxy response was decreased as age increased. For example, proxy responses were 9.72 times more likely to be provided by jobs held by 16 year old respondents compared to jobs held by 24 year old respondents (CI: 6.32, 14.93), independent of gender. By the time respondents were 20 years old, the likelihood decreases to 2.10 (CI: 1.36, 3.24).

Table 2. Estimates of Hazard Ratios for Work Disability Absence

		Parameter Estimate	Standard Error	Hazard Ratio	95 % CI	Percent Change
	Intercept	-9.08157	0.97277			
Gender						
	Females			1.00		
	Males	-0.27592	0.24384	0.76	0.47 , 1.22	-24.11
Age (years)		0.06010	0.04276	1.06	0.98 , 1.15	6.19
IRSST Job Type						
	Non-Manual			1.00		
	Manual	0.97449	0.25944	2.65	1.59 , 4.41	164.98
	Mixed	0.52963	0.39504	1.70	0.78 , 3.68	69.83
Total Hours Worked						
	0-60			1.00		
	61-120	0.62170	0.37648	1.86	0.89 , 3.89	86.21
	120-160	1.57010	0.41127	4.81	2.15 , 10.76	380.71
	161+	1.97772	0.41239	7.23	3.22 , 16.22	622.63
Highest Education						
	Less than High school			1.00		
	High school	-0.70533	0.31746	0.49	0.27 , 0.92	-50.61
	Post-Secondary	-1.04555	0.37235	0.35	0.17 , 0.73	-64.85
Multiple Concurrent Job						
	No			1.00		
	Yes	-0.17401	0.31059	0.84	0.46 , 1.54	-15.97
Tenure (months)						
	0-2	-0.55565	0.38290	0.57	0.27 , 1.22	-42.63
	3-4	0.19342	0.27224	1.21	0.71 , 2.07	21.34
	5-6	0.32052	0.28554	1.38	0.79 , 2.41	37.79
	7-12	-0.02507	0.20636	0.98	0.65 , 1.46	-2.48
	13+			1.00		
School Activity						
	No			1.00		
	Yes	-0.48234	0.26869	0.62	0.36 , 1.05	-38.27
Living in Urban Area						
	No			1.00		
	Yes	-0.15220	0.19831	0.86	0.58 , 1.27	-14.12
Panel						
	1			1.00		
	2	-0.22443	0.24427	0.80	0.50 , 1.29	-20.10
	3	-0.22754	0.26295	0.80	0.48 , 1.33	-20.35
	4	-0.67751	0.38777	0.51	0.24 , 1.09	-49.21

Discussion for Aim #1

Findings and limitations

This is the first prospective study of the predictors of work-related disability among young workers. We found young males had a higher work disability absence rate compared to young females. However, the adjusted odds of a work disability absence showed no significant gender differences. The lack of significance in the multivariate model may suggest that gender differences are due to differential work exposures of young males and female workers.

Job characteristics were the strongest predictors of work disability absence. Factors such as the physical demands and hazards of the job have been identified in previous cross-sectional studies as important variables mediating the risk of work injury in this age group (17;19;23). As would be expected, we observed a positive linear association between hours worked and work disability absence, with over time work (> 40 hours / week) showing more than a 600 percent increase in risk.

We found that independent of individual and job factors, a higher education level was associated with a decreased risk of WDA. Studies of adult workers have found higher education levels to be associated with lower risk of work injury (32). Future research might investigate the role of residual confounding since we controlled for only work hours and one of several job characteristics that may be associated with both injury risk and level of education. In addition, understanding the influence of different educational experiences (e.g., high school drop out, work experience programs) on job quality and during the school-to-work transition period may be a fruitful research direction.

