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Are the early predictors of long-term work absence following injury time-dependent? Results from the Prospective Outcomes of Injury Study

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Abstract

Objectives: Few studies examine the influence of early predictors of work absence beyond 12 months following injury or the time-dependent relative importance of these factors. This study aimed to identify the most important socio-demographic, occupational, health, lifestyle and injury predictors of work absence at 12- and 24-months following injury and to examine changes in the relative importance of these over time.

Design: Prospective cohort study.

Setting: The Prospective Outcomes of Injury Study, New Zealand.

Participants: 2626 injured New Zealand workers were identified from the Prospective Outcomes of Injury Study; 2092 completed the 12 month interview (79% follow-up) and 2082 completed the 24 month interview (79% follow-up).

Primary and secondary outcomes measures: The primary outcomes of interest was absence from work at the time of the 12- and 24-month follow-up interviews.

Results: Important groups of workers at increased risk of work absence at both 12- and 24-months included: males, low income workers, trade/manual workers, temporary employees, those reporting two or more co-morbidities, and those experiencing a work-related injury. Important factors unique to predicting work absence at 12 months included financial insecurity, fixed-term employment and long weekly hours worked; unique factors at 24 months included job dissatisfaction, long weekly days worked, a prior injury and sustaining an injury that was perceived to be a threat-to-life.

Conclusions: Important early predictors of work absence at 12- or 24-months following injury are multidimensional and have a time dependent pattern. A consistent set of predictors was, however, present at both time periods that are prime for early intervention. Understanding the multidimensional, time dependent patterns of early predictors of long-term disability is important to optimally target timely interventions to prevent long-term work disability.

Key terms: Work disability; return to work; outcome; multidimensional; socio-demographic; work organisation; health; lifestyle; time dependent predictors.

Article Summary

Strengths and limitations of this study

- Few studies examine the multidimensional influence of pre-injury and injury-related predictors of work absence beyond 12 months following injury or the time-dependent relative importance of these predictors.
- Using longitudinal cohort data we found a multidimensional set of predictors of work absence that differed at 12 and 24 months following injury.
- The strengths of the study include data collection on outcomes at multiple time points following injury independent of the time periods for measurement of exposure measures; a large sample size with acceptable follow-up to 24 months (79%); and examination of a muli-dimensional range of risk factors for work absence.
- The results are sensitive to interview and item missingness, however, sensitivity analysis found this had a negligible impact on estimates of effect size.

INTRODUCTION

A prolonged absence from work following injury can have many detrimental effects on an individual's long-term employment and earning prospects (1, 2) and health (3), as well as substantial societal costs (4). The longer a worker is absent from the workplace following injury the higher the likelihood that a worker will never return to work and thus the greater the individual and social impacts of injury (1, 5, 6). Returning to work following injury is a critical step in the rehabilitation process, making longer-term evaluation of vocational outcomes of interest. The early identification of predictors of long-term chronic work absence provides opportunities for timely intervention to prevent the development of prolonged work disability minimising the consequences of injury.

In the musculoskeletal injuries literature, the relative importance of predictive factors has been demonstrated to change across the stages of development of work disability (7, 8). The predictors of the acute phase of work disability often differ from the predictors of the chronic phase, suggesting different interventions are needed to address chronic long-term work disability (8). Few studies investigating work participation following traumatic injury have examined the importance of changes in predictive factors with increasing time following injury; studies typically have short follow-up periods of 6 months, or less, following injury (9).

A limited number of studies have examined vocational outcomes following injury from a broad population-based perspective. Previous studies have tended to focus on specific injury types, injury to specific body regions, on specific settings of injury and on injury types typically regarded as severe such as hospitalised injury and/or severe trauma. The Prospective Outcomes of Injury Study (POIS) gives us an opportunity to examine predictors for hospitalised and non-hospitalised acute injuries, and all injury settings including road, home, recreational and work (10). Furthermore, analysis of the large POIS cohort allows us to examine predictors using a broader multidimensional perspective.

Our previous analyses of work absence at 3-months following injury indicated a range of socio-demographic, occupational, lifestyle and injury factors were important predictors of outcome in the short term and that future analyses should continue examining a broader range of potential predictors for work disability (11).

The aim of this study is to examine the combined pre-injury influences of socio-demographic, occupational, health and lifestyle factors, and the injury itself, as predictors of work absence at 12- and 24-months following injury for a cohort of New Zealand workers. The focus of this analysis is on potentially identifiable and modifiable factors measured early in the development of long-term work absence. In addition, this study will examine if the relative importance of these early predictors of work absence change with increasing time following injury in this same cohort.

METHODS

Study setting

Recruitment of the POIS cohort was via New Zealand's universal no-fault Accident Compensation Corporation (ACC) scheme. Compensation covers all injury settings, including the home, workplace and road. Eligible participants included those on the ACC entitlement claims register (indicating their injury would require more than simple acute treatment) who had: 1) sustained an injury between June 2007 and May 2009; 2) were aged between 18-64 years; and 3) lived in one of five regions of New Zealand. Sensitive claims, such as for from victims of abuse, are excluded. The recruitment process and resulting cohort has been described in detail elsewhere (10, 12).

Data collection and explanatory variables

The POIS study recruited 2856 participants in the period December 2007 to August 2009 (12). This paper is restricted to those POIS participants who were active workforce participants prior to their injury and had completed either, or both, a 12- and 24-month interview. Structured telephone and postal interviews collected self-reported data following injury at 3 months, with simultaneous retrospective baseline recall, and 12- and 24-month intervals following injury.

With the exception of the injury-related variables, which relate to the injury event itself, all explanatory variables examined are pre-injury variables. A priori hypotheses of a relationship with work absence, and/or prior identification in previous studies was the basis of selection of each explanatory variable (7, 13). The explanatory variables examine seven dimensions:

1) socio-demographic (age, gender, income, highest qualification, occupation, relationship status, living arrangements, material standard of living, household income adequacy, financial security);

2) physical work (repetitive hand movements, heavy lifting, physical exertion, standing, painful/tiring body positions);

3) psychosocial (job strain, support, security, satisfaction, optimism, self-efficacy, prior depressive episode);

4) work organisation (number of hours and days worked per week, employment contract, multiple job holding) ;

5) lifestyle (alcohol consumption, smoking status, Body Mass Index (BMI), exercise, sleep quantity);

6) health (overall self-assessment for health, co-morbidities, pain/discomfort, prior injury, prior disabling condition, work capacity);

7) injury-related (work-related injury, nature and body region of injuries, intent of injury, hospital admission or at least 3 hours treatment at an Emergency Department within 7 days of injury, anatomical injury severity - NISS), injury perceived as a threat to life, injury perceived as a threat of serious disability, access to health services).

See Table 1 for more detailed information about the explanatory variables.

Table 1 Measures used in the questionnaire

Factor(s)	Description of measure and source
Age, gender, education, income, relationship status, occupation & living arrangements	Single item questions from the New Zealand Census (29) Occupation grouped into professional (major level 1-3), semi-professional (4-5) and trade/manual (6-9) using New Zealand Standard Classification of Occupations (30)
Adequacy of household income	Single item regarding adequacy of total household income to meet every day needs (31)
Material standard of living	Single item rating standard of living before injury.
Financial insecurity	Single item rating financial security in the next 10 years (22)
Repetitive hand movements, heavy lifting, painful/tiring body positions, standing & physical exertion	Set of five single items regarding amount of time spend doing physical task ranked on 4 point Likert Scale “never” to “all to ¾ of the time” (32)
Job strain, job support	Score using the Whitehall II study adaptation of Karasek’s job content model (33)
Job satisfaction	Single item rating overall job satisfaction/ dissatisfaction (32)
Self-efficacy	General Self-Efficacy Scale, scale from 0-40, dichotomised into poor (score ≤25) and good (score >25) (34)
Optimism	Agreement with expectation of more good things happen than bad, dichotomised yes (agree and strongly agree) and no (strongly disagree, disagree, neutral) (35)
Prior depressive episode	Two items from DSM-III on depressed mode and loss of interest or pleasure in daily activities for at least 2 weeks in

	the year prior (36)
Hours & days worked per week	Single items asking number of hours or days worked in main job (32)
Type of contract	Combination of two items on employment status and, for employees only, the type of employment contract (32)
Multiple job holding	Single item asking if work only one paying job or more than one job (32)
Alcohol consumption	Score (0-12) identifying hazardous drinking patterns in the year prior using the brief Alcohol Use Disorders Identification Test (Audit-C) (37)
Smoking status	Single item asking if smoke regularly.
Body Mass Index (BMI)	Calculated using weight and height, categorised underweight/normal (≤25), overweight (25-29) and obese (≥30)
Physical exercise	Multiple questions ascertaining how many days over a 7 day period engaged in 15 minutes vigorous activity or 30 minutes moderate activity. Dichotomised into ≤4 or 5-7 days a week (38)
Sleep quantity	Single item identifying how many nights a week usually obtain at least 7 hours sleep
Self-assessment for health	Single item rating health in the 4 weeks prior to injury with five point likert scale from excellent to poor (39)
Co-morbidities	Single item asking if had any of a list of 21 specific chronic conditions lasting or expected to last more than 6 months (40)
Prior injury	Single item regarding any prior injuries that affect participant

Prior disability	Single item asking if had a health problem or condition lasting 6 month or more than cased difficulty with either daily activities OR communication/socialised OR any other activity (29)
Injury nature and body region	12 binary Y/N variables indicating the presence of common nature and body region combinations were created using ACC injury diagnosis data. Variables were created for lower extremity fracture; lower extremity open wound; lower extremity superficial injury; upper extremity fracture; upper extremity open wound; upper extremity superficial injury; head, neck and inter-cranial injury; head and neck superficial injury; spine dislocation, sprain or strain; upper extremity dislocation, strain or sprain; lower extremity dislocation, strain or sprain; and injury to other region
Work capacity	Single item scale assessing working capacity prior to injury from 1 total working capacity to 0 total inability to work (41)
Pain	Single item on pain or discomfort from the EQ-5D (42)
Assault	Single item regarding if injury was the result of an assault
Hospital admission	Single item asking if admitted to hospital for day or more
Anatomical severity – NISS	Score created by mapping ICD-10 injury codes to the Abbreviated Injury Scale (AIS) with the squares of the three highest AIS scores subsequently summed to form the New Injury Severity Score (NISS).(43, 44) The higher the score, the greater the anatomical injury severity. Scores were categorised NISS1-3, NISS4-6, NISS >6

Self-perceived threat to life	Single item rating if felt injury was a threat to life
Self-perceived threat of disability	Single item rating if felt injury was threat of severe longer-term disability
Assessing health services	Single open ended item assessing troubles getting to or contacting health services. Positive and mixed responses form the "no difficult access" group, negative response "difficult access" group
Work-related	Single item regarding if injury was sustained while at work

Outcome measure

At 12- and 24-month interviews a single item "*Which of the following best describes your paid work situation now?*" was used to ascertain work status. Participants indicating full-time and part-time work for pay were considered to be "working", while those indicating they were receiving a benefit and/or compensation, or were unemployed were considered to be "absent from work".

Data analysis

The relationship between work absence and pre-injury and injury-related explanatory variables was examined using frequency tables, summary statistics and regression analyses.

For each time point adjusted univariate models were created using modified Poisson regression with robust error variance to estimate relative risks (14). Age, gender, anatomical severity of injury (NISS), interview region and all 12 injury nature and body region variables were included in all univariate models as potential covariates. To account for the range in the timing of the 12- and 24-

month interviews after the injury event, time since injury was also included as a continuous variable in all analyses.

