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Age Differences in Work-Disability Duration Across Canada: Examining Variations by Follow-Up Time and Context

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Abstract

Purpose This study aimed to understand age differences in wage-replacement duration by focusing on variations in the relationship across different periods of follow-up time. *Methods* We used administrative claims data provided by six workers' compensation systems in Canada. Included were time-loss claims for workers aged 15–80 years with a work-related injury/illness during the 2011 to 2015 period (N = 751,679 claims). Data were coded for comparability across cohorts. Survival analysis examined age-related differences in the hazard of transitioning off (versus remaining on) disability benefits, allowing for relaxed proportionality constraints on the hazard rates over time. Differences were examined on the absolute (hazard difference) and relative (hazard ratios [HR]) scales. *Results* Older age groups had a lower likelihood of transitioning off wage-replacement benefits compared to younger age groups in the overall models (e.g., 55–64 vs. 15–24 years: HR 0.62). However, absolute and relative differences in age-specific hazard rates varied as a function of follow-up time. The greatest age-related differences were observed at earlier event times and were attenuated towards a null difference across later follow-up event times. *Conclusions* Our study provides new insight into the workplace injury/illness claim and recovery processes and suggests that older age is not always strongly associated with worse disability duration outcomes. The use of data from multiple jurisdictions lends external validity to our findings and demonstrates the utility of using cross-jurisdictional data extracts. Future work should examine the social and contextual determinants that operate during various recovery phases, and how these factors interact with age.

Keywords Age · Work injury · Return to work · Workers' compensation · Survival analysis

Background

A large body of research has examined age-related similarities and differences in return to work (RTW) following a workplace injury [1–6]. Although older age has been linked with positive health and well-being outcomes [1], studies find that older age tends to be associated with negative RTW outcomes such as delayed time to RTW, greater duration of sickness absence, and more frequent disability recurrences following work-related injury [2–6]. Accordingly, a small subset of studies have examined the underlying factors that are responsible for the differences across age groups, including factors like chronic disease, job tenure, and injury severity are accounted for [1, 2, 5, 6]. A study from the Canadian province of British Columbia using workers' compensation data [2] found that age differences in the prevalence of pre-existing chronic health conditions partly explained why older age was associated with a greater duration of sickness absence. A study of time-loss injury claimants in the United States state of New Hampshire [1] found that age differences in RTW were not significant after adjustment for injury severity, injury-related surgery and physical functioning scores. In contrast, studies of workers' compensation

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claimants in Australia [5] and the United States [6] found that age differences in wage-replacement duration were not attenuated to a great extent after accounting for factors such as injury severity or job tenure, and that older age remained strongly associated with greater duration of sickness absence.

Taken together, these studies suggest that various clinical, functional or physiological factors may not fully account for age differences in wage-replacement duration, and that there are remaining research gaps in our understanding of age differences in work outcomes. One contextual factor that has been largely overlooked in research studies on age and work-disability duration is the potential impact of the phase of recovery [7, 8]. The process of recovery following a work-related injury or illness is complex. Within the workers' compensation system, the process is embedded not only within health needs and treatment, but also within organizational and social contexts that may change over time [8–10]. Thus, to the extent that time serves as a marker or proxy for these contextual factors [7, 8], we might expect a differential impact on the relationship between age and disability duration depending upon the phase of recovery (i.e., time-varying age effects). For example, a study by Krause [11] found that physical and psychological job demands were associated with greater work disability duration across all phases of disability; whereas factors such as low job control, high job strain, and low work scheduling flexibility were relevant during the later phases of recovery. The authors hypothesized that greater control over job and work scheduling facilitated an earlier RTW. Systematic reviews by Steenstra [12], examining prognostic factors for the duration of sick leave among workers off-work due to low back pain, found that recovery expectations were most important during the later phases of recovery. Other studies [11–17] suggest that psychosocial or claim-related factors are more strongly associated with work disability duration during the later phases of recovery, but less so during earlier phases. Finally, system-level factors, such as limitations in access to or adequacy of benefits at the tail ends of follow-up, might incentivise workers to RTW during later phases of recovery [18–20].

Recent economic policies have aimed to promote the retention of older workers in the labour market in order to retain critical skills, transfer knowledge to newer employees, and balance the labour supply for the coming decades [21–23]. This is within the context of a growing disability burden of compensated claims for work-related injuries and diseases among older workers in Canada and elsewhere [24]. From a policy perspective, it is important to understand the time-varying nature of RTW rates to determine the optimal timing for interventions [7, 25, 26] and to identify individuals that may require early interventions or workplace supports [27–31]. Moreover, if the phase of recovery is a modifier of age–duration relationships, reliance on a single summary measure (e.g., hazard ratio from a Cox proportional hazards model) may not provide a meaningful interpretation because hazards are not proportional [7, 32]. Despite this, most studies have ignored the potential for time-varying estimates and report instead on a single, pooled summary measure that assumes a constant association across follow-up time points [7, 26]. By testing for unique variations across the entire range of disability follow-up time, we gain potentially important nuances and contextual information on situations in which older workers fare better or worse compared to younger workers [27, 28]. Moreover, recent initiatives in the development of multi-jurisdictional workers' compensation claims databases for research purposes [16, 24, 33, 34] provide an opportunity to assess the generalizability of findings across settings.