Our findings need to be interpreted in the light of certain methodological limitations. Error could have been introduced into the reporting of WDAs by respondents' different definitions of work disability, different recovery times from sustained injuries and different financial pressures to remain at work. Also the type of work and the employers' policies and practices bear on whether a worker needs to take time off work when injured, or whether the worker can be accommodated on the job. These measurement biases would have generally reduced our ability to detect associations with the outcome. In addition, we cannot rule out the possibility that a WDA was a recurrence of a condition that arose in a previous job prior to entry into the panel.

The panel design led to a portion of the jobs held by youth to be excluded because we did not observe part of the work episode and therefore we did not know if a WDA occurred in the job prior to entering the panel. Therefore these findings may not generalize to young people's jobs with longer tenures. The information provided by proxy may be subject to recall biases that may further affect accuracy. Finally, we were not able to include other factors that may also have influenced the likelihood of a work disability absence such as previous work experience.

Implications and summary

Our findings support the notion that an important supplement to current school- and community-based education programs on work safety would be reducing the physical hazards youth encounter at work, potentially through technical safety improvements in the equipment and work environment.

In terms of work hours, U.S. Federal laws have restrictions on hours of work for youth 16 and under (6). However, our findings raise the question of whether work hour restrictions should be considered for older teenagers as a method of decreasing work disability.

Finally, young workers with less education appear to be a particularly vulnerable population, possibly due to inadequate job skills or particularly dangerous jobs (i.e., residual confounding of hazard exposures). Consequently, job training and injury prevention programs targeting this subgroup of workers may be warranted.

In summary, this prospective study indicates that job characteristics are a key risk factor in determining occupational health among young people. This study also contributes methodologically to the young worker literature by modelling the complex work patterns during the school-to-work transition.

Aim #2: Economic consequences of youth work-related disability

Background for Aim #2

In 2003, 186,220 US workers 15 to 24 years old in private industry sustained a workplace injury that led to at least one day of lost work (33). Fifteen per cent of injuries sustained by adolescents at work result in a permanent impairment, such as chronic pain, scarring, sensory loss, and loss of range of motion (34). Twenty six per cent of injured adolescents report ongoing medical problems associated with their injury (35).

Even though the health consequences of youth work injury have received much attention, no studies based on individual data have estimated the economic consequences associated with these injuries. A study of teenage occupational injury estimated the direct (e.g., medical costs, workplace disruption) and the indirect costs (e.g., lifetime earnings losses) to be US$5 billion in 1993 (11). However, this study did not specifically estimate lost earnings. Instead, income loss was assumed to be what legal cases of compensation typically award.

Studies of economic losses of adult workers show that both temporary and permanent disability lead to earnings losses (36-38). For example, adults with permanent disability claims earned 40% less after the injury (36). Amongst adult workers, people who had at least four lost days of temporary work disability were projected to have lost about $800 per year in earnings over a 10-year period (37).

There are several reasons to specifically study the economic losses of injured young workers. Adolescents and young adults have significantly higher work injury rates than other age groups (8))(9;39). In addition, a work disability occurring early in one's work life can have a greater impact on one's career and earnings compared to a disability occurring later in one's work life. Additionally, since young workers are also in the school-to-work transition and may have fewer family responsibilities than adult workers, the injury may be an impetus to return to school to prepare for another type of job (if one is unable to continue in an occupation due to a disability).

Long-term economic losses from a temporary disability due to work injuries could arise for a variety of reasons. For instance, a long-term physical disability might have ensued, but was not deemed compensable according to the workers' compensation system. Also, work absences due to work injuries may be stigmatized by employers and co-workers. In addition, the work absence could have led to missing valuable work experience (37). With young workers in particular, one would also need to evaluate the possibility that reduced earnings post injury were the result of increase school involvement.

In addressing the second aim of the project, we evaluated the earnings losses that young workers may experience after a work disability episode. Assessing the short-term economic losses of young people after a work injury provides an indication of whether work injuries do influence the initial earning trajectory. A secondary objective was to assess differences in school activity and work hours post-work disability absence, if income differences between disabled workers and controls were found.