Any variable from the adjusted univariate models for either the 12- or 24-month time point with a p≤0.2 was then entered into a multidimensional model for each time point. A consistent variable approach was used, resulting in both the 12- and 24-month overall multidimensional regression models including a consistent set of variables across both time points prior to stepwise Poisson regression. All multidimensional models were additionally adjusted for age, sex, region of interview, time since injury, anatomical injury severity – NISS and injury type and region with these variable entered as fixed variables. Complete case analysis was undertaken at both time periods. A sensitivity analysis was conducted by applying inverse probability weighting to the data to account for loss to follow-up (15). Analyses were performed using STATA statistical package 13.0 SE (16).

RESULTS

Of the 2626 POIS participants who were working prior to their injury, 2092 completed the 12 month interview (79% follow-up) and 2082 completed the 24 month interview (79% follow-up) (Table 2). At the 12 month interview 329 (16%) reported being absent from work, while 304 (15%) were absent at the 24 month interview. The majority (82% at 12 months, 81% at 24 months) had received earnings-related compensation from the ACC scheme, indicating a period at least 7 days absence from the workplace following injury.

Table 2 Completed interviews and work status in workforce active participants at the 12- and 24-month time-points.

	12 month	**24 month**
Workforce active prior to injury (N)	2 092	2 082

12

Follow-up from baseline N=2626 (%)	79%	79%
Work status at interview		
Working	1 751	1 764
Absent from work	329	304
Missing	12	14

A summary of the key socio-demographic and injury characteristics of the workforce active POIS participants interviewed at 12- and 24-months is provided in Table 3. The two sub-cohorts have broadly similar distributions of socio-demographic and injury characteristics. In comparison with the baseline interviewees the greatest loss to follow-up occurred in 18-29 year olds, males, non-professional occupational groups, in North Island regions (Auckland, Manukau & Gisborne), in those with less severe injuries and those receiving earnings-related compensation. In terms of loss to follow-up of participants by injury type and region at 12 months greater loss was observed for participants with lower extremity fractures and upper extremity dislocations, strains and sprains, while at 24 months greater loss was observed for those sustaining upper extremity open wounds and upper extremity superficial injuries.

Table 3. Socio-demographic and injury characteristics of POIS workforce active cohort at baseline, 12 and 24-month interviews.

	Baseline interview N=2 626	**12 month interview N=2 092**	**Relative difference[a] (%)**	**24 month interview N=2 082**	**Relative difference[a] (%)**
Age					

13

18-29	635	435	-31	427	-33
30-49	1 230	988	-20	991	-19
50-64	761	669	-8	664	-13
Gender					
Female	1 671	1 285	-23	1 271	-24
Male	955	807	-15	811	-15
Occupation					
Professional	914	772	-16	773	-15
Semi-professional	548	449	-18	445	-19
Trade or manual	1 058	798	-25	785	-26
Unclassified	85	64	-25	65	-24
Missing	21		9		
Region					
Auckland	866	686	-21	686	-21
Manukau	732	555	-24	555	-24
Gisborne	190	141	-26	134	-29
Otago	537	467	-13	455	-15
Southland	301	243	-19	252	-16
Anatomical injury severity – NISS					
1-3	1 101	864	-22	855	-22
4-6	1 179	956	-19	948	-20
>6	263	213	-19	217	-17
Missing	83	59			
Earnings-related compensation					
Yes	2 169	1 709	-21	1 694	-22

No	457	383	-16	388	-15
Lower extremity fracture					
No	2 206	1 739	-21	1 746	-21
Yes	420	353	-16	336	-20
Upper extremity fracture					
No	2 169	1 728	-20	1 717	-21
Yes	457	364	-20	365	-20
Lower extremity dislocation, sprain, strain					
No	2 031	1 608	-21	1 587	-22
Yes	595	484	-19	495	-17
Upper extremity dislocation, sprain, strain					
No	2 263	1 819	-20	1 804	-20
Yes	363	273	-25	278	-23
Spine dislocation, sprain, strain					
No	2 195	1 754	-20	1 743	-21
Yes	431	338	-22	339	-21
Head, neck and intracranial					
No	2 535	2 018	-20	2 003	-21
Yes	91	74	-19	79	-13
Lower extremity open wound					
No	2 522	2 007	-20	1 999	-21
Yes	104	85	-18	83	-20
Upper extremity open wound					

15

No	2 463	1 963	-20	1 966	-20
Yes	163	129	-21	116	-29
Lower extremity superficial					
No	2 446	1 950	-20	1 938	-21
Yes	180	142	-21	144	-20
Upper extremity superficial					
No	2 499	1 991	-20	1 988	-20
Yes	127	101	-20	94	-26
Head, neck superficial					
No	2 538	2 020	-20	2 011	-21
Yes	88	72	-18	71	-19
Other region					
No	2 175	1 724	-21	1 711	-21
Yes	451	368	-18	371	-18

[a] relative difference compared to baseline interview cohort

Most variables from the adjusted univariate modelling step (results not shown) were retained and entered into the final multivariable 12- and 24-month models. Variables not included in the final models included multiple job holding, repetitive hand movements, sleep quantity and work capacity.

12 months

Table 4 presents the final multivariable model for work absence 12 months following injury. Socio-demographic characteristics predictive of increased risk of work absence included being male, those with low levels of personal income or who could not provide an estimate of their personal income, those in trade/manual occupations and those reporting financial insecurity. Variables representing relationship status, living arrangements and adequacy of household income were not retained in the final model.

Table 4. Multivariable analysis of pre-injury and injury-related characteristics associated with work absence modelled for 12 months and 24 months post injury. [aRR=adjusted relative risk; 95% CI=95% confidence interval]

Dimension: variable	**12 months (n=1583)**		**24 months (n=1421)**	
	aRR*	**95% CI**	**aRR***	**95% CI**
Socio-demographic: Age				
18-29	Ref		Ref	
30-49	0.90	0.65-1.23	0.68	0.50-0.92
50-64	0.80	0.55-1.16	0.75	0.53-1.06
Socio-demographic: Gender				
Female	Ref		Ref	

17

Male	1.40	1.03-1.90	1.91	1.42-2.57
Socio-demographic: Income				
≥$50,001	Ref		Ref	
$30,000-50,000	1.50	1.05-2.15	1.74	1.19-2.53
≤$30,000	1.80	1.20-2.69	1.80	1.18-2.74
No income given	2.07	1.36-3.15	2.45	1.65-3.66
Socio-demographic: Occupation				
Professional	Ref		Ref	
Technical	1.07	0.77-1.50	1.34	0.94-1.88
Trade/manual	1.55	1.11-2.15	1.73	1.23-2.45
Unclassified	1.09	0.44-2.71	1.54	0.75-3.19
Socio-Demographic: Income adequacy				
Adequate	.	.	Ref	
Inadequate	.	.	0.80	0.62-1.01
Socio-demographic: Financial security				
Secure/Fairly secure	Ref		.	.
Fairly insecure/Insecure	1.51	1.17-1.95	.	.
Psychosocial: Job satisfaction				
Completely/mostly satisfied	Ref		Ref	
Neither satisfied nor dissatisfied	1.45	1.00-2.09	1.59	1.13-2.22
Mostly/completely dissatisfied	1.37	0.88-2.12	1.85	1.27-2.70
Physical: Exertion				
Never	.	.	Ref	
Occasionally-half the time	.	.	1.16	0.86-4.56
¾ of time or greater	.	.	0.78	0.55-1.12

Work organisation: Hours of work				
≤30 hrs	1.65	1.16-2.33	.	.
31-45 hrs	Ref		.	.
≥46 hrs	1.65	1.26-2.17	.	.
Work organisation: Pre-work days				
≤5 days	.	.	Ref	
6–7 days	.	.	1.35	1.03-1.78
Work organisation: Employment contract				
Employee – permanent	Ref		Ref	
Employee – temporary/casual	1.68	1.21-2.34	1.77	1.28-2.46
Employee – fixed term	2.15	1.34-3.44	1.40	0.79-2.48
Self-employed	1.33	0.90-1.97	1.27	0.81-1.98
Employer	0.45	0.19-1.06	0.42	0.14-1.24
Lifestyle: BMI				
≤ 24	Ref		Ref	
25-29	1.23	0.93-1.64	0.97	0.73-1.29
≥ 30	1.11	0.82-1.53	1.07	0.79-1.45
Health: Co-morbidities				
No co-morbidities	Ref		Ref	
1 co-morbidity	1.03	0.76-1.40	0.74	0.53-1.04
2 or more co-morbidities	1.65	1.24-2.21	1.79	1.36-2.35
Injury: Work-related injury				
No	Ref		Ref	
Yes	1.52	1.19-2.92	1.53	1.20-1.97

Injury: Prior injury				
No	.	.	Ref	
Yes	.	.	1.40	1.08-1.80
Injury: Threat to life				
No	.	.	Ref	
Yes/Maybe	.	.	1.48	1.07-2.04

* Additionally adjusted for time since injury, injury type and region, interview region and anatomical injury severity - NISS.

Job satisfaction was the only psychosocial factor to be retained in the final model of the seven variables initially assessed. There was statistically weak evidence that workers reporting a neutral position of neither satisfaction/dissatisfaction with their job had a higher risk of work absence (aRR 1.45, 95% CI 1.00-2.09). Of the four physical work variables none were retained in the final model.

Work organisational characteristics predictive of work absence included temporary or fixed term employment contracts, and long (≥46 hours per week) or part-time hours (≤ 30 hours per week). Variables indicating multiple job holding and number of weekly days worked were not retained in the final model. Of the five lifestyle factors examined only co-morbidities was retained in the final model with workers having two or more co-morbidities at increased risk of work absence (aRR 1.65, 95% CI 1.24-2.21). Only one injury-related factor was retained in the final model: those with a work injury had a higher risk of work absence (aRR 1.52, 95% CI 1.19-2.92) compared with those with a non-work injury.

24 months

Table 4 also presents the final multivariable model with adjusted relative risks of work absence 24 months following injury. Socio-demographic factors predictive of increased risk of work absence included being male (OR 1.91, 95% CI 1.42-2.57), those with incomes below $NZ 50,000, those not reporting an income (OR 2.45, 95% CI 1.65-3.66) and those with trade/manual occupation (1.73, 95% CI 1.23-2.45). Workers reporting inadequacy of household income were more likely to be working however the relationship was weakly statistical significant (aRR 0.80, 95% CI 0.62-1.01).

Workers reporting either feeling neutral (aRR 1.59, 95% CI 1.13-2.22) or dissatisfied (aRR 1.85, 95% CI 1.27-2.70) with their job had a higher risk of work absence. No clear relationship was apparent for physical exertion.

Of the work organisational factors examined workers with temporary employment contracts (aRR 1.77, 95% CI 1.28-2.46) and those working 6-7 days per week prior to injury (aRR 1.35, 95% CI 1.03-1.78) were at increased risk of work absence. Of the lifestyle factors examined workers with two or more co-morbidities were at increased likelihood of work absence (aRR 1.79, 95% CI 1.36-2.35).

Prior injury (aRR 1.40, 95% CI 1.08-1.80), injury perceived to be a threat to life (aRR 1.48, 95% CI 1.07-2.04) and work-related injuries (aRR 1.53, 95% CI 1.20-1.97) were also predictive of increased risk of work absence.

Sensitivity analysis

This study undertook complete case analysis for all models. Sensitivity analyses, using inverse probability weighting (IPW), were undertaken to assess the impact of not being included in the multivariable models in comparison to the cohort's baseline interview. Overall, the relative risks obtained using IPW were slightly lower than for the analyses presented in Table 4. Exceptions to this

included low income, insecure employment and part-time working hours (≤30 hrs per week) for the 12 month model and low income, occupation, job dissatisfaction, work-related injury & perceived threat to life for the 24 month model where the relative risks were higher than the presented analysis. Only the 12 month multivariable model had items with greater than 10% change in the effect size: the adjusted relative risk was lower in workers with an "unclassified" occupation (aRR 0.83, 95%CI 0.32-2.13, compared to aRR1.09, 95% CI 0.44-2.71), for those with self-employed contracts (aRR 1.18, 95% CI 0.85-1.64, compared to aRR 1.33, 95% CI 0.90-1.97) and higher in employers (aRR 0.57, 95% CI 0.29-1.11, compared to aRR 0.45, 95% CI 0.19-1.06) and for those working ≤30 hours per week (aRR1.88, 95% CI 1.37-2.59, compared to 1.65, 95% CI 1.16-2.33).