Using a unique dataset of claims records from six workers' compensation systems across Canada, this study aimed to better understand age-related similarities and differences in wage replacement duration following a work-related injury by investigating whether age differences varied across earlier versus later periods of follow-up time (as an indicator of the phase of recovery). We hypothesized there would be an age-related gradient in disability duration, with older age groups having greater disability duration compared to younger age groups. However, based on earlier studies examining time-varying effects of age on disability duration [13, 14, 26, 35], we anticipated that the relationship between age and disability duration would differ depending on follow-up time with age differences being attenuated during later periods of follow-up.

Methods

Data Sources and Study Population

This study used claim-level data provided by six provincial workers' compensation systems in Canada: WorkSafeBC (Workers' Compensation Board of British Columbia; BC), WCB Alberta (Workers' Compensation Board - Alberta; AB), WCB Saskatchewan (Saskatchewan Workers' Compensation Board; SK), WCB Manitoba (Workers Compensation Board of Manitoba; MB), WSIB Ontario (Workplace Safety and Insurance Board; ON), and WorkSafeNB (Workplace Health, Safety and Compensation Commission of New Brunswick; NB). In Canada, workers' compensation systems operate at the provincial-level based on a principle of no-fault, cause-based insurance [36]. Core operating funds for these systems are provided through employer premiums paid to the compensation authority. The employed workforce covered under these systems ranges from approximately 70% to 99% across jurisdictions [37]. Using these data, we created comparable analytic cohorts with harmonized research variables as part of an overarching research initiative, described in more detail elsewhere [16].

Inclusion criteria were accepted time-loss claims for work-related injury/illness from 2011 to 2015 (N = 988,345); at-least one day of time-loss (N = 763,647); and aged 15 to 80 years at time of injury (N = 762,750). We excluded observations with missing data on study covariates, including sex, occupation and industry (N = 11,071, 1.5%), which resulted in a final analytic cohort of N = 751,679 claims.

Measures

The primary outcome was wage-replacement duration, defined as the cumulative number of days paid to the injured worker for temporary disability benefits as a result of time off work. Wage-replacement days were ascertained over a 1-year calendar period. Days were standardized to a 5-day work week and then right-censored at 260 days, per methodology developed for a previous research initiative [16]. We note that most individuals would have returned to work within this study period of interest. Consistent with previous studies, we conceptualized wage-replacement days as a proxy measure for time to cessation of benefits [14, 34, 38], with the caveat that days may be accumulated non-consecutively. This variable has been described as an appropriate indicator of the overall burden of work disability duration among studies based solely on administrative claims data [38].

Our primary explanatory variable was age at time of injury, measured in calendar years and grouped for analysis (15–24, 25–34, 35–44, 45–54, 55–64, 65+). Covariates used for analyses included: province of claim submission (BC, AB, SK, MB, ON, NB); sex (male, female); and year of injury (ranging from 2011 to 2015). We also included occupation and industry, harmonized to the 2006 National Occupation Classification and 2012 North American Industry Classification System, respectively. Nature of injury was coded to Canadian Standards Association Z795 codes and aggregated into the broad groupings of musculoskeletal disorders (MSD) versus non-MSD. MSDs were further classified into soft-tissue versus fracture injuries. Groupings were selected for internal validity and comparability purposes, based on previous work [16].

Analyses

Descriptive statistics compared the distribution of injured worker characteristics across age groups. We used survival regression models to examine age-related differences in the hazard of transitioning off wage-replacement benefits comparing a given age group to the youngest age group (15–24 years) as the reference category. Hazard, in the context of our study, refers to the instantaneous rate of exit from wage-replacement benefits at a specific time point, given that the individual has remained on benefits until that time. Hazard ratios (HR) greater than '1' denote a more rapid transition off benefits (e.g., shorter disability duration) for a given age group compared to the reference age group; whereas HRs less than '1' denote a slower transition off benefits (e.g., longer disability duration).

To examine whether age differences in wage-replacement duration varied across earlier versus later phases of follow-up time, we used flexible parametric survival models [32], which incorporate non-linear time transformations that allow for the continuous estimation of the baseline hazard function. These non-linear time transformations (via restricted cubic splines) were then interacted with age to estimate hazard ratios at specific follow-up event times, thus allowing for non-proportional hazard specifications. We examined both absolute and relative differences in hazard rates to provide additional nuance into the time-varying relationships between age and disability duration [7, 32, 39].

All analyses were completed with Stata/IC 15 (College Station, TX). Flexible parametric survival models were run using the 'stpm2' package. Model estimates for flexible parametric survival models are robust to different specifications for the functional form of time-varying hazards [32]. To define the functional shape of the splines, we placed two interior knots at the 33rd and 67th percentiles of the distribution of uncensored log survival times (for the baseline hazard function) and four interior knots at the 25th, 50th, 75th and 90th centiles of the distribution of uncensored log survival times (for the age-by-time interactions). All models were adjusted for the full set of covariates, described above.