Methodology for Aim #2

Data and sample

Begun in 1993, the Survey of Labour and Income Dynamics (SLID) is a longitudinal survey of representative samples of Canadian households (27). It is designed to capture changes in the economic well-being of individuals and families over time with a specific focus on labour market experiences, income and family dynamics. The survey consists of a series of six-year panels, with a new panel being introduced every three years to replace the oldest panel. This study used the three panels started in 1993, 1996, and 1999. Data

up to 2000 for all three SLID panels show that 95 to 96% of the prior-year sample continues to participate from one year to the next (27).

The target population for the SLID is all persons living in Canada, excluding people in the Yukon or Northwest Territories, residents of institutions, persons living on Reserves, and full-time members of the Canadian Armed Forces living in barracks. Each panel contains approximately 15,000 households with about 31,000 respondents aged 16 years old and over. The present study focuses on respondents 16 to 24 years old during the time period 1993 to 2003.

Respondents are interviewed annually in January to collect labor market information from the preceding 12 months. During this interview they are asked about their work experiences over the previous calendar year on a monthly basis. Respondents are asked to give permission to access their tax files for income information for the corresponding time period (i.e., wages and salary). If permission to access tax file information is not given, respondents are re-interviewed again in May to collect this income information.

Definition of a case. Cases were defined as young workers who experienced a work disability absence and had at least three years of annual earnings information (i.e., year prior to the absence, year of absence, year post-absence). Work disability absence refers to an absence of one week or more due to a work-related illness or disability.

From 1993 to 2003, a total of 389 young workers met our case definition. We excluded from this analysis 109 respondents who lacked pre-absence information on our key matching variables (matching procedure described below). We also excluded 67 cases because they had exited the cohort prior to having a full year of data post-absence. We further excluded 40 cases because of missing post-absence earnings data (for further details see below) or a matching control was not found. These exclusions left 173 respondents with work disability absences.

Measures

Age. The age was defined as months from date of birth to the point of young worker's absence.

Gender: Sex of respondent was either Female or Male.

School activity: The school activity variable indicated if the respondent was attending school, college, CEGEP (a French acronym meaning College of General and Vocational Education), or university in the reference year or not. School activity at the time of the work absence was used as a matching variable (see below). In addition, school activity in the calendar year after the work absence was part of our secondary analyses to examine what factors may have contributed to any earnings losses.

Annual earnings. The annual earnings data was primarily based on the linkage with the respondent's tax files (40). However, a small percentage of the respondents provided their annual earnings information during the interview in May. We calculated earnings for the calendar year prior to, the year of, and the year after the work absence.

The SLID designers handled missing income information differently depending on the household response pattern. Households where no one responded in a given year were left as missing income. In partially responding households, the SLID staff imputed income data using a nearest neighbor approach (40). Although we retained the imputed incomes *prior* to any work absence, any *post*-absence imputations of income were set to missing. This is because the work absence could have influenced the variables used in imputing the post-absence income.

Hours worked. For the secondary analyses on potential reasons behind any income differences, we also used the total number of work hours in the calendar year after the work absence to calculate the proportion of a full-time equivalent (FTE), with 2000 hours in a year equaling 1.0 FTEs.

Matching controls to cases

We used a matched case-control design to estimate the earnings a worker would have received had they not been injured. That is, we compared post-absence earnings of a disabled worker with a comparison group who had not experienced a work disability absence.

Our matching procedure followed a two-stage process. Cases and controls were matched based on age, gender, school activity (the month of the absence), and income in the calendar year prior to the absence. First, we randomly selected a case and matched it with control candidates based on gender and school activity at the time point of the absence (i.e., exact matching on these variables).