DISCUSSION

In this prospective cohort study of injured New Zealand workers we identified a number of new pre-injury socio-demographic, work organisational, health and injury-related factors that are important predictors of work absence at 12- and 24-months following injury, and confirmed predictors identified previously. While a time-dependent pattern of predictors of work absence was also observed, a consistent set of six predictors was identified across both time periods with only two unique predictors at 12 months and four at 24 months following injury.

Comparisons of our findings with previous injury studies examining time-dependent patterns of risk factors for work absence are limited by our study's broader population based design, study sample and longer follow-up. Nevertheless, our findings are broadly consistent with the few studies which have previously demonstrated that the influence and relative importance of risk factors changes with increasing time since injury (9). Our study also provides further support to the importance of considering a multidimensional set of predictors across several time points when following the development of long-term work disability to provide longitudinal insight and to detect risk factors

commonly, or primarily, associated with one or another stage of the disabling process (7-9, 17). As in our earlier paper examining outcomes at 3 months following injury (11), findings from this study indicate a broad range of financial, occupational, psychosocial, work organisational and health supports for employees during recovery from injury are potentially important avenues for early intervention to interrupt prolonged absence from work.

Certain domains examined in our study have had limited, if any attention, in other research examining outcomes following acute injury (13). Work organisational factors were identified in our study as important predictors of work absence. These findings point to the provision of opportunities for recovery from over-demanding work schedules (be it long working hours or weeks) in the long-term following injury as being important for returning to work. Workers with temporary employment contracts were at higher risk of work absence at both time points. Potential mechanisms for this relationship may include the poor quality employment protections and employment relationships between parties with the use of precarious temporary employment contracts, the degree to which substitute workers are available, and the difficulties of realising job accommodations for temporary workers (17, 20). While the evidence for a relationship between precarious employment contracts and work absence following injury is lacking, elsewhere, temporary employment has been associated with delays in returning to work following depression-related work disability episodes (21). Financial insecurity predicted work absence at 12 months only, suggesting financial security has an important time-dependent influence on work disability in the first year following injury, possibly through feelings of anxiety generated by future economic insecurity (19). Further research confirming these newly identified risk factors and examining potential mechanisms of these for work absence following injury is warranted.

Injury-related factors displayed a time dependent pattern. Work-related injury was predictive of work status at both time points supporting our previous findings that workers with work-related injuries had poorer vocational outcomes by 12 months following injury (26). Our findings indicate work-related injury has an important influence on the development of long-term work absence and interventions focusing on primary and secondary prevention of work-related injury would influence not only work absence in the long-term, but also primary prevention of these common injuries in the first place. By 24 months, the perception of the injury as having been a threat to life and having had a prior injury emerged as important injury-related risk factors. Possible mechanisms for this relationship may lie in the psychological trauma associated with the event, such as through the development of Post-Traumatic Stress Disorder (PTSD). Self-perception of the injury event is rarely examined in studies of work absence and this relationship merits further investigation. Few studies examining outcomes following injury examine previous injury, however the only other study to consider previous injury found higher odds of work disability at 1 year following back injury (27). Further studies should consider prior injury as a potential risk factor for long-term work disability.

A number of our findings support and extend previous studies findings. Our finding that income and occupation are important predictors of work absence at both 12- and 24-months following injury is consistent with a growing body of longitudinal evidence (8, 13, 18). Differing financial incentives, commonly substituted low remuneration work skills, the physical nature of work and practical difficulties in providing work accommodations to trade/manual workers are possible income and occupational barriers to work participation. Our finding that the presence of several pre-existing co-morbidities is an important health-related risk factor for work absence at both time periods extends the findings of previous studies observing co-morbid conditions associated with a delayed return-to-work up to six months following injury (23, 24). Workers with several comorbid conditions experience an impaired health state prior to injury, and following the injury itself this may limit a

person's ability to engage with the injury rehabilitation process, or to manage their chronic conditions, resulting in difficulties maintaining work. The prevalence of multimorbidity in developed nations is increasing rapidly (25), therefore, further analysis is warranted to examine the long-term influence of co-morbidity on the risk of work disability following injury.

Job satisfaction emerged as the only important pre-injury psychosocial factor predictive of work status at 24 months following injury. Recent evidence that job satisfaction is not predictive of return-to work following injury or musculoskeletal disorders is limited by short follow-up periods up to 12 months following injury (20, 22). Our findings suggest studies with follow-up beyond 12 months should consider job satisfaction as a possible risk factor for prolonged work absence. Psychosocial factors have been identified as predictive of work absence in other injury studies (8, 13), however, this evidence is limited by the lack of multivariable analysis and the narrow range of potential pre-injury predictors and co-variates examined, potentially explaining why our findings differ from others.

Finally, changes in the predictive value of risk factors over time has significant implications for the types and timing of interventions required to prevent the development of work disability (8, 17). While our findings highlight the importance of distinguishing time dependent predictors we did identify a consistent set of potentially modifiable pre-injury and injury-related risk factors that are present regardless of the disability phase that are prime for early intervention. Risk factors consistently identified in our current analysis at 12-and 24-months and in our previous analysis at three months following injury (11) include workers with low incomes, trade/manual occupations, temporary employment contracts, over-demanding work schedules and an injury perceived to be a threat to life. Given our study identified few unique time dependent risk factors our findings suggest

that interventions primarily targeting these consistent pre-injury and injury risk factors should be made in the first few months following injury as early interventions targeting improvements in employment status can potentially change the progression of both short-term and long-term work absence (28).

This study has some limitations. Firstly pre-injury factors and baseline pre-injury work status were collected through self-report at the first interview (on average 3 months following injury) and may be subject to recall bias, particularly in those variables of a subjective nature such as the psychosocial factors. The self-reported pre-injury work absence measure was found to be accurate by verifying self-reported data against ACC injury claims data about paid employment, with greater than 99% concordance. Secondly, use of single item constructs for many psychosocial factors, such as optimism and job security, may be a limitation. However, good reliability and validity has been demonstrated with parsimonious measures while reducing the interview burden on participants (22). Finally, this analysis uses two slightly different groups of individuals followed up at two separate time points following the original injury using complete case analysis. While 90% of participants who completed the 12 month interview also completed the 24 month interview this analysis is sensitive to interview missingness, as well as item missingness for those who completed 12 & 24 month interviews. Sensitivity analyses, undertaken to assess the impact of being included in the final multivariable models in comparison to the baseline interview, found very few variables had a meaningful increase in effect size (ie. > 10% change) and only one, working part-time hours was significant in the final 12-month multivariable model.

Our study offers a number of strengths that overcome some of the limitations of previous studies including: the collection of comprehensive pre-injury information at 12- and 24-months following injury across a broad multi-dimensional perspective; a large sample size with acceptable follow-up to

24 months (79%); the inclusion of non-hospitalised injured participants; the measurement of outcomes at time periods independent of the time periods for measurement of exposure measures; and combined multi-dimensional analysis examining a comprehensive range of risk factors for work disability. A further key strength is the measurement of pre- and early-injury exposures which provide opportunity for identifying early interventions to influence long-term work disability outcomes. The use of two point-in-time measures of work participation is also a strength as it best captures long-term outcomes since follow-up occurs regardless of previous work status and of previous non-response. Finally, we have been able to examine within NZ's universal no-fault injury rehabilitation and compensation scheme the early predictors of long-term work disability for all injured workers, regardless of whether the injury was sustained at work or not. This is a strength as being absent from the workplace, irrespective of where the injury occurred, has substantial socio-economic costs to individuals, employers and to society. Our findings are generalizable to those injury rehabilitation and compensation systems with similar coverage of work and non-work injury.

In conclusion, in this study we identified a number of known and new socio-demographic, work organisational, health and injury-related factors predictive of work absence at 12- and 24-months following injury in a cohort of New Zealand workers. Our study confirmed and extended previous observations of a time dependent pattern of predictors of work disability following injury, however, there was a consistent set of socio-demographic, work organisational, health and injury-related factors present regardless of the timing of follow-up that are prime for early intervention to prevent the development of long term work disability. Understanding the multi-dimensional and time dependent patterns of predictors of long-term disability and how they may, or may not, differ by time is important if we are to develop and optimally target early interventions to reduce the significant personal and social burden and costs of long-term work disability.

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Contributions

RL was the lead author and is guarantor of this paper. RL analysed the data. GD and SD contributed to the study design, interpretation of the results, and the review and editing of the manuscript. RL, GD, SD approved the submitted manuscript.

Competing Interests

None declared.

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Ethics approval

The New Zealand Multi-Region Ethics Committee granted ethical approval for this study (MEC/07/07/093). Informed consent was obtained from all participants.

Data sharing statement

We have a data sharing policy and would consider requests on a case by case basis. Please contact sarah.derrett@otago.ac.nz.

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STROBE Statement: checklist of items included in reports of observational studies

	Item No	Recommendation	Check list
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	YES p2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	YES p2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	YES p4
Objectives	3	State specific objectives, including any prespecified hypotheses	YES p5
Methods			
Study design	4	Present key elements of study design early in the paper	YES p6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	YES p5-6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	YES p5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	YES p11
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	YES p6-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	YES table 1
Bias	9	Describe any efforts to address potential sources of bias	YES p11
Study size	10	Explain how the study size was arrived at	YES p11, refs 10,11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	YES table1
Statistical methods	12	(*a*) Describe all statistical methods, including control for confounding	YES p10-11
		(*b*) Describe any methods used to examine subgroups and interactions	YES p10-11
		(*c*) Explain how missing data were addressed	YES p11
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	YES p11

		(*e*) Describe any sensitivity analyses	YES p11
Results			**Check list**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	YES p11, table 1
		(b) Give reasons for non-participation at each stage	YES p12
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	YES p12, table 3
		(b) Indicate number of participants with missing data for each variable of interest	YES p12, table 3
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	YES – 12 & 24 months
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	YES p11, table 1
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	YES tables 4&5
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	YES p20
Discussion			
Key results	18	Summarise key results with reference to study objectives	YES p21
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	YES p25
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	YES p21-26
Generalisability	21	Discuss the generalisability (external validity) of the study results	YES p26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	YES p27

BMJ Open

Are the early predictors of long-term work absence following injury time-dependent? Results from the Prospective Outcomes of Injury Study

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Are the early predictors of long-term work absence following injury time-dependent? Results from the Prospective Outcomes of Injury Study

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Abstract

Objectives: Few studies examine the influence of early predictors of work absence beyond 12 months following injury or the time-dependent relative importance of these factors. This study aimed to identify the most important socio-demographic, occupational, health, lifestyle and injury predictors of work absence at 12- and 24-months following injury and to examine changes in the relative importance of these over time.

Design: Prospective cohort study.

Setting: The Prospective Outcomes of Injury Study, New Zealand.

Participants: 2626 injured New Zealand workers were identified from the Prospective Outcomes of Injury Study; 2092 completed the 12 month interview (80% follow-up) and 2082 completed the 24 month interview (79% follow-up).

Primary and secondary outcomes measures: The primary outcomes of interest was absence from work at the time of the 12- and 24-month follow-up interviews.

Results: Using modified Poisson regression to estimate Relative Risks important groups of workers were identified at increased risk of work absence at both 12- and 24-months: males, low income workers, trade/manual workers, temporary employees, those reporting two or more co-morbidities, and those experiencing a work-related injury. Important factors unique to predicting work absence at 12 months included financial insecurity, fixed-term employment and long weekly hours worked; unique factors at 24 months included job dissatisfaction, long weekly days worked, a prior injury and sustaining an injury that was perceived to be a threat-to-life.

