Original research

Does gradually returning to work improve time to sustainable work after a work-acquired musculoskeletal disorder in British Columbia, Canada? A matched cohort effectiveness study

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ABSTRACT

Objective This study investigates if gradual return to work (GRTW) is associated with full sustainable return to work (RTW) for seriously injured workers with a musculoskeletal disorder (MSD), in British Columbia, Canada.

Methods This is an effectiveness study using a retrospective cohort study design. Accepted workers' compensation lost-time claims were extracted for workers with an MSD who were on full work disability for at least 30 days, between 2010 and 2015 (n=37 356). Coarsened exact matching yielded a final matched cohort of 12 494 workers who experienced GRTW at any point 30 days post-injury and 12 494 workers without any GRTW. The association between GRTW and sustainable RTW through to end of 12 months was estimated with multivariable quantile regression.

Results Workers who were provided with GRTW experienced more time-loss days until sustainable RTW between the 2nd and 5th months after the first time-loss day (<50th quantile of time loss), but less time-loss days until sustainable RTW between the 6th and 12th months of work disability (70th quantile of time loss), with the largest effect for women, workers with soft-tissue injuries and workers in the manufacturing or trades sector (all in the 60th and 70th percentile, after 6–7 months of time loss).

Conclusions For seriously injured workers with at least 30 days of disability due to a work-acquired MSD, the effect of GRTW becomes apparent at longer disability durations (more than 6 months), with larger beneficial effects for women, workers with soft-tissue injuries and for trade and manufacturing sectors.

Key messages

What is already known about this subject?
► Gradual return to work opportunities after a period of work disability due to a musculoskeletal disorder are considered a key aspect of work disability management. There is limited evidence on the effectiveness of gradual return to work for longer term claims as a population-based intervention at a jurisdictional level, where there may be specific policies or practices that determine the likelihood and effectiveness of gradual return to work.

What are the new findings?
► Gradual return to work was associated with sustainable return to work after 6 months of work disability for workers with a work-acquired musculoskeletal disorder, compared with similar workers without gradual return to work, in British Columbia, Canada. The positive long-term effects of gradual return to work were larger for women, workers with torso sprains and workers in the manufacturing and trades sector.

How might this impact on policy or clinical practice in the foreseeable future?
► For seriously injured workers (off work for at least 30 days) with a musculoskeletal disorder, the effect of gradual return to work becomes more apparent in the longer term, at least 6 months after the first time-loss day. A focus on increasing the use of gradual return to work for longer term claims could improve overall work disability duration.

INTRODUCTION

Work injury rates are declining in most high-income countries, while work disability durations remained static.[1–4] There is an increased interest in workplace-based return to work (RTW) interventions, like gradual RTW (GRTW),[5–7] as part of work disability management.[8] GRTW provides workers with the opportunity to increase working hours and workload, and to limit or modify work tasks while recovering from an injury, with the goal to return to full hours and duties.[9] GRTW is intended to reduce work disability or work disability duration.[7 10–13] Krause *et al* found that modified work facilitates

RTW for temporarily and permanently disabled workers,[10] and a recent systematic review from Cullen *et al* supported a strong association between gradual work activities and a reduction in lost time associated with work disability.[7]

Studies have focused on GRTW interventions within the workplace. However, there is limited evidence for the effectiveness of GRTW for longer term disability due to serious injury (ie, at least 30 days of work disability), or as a population-based intervention at a jurisdictional level. In the case

of the Canadian province of British Columbia (BC), GRTW is encouraged but not legislated. Accordingly, GRTW in BC, and many other jurisdictions, is not standardised by the disability compensation system and the provision of GRTW by employers varies substantially.[14–16]

In BC, almost 80% of all work disability days between 2009 and 2013 were due to a work-acquired musculoskeletal disorder (MSD).[2] Besides being a major cause of work disability and reduced productivity, MSDs are often episodic and recurrent, causing longer duration claims. GRTW may be an appropriate work disability management strategy to maintain workplace interaction while in a recovery phase.[8] The objective of this study is to investigate the effects of GRTW on sustainable RTW for workers with a disability duration 30 days or longer for a work-acquired MSD, in BC, Canada.

METHODS
Jurisdictional context
Workers who experience a recognised work-acquired injury or disease in BC are provided with disability benefits, medical aid and rehabilitation services by WorkSafeBC (the workers' compensation system in BC). WorkSafeBC is funded through employer-paid insurance premiums and provides short-term disability wage replacement to injured workers with the goal to RTW in a timely manner. For most workers, short-term disability payments, representing 90% of workers' pre-injury wage, are provided until workers fully RTW. Workers who do not completely recover from their injury and who have a permanent partial impairment are eligible for vocational re-training and/or long-term disability benefits. Over 97% of the BC labour force is covered by this work disability insurance system.[17]

Study design and data
This is an effectiveness study using a retrospective cohort study design, with a 1 year follow-up period from the first recorded time-loss day. Administrative claims data collected by the province of BC's Ministry of Health (Medical Registry data, Medical Services Plan (MSP) data, Hospital discharge abstract data and Pharmanet data) and WorkSafeBC (claims and RTW data) were linked at the individual level, and used to select workers with an accepted work-acquired MSD lost-time claim filed between 1 January 2010 and 31 December 2015.[18–22] More information about the databases can be found in online supplemental appendix 1.