Second, we identified potential controls based on similar age and income to each case by initially excluding those individuals with a greater than 6 month age difference or a greater than 20% pre-absence earnings difference. Individuals not meeting these criteria were not candidate controls for that particular case. We then used the following formula to calculate the distance between cases and the potential controls:

$$D_{case-control} = |age_{case} - age_{control}| + wt*log10(|pre\text{-}income_{case} / pre\text{-}income_{control}|),$$

where, *age* is months at the point of absence; *pre-income* is the earnings in the calendar year before absence; *wt* is the weight adjusted by:

wt = max. allowed age difference / log10(1 + max. allowed pre-income difference),

Those potential controls with the smallest distance from the cases were selected first. Following recommendations by (41), we selected a maximum of five controls for each case. This matching process resulted in 173 cases being matched - with 83.2% of them having five controls, 5.2% having four controls, and 11.6% having three controls or less - for a total of 795 controls.

Analytic approach for earnings difference

Our dependent variable was the difference between each case and their respective controls. We examined the distribution of the different scores and found them to follow approximately a normal distribution.

Due to the matching process, a case and its controls represent blocks of non-independent observations. To deal with this circumstance, we utilized a "treatment" by blocks analysis of variance (ANOVA) (42), with each set of case and controls representing a block. This model is defined as:

$$Y_{ij} - Y_{control} = \mu.. + \lambda_j + \varepsilon_{ij},$$

where Y_{ij} is the post-absence earnings, $\mu..$ is general mean, ρ_i is the effect of a work disability absence, λ_j is the effect of each block of case/controls, and ε_{ij} is the error term. Given that the dependent variable is a difference score, whether the intercept is significantly different than zero is the test of differences between cases and controls. We used the traditional threshold of $p < .05$ in defining a significant difference.

Analytic approach for secondary analyses

To assess any between-group differences in hours worked (FTEs), a similar ANOVA with blocks procedure was used. To examine differences in the proportion of respondents in school between cases and controls, we performed a chi-square test.

Results for Aim #2

Background characteristics

Table 3 presents the descriptive statistics for the cases (pre-absence) and controls. On average, these young workers were 21.5 years old (SD =2.1). More than 60% were male and 33.5% were attending either high school or post-secondary school. The virtually identical average pre-absence income between cases and controls indicates that the matching procedure was effective in selecting comparable controls. The standard deviation for pre-absence income are substantial because it represents both the variation within case-control blocks and variation between blocks. Also as noted above the dependent variable in our ANOVA was the difference in earnings between cases and controls.