Conclusions: Important early predictors of work absence at 12- or 24-months following injury are multidimensional and have a time dependent pattern. A consistent set of predictors was, however, present at both time periods that are prime for early intervention. Understanding the multidimensional, time dependent patterns of early predictors of long-term disability is important to optimally target timely interventions to prevent long-term work disability.

Key terms: Work disability; return to work; outcome; multidimensional; socio-demographic; work organisation; health; lifestyle; time dependent predictors.

Article Summary

Strengths and limitations of this study

- Few studies examine the multidimensional influence of pre-injury and injury-related predictors of work absence beyond 12 months following injury or the time-dependent relative importance of these predictors.
- Using longitudinal cohort data we found a multidimensional set of predictors of work absence that differed at 12 and 24 months following injury.
- The strengths of the study include data collection on outcomes at multiple time points following injury independent of the time periods for measurement of exposure measures; a large sample size with acceptable follow-up to 24 months (79%); and examination of a multi-dimensional range of risk factors for work absence.
- The results are sensitive to interview and item missingness, however, sensitivity analysis found this had a negligible impact on estimates of effect size.

INTRODUCTION

A prolonged absence from work following injury can have many detrimental effects on an individual's long-term employment and earning prospects [1,2] and health[3], as well as substantial societal costs.[4] The longer a worker is absent from the workplace following injury the higher the likelihood that a worker will never return to work and thus the greater the individual and social impacts of injury.[1,5,6] Returning to work following injury is a critical step in the rehabilitation process, making longer-term evaluation of vocational outcomes of interest. The early identification of predictors of long-term chronic work absence provides opportunities for timely intervention to prevent the development of prolonged work disability minimising the consequences of injury.

In the musculoskeletal injuries literature, the relative importance of predictive factors has been demonstrated to change across the stages of development of work disability.[7,8] The predictors of the acute phase of work disability often differ from the predictors of the chronic phase, suggesting different interventions are needed to address chronic long-term work disability.[8] Few studies investigating work participation following traumatic injury have examined the importance of changes in predictive factors with increasing time following injury; studies typically have short follow-up periods of 6 months, or less, following injury.[9]

A limited number of studies have examined vocational outcomes following injury from a broad population-based perspective. Previous studies have tended to focus on specific injury types, injury to specific body regions, on specific settings of injury and on injury types typically regarded as severe such as those resulting in hospitalisation.[7-10] The Prospective Outcomes of Injury Study (POIS) gives us an opportunity to examine predictors for hospitalised and non-hospitalised acute injuries, and all injury settings including road, home, recreational and work.[11] Furthermore, analysis of the large POIS cohort allows us to examine predictors using a broader multidimensional perspective. Our

previous analyses of work absence at 3-months following injury indicated a range of socio-demographic, occupational, lifestyle and injury factors were important predictors of outcome in the short term and that future analyses should continue examining a broader range of potential predictors for work disability.[12]

The aim of this study is to examine the combined pre-injury influences of socio-demographic, occupational, health and lifestyle factors, and the injury itself, as predictors of work absence at 12- and 24-months following injury for a cohort of New Zealand workers. The focus of this analysis is on potentially identifiable and modifiable factors measured early in the development of long-term work absence. In addition, this study will examine if the relative importance of these early predictors of work absence change with increasing time following injury in this same cohort.

METHODS

Study setting

Recruitment of the POIS cohort was via New Zealand's universal no-fault Accident Compensation Corporation (ACC) scheme. Compensation covers all injury settings, including the home, workplace and road. Eligible participants included those on the ACC entitlement claims register (indicating their injury would require more than simple acute treatment) who had: 1) sustained an injury between June 2007 and May 2009; 2) were aged between 18-64 years; and 3) lived in one of five regions of New Zealand. Sensitive claims, such as for from victims of abuse, are excluded. The recruitment process and resulting cohort has been described in detail elsewhere.[11,13]

Data collection and explanatory variables

The POIS study recruited 2856 participants in the period December 2007 to August 2009.[13] This paper is restricted to those POIS participants who were active workforce participants prior to their injury and had completed either, or both, a 12- and 24-month interview. Structured telephone and postal interviews collected self-reported data following injury at 3 months, with simultaneous retrospective baseline recall, and 12- and 24-month intervals following injury.

With the exception of the injury-related variables, which relate to the injury event itself, all explanatory variables examined are pre-injury variables. A priori hypotheses of a relationship with work absence, and/or prior identification in previous studies was the basis of selection of each explanatory variable.[7,10] The explanatory variables examine seven dimensions:

1) socio-demographic (age, gender, income, highest qualification, occupation, relationship status, living arrangements, material standard of living, household income adequacy, financial security);

2) physical work (repetitive hand movements, heavy lifting, physical exertion, standing, painful/tiring body positions);

3) psychosocial (job strain, support, security, satisfaction, optimism, self-efficacy, prior depressive episode);

4) work organisation (number of hours and days worked per week, employment contract, multiple job holding) ;

5) lifestyle (alcohol consumption, smoking status, Body Mass Index (BMI), exercise, sleep quantity);

6) health (overall self-assessment for health, co-morbidities, pain/discomfort, prior injury, prior disabling condition, work capacity);

7) injury-related (work-related injury, nature and body region of injuries, intent of injury, hospital admission or at least 3 hours treatment at an Emergency Department within 7 days of injury, anatomical injury severity - NISS), injury perceived as a threat to life, injury perceived as a threat of serious disability, access to health services).

See Table 1 for more detailed information about the explanatory variables.

Table 1 Measures used in the questionnaire

Factor(s)	Description of measure and source
Age, gender, education, income, relationship status, occupation & living arrangements	Single item questions from the New Zealand Census [14] Occupation grouped into professional (major level 1-3), semi-professional (level 4 &5) and trade/manual (level 6-9) using New Zealand Standard Classification of Occupations [15]
Adequacy of household income	Single item regarding adequacy of total household income to meet every day needs [16]
Material standard of living	Single item rating standard of living before injury.
Financial insecurity	Single item rating financial security in the next 10 years [17]
Repetitive hand movements, heavy lifting, painful/tiring body positions, standing & physical exertion	Set of five single items regarding amount of time spend doing physical task ranked on 4 point Likert Scale “never” to “all to ¾ of the time” [18]
Job strain, job support	Score using the Whitehall II study adaptation of Karasek’s job content model [19]
Job satisfaction	Single item rating overall job satisfaction/ dissatisfaction [18]
Self-efficacy	General Self-Efficacy Scale, scale from 0-40, dichotomised into poor (score ≤25) and good (score >25) [20]
Optimism	Agreement with expectation of more good things happen than bad, dichotomised yes (agree and strongly agree) and no (strongly disagree, disagree, neutral) [21]
Prior depressive episode	Two items from DSM-III on depressed mode and loss of interest or pleasure in daily activities for at least 2 weeks in

	the year prior [22]
Hours & days worked per week	Single items asking number of hours or days worked in main job [18]
Type of contract	Combination of two items on employment status and, for employees only, the type of employment contract [18]
Multiple job holding	Single item asking if work only one paying job or more than one job [18]
Alcohol consumption	Score (0-12) identifying hazardous drinking patterns in the year prior using the brief Alcohol Use Disorders Identification Test (Audit-C) [23]
Smoking status	Single item asking if smoke regularly.
Body Mass Index (BMI)	Calculated using weight and height, categorised underweight/normal (≤25), overweight (25-29) and obese (≥30)
Physical exercise	Multiple questions ascertaining how many days over a 7 day period engaged in 15 minutes vigorous activity or 30 minutes moderate activity. Dichotomised into ≤4 or 5-7 days a week [24]
Sleep quantity	Single item identifying how many nights a week usually obtain at least 7 hours sleep
Self-assessment for health	Single item rating health in the 4 weeks prior to injury with five point likert scale from excellent to poor [25]
Co-morbidities	Single item asking if had any of a list of 21 specific chronic conditions lasting or expected to last more than 6 months [26]
Prior injury	Single item regarding any prior injuries that affect participant
Prior disability	Single item asking if had a health problem or condition lasting

	6 months or more that caused difficulty with daily activities OR communication/socialising OR any other activity [14]
Injury nature and body region	12 binary Y/N variables indicating the presence of common nature and body region combinations were created using ACC injury diagnosis data. Variables were created for lower extremity fracture; lower extremity open wound; lower extremity superficial injury; upper extremity fracture; upper extremity open wound; upper extremity superficial injury; head, neck and inter-cranial injury; head and neck superficial injury; spine dislocation, sprain or strain; upper extremity dislocation, strain or sprain; lower extremity dislocation, strain or sprain; and injury to other region
Work capacity	Single item scale assessing working capacity prior to injury from 1 total working capacity to 0 total inability to work [27]
Pain	Single item on pain or discomfort from the EQ-5D [28]
Assault	Single item regarding if injury was the result of an assault
Hospital admission	Single item asking if admitted to hospital for day or more
Anatomical severity – NISS	Score created by mapping ICD-10 injury codes to the Abbreviated Injury Scale (AIS) with the squares of the three highest AIS scores subsequently summed to form the New Injury Severity Score (NISS).[29,30] The higher the score, the greater the anatomical injury severity. Scores were categorised NISS1-3, NISS4-6, NISS >6.
Self-perceived threat to life	Single item rating if felt injury was a threat to life
Self-perceived threat of disability	Single item rating if felt injury was threat of severe longer-

	term disability
Assessing health services	Single open ended item assessing troubles getting to or contacting health services. Positive and mixed responses form the "no difficult access" group, negative response "difficult access" group
Work-related	Single item regarding if injury was sustained while at work

Outcome measure

At 12- and 24-month interviews a single item "*Which of the following best describes your paid work situation now?*" was used to ascertain work status. Participants indicating full-time and part-time work for pay were considered to be "working", while those indicating they were receiving a benefit and/or compensation, or were unemployed were considered to be "absent from work".

Data analysis

The relationship between work absence and pre-injury and injury-related explanatory variables was examined using frequency tables, summary statistics and regression analyses.

For each time point adjusted univariate models were created using modified Poisson regression with robust error variance to estimate relative risks.[31] Age, gender, anatomical severity of injury (NISS), interview region and all 12 injury nature and body region variables were included in all univariate models as potential covariates. To account for the range in the timing of the 12- and 24-month interviews after the injury event, time since injury was also included as a continuous variable in all analyses.

Any variable from the adjusted univariate models for either the 12- or 24-month time point with a p≤0.2 was then entered into a multidimensional model for each time point. A consistent variable approach was used, resulting in both the 12- and 24-month overall multidimensional regression models including a consistent set of variables across both time points prior to stepwise Poisson regression. All multidimensional models were additionally adjusted for age, sex, region of interview, time since injury, anatomical injury severity – NISS and injury type and region with these variable entered as fixed variables. Complete case analysis was undertaken at both time periods. A sensitivity analysis was conducted by applying inverse probability weighting to the data to account for loss to follow-up.[32] Analyses were performed using STATA statistical package 13.0 SE.[33]

RESULTS

Of the 2626 POIS participants who were working prior to their injury, 2092 completed the 12 month interview (79% follow-up) and 2082 completed the 24 month interview (79% follow-up) (Table 2). At the 12 month interview 329 (16%) reported being absent from work, while 304 (15%) were absent at the 24 month interview. Reasons for work absence were reported at 24 months following injury only and were varied: predominantly the sample was absent from work due to ongoing recovery and rehabilitation (43%) associated with the original injury event. The majority (82% at 12 months, 81% at 24 months) had received earnings-related compensation from the ACC scheme, indicating a period at least 7 days absence from the workplace following injury. There was no evidence of statistically significant differences in patterns of work absence at either 12 or 24 months by receipt of earnings-related compensation therefore it has not been included in our analyses.

Table 2 Completed interviews and work status in workforce active participants at the 12- and 24-month time-points.