Results

Table 1 presents the distribution of selected study variables, calculated overall and by age group. The majority of the cohort had soft-tissue MSDs (63%); were employed in trades and transport (35%) or sales and service (26%) occupations; and/or were male (62%). The frequency of compensation claims was stable over the study period. The majority of the cohort was comprised of claims from BC (32%) and ON (32%), with the smallest proportions from SK (6%) and NB (3%). By age group, there were notable differences in the distribution of claims by sex, injury type, industry and injury year.

Table 2 presents the unadjusted median days of wage-replacement across age groups. There was an age-related gradient with older age groups having a greater median number of days compared to younger age groups (ranging from 5 days among the youngest age group to 17 days among the oldest age group). The relative variation in median days

Table 1 Distribution of study covariates by age group

	Total	Age group (years)		
	N (col. %)	15–34	35–54	55 +
		N (col. %)	N (col. %)	N (col. %)
Province				
British Columbia	243,222 (32.4%)	83,323 (32.5%)	116,469 (32.1%)	43,430 (32.8%)
Alberta	129,808 (17.3%)	48,955 (19.1%)	58,753 (16.2%)	22,100 (16.7%)
Saskatchewan	44,629 (5.9%)	16,277 (6.4%)	20,781 (5.7%)	7571 (5.7%)
Manitoba	70,565 (9.4%)	25,605 (10.0%)	33,779 (9.3%)	11,181 (8.4%)
Ontario	239,084 (31.8%)	75,342 (29.4%)	120,402 (33.2%)	43,340 (32.7%)
New Brunswick	24,371 (3.2%)	6486 (2.5%)	12,979 (3.6%)	4906 (3.7%)
Sex				
Male	465,327 (61.9%)	172,298 (67.3%)	215,697 (59.4%)	77,332 (58.4%)
Female	286,352 (38.1%)	83,690 (32.7%)	147,466 (40.6%)	55,196 (41.6%)
Occupation (NOC)				
Management	17,720 (2.4%)	4397 (1.7%)	9652 (2.7%)	3671 (2.8%)
Business, finance, admin	47,874 (6.4%)	12,080 (4.7%)	26,051 (7.2%)	9743 (7.4%)
Natural/applied sciences	13,181 (1.8%)	4380 (1.7%)	6575 (1.8%)	2226 (1.7%)
Health	82,292 (10.9%)	21,188 (8.3%)	45,868 (12.6%)	15,236 (11.5%)
Social sciences	33,044 (4.4%)	9970 (3.9%)	17,128 (4.7%)	5946 (4.5%)
Art, culture, recreation, sport	4748 (0.6%)	2000 (0.8%)	1980 (0.5%)	768 (0.6%)
Sales, service	195,188 (26.0%)	70,307 (27.5%)	88,791 (24.4%)	36,090 (27.2%)
Trades, transport	264,874 (35.2%)	96,273 (37.6%)	123,979 (34.1%)	44,622 (33.7%)
Primary industry	23,109 (3.1%)	10,561 (4.1%)	9402 (2.6%)	3146 (2.4%)
Processing, manufacturing	69,649 (9.3%)	24,832 (9.7%)	33,737 (9.3%)	11,080 (8.4%)
Industry (NAICS)				
Natural resources and mining	24,310 (3.2%)	10,058 (3.9%)	10,549 (2.9%)	3703 (2.8%)
Construction	89,640 (11.9%)	42,852 (16.7%)	36,442 (10.0%)	10,346 (7.8%)
Manufacturing	100,771 (13.4%)	33,315 (13.0%)	50,143 (13.8%)	17,313 (13.1%)
Trade, transportation, and utilities	191,981 (25.5%)	65,673 (25.7%)	90,568 (24.9%)	35,740 (27.0%)
Information	6652 (0.9%)	1701 (0.7%)	3721 (1.0%)	1230 (0.9%)
Financial activities	8132 (1.1%)	2093 (0.8%)	3983 (1.1%)	2056 (1.6%)
Professional and business services	31,488 (4.2%)	12,206 (4.8%)	13,959 (3.8%)	5323 (4.0%)
Education and health services	151,599 (20.2%)	33,781 (13.2%)	84,335 (23.2%)	33,483 (25.3%)
Leisure and hospitality	59,338 (7.9%)	30,940 (12.1%)	20,747 (5.7%)	7651 (5.8%)
Other (including public)	87,768 (11.7%)	23,369 (9.1%)	48,716 (13.4%)	15,683 (11.8%)
Injury type				
Non-MSD	211,694 (28.2%)	90,196 (35.2%)	88,936 (24.5%)	32,562 (24.6%)
MSD soft tissue	475,753 (63.3%)	146,911 (57.4%)	245,374 (67.6%)	83,468 (63.0%)
MSD fractures	64,232 (8.5%)	18,881 (7.4%)	28,853 (7.9%)	16,498 (12.4%)
Injury year				
2011	153,468 (20.4%)	51,526 (20.1%)	77,067 (21.2%)	24,875 (18.8%)
2012	152,277 (20.3%)	51,980 (20.3%)	74,680 (20.6%)	25,617 (19.3%)
2013	150,770 (20.1%)	51,213 (20.0%)	72,815 (20.1%)	26,742 (20.2%)
2014	150,503 (20.0%)	51,359 (20.1%)	71,339 (19.6%)	27,805 (21.0%)
2015	144,661 (19.2%)	49,910 (19.5%)	67,262 (18.5%)	27,489 (20.7%)
	751,679	255,988	363,163	132,528