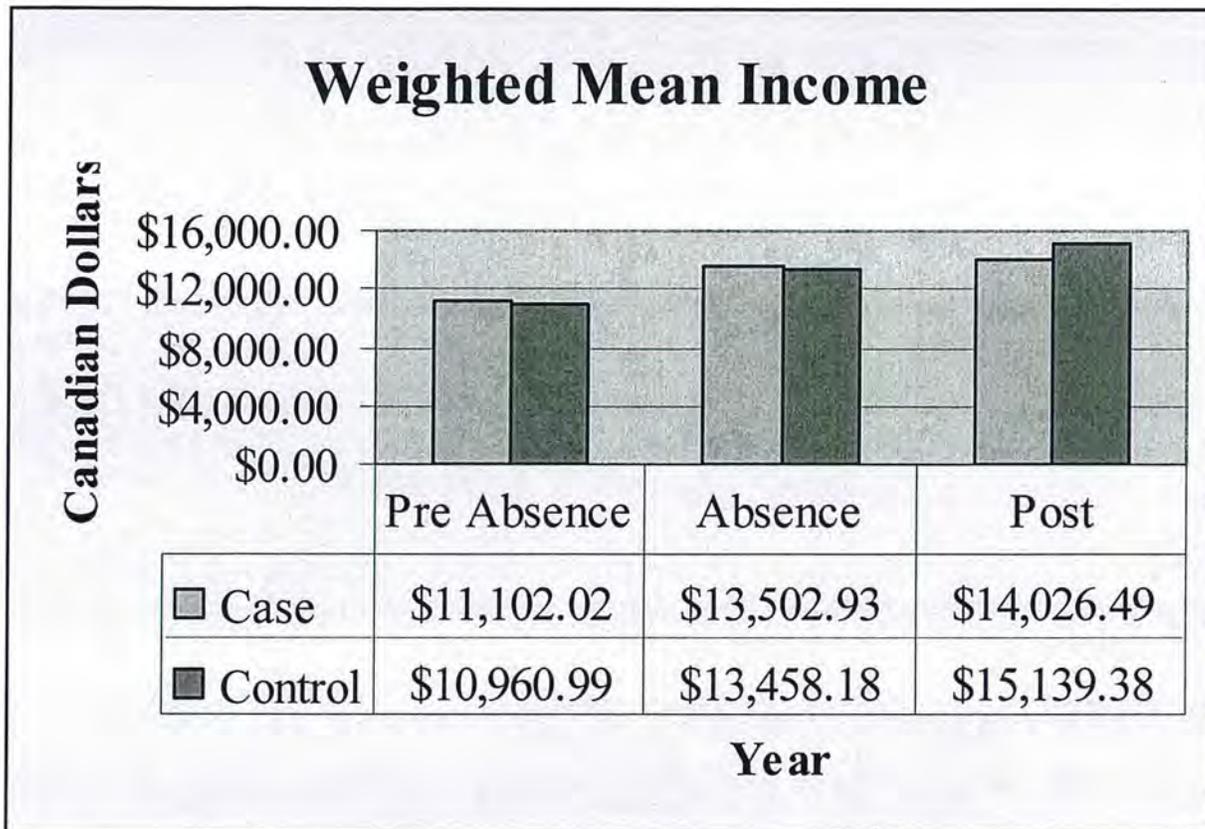**Table 3. Characteristics for cases and controls in year before work absence.**

	N	Avg. age (std.)	Avg. pre-absence income $ (std.)	Male (%)	Student (%)
Case	173	21.5 (2.1)	11102 (8983)	110 (63.6%)	58 (33.5%)
Control	795	21.5 (2.1)	10961 (8585)	499 (62.8%)	267 (33.6%)

A priori and secondary analyses

The earnings results are presented graphically in Figure 1. This figure shows the mean (before deduction) earnings of the workers who had a work disability absence and the controls over time. Before injury, the mean earnings of disabled workers and their controls were indistinguishable due to the fact that pre-absence earnings was a matching variable.

The analyses of variance model showed the post-absence difference to be statistically significant (the F-value for the model was 6.90, with a p-value of 0.009). During the year post-absence, the mean earnings of the disabled workers were $1113.00 less than controls. This is a substantial sum when one takes into consideration how little they are earning in this early stage of their work life (i.e., cases earned 7.3% than controls).

Figure 1. Earnings for cases and controls in the calendar years before, during, and after the work absence.

Weighted Mean Income

	Pre Absence	Absence	Post
☐ Case	$11,102.02	$13,502.93	$14,026.49
■ Control	$10,960.99	$13,458.18	$15,139.38

Canadian Dollars — $16,000.00, $12,000.00, $8,000.00, $4,000.00, $0.00

Year

Discussion for Aim #2

Findings and limitations

Our findings show that work days lost due to workplace injuries and illnesses lead to lost earnings for young workers in the year following the event. This degree of earnings losses per year is generally in line with that found among adult workers with temporary disability (37). Our estimates of the economic consequences are based on work disability absences of five working days or more. Consequently, the degree to which shorter absences may influence subsequent earnings remains to be determined.

We examined a few possible explanations for these post-disability earnings losses. We did not find a change in educational activity among those young workers who experienced a work disability compared to their controls. Also, young workers who experienced a work disability absence reported working similar number of hours as their non-disabled counterparts. The lack of differences on these factors seems to suggest that young workers who experienced a disability earned less per hour in the year after their disability.