	12 month	24 month
Total sample (N)	2 092	2 082
Employed prior to injury (N)	2 092	2 082
Working 3 months following injury (N)	1 537	1 537
Follow-up from baseline N=2626 (%)	79%	79%
Work status at interview		
Working	1 751	1 764
Absent from work	329	304
Missing	12	14
Reasons for work absence - 24 months		
Not recovered yet/rehabilitation		132
Seeking employment		63
Retired early		27
Domestic reasons		27
Other (eg. volunteering)		22
Missing		33

A summary of the key socio-demographic and injury characteristics of the workforce active POIS participants interviewed at 12- and 24-months is provided in Table 3. The two sub-cohorts have broadly similar distributions of socio-demographic and injury characteristics. In comparison with the baseline interviewees the greatest loss to follow-up occurred in 18-29 year olds, males, non-professional occupational groups, in North Island regions (Auckland, Manukau & Gisborne), in those with less severe injuries and those receiving earnings-related compensation. In terms of loss to

follow-up of participants by injury type and region at 12 months greater loss was observed for participants with lower extremity fractures and upper extremity dislocations, strains and sprains, while at 24 months greater loss was observed for those sustaining upper extremity open wounds and upper extremity superficial injuries.

Table 3. Socio-demographic and injury characteristics of POIS workforce active cohort at baseline, 12 and 24-month interviews.

	Baseline interview N=2 626	12 month interview N=2 092	Relative difference[a] (%)	24 month interview N=2 082	Relative difference[a] (%)
Age					
18-29	635	435	-31	427	-33
30-49	1 230	988	-20	991	-19
50-64	761	669	-8	664	-13
Gender					
Female	1 671	1 285	-23	1 271	-24
Male	955	807	-15	811	-15
Occupation					
Professional	914	772	-16	773	-15
Semi-professional	548	449	-18	445	-19
Trade or manual	1 058	798	-25	785	-26
Unclassified	85	64	-25	65	-24
Missing	21		9		
Region					
Auckland	866	686	-21	686	-21

Manukau	732	555	-24	555	-24
Gisborne	190	141	-26	134	-29
Otago	537	467	-13	455	-15
Southland	301	243	-19	252	-16
Anatomical injury severity – NISS					
1-3	1 101	864	-22	855	-22
4-6	1 179	956	-19	948	-20
>6	263	213	-19	217	-17
Missing	83	59			
Earnings-related compensation					
Yes	2 169	1 709	-21	1 694	-22
No	457	383	-16	388	-15
Lower extremity fracture					
No	2 206	1 739	-21	1 746	-21
Yes	420	353	-16	336	-20
Upper extremity fracture					
No	2 169	1 728	-20	1 717	-21
Yes	457	364	-20	365	-20
Lower extremity dislocation, sprain, strain					
No	2 031	1 608	-21	1 587	-22
Yes	595	484	-19	495	-17
Upper extremity dislocation, sprain, strain					
No	2 263	1 819	-20	1 804	-20

15

Yes	363	273	-25	278	-23
Spine dislocation, sprain, strain					
No	2 195	1 754	-20	1 743	-21
Yes	431	338	-22	339	-21
Head, neck and intracranial					
No	2 535	2 018	-20	2 003	-21
Yes	91	74	-19	79	-13
Lower extremity open wound					
No	2 522	2 007	-20	1 999	-21
Yes	104	85	-18	83	-20
Upper extremity open wound					
No	2 463	1 963	-20	1 966	-20
Yes	163	129	-21	116	-29
Lower extremity superficial					
No	2 446	1 950	-20	1 938	-21
Yes	180	142	-21	144	-20
Upper extremity superficial					
No	2 499	1 991	-20	1 988	-20
Yes	127	101	-20	94	-26
Head, neck superficial					
No	2 538	2 020	-20	2 011	-21
Yes	88	72	-18	71	-19
Other region					
No	2 175	1 724	-21	1 711	-21
Yes	451	368	-18	371	-18

[a] relative difference compared to baseline interview cohort

Most variables from the adjusted univariate modelling step (results not shown) were retained and entered into the final multivariable 12- and 24-month models. Variables not included in the final models included multiple job holding, repetitive hand movements, sleep quantity and work capacity.

12 months

Table 4 presents the final multivariable model for work absence 12 months following injury. Socio-demographic characteristics predictive of increased risk of work absence included being male, those with low levels of personal income or who could not provide an estimate of their personal income, those in trade/manual occupations and those reporting financial insecurity. Variables representing relationship status, living arrangements and adequacy of household income were not retained in the final model.

Table 4. Multivariable analysis of pre-injury and injury-related characteristics associated with work absence modelled for 12 months and 24 months post injury. [aRR=adjusted relative risk; 95% CI=95% confidence interval]

Dimension: variable	**12 months (n=1583)**		**24 months (n=1421)**	
	aRR*	**95% CI**	**aRR***	**95% CI**
Socio-demographic: Age				
18-29	Ref		Ref	
30-49	0.90	0.65-1.23	0.68	0.50-0.92
50-64	0.80	0.55-1.16	0.75	0.53-1.06
Socio-demographic: Gender				
Female	Ref		Ref	

Male	1.40	1.03-1.90	1.91	1.42-2.57
Socio-demographic: Income				
≥$50,001	Ref		Ref	
$30,000-50,000	1.50	1.05-2.15	1.74	1.19-2.53
≤$30,000	1.80	1.20-2.69	1.80	1.18-2.74
No income given	2.07	1.36-3.15	2.45	1.65-3.66
Socio-demographic: Occupation				
Professional	Ref		Ref	
Technical	1.07	0.77-1.50	1.34	0.94-1.88
Trade/manual	1.55	1.11-2.15	1.73	1.23-2.45
Unclassified	1.09	0.44-2.71	1.54	0.75-3.19
Socio-Demographic: Income adequacy				
Adequate	.	.	Ref	
Inadequate	.	.	0.80	0.62-1.01
Socio-demographic: Financial security				
Secure/Fairly secure	Ref		.	.
Fairly insecure/Insecure	1.51	1.17-1.95	.	.
Psychosocial: Job satisfaction				
Completely/mostly satisfied	Ref		Ref	
Neither satisfied nor dissatisfied	1.45	1.00-2.09	1.59	1.13-2.22
Mostly/completely dissatisfied	1.37	0.88-2.12	1.85	1.27-2.70
Physical: Exertion				
Never	.	.	Ref	
Occasionally-half the time	.	.	1.16	0.86-4.56
¾ of time or greater	.	.	0.78	0.55-1.12

19

Work organisation: Hours of work				
≤30 hrs	1.65	1.16-2.33	.	.
31-45 hrs	Ref		.	.
≥46 hrs	1.65	1.26-2.17	.	.
Work organisation: Pre-work days				
≤5 days	.	.	Ref	
6–7 days	.	.	1.35	1.03-1.78
Work organisation: Employment contract				
Employee – permanent	Ref		Ref	
Employee – temporary/casual	1.68	1.21-2.34	1.77	1.28-2.46
Employee – fixed term	2.15	1.34-3.44	1.40	0.79-2.48
Self-employed	1.33	0.90-1.97	1.27	0.81-1.98
Employer	0.45	0.19-1.06	0.42	0.14-1.24
Lifestyle: BMI				
≤ 24	Ref		Ref	
25-29	1.23	0.93-1.64	0.97	0.73-1.29
≥ 30	1.11	0.82-1.53	1.07	0.79-1.45
Health: Co-morbidities				
No co-morbidities	Ref		Ref	
1 co-morbidity	1.03	0.76-1.40	0.74	0.53-1.04
2 or more co-morbidities	1.65	1.24-2.21	1.79	1.36-2.35
Injury: Work-related injury				
No	Ref		Ref	
Yes	1.52	1.19-2.92	1.53	1.20-1.97

20

Injury: Prior injury				
No	.	.	Ref	
Yes	.	.	1.40	1.08-1.80
Injury: Threat to life				
No	.	.	Ref	
Yes/Maybe	.	.	1.48	1.07-2.04

* Additionally adjusted for time since injury, injury type and region, interview region and anatomical injury severity - NISS.

Job satisfaction was the only psychosocial factor to be retained in the final model of the seven variables initially assessed. There was statistically weak evidence that workers reporting a neutral position of neither satisfaction/dissatisfaction with their job had a higher risk of work absence (aRR 1.45, 95% CI 1.00-2.09). Of the four physical work variables none were retained in the final model.

Work organisational characteristics predictive of work absence included temporary or fixed term employment contracts, and long (≥46 hours per week) or part-time hours (≤ 30 hours per week). Variables indicating multiple job holding and number of weekly days worked were not retained in the final model. Of the five lifestyle factors examined only co-morbidities was retained in the final model with workers having two or more co-morbidities at increased risk of work absence (aRR 1.65, 95% CI 1.24-2.21). Only one injury-related factor was retained in the final model: those with a work injury had a higher risk of work absence (aRR 1.52, 95% CI 1.19-2.92) compared with those with a non-work injury.

24 months

Table 4 also presents the final multivariable model with adjusted relative risks of work absence 24 months following injury. Socio-demographic factors predictive of increased risk of work absence included being male (OR 1.91, 95% CI 1.42-2.57), those with incomes below $NZ 50,000, those not reporting an income (OR 2.45, 95% CI 1.65-3.66) and those with trade/manual occupation (1.73, 95% CI 1.23-2.45). Workers reporting inadequacy of household income were more likely to be working however the relationship was weakly statistical significant (aRR 0.80, 95% CI 0.62-1.01).

Workers reporting either feeling neutral (aRR 1.59, 95% CI 1.13-2.22) or dissatisfied (aRR 1.85, 95% CI 1.27-2.70) with their job had a higher risk of work absence. No clear relationship was apparent for physical exertion.

Of the work organisational factors examined workers with temporary employment contracts (aRR 1.77, 95% CI 1.28-2.46) and those working 6-7 days per week prior to injury (aRR 1.35, 95% CI 1.03-1.78) were at increased risk of work absence. Of the lifestyle factors examined workers with two or more co-morbidities were at increased likelihood of work absence (aRR 1.79, 95% CI 1.36-2.35).

Prior injury (aRR 1.40, 95% CI 1.08-1.80), injury perceived to be a threat to life (aRR 1.48, 95% CI 1.07-2.04) and work-related injuries (aRR 1.53, 95% CI 1.20-1.97) were also predictive of increased risk of work absence.

Sensitivity analysis

Complete case analysis was under taken for all models. Sensitivity analyses, using inverse probability weighting (IPW), were undertaken to assess the impact of not being included in the multivariable models in comparison to the cohort's baseline interview. Overall, the relative risks obtained using IPW were slightly lower than for the analyses presented in Table 4. Exceptions to this

included low income, insecure employment and part-time working hours (≤30 hrs per week) for the 12 month model and low income, occupation, job dissatisfaction, work-related injury & perceived threat to life for the 24 month model where the relative risks were higher than the presented analysis. Only the 12 month multivariable model had items with greater than 10% change in the effect size: the adjusted relative risk was lower in workers with an "unclassified" occupation (aRR 0.83, 95%CI 0.32-2.13, compared to aRR1.09, 95% CI 0.44-2.71), for those with self-employed contracts (aRR 1.18, 95% CI 0.85-1.64, compared to aRR 1.33, 95% CI 0.90-1.97) and higher in employers (aRR 0.57, 95% CI 0.29-1.11, compared to aRR 0.45, 95% CI 0.19-1.06) and for those working ≤30 hours per week (aRR1.88, 95% CI 1.37-2.59, compared to 1.65, 95% CI 1.16-2.33).

DISCUSSION

In this prospective cohort study of injured New Zealand workers we identified a number of new pre-injury socio-demographic, work organisational, health and injury-related factors that are important predictors of work absence at 12- and 24-months following injury, and confirmed predictors identified previously. While a time-dependent pattern of predictors of work absence was also observed, a consistent set of six predictors was identified across both time periods with only two unique predictors at 12 months and four at 24 months following injury.