The data were obtained and de-identified by Population Data BC, a multi-university, data and education resource that supports access to data on BC's 4.6 million residents for research.[23] The Behavioral Research Ethics Board at the University of British Columbia approved the study (certificate no. H17-02019).

MSDs were categorised into nine major categories using the Barell matrix for musculoskeletal injuries[24] (sprains/strains, fractures, dislocations) and International Classification of Diseases (ICD)-9-CM codes for musculoskeletal diseases (dorsopathies and rheumatism (excluding the back)). Sprains/strains and fractures were divided into three body regions: (a) head and neck/spine/back/torso; (b) upper extremities; (c) lower extremities.

The cohort was restricted to the first MSD work disability claim per worker in the study period, with a follow-up period of 365 days. Most workers RTW within 1 year after the first time-loss day.[25] Workers were excluded from the study for the following reasons (figure 1):
1. Healthcare only claims (no time loss).
2. Exclusions based on cohort definitions:

– Non-MSD-related claims (defined using ICD-9-CM codes and National Work Injury Statistics Program Nature of Injury codes).
– Age <15 or ≥65 years.
– Multiple jobholders at the time of injury.
– Claims from self-insured industry sectors. There is less RTW data available for these firms as WorkSafeBC interacts differently with these companies.
– Work-related fatal injuries.
3. Exclusions based on missing data on firm size, industry, wage or gender.
4. Exclusions based on missing MSP registration date, or lack of registration in the year before and after injury.
5. Pregnancy in year before claim.

A total of 127 181 unique MSD claims were included in the study, including 53 102 workers (41.8%) with at least 1 day of GRTW.

The cohort was restricted to those on full disability for at least 30 days after the first time-loss injury day, a threshold to distinguish between short and longer work disability duration.[26] Further, the provision of GRTW within 30 days of the first time-loss day is less common for injuries with longer disability durations[25 27] and workers with these injuries may be less likely to benefit from GRTW.

Outcomes
The primary outcome was calendar days from the first time-loss day until sustainable RTW (end of claim, no further disability days) up to 365 days. Secondary outcomes were (a) time-loss days until full sustainable RTW or sustainable GRTW (end of claim defined as GRTW, no further full disability days) until 365 days and (b) time-loss days until sustainable RTW up to 730 days.

Explanatory variable
GRTW was defined as temporarily changing a worker's duties, hours and/or days of work within the same job/same employer while being on a compensation claim. Partial benefits compensate for the income loss due to the disability. This is distinct from vocational rehabilitation that would be provided to workers with permanent partial work disability.

GRTW was indicated in WorkSafeBC's RTW event data (work disability, GRTW, non-RTW or RTW) daily after injury. GRTW was measured as 'yes' versus 'no' for at least 1 day of GRTW in each month of follow-up, starting at the second month after the first time-loss day. More information on GRTW can be found in Maas et al.[27]

Covariates
The following variables were included as potential confounders based on prior research and those with the greatest association with being provided GRTW (as explained below):
► MSD, as specified above.
► Age (15–24, 25–34, 35–44, 45–54, 55–64 years).
► Gender (woman, man).
► Annual wage (<\$20 000, \$20 000–39 999, \$40 000–59 999, >\$59 999 Canadian dollars (CAD\$)).
► Occupation, classified according to Statistics Canada's Standard Occupational Classification.[28]
► History of prior claims (yes/no): at least one accepted claim for any type of injury or illness in the preceding 10 years to the MSD claim.
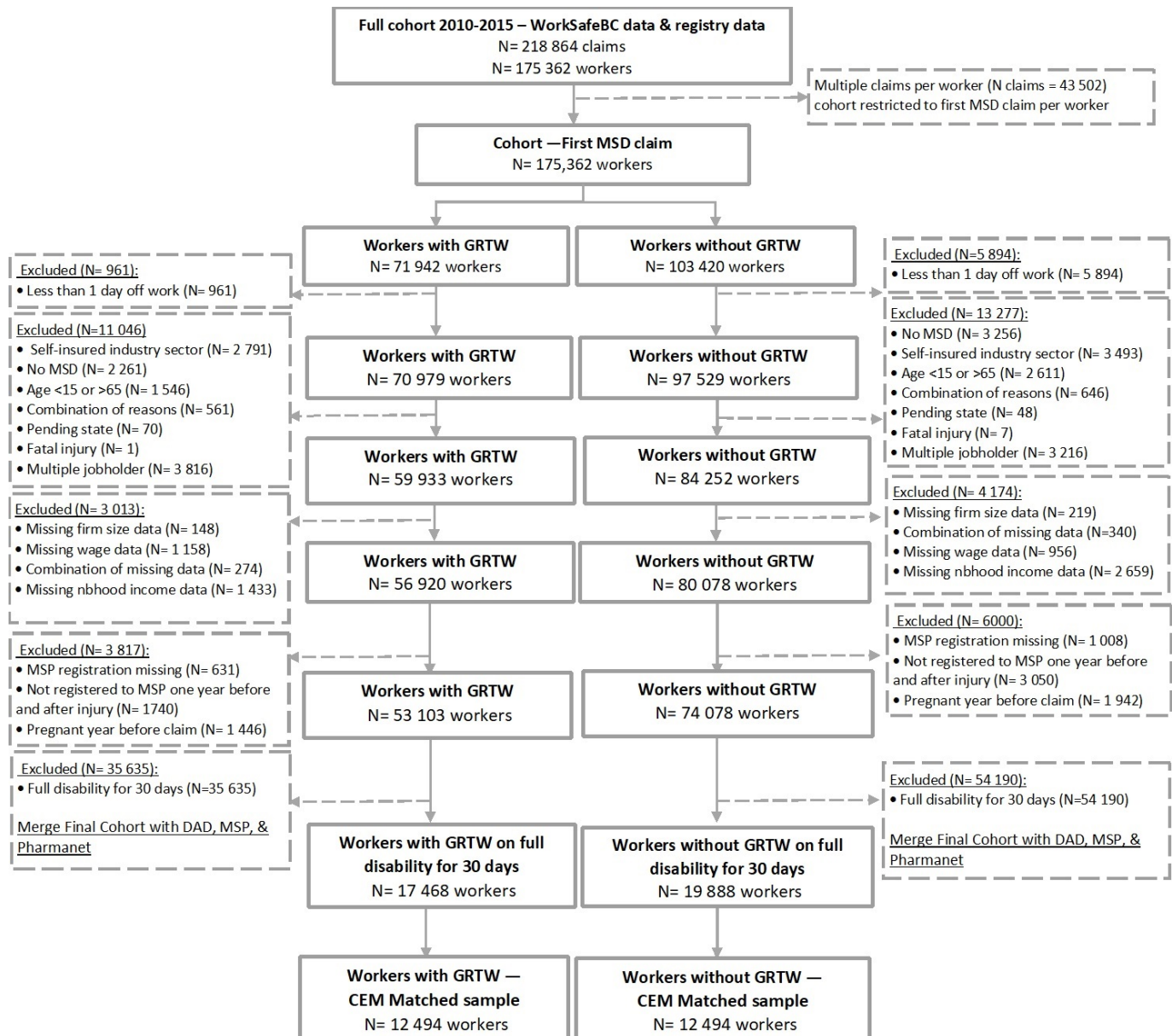
Figure 1 Construction of a cohort of workers with work-acquired musculoskeletal disorders from compensation claims data in British Columbia between 2010 and 2015. GRTW, gradual return to work; MSD, musculoskeletal disorder; MSP, Medical Services Plan.