Unlike older workers, these young workers did not show an earning decrement the year of the work disability absence. This may be due to the fact that it is common for young people to work temporary and part-time jobs, meaning that even uninjured young workers have significant periods of unpaid "absences." In addition, adults may have longer absence durations leading the a greater impact on injured adult worker earnings.

The study findings need to be considered in the light of certain methodological limitations. The outcome measure did not provide information on whether the disability was temporary or permanent. This information would have allowed us to provide more detail on the differential impact of these types of work disability absences. A related issue is that the ability to take a week off work due to a disability is dependent on not just the severity of the injury or illness. That is, equally severe injuries may result in some people taking a week off work and others not – differences could be due to financial needs, work arrangements, etc. These types of misspecification errors would probably lead to an underestimate of between-group differences. Finally, due to the nature of the panel survey design, the temporal profile of post-absence earnings was short (i.e., year after the absence).

Implications and summary

To ascertain whether to disproportionately target prevention resources on young workers, more research needs to be done to determine how persistent these earnings losses are. There is the possibility that the negative impact of work disability on earnings could disappear sooner with young workers than older, more established workers.

If such earning losses persist, this may be a consideration for compensation systems because work disability absences among young workers occur as their income trajectory is still increasing. From an equity perspective, workers' compensation programs that are based on current pay at an entry level job would not take into account the fact that young workers are transitioning into the labor market. Of course, this implication awaits further research on the nature and duration of the earnings losses due to work disability in this age group.

In sum, young workers who experience a work disability show earnings losses in the year post injury. Important issues for future research are to determine how long such earnings losses persist. A better understanding of the extent to which these losses are related to residual work disability, injury-related job loss or the stigma attached to work disability is also a useful question for future research.

Publications

Breslin FC, Pole JD, Tompa E, Amick III BC, Smith P, Hogg-Johnson S. Antecedents of Work Disability Absence Among Young People: A Prospective Study. Annals of Epidemiology, submitted.

Breslin FC, Tompa E, Zhao R, Amick III BC, Pole JD, Smith P, Hogg-Johnson S. Work Disability Absences Among Young Workers Leads to Persistent Earnings Losses. Scandinavian Journal of Work, Environment and Health, submitted.

Inclusion of gender and minority study subjects

See Inclusion Enrollment Report Table below.

Inclusion Enrollment Report Table

This report format should NOT be used for data collection from study participants.

Study Title: Work injuries and young people: A prospective study

Total Enrollment: _____   **Protocol Number:** _____

Grant Number: _____

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race

Ethnic Category	Sex/Gender			
	Females	Males	Unknown or Not Reported	Total
Hispanic or Latino			90	90 **
Not Hispanic or Latino			13739	13739
Unknown (Individuals not reporting ethnicity)			1129	1129
Ethnic Category: Total of All Subjects*			14958	14958 *
Racial Categories				
American Indian/Alaska Native			457	457
Asian			725	725
Native Hawaiian or Other Pacific Islander			201	201
Black or African American			204	204
White			12152	12152
More than one race				
Unknown or not reported			1219	1219
Racial Categories: Total of All Subjects*			14958	14958 *

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)

Racial Categories	Females	Males	Unknown or Not Reported	Total
American Indian or Alaska Native				
Asian				
Native Hawaiian or Other Pacific Islander				
Black or African American				
White				
More Than One Race				
Unknown or not reported			90	90
Racial Categories: Total of Hispanics or Latinos**			90	90 **

Inclusion of Children

Given that our focus was on workers 16 to 24 years of age, our primary analytic sample of 14,958 includes 10,370 individuals that were less than 21 years of age at the start of entry into the survey panel. We were unable to include people younger than 16 because the survey did not collect work information on dependents in the household that were less than 16 years old.

Materials available for other investigators

The federal agency Statistics Canada is the custodian of the data that we used for these secondary data analyses, so we cannot share the raw data. We can share details of our statistical methodologies to researchers upon request.

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