WCB claims, 2011–2015. N = 751,679

NOC National Occupation Classification, by major groups, *NAICS* North American Industrial Classification System, by supersector, *MSD* musculoskeletal disorder

Table 2 Unadjusted median days of cumulative wage-replacement (with interquartile ranges), differences in median days, and ratio of mediation days, by age group

	Med. (IQR)	Diff.[a]	Ratio[b]
Age group			
15–24	5 (2 to 16)	0 (ref.)	1 (ref.)
25–34	6 (2 to 27)	1	1.2
35–44	8 (3 to 36)	3	1.6
45–54	10 (3 to 43)	5	2.0
55–64	12 (3 to 48)	7	2.4
65+	17 (4 to 62)	12	3.4
Overall median (IQR)	8 (3 to 35)		
Overall mean	31 days		

WCB claims, 2011–2015. N = 751,679. Days are standardized work days and are not raw calendar counts

[a]Differences greater than ‘0’ correspond greater median days for a given age group compared to the reference age group

[b]Ratios greater than 1.00 correspond greater median days for a given age group compared to the reference age group

ranged from 3 to 4 times greater, comparing the oldest versus youngest age groups. The absolute difference was 12 days, comparing the oldest versus youngest age groups.

Figure 1 presents descriptive information on the proportion of individuals who were still receiving wage-replacement benefits at specific follow-up event times, by age group. After 5 work days of follow-up (approximately 1 calendar work week), the proportion of individuals still receiving wage-replacement ranged from 49% among the 15–24 age group to 71% among the 65+ age group. By 130 work days of follow-up (6 calendar months), the proportion ranged from 2% among the 15–24 age group to 11% among the 65+ age group. By the end of 1-year of follow-up, less than 3% of individuals within each age group were still on benefits.

Figure 2 present the adjusted hazard rates of transitioning off benefits per 100 workers (Panel A), the differences in hazard rates (Panel B), and the ratios of hazard rates across age groups (Panel C), derived from the flexible parametric models that allowed for non-proportional hazards for the estimates of age. Estimates are based on data pooled across provinces and adjusted for the full set of covariates. “Appendix” presents the accompanying model coefficients (with 99% confidence intervals) for various follow-up event times.

Overall, the rate of exit from wage-replacement (Fig. 2a) was greatest in the initial few weeks of follow-up, followed by a decrease in the first calendar month and then a gradual decline to approximately 2 to 5 wage-replacement exits per