- ► Industry sector, classified according to the WorkSafeBC industry classification structure.[29]
- ► Size of the workers' firm measured as fulltime equivalent (FTE) workers employed by the firm at the time of the MSD injury (<20, 20–99, 100–499, 500–999, >999 FTE).
- ► Claim year was identified as start date of the claim (2010–2015).
- ► Opioid, non-steroidal anti-inflammatory drugs, and skeletal muscle relaxants use within 30 days after the first time-loss day.
- ► Comorbidities (see online supplemental appendix 1).

Statistical analyses

Descriptive statistics identified differences between workers with and without GRTW in the cohort of workers that were on full disability for 30 days.

A logistic regression model assessed the relative contribution of injury, sociodemographic, workplace, healthcare and temporal characteristics in predicting the likelihood of GRTW 30 days or more after the first time-loss day to inform the matching strategy. The model was built according to recommended methodological guidelines for multivariable logistic regression analysis.[30 31] We have used the prediction model in addition to prior independent work to select the matching variables.[27]

Workers with and without GRTW were matched on the identified characteristics using coarsened exact matching (CEM).[32 33] The aim of matching was to find balance across the multidimensional distribution of covariates. This reduces the degree of dependence on the estimation model for the outcome variable and reduces estimation bias.[34]

Quantile regression was used to estimate the number of additional time-loss days until sustainable full RTW for workers with GRTW compared with workers without GRTW at different points in the disability distribution. This method is ideal for analyses where the outcome variable can be skewed, and outliers may affect the mean.[35] Quantile regression is not restricted by the

proportional hazard's assumption like cox proportional hazards, which require complex modifications when this assumption is violated. In contrast, quantile regression estimates the effect on the outcome directly instead of the hazard rate and this can be more intuitive, easier to interpret and relevant to decision-making. Based on visualisation of time loss days, the quantile regressions were specified a priori from the 10th to the 90th percentile in 10% increments. All covariates were included in the model.

The main model was used to estimate predicted time-loss days between workers with and without GRTW until full sustainable RTW up to 365 days after the first time-loss day at various points in the disability distribution, holding other independent variables at their mean values.[36]

To test study assumptions, secondary models were used to estimate differences in time-loss days until (a) sustainable RTW or sustainable GRTW (no further full disability days) up to 365 days (the assumption being that sustainable work accommodation is preferred over continued time-loss as a positive outcome), and (b) sustainable RTW until 730 days. For the latter model, the cohort was redefined and re-matched for claims occurring between 2010 and 2014 to enable 2 years of follow-up. Further, separate models were constructed for the unmatched cohort for comparison of results, and for the cohort of workers employed at firms who had offered GRTW at least once between 2010 and 2015 to control for workplace variability. This leaves out workers at firms that never offered GRTW in the study period and who are not 'at risk' of being offered GRTW.

All analyses were performed in Stata V.16.0 (Stata Corp).

RESULTS
Descriptive statistics
The characteristics used for cohort matching are summarised in table 1.

The unmatched cohort of workers with a work-acquired MSD lost-time claim who were on work disability for at least 30 days between 2010 and 2015 comprised 37 356 workers, of which 47% of workers had experienced GRWT between 30 days and 1 year after injury. The sample comprised 65% men, had a median age of 46 years (IQR 35–54) and a median annual wage prior to injury of approximately CAD\$ 42 000 (IQR 30 000–60 000). Back sprains and strains were the most common disorder type (34%). The most common industry sector was the services sector (39%), and the most common occupation was trades, transport and equipment operations (38%). The median firm size associated with an injured worker was 46 FTE (IQR 9–254). More information and clinical characteristics (healthcare utilisation and medication use) are shown in online supplemental appendix 2.