Comparisons of our findings with previous injury studies examining time-dependent patterns of risk factors for work absence are limited by our study's broader population based design, study sample and longer follow-up. Nevertheless, our findings are broadly consistent with the few studies which have previously demonstrated that the influence and relative importance of risk factors changes with increasing time since injury.[9] Our study also provides further support to the importance of considering a multidimensional set of predictors across several time points when following the development of long-term work disability to provide longitudinal insight and to detect risk factors

commonly, or primarily, associated with one or another stage of the disabling process.[7-9, 34] As in our earlier paper examining outcomes at 3 months following injury [11], findings from this study indicate a broad range of financial, occupational, psychosocial, work organisational and health supports for employees during recovery from injury are potentially important avenues for early intervention to interrupt prolonged absence from work.

Certain domains examined in our study have had limited, if any attention, in other research examining outcomes following acute injury.[10] Work organisational factors were identified in our study as important predictors of work absence. These findings point to the provision of opportunities for recovery from over-demanding work schedules (be it long working hours or weeks) in the long-term following injury as being important for returning to work. Workers with temporary employment contracts were at higher risk of work absence at both time points. Potential mechanisms for this relationship may include the poor quality employment protections and employment relationships between parties with the use of precarious temporary employment contracts, the degree to which substitute workers are available, and the difficulties of realising job accommodations for temporary workers.[34,35] While the evidence for a relationship between precarious employment contracts and work absence following injury is lacking, elsewhere, temporary employment has been associated with delays in returning to work following depression-related work disability episodes.[36] Financial insecurity predicted work absence at 12 months only, suggesting financial security has an important time-dependent influence on work disability in the first year following injury, possibly through feelings of anxiety generated by future economic insecurity.[37] Further research confirming these newly identified risk factors and examining potential mechanisms of these for work absence following injury is warranted.

Injury-related factors displayed a time dependent pattern. Work-related injury was predictive of work status at both time points supporting our previous findings that workers with work-related injuries had poorer vocational outcomes by 12 months following injury.[38] Our findings indicate work-related injury has an important influence on the development of long-term work absence and interventions focusing on primary and secondary prevention of work-related injury would influence not only work absence in the long-term, but also primary prevention of these common injuries in the first place. By 24 months, the perception of the injury as having been a threat to life and having had a prior injury emerged as important injury-related risk factors. Possible mechanisms for this relationship may lie in the psychological trauma associated with the event, such as through the development of Post-Traumatic Stress Disorder (PTSD). Self-perception of the injury event is rarely examined in studies of work absence and this relationship merits further investigation. Few studies examining outcomes following injury examine previous injury, however the only other study to consider previous injury found higher odds of work disability at 1 year following back injury.[39] Further studies should consider prior injury as a potential risk factor for long-term work disability.

A number of our findings support and extend previous studies findings. Our finding that income and occupation are important predictors of work absence at both 12- and 24-months following injury is consistent with a growing body of longitudinal evidence.[8,10,40] Differing financial incentives, commonly substituted low remuneration work skills, the physical nature of work and practical difficulties in providing work accommodations to trade/manual workers are possible income and occupational barriers to work participation. Our finding that the presence of several pre-existing co-morbidities is an important health-related risk factor for work absence at both time periods extends the findings of previous studies observing co-morbid conditions associated with a delayed return-to-work up to six months following injury.[41,42] Workers with several comorbid conditions experience an impaired health state prior to injury, and following the injury itself this may limit a person's ability to

engage with the injury rehabilitation process, or to manage their chronic conditions, resulting in difficulties maintaining work. The prevalence of multimorbidity in developed nations is increasing rapidly[43], therefore, further analysis is warranted to examine the long-term influence of co-morbidity on the risk of work disability following injury.

Job satisfaction emerged as the only important pre-injury psychosocial factor predictive of work status at 24 months following injury. Recent evidence that job satisfaction is not predictive of return-to work following injury or musculoskeletal disorders is limited by short follow-up periods up to 12 months following injury.[35,17] Our findings suggest studies with follow-up beyond 12 months should consider job satisfaction as a possible risk factor for prolonged work absence. Psychosocial factors have been identified as predictive of work absence in other injury studies [8,10], however, this evidence is limited by the lack of multivariable analysis and the narrow range of potential pre-injury predictors and co-variates examined, potentially explaining why our findings differ from others.

Finally, changes in the predictive value of risk factors over time has significant implications for the types and timing of interventions required to prevent the development of work disability. [8,34] While our findings highlight the importance of distinguishing time dependent predictors we did identify a consistent set of potentially modifiable pre-injury and injury-related risk factors that are present regardless of the disability phase that are prime for early intervention. Risk factors consistently identified in our current analysis at 12-and 24-months and in our previous analysis at three months following injury include workers with low incomes, trade/manual occupations, temporary employment contracts, over-demanding work schedules and an injury perceived to be a threat to life.[12] Given our study identified few unique time-dependent risk factors our findings suggest that interventions primarily targeting workers with these consistent pre-injury and injury risk factors

should be made in the first few months following injury as early interventions targeting improvements in employment status can potentially change the progression of both short-term and long-term work absence.[44]

This study has some limitations. Firstly pre-injury factors and baseline pre-injury work status were collected through self-report at the first interview (on average 3 months following injury) and may be subject to recall bias, particularly in those variables of a subjective nature such as the psychosocial factors. The self-reported pre-injury work absence measure was found to be accurate by verifying self-reported data against ACC injury claims data about paid employment, with greater than 99% concordance. Secondly, use of single item constructs for many psychosocial factors, such as optimism and job security, may be a limitation. However, good reliability and validity has been demonstrated with parsimonious measures while reducing the interview burden on participants.[17] Thirdly, the capture of all types of work absence (more commonly for disability or unemployment) could potentially explain the shift in patterns of risk factors overtime as the longer a worker is absent from work the greater the likelihood of unemployment or redundancy. The relative proportion of officially unemployment in our work-absent participant at 12- (15%) and 24-months (18%) was small and was unlikely to be the substantial driver of the time dependent shift in risk factors that we observed. Finally, this analysis uses two slightly different groups of individuals followed up at two separate time points following the original injury using complete case analysis. While 90% of participants who completed the 12 month interview also completed the 24 month interview this analysis is sensitive to interview missingness, as well as item missingness for those who completed 12 & 24 month interviews. Sensitivity analyses, undertaken to assess the impact of being included in the final multivariable models in comparison to the baseline interview, found very few variables had a meaningful increase in effect size (ie. > 10% change) and only one, working part-time hours was significant in the final 12-month multivariable model.

Our study offers a number of strengths that overcome some of the limitations of previous studies including: the collection of comprehensive pre-injury information at 12- and 24-months following injury across a broad multi-dimensional perspective; a large sample size with acceptable follow-up to 24 months (79%); the inclusion of non-hospitalised injured participants; the measurement of outcomes at time periods independent of the time periods for measurement of exposure measures; and combined multi-dimensional analysis examining a comprehensive range of risk factors for work disability. A further key strength is the measurement of pre- and early-injury exposures which provide opportunity for identifying early interventions to influence long-term work disability outcomes. The use of two point-in-time measures of work participation is also a strength as it best captures long-term outcomes since follow-up occurs regardless of previous work status and of previous non-response. Finally, we have been able to examine within NZ's universal no-fault injury rehabilitation and compensation scheme the early predictors of long-term work disability for all injured workers, regardless of whether the injury was sustained at work or not. This is a strength as being absent from the workplace, irrespective of where the injury occurred, has substantial socio-economic costs to individuals, employers and to society. Our findings are generalizable to those injury rehabilitation and compensation systems with similar coverage of work and non-work injury.

In conclusion, in this study we identified a number of known and new socio-demographic, work organisational, health and injury-related factors predictive of work absence at 12- and 24-months following injury in a cohort of New Zealand workers. Our study confirmed and extended previous observations of a time dependent pattern of predictors of work disability following injury, however, there was a consistent set of socio-demographic, work organisational, health and injury-related factors present regardless of the timing of follow-up that are prime for early intervention to prevent the development of long term work disability. Understanding the multi-dimensional and time

dependent patterns of predictors of long-term disability and how they may, or may not, differ by time is important if we are to develop and optimally target early interventions to reduce the significant personal and social burden and costs of long-term work disability.

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Contributions

RL was the lead author and is guarantor of this paper. RL analysed the data. GD and SD contributed to the study design, interpretation of the results, and the review and editing of the manuscript. RL, GD, SD approved the submitted manuscript.

Competing Interests

None declared.

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Ethics approval

The New Zealand Multi-Region Ethics Committee granted ethical approval for this study (MEC/07/07/093). Informed consent was obtained from all participants.

Data sharing statement

We have a data sharing policy and would consider requests on a case by case basis. Please contact sarah.derrett@otago.ac.nz.

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31

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STROBE Statement: checklist of items included in reports of observational studies

	Item No	Recommendation	Check list
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	YES p2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	YES p2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	YES p4
Objectives	3	State specific objectives, including any prespecified hypotheses	YES p5
Methods			
Study design	4	Present key elements of study design early in the paper	YES p6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	YES p5-6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	YES p5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	YES p11
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	YES p6-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	YES table 1
Bias	9	Describe any efforts to address potential sources of bias	YES p11
Study size	10	Explain how the study size was arrived at	YES p11, refs 10,11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	YES table1
Statistical methods	12	(*a*) Describe all statistical methods, including control for confounding	YES p10-11
		(*b*) Describe any methods used to examine subgroups and interactions	YES p10-11
		(*c*) Explain how missing data were addressed	YES p11
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	YES p11

		(*e*) Describe any sensitivity analyses	YES p11
Results			**Check list**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	YES p11, table 1
		(b) Give reasons for non-participation at each stage	YES p12
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	YES p12, table 3
		(b) Indicate number of participants with missing data for each variable of interest	YES p12, table 3
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	YES – 12 & 24 months
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	YES p11, table 1
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	YES tables 4&5
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	YES p20
Discussion			
Key results	18	Summarise key results with reference to study objectives	YES p21
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	YES p25
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	YES p21-26
Generalisability	21	Discuss the generalisability (external validity) of the study results	YES p26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	YES p27

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Are the early predictors of long-term work absence following injury time-dependent? Results from the Prospective Outcomes of Injury Study

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Are the early predictors of long-term work absence following injury time-dependent? Results from the Prospective Outcomes of Injury Study

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Abstract

Objectives: Few studies examine the influence of early predictors of work absence beyond 12 months following injury or the time-dependent relative importance of these factors. This study aimed to identify the most important socio-demographic, occupational, health, lifestyle and injury predictors of work absence at 12- and 24-months following injury and to examine changes in the relative importance of these over time.

Design: Prospective cohort study.

Setting: The Prospective Outcomes of Injury Study, New Zealand.

Participants: 2626 injured New Zealand workers aged 18-64 years were identified from the Prospective Outcomes of Injury Study recruited form New Zealand's monopoly injury compensation provider injury claims register; 2092 completed the 12 month interview (80% follow-up) and 2082 completed the 24 month interview (79% follow-up).

Primary and secondary outcomes measures: The primary outcomes of interest was absence from work at the time of the 12- and 24-month follow-up interviews.

Results: Using modified Poisson regression to estimate Relative Risks important groups of workers were identified at increased risk of work absence at both 12- and 24-months: males, low income workers, trade/manual workers, temporary employees, those reporting two or more co-morbidities, and those experiencing a work-related injury. Important factors unique to predicting work absence at 12 months included financial insecurity, fixed-term employment and long weekly hours worked; unique factors at 24 months included job dissatisfaction, long weekly days worked, a prior injury and sustaining an injury that was perceived to be a threat-to-life.