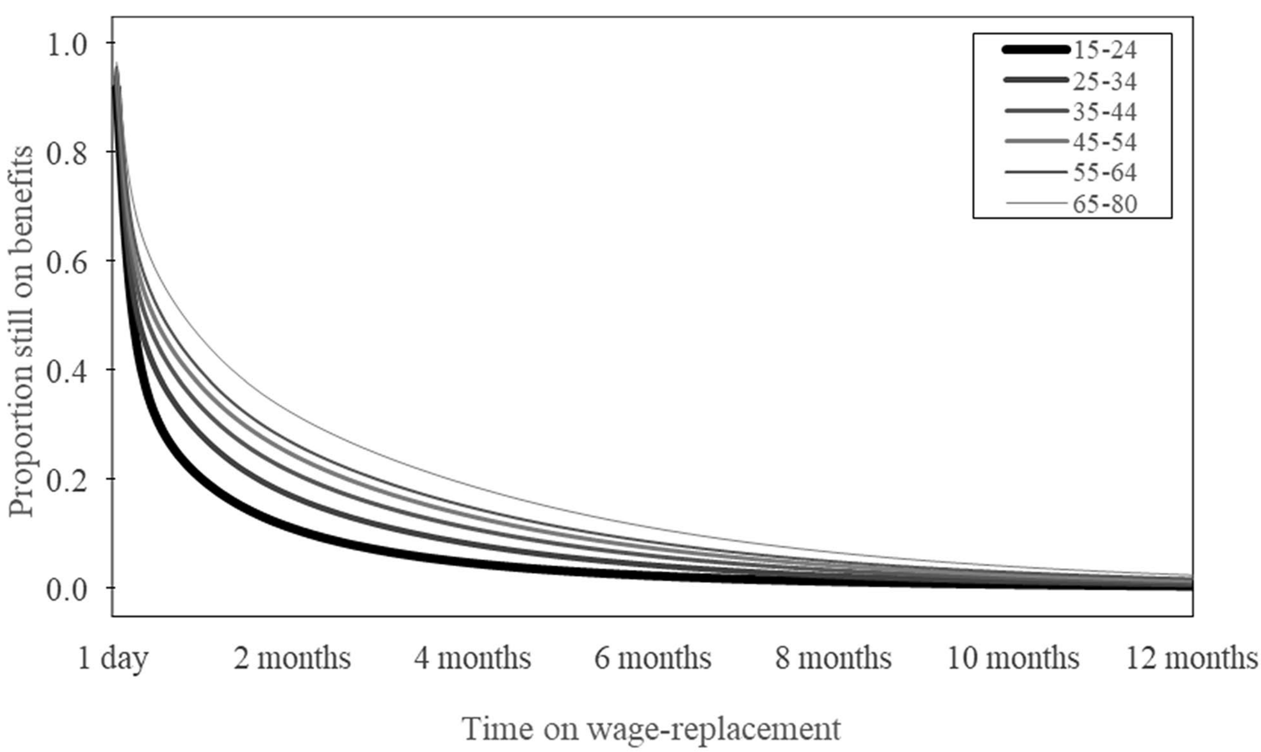
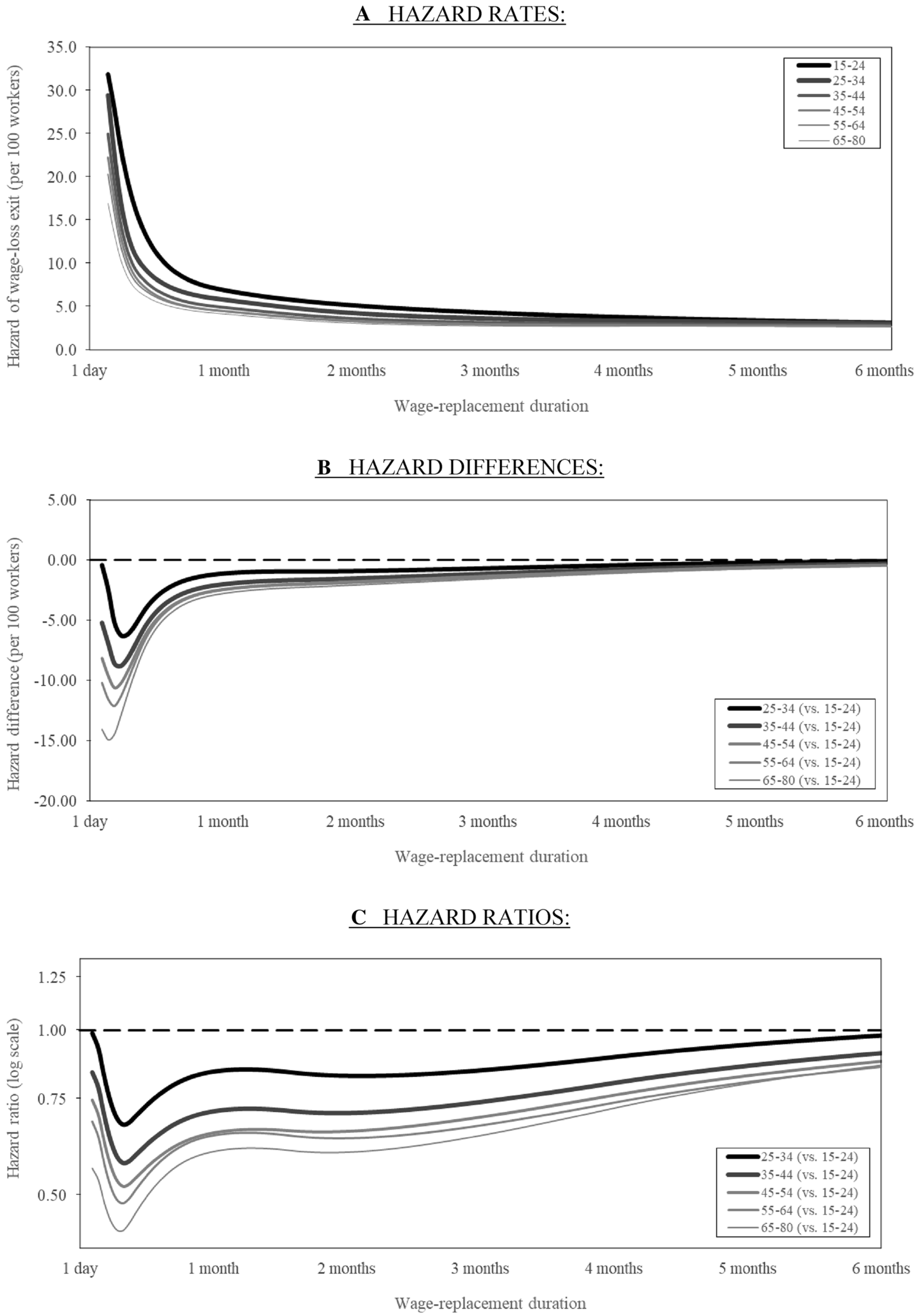


Fig. 1 Unadjusted survivor function showing the proportion of individuals who were still receiving wage-replacement benefits at specific follow-up event times, by age group. Days are standardized across provinces. WCB claims, 2011–2015. N = 751,679



[a] Models are adjusted for: age, sex, province, occupation, industry, injury type, and injury year.
[b] Estimated using flexible parametric models to allow for time-varying hazards across the distribution of event times. Interior knots for flexible parametric models are placed at the 25th, 50th, 75th and 90th centiles of the distribution of uncensored log survival times (5 degrees of freedom).
[c] Differences less than '0' correspond to a longer disability duration for a given age group compared to the reference age group.
[d] Ratios below 1.00 correspond to a longer disability duration for a given age group compared to the reference age group.