Proportionately more women were provided with GRTW (56%) compared with men (42%). The provision of GRTW among injured workers increased with increasing age, wage and year of the study. There were more workers with GRTW in larger firms, in the trade industry and on fixed job shifts. There was little variation between workers with and without GRTW in terms of clinical characteristics in the 30 days after the first time-loss day. Clinical characteristic, as one of the proxy measures for injury severity, was not found as being predictive of being offered GRTW.

Likelihood of workers to receive GRTW
Firm size, gender, claim year, shift type, annual wage, occupation and industry sector were statistically significant ($p < 0.05$)

predictors of the likelihood that a worker would be provided with GRTW based on the multivariate logistic regression model, as well univariate F tests (online supplemental appendix 3), and were used for the CEM. Occupation and industry sector were collinear and only industry sector was used for CEM.

Matching
After using CEM, the matched cohorts resulted in equal distributions in matched covariates between workers with (n=12 494) and without (n=12 494) GRTW (table 1). The multivariable imbalance measure L1 improved from 0.33 to 0.00 by CEM, indicating that balance in the matched cohorts could not be improved.

Difference in time-loss days between workers with and without GRTW
Among the matched cohort, the quantile regression results for the main model indicated that between the 10th and the 50th percentile of the disability distribution, workers with GRTW had on average 24 more work disability days until sustainable RTW compared with workers without GRTW (eg, at the 10th percentile=β 21.8; 95% CI 20.7 to 22.8) and at the 50th percentile=β 24.6; 95% CI 19.9 to 29.2) (table 2). By the 70th percentile of the distribution, however, workers with GRTW had fewer disability days than workers without GRTW (β −9.4; 95% CI −22.2 to 3.5). There was no difference in time-loss days until sustainable RTW between workers with and without GRTW at the 80th and 90th percentile.

Results for the effect of GRTW were larger when sustainable GRTW was included in the outcome along with sustainable RTW (table 2). Between the 10th and 50th percentile of the distribution, workers with GRTW had on average 10 more disability days than workers without GRTW. However, workers with GRTW had fewer disability days at the 60th percentile (β −21.5 days; 95% CI −28.7 to −14.4 days), 70th (β −85.7; 95% CI −94.5 to −76.9) and 80th percentile (β −82.0; 95% CI −88.8 to −75.3). No differences in disability duration were found at the 90th percentile due to the censoring effect at 365 days.

A graphical representation of these results is presented in online supplemental appendix 8.

Results were also comparable for the matched cohort of workers followed for 2 years (online supplemental appendix 6), but the effect sizes were larger given the longer disability window. Among the cohort comprised of 23 318 workers, beneficial effects for GRTW on sustainable RTW were observed at the 60th (β −22.5 days; 95% CI −41.6 to −3.5) and 70th percentile (β −139.5; 95% CI −166.8 to −111.9); and on sustainable RTW or GRTW between the 50th and 80th percentiles (eg, β at 70th percentile −374.7 days; 95% CI −393.6 to −355.9).

Difference in time-loss days between workers with and without GRTW, by gender and industry sector
Differences emerged in the pattern of disability duration by GRTW status were interacted by gender (table 3). Women with GRTW had fewer time-loss days at the 60th and 70th percentile of the disability distribution compared with women without GRTW and no difference after that, while men with GRTW had more time-loss days until the 80th percentile compared with men without GRTW.

The largest differences in the effect of GRTW appear when interacted with injury type, for torso sprains, upper

Table 1 Descriptive statistics of workers on full work disability for 30 days with an accepted MSD lost-time claim between 2010 and 2015, by GRTW status, in the Canadian jurisdiction of British Columbia