Conclusions: Important early predictors of work absence at 12- or 24-months following injury are multidimensional and have a time dependent pattern. A consistent set of predictors was, however, present at both time periods that are prime for early intervention. Understanding the

multidimensional, time dependent patterns of early predictors of long-term disability is important to optimally target timely interventions to prevent long-term work disability.

Key terms: Work disability; return to work; outcome; multidimensional; socio-demographic; work organisation; health; lifestyle; time dependent predictors.

Article Summary

Strengths and limitations of this study

- Few studies examine the multidimensional influence of pre-injury and injury-related predictors of work absence beyond 12 months following injury or the time-dependent relative importance of these predictors.
- Using longitudinal cohort data we found a multidimensional set of predictors of work absence that differed at 12 and 24 months following injury.
- The strengths of the study include data collection on outcomes at multiple time points following injury independent of the time periods for measurement of exposure measures; a large sample size with acceptable follow-up to 24 months (79%); and examination of a multi-dimensional range of risk factors for work absence.
- The results are sensitive to interview and item missingness, however, sensitivity analysis found this had a negligible impact on estimates of effect size.

INTRODUCTION

A prolonged absence from work following injury can have many detrimental effects on an individual's long-term employment and earning prospects [1,2] and health[3], as well as substantial societal costs.[4] The longer a worker is absent from the workplace following injury the higher the likelihood that a worker will never return to work and thus the greater the individual and social impacts of injury.[1,5,6] Returning to work following injury is a critical step in the rehabilitation process, making longer-term evaluation of vocational outcomes of interest. The early identification of predictors of long-term chronic work absence provides opportunities for timely intervention to prevent the development of prolonged work disability minimising the consequences of injury.

In the musculoskeletal injuries literature, the relative importance of predictive factors has been demonstrated to change across the stages of development of work disability.[7,8] The predictors of the acute phase of work disability often differ from the predictors of the chronic phase, suggesting different interventions are needed to address chronic long-term work disability.[8] Few studies investigating work participation following traumatic injury have examined the importance of changes in predictive factors with increasing time following injury; studies typically have short follow-up periods of 6 months, or less, following injury.[9]

A limited number of studies have examined vocational outcomes following injury from a broad population-based perspective. Previous studies have tended to focus on specific injury types, injury to specific body regions, on specific settings of injury and on injury types typically regarded as severe such as those resulting in hospitalisation.[7-10] The Prospective Outcomes of Injury Study (POIS) gives us an opportunity to examine predictors for hospitalised and non-hospitalised acute injuries, and all injury settings including road, home, recreational and work.[11] Furthermore, analysis of the large POIS cohort allows us to examine predictors using a broader multidimensional perspective. Our

previous analyses of work absence at 3-months following injury indicated a range of socio-demographic, occupational, lifestyle and injury factors were important predictors of outcome in the short term and that future analyses should continue examining a broader range of potential predictors for work disability.[12]

The aim of this study is to examine the combined pre-injury influences of socio-demographic, occupational, health and lifestyle factors, and the injury itself, as predictors of work absence at 12- and 24-months following injury for a cohort of New Zealand workers. The focus of this analysis is on potentially identifiable and modifiable factors measured early in the development of long-term work absence. In addition, this study will examine if the relative importance of these early predictors of work absence change with increasing time following injury in this same cohort.

METHODS

Study setting

Recruitment of the POIS cohort was via New Zealand's universal no-fault Accident Compensation Corporation (ACC) scheme. Compensation covers all injury settings, including the home, workplace and road. Eligible participants included those on the ACC entitlement claims register (indicating their injury would require more than simple acute treatment) who had: 1) sustained an injury between June 2007 and May 2009; 2) were aged between 18-64 years; and 3) lived in one of five regions of New Zealand. Sensitive claims, such as for from victims of abuse, are excluded. The recruitment process and resulting cohort has been described in detail elsewhere.[11,13]

Data collection and explanatory variables

The POIS study recruited 2856 participants in the period December 2007 to August 2009.[13] This paper is restricted to those POIS participants who were active workforce participants prior to their injury and had completed either, or both, a 12- and 24-month interview. Structured telephone and postal interviews collected self-reported data following injury at 3 months, with simultaneous retrospective baseline recall, and 12- and 24-month intervals following injury.

With the exception of the injury-related variables, which relate to the injury event itself, all explanatory variables examined are pre-injury variables. A priori hypotheses of a relationship with work absence, and/or prior identification in previous studies was the basis of selection of each explanatory variable.[7,10] The explanatory variables examine seven dimensions:

1) socio-demographic (age, gender, income, highest qualification, occupation, relationship status, living arrangements, material standard of living, household income adequacy, financial security);

2) physical work (repetitive hand movements, heavy lifting, physical exertion, standing, painful/tiring body positions);

3) psychosocial (job strain, support, security, satisfaction, optimism, self-efficacy, prior depressive episode);

4) work organisation (number of hours and days worked per week, employment contract, multiple job holding) ;

5) lifestyle (alcohol consumption, smoking status, Body Mass Index (BMI), exercise, sleep quantity);

6) health (overall self-assessment for health, co-morbidities, pain/discomfort, prior injury, prior disabling condition, work capacity);

7) injury-related (work-related injury, nature and body region of injuries, intent of injury, hospital admission or at least 3 hours treatment at an Emergency Department within 7 days of injury, anatomical injury severity - NISS), injury perceived as a threat to life, injury perceived as a threat of serious disability, access to health services).

See Table 1 for more detailed information about the explanatory variables.

Table 1 Measures used in the questionnaire

Factor(s)	Description of measure and source
Age, gender, education, income, relationship status, occupation & living arrangements	Single item questions from the New Zealand Census [14] Occupation grouped into professional (major level 1-3), semi-professional (level 4 &5) and trade/manual (level 6-9) using New Zealand Standard Classification of Occupations [15]
Adequacy of household income	Single item regarding adequacy of total household income to meet every day needs [16]
Material standard of living	Single item rating standard of living before injury.
Financial insecurity	Single item rating financial security in the next 10 years [17]
Repetitive hand movements, heavy lifting, painful/tiring body positions, standing & physical exertion	Set of five single items regarding amount of time spend doing physical task ranked on 4 point Likert Scale “never” to “all to ¾ of the time” [18]
Job strain, job support	Score using the Whitehall II study adaptation of Karasek’s job content model [19]
Job satisfaction	Single item rating overall job satisfaction/ dissatisfaction [18]
Self-efficacy	General Self-Efficacy Scale, scale from 0-40, dichotomised into poor (score ≤25) and good (score >25) [20]
Optimism	Agreement with expectation of more good things happen than bad, dichotomised yes (agree and strongly agree) and no (strongly disagree, disagree, neutral) [21]
Prior depressive episode	Two items from DSM-III on depressed mode and loss of interest or pleasure in daily activities for at least 2 weeks in

	the year prior [22]
Hours & days worked per week	Single items asking number of hours or days worked in main job [18]
Type of contract	Combination of two items on employment status and, for employees only, the type of employment contract [18]
Multiple job holding	Single item asking if work only one paying job or more than one job [18]
Alcohol consumption	Score (0-12) identifying hazardous drinking patterns in the year prior using the brief Alcohol Use Disorders Identification Test (Audit-C) [23]
Smoking status	Single item asking if smoke regularly.
Body Mass Index (BMI)	Calculated using weight and height, categorised underweight/normal (≤25), overweight (25-29) and obese (≥30)
Physical exercise	Multiple questions ascertaining how many days over a 7 day period engaged in 15 minutes vigorous activity or 30 minutes moderate activity. Dichotomised into ≤4 or 5-7 days a week [24]
Sleep quantity	Single item identifying how many nights a week usually obtain at least 7 hours sleep
Self-assessment for health	Single item rating health in the 4 weeks prior to injury with five point likert scale from excellent to poor [25]
Co-morbidities	Single item asking if had any of a list of 21 specific chronic conditions lasting or expected to last more than 6 months [26]
Prior injury	Single item regarding any prior injuries that affect participant
Prior disability	Single item asking if had a health problem or condition lasting

	6 months or more that caused difficulty with daily activities OR communication/socialising OR any other activity [14]
Injury nature and body region	12 binary Y/N variables indicating the presence of common nature and body region combinations were created using ACC injury diagnosis data. Variables were created for lower extremity fracture; lower extremity open wound; lower extremity superficial injury; upper extremity fracture; upper extremity open wound; upper extremity superficial injury; head, neck and inter-cranial injury; head and neck superficial injury; spine dislocation, sprain or strain; upper extremity dislocation, strain or sprain; lower extremity dislocation, strain or sprain; and injury to other region
Work capacity	Single item scale assessing working capacity prior to injury from 1 total working capacity to 0 total inability to work [27]
Pain	Single item on pain or discomfort from the EQ-5D [28]
Assault	Single item regarding if injury was the result of an assault
Hospital admission	Single item asking if admitted to hospital for day or more
Anatomical severity – NISS	Score created by mapping ICD-10 injury codes to the Abbreviated Injury Scale (AIS) with the squares of the three highest AIS scores subsequently summed to form the New Injury Severity Score (NISS).[29,30] The higher the score, the greater the anatomical injury severity. Scores were categorised NISS1-3, NISS4-6, NISS >6.
Self-perceived threat to life	Single item rating if felt injury was a threat to life
Self-perceived threat of disability	Single item rating if felt injury was threat of severe longer-

10

	term disability
Assessing health services	Single open ended item assessing troubles getting to or contacting health services. Positive and mixed responses form the "no difficult access" group, negative response "difficult access" group
Work-related	Single item regarding if injury was sustained while at work

Outcome measure

At 12- and 24-month interviews a single item "*Which of the following best describes your paid work situation now?*" was used to ascertain work status. Participants indicating full-time and part-time work for pay were considered to be "working", while those indicating they were receiving a benefit and/or compensation, or were unemployed were considered to be "absent from work".

Data analysis

The relationship between work absence and pre-injury and injury-related explanatory variables was examined using frequency tables, summary statistics and regression analyses.

For each time point adjusted univariate models were created using modified Poisson regression with robust error variance to estimate relative risks.[31] Age, gender, anatomical severity of injury (NISS), interview region and all 12 injury nature and body region variables were included in all univariate models as potential covariates. To account for the range in the timing of the 12- and 24-month interviews after the injury event, time since injury was also included as a continuous variable in all analyses.

Any variable from the adjusted univariate models for either the 12- or 24-month time point with a p≤0.2 was then entered into a multidimensional model for each time point. A consistent variable approach was used, resulting in both the 12- and 24-month overall multidimensional regression models including a consistent set of variables across both time points prior to stepwise Poisson regression. All multidimensional models were additionally adjusted for age, sex, region of interview, time since injury, anatomical injury severity – NISS and injury type and region with these variable entered as fixed variables. Complete case analysis was undertaken at both time periods. A sensitivity analysis was conducted by applying inverse probability weighting to the data to account for loss to follow-up.[32] Analyses were performed using STATA statistical package 13.0 SE.[33]

RESULTS

Of the 2626 POIS participants who were working prior to their injury, 2092 completed the 12 month interview (79% follow-up) and 2082 completed the 24 month interview (79% follow-up) (Table 2). At the 12 month interview 329 (16%) reported being absent from work, while 304 (15%) were absent at the 24 month interview. Reasons for work absence were reported at 24 months following injury only and were varied: predominantly the sample was absent from work due to ongoing recovery and rehabilitation (43%) associated with the original injury event. The majority (82% at 12 months, 81% at 24 months) had received earnings-related compensation from the ACC scheme, indicating a period at least 7 days absence from the workplace following injury. There was no evidence of statistically significant differences in patterns of work absence at either 12 or 24 months by receipt of earnings-related compensation therefore it has not been included in our analyses.

Table 2 Completed interviews and work status in workforce active participants at the 12- and 24-month time-points.