Fig. 2 Adjusted hazard rates (Panel **A**), rate differences (Panel **B**) and rate ratios (Panel **C**) for the event of transitioning off benefits, by age group[a,b,c,d]. Days are standardized across provinces. Graphs display up to 6 calendar months of follow-up

100 workers. The relative ordering of hazard functions for each age group was consistent during the initial follow-up periods, with the youngest age groups (compared to the oldest age groups) having the highest rate of exit.

The greatest absolute and relative differences (Fig. 2b, c) were observed for claims that received up to 20 work days of wage-replacement benefits. For example, among individuals who remained on benefits for 5 work days (approximately 1 calendar week), those aged 55–64 years had an absolute difference of 11.4 fewer exits (per 100 workers) and a relative difference of HR 0.52 (99% CI 0.51, 0.53), compared to those aged 15–24 years. However, by 20 work days of follow-up (approximately 1 calendar month), the absolute difference attenuated to less than 3.0 exits per 100 workers while the relative difference attenuated to HR 0.64 (99% CI 0.62, 0.65). By approximately 145 and 220 work days of follow-up (7 to 10 calendar months), the age-specific hazard functions converged due to an 'accelerating' decline in the exit rate among younger workers and a 'decelerating' decline in the exit rate among older workers. As a result, the age difference in hazard rates on the absolute and relative scales further attenuated towards a null difference of '0' (for absolute differences in rates) and '1.00' (for relative differences in rates) at later follow-up times. For comparison, the time-constant hazard ratio, assuming proportional hazards across the entire length of follow-up, was HR 0.62 (99% CI 0.61, 0.62) for ages 55–64 vs. 15–24 years.

Discussion

This study aimed to better understand age-related similarities and differences in wage-replacement duration by examining this relationship across earlier versus later periods of follow-up time as an indicator of the phase of recovery. The research is novel in its focus and in using a unique and comprehensive source of data while addressing existing methodological limitations in the analysis of wage-replacement duration outcomes. Our study has two main findings. First, we observed that older age groups exited wage-replacement benefits at a slower rate (i.e., greater disability duration) compared to younger age groups in our initial models. Second, we found unique patterns in these age-related associations depending upon follow-up time. As follow-up progressed, hazard rates for older and younger workers converged, suggesting an interaction between age and time since injury. The overall pattern of time-varying age differences was present using our cross-jurisdictional dataset, lending external validity to our findings. Together, these findings suggest that age differences in wage-replacement duration may not be ubiquitous across all contexts and that there may be social and contextual determinants that operate during various recovery phases that are important to understand.

Time-Varying Hazards

Previous studies examining the time-varying effects of age [13, 26] have found that the relationship between age and length of disability differs across acute versus chronic phases of the recovery process, with the greatest differences observed during the earlier phases followed by a diminishing effect of age over time. These studies focused on restricted samples with selected injury conditions, while using less flexible analytic methods to model the complexity of time-varying estimates across phases of recovery [7]. Our findings are consistent with these previous studies but extend the existing literature by improving upon the estimation of time-varying effects of age [32] and using a broader sample of compensation claimants.

As noted earlier, one possible explanation for the time-varying hazards is that time serves as a marker for unique contextual or workplace factors that play a differential role depending on the phase of recovery [4, 12]. If these mechanisms operate primarily during earlier versus later phases of the claim process [7, 8], then this might explain the large differences in hazard rates between age groups during the initial phases of follow-up. For example, previous systematic reviews of workplace interventions suggest that offers of modified duties and early contact with care providers may be important factors that facilitate the RTW process following work-related injury and disability [29–31]. The importance of early intervention has been noted in previous studies, and fits with a phase-specific conceptualization of RTW [8–10]. Yet, previous research examining workers' compensation claimants [40] found that older workers may be less likely to receive offers of modified work duties compared to younger workers. Thus, to the extent that the older workers have reduced control over job or work scheduling during the initial phases of follow-up [11], we might expect to see differences in the impact of these factors among older versus younger workers. On the other hand, system-level factors, such as limitations in access to, or adequacy of, benefits at the tail ends of follow-up, might incentivise workers to RTW at an increasingly faster rate over time [18]. For example, a recent study [18] found that the amount of lost income due to work-related injury increased as time off work progressed, and that the relative decline over time was greater among the oldest age groups. If these economic consequences lead to incentives to RTW [19], then this might explain the 'decelerating decline' in wage-replacement exit rates over time among older versus younger workers. Alternatively, factors such as higher job satisfaction and workplace attachment [1] may have provided a relative advantage to older workers during the later phases of the RTW process. Nevertheless, the reduced differences at later phases among both older and younger workers suggests that once workers remain off work for longer periods, they are likely to remain off work, regardless of age.

Important to note is that we conceptualized the cessation of wage-replacement payments as a terminal event that demarcated the end of a disability episode following a work-related injury, which is in keeping with previous studies [41]. However, this may be a poor indicator for an actual recovery or RTW event given the existence of competing risks, such as commencement of other benefit programs or services (e.g., vocational rehabilitation, long-term disability), labour market exit, or claim termination (e.g., being deemed capable of returning to work with no actual return) [38]. Alternatively, workers may be receiving temporary disability benefits but have actually returned to work in some capacity. Although early and safe RTW may be beneficial for health outcomes such as functional recovery following back injury [41], the early termination of benefits may not necessarily imply better outcomes from a broader RTW perspective [42]. Future work could examine other conceptualizations of disability duration [38] and confirm whether age differences persist (or attenuate) beyond the point of censoring in our study.