	Unmatched cohort			Matched cohort		
	Workers with GRTW	Workers without GRTW		Workers with GRTW	Workers without GRTW	
	n=17 468 (46.8%)	n=19 888 (53.2%)	χ^2	n=12 494 (50.0%)	n=12 494 (50.0%)	χ^2
	(Column %)	(Column %)	P value	(Column %)	(Column %)	P value
Unmatched variables						
Injury and sociodemographic characteristics						
Musculoskeletal disorder			<0.001			<0.001
Upper extremity sprains and strains	18.82	16.23		18.42	16.98	
Lower extremity sprains and strains	13.30	14.66		13.34	14.70	
Back* sprains and strains	33.56	33.60		32.12	34.79	
Upper extremity fractures	9.85	10.45		10.54	9.64	
Lower extremity fractures	8.32	7.91		8.80	7.18	
Torso† fractures	3.26	4.36		3.68	3.75	
Dislocation	2.32	2.75		2.44	2.55	
Dorsopathies	4.91	4.84		5.06	4.73	
Rheumatism (excluding the back)	5.66	5.19		5.59	5.67	
Age (in years)			<0.001			<0.001
15–24	5.82	9.77		6.34	8.80	
25–34	16.27	18.13		17.21	17.45	
35–44	22.80	22.35		22.60	22.38	
45–54	32.76	29.88		31.88	30.73	
55–64	22.26	19.88		21.97	20.63	
Occupation			<0.001			<0.001
Trades, transport and equipment operations‡	37.79	48.44		41.70	42.88	
Business, finance and administration§	4.05	2.77		3.75	3.03	
Natural and applied sciences¶	1.76	1.86		1.80	1.78	
Health	13.56	9.35		12.15	12.05	
Education, law and social services**	4.17	3.30		3.87	4.78	
Art, culture, recreation and sports††	0.88	1.39		0.86	1.39	
Sales, service	22.70	16.92		21.35	19.85	
Management	2.68	2.03		2.50	2.04	
Natural resources, agriculture	3.30	7.05		3.75	4.35	
Manufacturing and utilities‡‡	9.11	6.59		8.28	7.87	
Variables used for coarsened exact matching						
Gender			<0.001			1.000
Men	58.82	71.33		35.32	35.32	
Women	41.18	28.67		64.68	64.68	
Annual wage (CAD$)			<0.001			1.000
<$20 000	7.60	11.68		7.93	7.93	
$20 000–$39 999	45.66	36.34		37.19	37.19	
$40 000–$59 999	50.96	27.11		29.75	29.75	
>$59 999	47.45	24.87		25.13	25.13	
Workplace characteristics						
Shift type			<0.001			1.000
Fixed	49.21	41.72		48.09	48.09	
Rotating	7.88	7.35		6.68	6.68	
Variable	42.91	50.93		45.24	45.24	
Industry sector			<0.001			1.000
Primary resources	2.95	7.41		3.41	3.41	
Manufacturing	14.93	10.49		13.22	13.22	
Construction	13.25	20.60		17.37	17.37	
Transportation and warehousing	9.58	14.72		10.18	10.18	
Trade	12.24	7.57		9.08	9.08	
Public sector	4.53	3.16		3.12	3.12	
Service sector	42.52	36.05		43.61	43.61	
Firm size (FTE)			<0.001			1.000

Table 1 continued

	Unmatched cohort			Matched cohort		
	Workers with GRTW	Workers without GRTW		Workers with GRTW	Workers without GRTW	
	n=17 468 (46.8%)	n=19 888 (53.2%)	χ^2	n=12 494 (50.0%)	n=12 494 (50.0%)	χ^2
	(Column %)	(Column %)	P value	(Column %)	(Column %)	P value
<20	28.56	45.52		36.15	36.15	
20–100	23.81	24.26		26.25	26.25	
100–500	23.81	16.08		20.11	20.11	
500–1000	5.93	3.85		3.94	3.94	
>1000	17.89	10.29		13.56	13.56	
Claim year			<0.001			1.000
2010	15.15	18.48		16.37	16.37	
2011	15.87	19.36		17.68	17.68	
2012	17.03	17.42		18.14	18.14	
2013	17.09	16.55		17.05	17.05	
2014	17.63	14.96		15.94	15.94	
2015	17.23	13.22		14.82	14.82	

*Back, head, neck, spine and torso.
†Torso, back, neck, spine and head.
‡Trades, transport, equipment operators and related occupations.
§Business, finance and administration.
¶Natural and applied sciences, related occupations.
**Social science, education, government, service and religion.
††Recreation, arts, culture and sport.
‡‡Manufacturing, processing and utilities.
CAD$, Canadian dollars; FTE, fulltime equivalent; GRTW, gradual return to work; MSD, musculoskeletal disorder.

extremity fractures and rheumatism (table 4; other injury types presented in online supplemental appendix 4). For torso sprains, workers with GRTW had fewer time-loss days at the 60th (β −18.9; 95% CI –33.7 to –4.1) and the 70th percentile (β −82.2; 95% CI –101.9 to –62.3). Censoring prevented identifying differences at the 80th and 90th percentiles. For upper extremity fractures, workers with GRTW had more time-loss days at every percentile of the disability duration; and for rheumatism claims, workers

with GRTW had smaller but beneficial effects at the 60th (β −13.8; 95% CI −49.7 to 22.2) and 70th percentile (β −17.6; 95% CI −65.8 to 30.6).

By industry sector (table 5), being provided with GRTW showed beneficial effects in the trade and manufacturing sectors in the 60th and 70th percentile. No differences were observed in the services or construction sectors, or among the remaining other smaller industry sectors (online supplemental appendix 5).

Table 2 Adjusted quantile regression for differences in time-loss days until full sustainable RTW 1 year after the first time-loss day*

	Outcome=full sustainable RTW 1 year after the first time-loss day (n=24 988)			Outcome=sustainable GRTW OR full sustainable RTW 1 year after the first time-loss day (n=24 988)	
	Calendar days off work for workers without GRTW† (95% CI)	Coefficient—additional calendar days off work for workers with GRTW (95% CI)		Calendar days off work for workers without GRTW (95% CI)	Coefficient—additional calendar days off work for workers with GRTW (95% CI)
10th	44.63 (43.86 to 45.39)	21.76 (20.67 to 22.84)	10th	44.15 (43.44 to 44.86)	11.51 (10.50 to 12.52)
20th	57.77 (56.68 to 58.86)	24.75 (23.20 to 26.29)	20th	57.10 (56.07 to 58.13)	13.68 (12.21 to 15.14)
30th	74.24 (72.69 to 75.80)	26.32 (24.11 to 28.52)	30th	73.01 (71.62 to 74.40)	12.66 (10.68 to 14.64)
40th	96.10 (93.86 to 98.35)	25.87 (22.68 to 29.05)	40th	94.20 (92.35 to 96.06)	9.48 (6.86 to 12.11)
50th	128.06 (124.79 to 131.34)	24.55 (19.91 to 29.20)	50th	123.81 (120.97 to 126.66)	2.68 (−1.36 to 6.72)
60th	185.53 (179.58 to 191.47)	13.26 (4.82 to 21.69)	60th	177.87 (172.85 to 182.89)	−21.52 (−28.65 to −14.40)
70th	284.27 (275.24 to 293.31)	−9.35 (−22.18 to 3.47)	70th	285.62 (179.42 to 291.83)	−85.73 (−94.54 to −76.93)
80th	348.79 (347.70 to 349.88)	0 (−1.54 to 1.54)	80th	350.50 (345.74 to 355.26)	−82.00 (−88.75 to −75.25)
90th	365.00 (365.00 to 365.00)	0 (0 to 0)‡	90th	365 (364.93 to 365.07)	0 (−0.1 to 0.09)

The regression coefficients represent the difference in days relative to the number of disability days for the workers without GRTW by 10 percentiles of the distribution.
*Adjusted for: MSD, age, wage, gender, occupation, prior claims, firm size, industry sector, claim year, use of opioids, NSAIDs and SMRs within 30 days post claim.
†Adjusted prediction of cumulative time-loss days when all other variables are set at the sample means.
‡Zero value caused by censoring of the data at 365 days.
GRTW, gradual return to work; MSD, musculoskeletal disorder; NSAIDs, non-steroidal anti-inflammatory drugs; RTW, return to work.

Table 3 Adjusted quantile regression for differences in time-loss days until full sustainable RTW 1 year after the first time-loss day,* by gender

	Women		Men	
	Calendar days off work for workers without GRTW (95% CI)†	Coefficient (additional calendar days off work for workers with GRTW) (95% CI)	Calendar days off work for workers without GRTW (95% CI)	Coefficient (additional calendar days off work for workers with GRTW) (95% CI)
10th	46.26 (44.79 to 47.73)	19.9 (18.10 to 21.70)	43.60 (42.57 to 44.62)	23.03 (21.69 to 24.36)
20th	61.39 (59.20 to 63.58)	20.46 (17.77 to 23.15)	55.88 (54.35 to 57.41)	27.58 (25.59 to 29.58)
30th	78.40 (75.46 to 81.34)	19.76 (16.15 to 23.36)	71.28 (69.22 to 73.33)	31.21 (28.54 to 33.88)
40th	101.62 (97.37 to 105.86)	17.33 (12.12 to 22.53)	92.80 (89.83 to 95.77)	31.54 (27.69 to 35.39)
50th	135.20 (128.57 to 141.83)	14.13 (5.99 to 22.26)	123.23 (118.59 to 141.83)	32.55 (26.52 to 38.57)
60th	198.50 (187.09 to 209.91)	−3.48 (−17.47 to 10.51)	175.02 (167.04 to 183.00)	27.23 (16.87 to 37.60)
70th	299.63 (282.20 to 317.07)	−32.98 (−54.37 to −11.59)	278.57 (266.37 to 290.76)	1.88 (−13.97 to 17.73)
80th	348.79 (346.68 to 350.90)	0 (−2.59 to 2.59)	348.79 (347.31 to 350.26)	0 (−2.59 to 2.59)
90th	365.00 (365.00 to 365.00)	0 (0 to 0)‡	365.00 (365.00 to 365.00)	0 (0 to 0)‡

The regression coefficients represent the difference in days relative to the number of days for the workers without GRTW by 10 percentiles of the distribution.
*Adjusted for: MSD, age, wage, gender, occupation, prior claims, firm size, industry sector, claim year, use of opioids, NSAIDs and SMRs within 30 days post claim.
†Adjusted prediction of cumulative time-loss days when all other variables are set at the sample means.
‡Zero value caused by censoring of the data at 365 days.
GRTW, gradual return to work; MSD, musculoskeletal disorder; NSAIDs, non-steroidal anti-inflammatory drugs; RTW, return to work.

Other comparisons

The matched cohort of workers who were followed-up for 2 years (online supplemental appendix 6) comprised 23 318 workers and showed large beneficial effects for GRTW at the 60th (β −22.5; 95% CI −41.6 to −3.5) and 70th percentile (β −139.5; 95% CI −166.8 to −111.87). Larger effects were shown between the 50th and 80th percentile in favour of GRTW when sustainable GRTW is considered a positive outcome (online supplemental appendix 6).

Online supplemental appendix 7 provides the results for the matched cohort of workers limited to employers who offered GRTW at least once between 2010 and 2015 (n=19 568 workers). The overall conclusions were similar, but the effect sizes were attenuated, as expected, since the contrast of workers with and without GRTW was decreased with the removal of workers at employers who never offered GRTW.

DISCUSSION
Main results
The objective was to investigate if GRTW facilitates sustainable RTW for workers with a work-acquired MSD, who are off work for at least 30 days, between 2010 and 2015 in BC, Canada. First, there were differences in work disability duration by GRTW status over the longer term, even after accounting for a

wide range of sociodemographic, economic and injury predictors. Workers with GRTW had fewer disability (time-loss) days at the 60th and 70th percentile of the disability duration. This is an important finding for work disability management of the benefits of GRTW beyond typical work disability windows for most MSDs. Second, workers with GRTW had fewer disability days when both sustained RTW or GRTW were considered a positive outcome. It is important for work disability management systems to consider sustained work accommodations for workers with long duration claims and to reflect the real-world application of GRTW as an intermediate state in the RTW process. However, there is a group of workers who have significant injuries and permanent disability who may not be able to RTW to their previous job, and for who GRTW is not effective. These workers require vocational rehabilitation and, in some cases, will not RTW. Third, the effect of GRTW differed by MSD type, with the greatest differences observed for soft-tissue disorders, which may be more likely to resolve after initial treatment and compared with chronic inflammatory disorders.