Taken together, our findings suggest that older age may not always be strongly associated with duration of wage-replacement and that the time-varying nature of risk estimates should be considered when examining the potential burden and impact of increased duration of wage-replacement. From a policy perspective, the time-varying nature of RTW provides information on optimal timing points for interventions [7, 25, 26] given that the relationship may vary in magnitude across the duration of recovery. Specifically, the largest absolute differences in hazard rates between age groups was observed within the first few weeks of receiving wage-replacement, followed by smaller absolute differences at later follow-up times that amounted to only two to three exits per 100 workers. Thus, applied work interventions, workplace supports or multi-component interventions for older workers [20, 27–31] might be targeted towards this period of greatest absolute risk to maximize the potential public-health impact among specific age groups [39]. These interventions may include vocational rehabilitation and claims management activities, such as return-to-work planning, worker education/training or modified work duties [30, 40]. From a methodological perspective, if the phase of recovery serves as a modifier of the relationship between age and disability duration, then the reliance on a single summary measure of risk (e.g., hazard ratio from a Cox proportional hazards model) may not provide a meaningful interpretation due to non-proportional hazards. Future studies should continue to examine the potential for time-varying effects across follow-up, given the availability and accessibility of methods [7, 32]. Finally, the finding that age differences may be contextually dependent would suggest that a fatalistic view of older workers may not be warranted [43, 44]; that we need greater understanding of social and contextual determinants of age in relation to RTW [7, 8]; and that concerns about older workers having greater sickness absence duration or claim costs [42] may require further study that is contextually-sensitive.

Strengths and Limitations

A key strength of this study was the opportunity to combine claim-level data on injured workers from six provincial-level compensation systems in Canada. Our methods accounted for time-varying relationships by considering both absolute and relative age effects. Comparisons of additive differences in hazard rates remain underutilized in previous studies [7, 32]. Moreover, we estimated the time-varying nature of these estimates across the entire range of follow-up to provide a balanced understanding of overall age differences [7, 32]. The attenuated age gradients that we observed might not have been recognized had we relied only on a single summary measure of effect. Finally, the presence of time-varying age differences using data across multiple jurisdictions lends external validity to our findings.

Our study also had limitations. The findings for time-varying hazards may be impacted by spurious duration dependence [45], whereby the population of claimants still on benefits may contain an increasingly smaller proportion of those who exit benefits at a faster rate and a growing proportion of those who exit benefits at a slower rate, resulting in a selected population with lower overall hazard rates and potential unobserved heterogeneity. At the population-level, distinguishing between true time-varying processes and unobserved heterogeneity is limited due to model identification issues [45]. The measure of wage-replacement duration was based on the cumulative number of days paid to the injured worker for temporary disability benefits as a result of time off work. Given that individuals may experience multiple recovery attempts throughout the course of recovery [3], this might have underestimated the total duration of disability following work injury if there were large gaps between payments or if days were accumulated towards the end of follow-up. Nevertheless, our outcome of cumulative days paid has been described as an appropriate option to convey the overall burden of work disability based on administrative claims data [38]. Future work should consider the role of these alternative explanations when examining time-varying age gradients in disability duration. Finally, given the use of multi-jurisdictional administrative claims data with different data collection systems, we could only examine a selected range of harmonized variables across provinces. However, there may be other unmeasured variables that could bias the results, including physical or psychosocial work conditions, injury severity or job tenure [4–6, 11, 13].

Conclusions

In this multi-jurisdictional study of workers' compensation claimants, we observed that absolute and relative differences in age-specific hazard rates of cessation of wage replacement varied as a function of follow-up time. This may have relevance for the development of targeted interventions, such as case management activities, return-to-work planning, worker education/training or modified work duties. For example, workplace supports or multi-component interventions for older workers could be targeted towards the earlier phases of the process where the hazard differences may be greatest. Future research on the different contextual factors that operate during early versus later phases of recovery, and how these factors interact with age, may help to understand why older age is strongly associated with greater duration of wage-replacement when examined overall, but perhaps less so once the differences are considered within the entirety of the recovery process.

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Appendix

Adjusted hazard rates (Panel A), rate differences (Panel B) and rate ratios (Panel C) for the event of transitioning off benefits, by age group[a]. Estimates calculated at various follow-up event times [b]. WCB claims, 2011–2015. N = 751,679.