Another notable finding is the larger effect of GRTW for women. This effect was likely attributable to the lower likelihood of sustainable RTW for women who were not provided with GRTW over the longest disability durations, as shown in other studies.[37–39] By industry, larger effects were found for the

Table 4 Adjusted quantile regression for differences in time-loss days until full sustainable RTW 1 year after the first time-loss day,* by MSD

	Torso sprains		Upper extremity fractures		Rheumatism	
	Calendar days off work for workers without GRTW (95% CI)†	Coefficient (additional calendar days off work for workers with GRTW) (95% CI)	Calendar days off work for workers without GRTW (95% CI)	Coefficient (additional calendar days off work for workers with GRTW) (95% CI)	Calendar days off work for workers without GRTW (95% CI)	Coefficient (additional calendar days off work for workers with GRTW) (95% CI)
10th	43.16 (41.80 to 44.53)	17.48 (15.58 to 19.39)	46.47 (43.52 to 49.42)	31.4 (27.49 to 35.31)	42.55 (39.24 to 45.85)	26.46 (21.89 to 31.09)
20th	56.36 (54.37 to 58.35)	16.25 (13.48 to 19.02)	57.88 (54.16 to 61.60)	42.24 (36.56 to 47.92)	56.66 (51.86 to 61.45)	32.18 (25.45 to 38.90)
30th	72.09 (69.39 to 74.78)	12.95 (9.19 to 16.71)	73.64 (67.83 to 79.45)	51.48 (43.76 to 59.19)	77.57 (71.06 to 84.08)	27.62 (18.49 to 36.75)
40th	89.76 (85.96 to 93.57)	10.78 (5.49 to 16.08)	94.15 (85.96 to 102.34)	53.16 (42.29 to 64.03)	108.31 (99.13 to 117.49)	15.80 (2.93 to 28.67)
50th	119.94 (114.10 to 125.79)	4.37 (−3.77 to 12.50)	119.29 (106.70 to 131.87)	57.17 (40.46 to 73.88)	152.40 (138.30 to 166.50)	2.79 (−16.98 to 22.57)
60th	180.07 (169.46 to 190.68)	−18.91 (−33.68 to −4.14)	158.50 (135.65 to 181.35)	50.16 (19.83 to 80.49)	216.01 (190.40 to 241.62)	−13.75 (−49.66 to 22.16)
70th	307.07 (292.82 to 321.31)	−82.16 (−101.98 to −62.33)	240.61 (209.93 to 271.29)	34.7 (−6.01 to 75.41)	310.00 (276.43 to 345.17)	−17.63 (−65.83 to 30.57)
80th	348.79 (346.06 to 351.52)	0 (0 to 0)‡	348.79 (342.90 to 354.67)	0 (−7.81 to 7.81)	348.79 (342.19 to 355.38)	0 (−9.25 to 9.25)
90th	365.00 (365.00 to 365.00)	0 (0 to 0)‡	365.00 (365.00 to 365.00)	0 (0 to 0)‡	365.00 (365.00 to 365.00)	0 (0 to 0)‡

The regression coefficients represent the difference in days relative to the number of days for the workers without GRTW by 10 percentiles of the distribution.
*Adjusted for: MSD, age, wage, gender, occupation, prior claims, firm size, industry sector, claim year, use of opioids, NSAIDs and SMRs within 30 days post claim.
†Adjusted prediction of cumulative time-loss days when all other variables are set at the sample means.
‡Zero value caused by censoring of the data at 365 days.
GRTW, gradual return to work; MSD, musculoskeletal disorder; NSAIDs, non-steroidal anti-inflammatory drugs; RTW, return to work.

Table 5 Adjusted quantile regression for differences in time-loss days until full sustainable RTW 1 year after the first time-loss day,* by industry sector

	Service sector		Trade		Manufacturing		Construction	
	Calendar days off work for workers without GRTW (95% CI)†	Coefficient (additional calendar days off work for workers with GRTW) (95% CI)	Calendar days off work for workers without GRTW (95% CI)†	Coefficient (additional calendar days off work for workers with GRTW) (95% CI)	Calendar days off work for workers without GRTW (95% CI)†	Coefficient (additional calendar days off work for workers with GRTW) (95% CI)	Calendar days off work for workers without GRTW (95% CI)†	Coefficient (additional calendar days off work for workers with GRTW) (95% CI)
10th	44.94 (43.60 to 46.28)	20.22 (18.55 to 21.89)	42.71 (40.07 to 45.35)	25.72 (22.06 to 29.37)	44.98 (42.52 to 47.43)	22.7 (19.67 to 25.73)	44.97 (42.91 to 47.03)	22.5 (19.89 to 25.15)
20th	58.45 (56.52 to 60.39)	21.90 (19.49 to 24.30)	56.82 (53.01 to 60.62)	26.57 (21.30 to 31.83)	58.96 (55.43 to 62.50)	24.68 (20.31 to 29.04)	58.93 (55.96 to 61.91)	25.62 (21.81 to 29.43)
30th	74.83 (72.19 to 77.47)	22.65 (19.36 to 25.95)	74.53 (69.32 to 79.73)	26.61 (19.41 to 33.82)	76.25 (71.41 to 81.09)	25.62 (19.65 to 31.59)	75.85 (71.79 to 79.92)	27.11 (21.90 to 32.32)
40th	95.14 (91.33 to 98.96)	22.15 (17.39 to 26.90)	98.20 (90.68 to 105.71)	23.27 (12.87 to 33.67)	104.04 (97.06 to 111.03)	20.39 (11.77 to 29.02)	98.07 (92.20 to 103.94)	28.56 (21.04 to 36.09)
50th	124.13 (118.27 to 130.00)	20.65 (13.34 to 27.96)	134.71 (123.16 to 146.27)	11.72 (−4.26 to 27.71)	146.73 (136.00 to 157.47)	5.94 (−7.31 to 19.20)	135.25 (126.22 to 144.28)	27.19 (15.63 to 38.75)
60th	175.21 (164.87 to 185.55)	12.70 (−0.18 to 25.58)	245.72 (225.37 to 266.08)	−59.66 (−87.93 to −31.50)	245.05 (226.14 to 263.97)	−53.79 (−77.14 to −30.43)	206.38 (190.47 to 222.29)	7.07 (−13.31 to 27.44)
70th	276.59 (260.82 to 292.36)	−16.23 (−35.88 to 3.42)	316.72 (285.67 to 347.77)	−70.49 (−113.45 to −27.52)	317.24 (288.39 to 346.09)	−44.15 (−79.77 to −8.52)	305.55 (281.29 to 329.82)	−8.03 (−39.11 to 23.04)
80th	348.79 (346.78 to 350.80)	0 (−2.51 to 2.51)‡	348.79 (344.96 to 352.62)	0 (−5.48 to 5.48)‡	348.79 (345.11 to 352.47)	0 (−4.55 to 4.55)	348.79 (345.69 to 351.88)	0 (−3.96 to 3.96)
90th	365.00 (365.00 to 365.00)	0 (0 to 0)‡	365.00 (365.00 to 365.00)	0 (0 to 0)‡	365.00 (365.00 to 365.00)	0 (0 to 0)‡	365.00 (365.00 to 365.00)	0 (0 to 0)‡

The regression coefficients represent the difference in days relative to the number of days for the workers without GRTW by 10 percentiles of the distribution.
*Adjusted for: MSD, age, wage, gender, occupation, prior claims, firm size, industry sector, claim year, use of opioids, NSAIDs and SMRs within 30 days post claim.
†Adjusted prediction of cumulative time-loss days when all other variables are set at the sample means.
‡Zero value caused by censoring of the data at 365 days.
GRTW, gradual return to work; MSD, musculoskeletal disorder; NSAIDs, non-steroidal anti-inflammatory drugs; RTW, return to work.

trade and manufacturing sectors, sectors that are more likely to offer GRTW to their injured workers.[27] These sectors generally have better access to resources and more possibilities to offer modified hours or duties compared with other industry sectors.

Finally, the importance of workplace factors being most predictive for providing GRTW speaks to the need to provide supports and resources to workplaces to improve workplace practices in accommodating workers while they recover.

Strengths and limitations

Major strengths of this study are the population-based sample that represents all compensated lost-time MSDs in BC from 2010 to 2015, as well as the use of longitudinal and comprehensive health data from the pre-injury and post-injury period. We also implemented a robust analytical approach that minimised bias due to differences in the distribution of covariates between workers with and without GRTW. CEM improved the balance in the distribution of covariates to achieve robust inferences.

Regardless of the strengths, reliance on administrative data may be subject to misclassification and information bias. However, derivation of variables from the administrative data was detailed, and any bias is hypothesised to be non-differential with a conservative effect on the observed findings. Reliance on administrative data did not allow us to get a more granular understanding of the type of GRTW, and this study provides the reader with a general effect of GRTW on a jurisdictional level, compared with specific practices.

Restricting the analyses to claims with more than 30 days of wage replacement may lead to collider-stratification bias.[40] However, the construction of the cohort was done to minimise selection bias, including by thorough variable construction, transparency of exclusions, selecting workers who were on work disability for at least 30 days and might benefit from GRTW, and the use of a matching strategy to create comparable cohorts with and without GRTW.

Implications for research and practice

This study provides evidence for policymakers and occupational health professionals concerned with work disability management and the effect of GRTW in facilitating both sustainable RTW or sustainable GRTW. GRTW was effective for MSD claims with a longer duration representing moderate to severe injuries and claims with sustainable GRTW as a positive outcome, with larger effects observed for women, workers with soft-tissue injuries and for major industrial sectors. A focus on increasing the use of GRTW for long-term claims among employers in BC, and similar jurisdictions, could reduce work disability duration for those off work for 30 days.

Future research would benefit from addressing the issue of more refined or detailed measures of GRTW and sustained RTW outcomes. For example, we were not able to identify the type of GRTW that was most effective.

Conclusion

We found a positive effect of GRTW on sustainable RTW at more than 6 months of disability duration, among seriously injured workers with a work-acquired MSD in BC, Canada. We recommend endorsement of GRTW for injured workers by employers and workers' compensation systems to reduce lost time for MSDs, including additional resources and supports to help workplaces to offer accommodations and the strengthening of jurisdictional policies to support this as a standard component of disability management.

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