Age group	1 week	1 month	2 months	3 months	6 months	9 months	12 months
(A) Hazard Rates Per 100 Workers (99% CI)							
15–24	23.7 (23.2, 24.1)	7.2 (7.0, 7.3)	5.3 (5.2, 5.4)	4.4 (4.3, 4.6)	3.1 (3.1, 3.3)	2.6 (2.5, 2.7)	2.3 (2.2, 2.4)
25–34	17.5 (17.1, 17.8)	6.0 (5.9, 6.1)	4.4 (4.3, 4.5)	3.7 (3.6, 3.8)	3.1 (3.0, 3.2)	2.7 (2.7, 2.8)	2.5 (2.4, 2.6)
35–44	14.9 (14.6, 15.2)	5.1 (5.0, 5.2)	3.7 (3.7, 3.8)	3.2 (3.2, 3.3)	2.9 (2.8, 2.9)	2.6 (2.5, 2.7)	2.4 (2.3, 2.5)
45–54	13.4 (13.1, 13.6)	4.6 (4.5, 4.7)	3.5 (3.4, 3.5)	3.0 (3.0, 3.1)	2.8 (2.7, 2.8)	2.6 (2.5, 2.6)	2.4 (2.3, 2.5)
55–64	12.2 (12.0, 12.5)	4.6 (4.5, 4.7)	3.4 (3.3, 3.4)	2.9 (2.9, 3.0)	2.7 (2.6, 2.8)	2.5 (2.5, 2.6)	2.4 (2.3, 2.5)
65+ years	10.6 (10.1, 11.2)	4.3 (4.1, 4.5)	3.2 (3.0, 3.3)	2.8 (2.7, 2.9)	2.7 (2.6, 2.8)	2.6 (2.5, 2.8)	2.5 (2.3, 2.7)
(B) Hazard differences per 100 workers (99% CI)[c]							
15–24	0.00 (ref.)	0.00 (ref.)	0.00 (ref.)	0.00 (ref.)	0.00 (ref.)	0.00 (ref.)	0.00 (ref.)
25–34	− 6.2 (− 6.6, − 5.8)	− 1.2 (− 1.3, − 1.0)	− 0.9 (− 1.0, − 0.8)	− 0.7 (− 0.8, − 0.6)	− 0.1 (− 0.2, 0.0)	0.1 (0.0, 0.2)	0.2 (0.1, 0.3)
35–44	− 8.8 (− 9.2, − 8.4)	− 2.1 (− 2.3, − 2.0)	− 1.6 (− 1.7, − 1.5)	− 1.1 (− 1.2, − 1.0)	− 0.3 (− 0.4, − 0.2)	0.0 (− 0.1, 0.1)	0.1 (0.0, 0.2)
45–54	− 10.3 (− 10.6, − 9.9)	− 2.6 (− 2.7, − 2.4)	− 1.8 (− 1.9, − 1.8)	− 1.3 (− 1.4, − 1.2)	− 0.4 (− 0.5, − 0.3)	0.0 (− 0.1, 0.1)	0.1 (0.0, 0.2)
55–64	− 11.4 (− 11.8, − 11.0)	− 2.6 (− 2.8, − 2.5)	− 1.9 (− 2.0, − 1.8)	− 1.4 (− 1.5, − 1.3)	− 0.4 (− 0.6, − 0.3)	− 0.1 (− 0.2, 0.0)	0.1 (0.0, 0.2)
65+ years	− 13.0 (− 13.7, − 12.4)	− 2.9 (− 3.2, − 2.7)	− 2.1 (− 2.3, − 2.0)	− 1.5 (− 1.7, − 1.4)	− 0.4 (− 0.6, − 0.3)	0.0 (− 0.2, 0.2)	0.2 (0.0, 0.4)

Age group	1 week	1 month	2 months	3 months	6 months	9 months	12 months	Time-constant
(C) Hazard ratios (99% CI)[d]								
15–24	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
25–34	0.74 (0.72, 0.75)	0.83 (0.81, 0.85)	0.83 (0.81, 0.85)	0.84 (0.82, 0.87)	0.98 (0.94, 1.01)	1.05 (1.00, 1.10)	1.09 (1.03, 1.14)	0.83 (0.82, 0.84)
35–44	0.63 (0.62, 0.64)	0.71 (0.69, 0.72)	0.71 (0.69, 0.72)	0.74 (0.72, 0.76)	0.91 (0.88, 0.94)	1.00 (0.96, 1.05)	1.06 (1.01, 1.11)	0.71 (0.70, 0.72)
45–54	0.57 (0.56, 0.58)	0.64 (0.63, 0.66)	0.65 (0.64, 0.67)	0.69 (0.68, 0.71)	0.88 (0.85, 0.91)	0.98 (0.95, 1.02)	1.05 (1.00, 1.10)	0.65 (0.64, 0.66)
55–64	0.52 (0.51, 0.53)	0.64 (0.62, 0.65)	0.64 (0.62, 0.65)	0.67 (0.65, 0.69)	0.86 (0.83, 0.89)	0.97 (0.93, 1.01)	1.04 (0.99, 1.09)	0.62 (0.61, 0.62)
65+ years	0.45 (0.43, 0.47)	0.59 (0.56, 0.63)	0.60 (0.57, 0.63)	0.64 (0.61, 0.68)	0.86 (0.82, 0.91)	1.00 (0.93, 1.08)	1.09 (1.00, 1.19)	0.56 (0.55, 0.57)

[a]Models are adjusted for: age, sex, province, occupation, industry, injury type, and injury year

[b]Estimated using flexible parametric models to allow for time-varying hazards across the distribution of event times

[c]Differences less than ‘0’ correspond to a longer disability duration for a given age group compared to the reference age group

[d]Ratios less than ‘1’ correspond to a decreased likelihood of transitioning off benefits (e.g., longer disability duration) for a given age group compared to the reference age group

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