12

	12 month	24 month
Total sample (N)	2 092	2 082
Employed prior to injury (N)	2 092	2 082
Working 3 months following injury (N)	1 537	1 537
Follow-up from baseline N=2626 (%)	79%	79%
Work status at interview		
Working	1 751	1 764
Absent from work	329	304
Missing	12	14
Reasons for work absence - 24 months		
Not recovered yet/rehabilitation		132
Seeking employment		63
Retired early		27
Domestic reasons		27
Other (eg. volunteering)		22
Missing		33

A summary of the key socio-demographic and injury characteristics of the workforce active POIS participants interviewed at 12- and 24-months is provided in Appendix 1. The two sub-cohorts have broadly similar distributions of socio-demographic and injury characteristics. In comparison with the baseline interviewees the greatest loss to follow-up occurred in 18-29 year olds, males, non-professional occupational groups, in North Island regions (Auckland, Manukau & Gisborne), in those with less severe injuries and those receiving earnings-related compensation. In terms of loss to

follow-up of participants by injury type and region at 12 months greater loss was observed for participants with lower extremity fractures and upper extremity dislocations, strains and sprains, while at 24 months greater loss was observed for those sustaining upper extremity open wounds and upper extremity superficial injuries.

Most variables from the adjusted univariate modelling step (results not shown) were retained and entered into the final multivariable 12- and 24-month models. Variables not included in the final models included multiple job holding, repetitive hand movements, sleep quantity and work capacity.

12 months

Table 3 presents the final multivariable model for work absence 12 months following injury. Socio-demographic characteristics predictive of increased risk of work absence included being male, those with low levels of personal income or who could not provide an estimate of their personal income, those in trade/manual occupations and those reporting financial insecurity. Variables representing relationship status, living arrangements and adequacy of household income were not retained in the final model.

Table 3. Multivariable analysis of pre-injury and injury-related characteristics associated with work absence modelled for 12 months and 24 months post injury. [aRR=adjusted relative risk; 95% CI=95% confidence interval]

Dimension: variable	**12 months (n=1583)**		**24 months (n=1421)**	
	aRR*	**95% CI**	**aRR***	**95% CI**
Socio-demographic: Age				
18-29	Ref		Ref	

30-49	0.90	0.65-1.23	0.68	0.50-0.92
50-64	0.80	0.55-1.16	0.75	0.53-1.06
Socio-demographic: Gender				
Female	Ref		Ref	
Male	1.40	1.03-1.90	1.91	1.42-2.57
Socio-demographic: Income				
≥$50,001	Ref		Ref	
$30,000-50,000	1.50	1.05-2.15	1.74	1.19-2.53
≤$30,000	1.80	1.20-2.69	1.80	1.18-2.74
No income given	2.07	1.36-3.15	2.45	1.65-3.66
Socio-demographic: Occupation				
Professional	Ref		Ref	
Technical	1.07	0.77-1.50	1.34	0.94-1.88
Trade/manual	1.55	1.11-2.15	1.73	1.23-2.45
Unclassified	1.09	0.44-2.71	1.54	0.75-3.19
Socio-Demographic: Income adequacy				
Adequate	.	.	Ref	
Inadequate	.	.	0.80	0.62-1.01
Socio-demographic: Financial security				
Secure/Fairly secure	Ref		.	.
Fairly insecure/Insecure	1.51	1.17-1.95	.	.
Psychosocial: Job satisfaction				
Completely/mostly satisfied	Ref		Ref	
Neither satisfied nor dissatisfied	1.45	1.00-2.09	1.59	1.13-2.22
Mostly/completely dissatisfied	1.37	0.88-2.12	1.85	1.27-2.70

15

Physical: Exertion				
Never	.	.	Ref	
Occasionally-half the time	.	.	1.16	0.86-4.56
¾ of time or greater	.	.	0.78	0.55-1.12
Work organisation: Hours of work				
≤30 hrs	1.65	1.16-2.33	.	.
31-45 hrs	Ref		.	.
≥46 hrs	1.65	1.26-2.17	.	.
Work organisation: Pre-work days				
≤5 days	.	.	Ref	
6–7 days	.	.	1.35	1.03-1.78
Work organisation: Employment contract				
Employee – permanent	Ref		Ref	
Employee – temporary/casual	1.68	1.21-2.34	1.77	1.28-2.46
Employee – fixed term	2.15	1.34-3.44	1.40	0.79-2.48
Self-employed	1.33	0.90-1.97	1.27	0.81-1.98
Employer	0.45	0.19-1.06	0.42	0.14-1.24
Lifestyle: BMI				
≤ 24	Ref		Ref	
25-29	1.23	0.93-1.64	0.97	0.73-1.29
≥ 30	1.11	0.82-1.53	1.07	0.79-1.45
Health: Co-morbidities				
No co-morbidities	Ref		Ref	
1 co-morbidity	1.03	0.76-1.40	0.74	0.53-1.04

2 or more co-morbidities	1.65	1.24-2.21	1.79	1.36-2.35
Injury: Work-related injury				
No	Ref		Ref	
Yes	1.52	1.19-2.92	1.53	1.20-1.97
Injury: Prior injury				
No	.	.	Ref	
Yes	.	.	1.40	1.08-1.80
Injury: Threat to life				
No	.	.	Ref	
Yes/Maybe	.	.	1.48	1.07-2.04

* Additionally adjusted for time since injury, injury type and region, interview region and anatomical injury severity - NISS.

Job satisfaction was the only psychosocial factor to be retained in the final model of the seven variables initially assessed. There was statistically weak evidence that workers reporting a neutral position of neither satisfaction/dissatisfaction with their job had a higher risk of work absence (aRR 1.45, 95% CI 1.00-2.09). Of the four physical work variables none were retained in the final model.

Work organisational characteristics predictive of work absence included temporary or fixed term employment contracts, and long (≥46 hours per week) or part-time hours (≤ 30 hours per week). Variables indicating multiple job holding and number of weekly days worked were not retained in the final model. Of the five lifestyle factors examined only co-morbidities was retained in the final model with workers having two or more co-morbidities at increased risk of work absence (aRR 1.65, 95% CI 1.24-2.21). Only one injury-related factor was retained in the final model: those with a work injury had a higher risk of work absence (aRR 1.52, 95% CI 1.19-2.92) compared with those with a non-work injury.

24 months

Table 3 also presents the final multivariable model with adjusted relative risks of work absence 24 months following injury. Socio-demographic factors predictive of increased risk of work absence included being male (OR 1.91, 95% CI 1.42-2.57), those with incomes below $NZ 50,000, those not reporting an income (OR 2.45, 95% CI 1.65-3.66) and those with trade/manual occupation (1.73, 95% CI 1.23-2.45). Workers reporting inadequacy of household income were more likely to be working however the relationship was weakly statistical significant (aRR 0.80, 95% CI 0.62-1.01).

Workers reporting either feeling neutral (aRR 1.59, 95% CI 1.13-2.22) or dissatisfied (aRR 1.85, 95% CI 1.27-2.70) with their job had a higher risk of work absence. No clear relationship was apparent for physical exertion.

Of the work organisational factors examined workers with temporary employment contracts (aRR 1.77, 95% CI 1.28-2.46) and those working 6-7 days per week prior to injury (aRR 1.35, 95% CI 1.03-1.78) were at increased risk of work absence. Of the lifestyle factors examined workers with two or more co-morbidities were at increased likelihood of work absence (aRR 1.79, 95% CI 1.36-2.35).

Prior injury (aRR 1.40, 95% CI 1.08-1.80), injury perceived to be a threat to life (aRR 1.48, 95% CI 1.07-2.04) and work-related injuries (aRR 1.53, 95% CI 1.20-1.97) were also predictive of increased risk of work absence.

Sensitivity analysis

Complete case analysis was under taken for all models. Sensitivity analyses, using inverse probability weighting (IPW), were undertaken to assess the impact of not being included in the multivariable models in comparison to the cohort's baseline interview. Overall, the relative risks obtained using IPW were slightly lower than for the analyses presented in Table 3. Exceptions to this included low income, insecure employment and part-time working hours (≤30 hrs per week) for the 12 month model and low income, occupation, job dissatisfaction, work-related injury & perceived threat to life for the 24 month model where the relative risks were higher than the presented analysis. Only the 12 month multivariable model had items with greater than 10% change in the effect size: the adjusted relative risk was lower in workers with an "unclassified" occupation (aRR 0.83, 95%CI 0.32-2.13, compared to aRR1.09, 95% CI 0.44-2.71), for those with self-employed contracts (aRR 1.18, 95% CI 0.85-1.64, compared to aRR 1.33, 95% CI 0.90-1.97) and higher in employers (aRR 0.57, 95% CI 0.29-1.11, compared to aRR 0.45, 95% CI 0.19-1.06) and for those working ≤30 hours per week (aRR1.88, 95% CI 1.37-2.59, compared to 1.65, 95% CI 1.16-2.33).

DISCUSSION

In this prospective cohort study of injured New Zealand workers we identified a number of new pre-injury socio-demographic, work organisational, health and injury-related factors that are important predictors of work absence at 12- and 24-months following injury, and confirmed predictors identified previously. While a time-dependent pattern of predictors of work absence was also observed, a consistent set of six predictors was identified across both time periods with only two unique predictors at 12 months and four at 24 months following injury.

Comparisons of our findings with previous injury studies examining time-dependent patterns of risk factors for work absence are limited by our study's broader population based design, study sample and longer follow-up. Nevertheless, our findings are broadly consistent with the few studies which

have previously demonstrated that the influence and relative importance of risk factors changes with increasing time since injury.[9] Our study also provides further support to the importance of considering a multidimensional set of predictors across several time points when following the development of long-term work disability to provide longitudinal insight and to detect risk factors commonly, or primarily, associated with one or another stage of the disabling process.[7-9, 34] As in our earlier paper examining outcomes at 3 months following injury [11], findings from this study indicate a broad range of financial, occupational, psychosocial, work organisational and health supports for employees during recovery from injury are potentially important avenues for early intervention to interrupt prolonged absence from work.

Certain domains examined in our study have had limited, if any attention, in other research examining outcomes following acute injury.[10] Work organisational factors were identified in our study as important predictors of work absence. These findings point to the provision of opportunities for recovery from over-demanding work schedules (be it long working hours or weeks) in the long-term following injury as being important for returning to work. Workers with temporary employment contracts were at higher risk of work absence at both time points. Potential mechanisms for this relationship may include the poor quality employment protections and employment relationships between parties with the use of precarious temporary employment contracts, the degree to which substitute workers are available, and the difficulties of realising job accommodations for temporary workers.[34,35] While the evidence for a relationship between precarious employment contracts and work absence following injury is lacking, elsewhere, temporary employment has been associated with delays in returning to work following depression-related work disability episodes.[36] Financial insecurity predicted work absence at 12 months only, suggesting financial security has an important time-dependent influence on work disability in the first year following injury, possibly through feelings of anxiety generated by future economic

insecurity.[37] Further research confirming these newly identified risk factors and examining potential mechanisms of these for work absence following injury is warranted.

Injury-related factors displayed a time dependent pattern. Work-related injury was predictive of work status at both time points supporting our previous findings that workers with work-related injuries had poorer vocational outcomes by 12 months following injury.[38] Our findings indicate work-related injury has an important influence on the development of long-term work absence and interventions focusing on primary and secondary prevention of work-related injury would influence not only work absence in the long-term, but also primary prevention of these common injuries in the first place. By 24 months, the perception of the injury as having been a threat to life and having had a prior injury emerged as important injury-related risk factors. Possible mechanisms for this relationship may lie in the psychological trauma associated with the event, such as through the development of Post-Traumatic Stress Disorder (PTSD). Self-perception of the injury event is rarely examined in studies of work absence and this relationship merits further investigation. Few studies examining outcomes following injury examine previous injury, however the only other study to consider previous injury found higher odds of work disability at 1 year following back injury.[39] Further studies should consider prior injury as a potential risk factor for long-term work disability.

A number of our findings support and extend previous studies findings. Our finding that income and occupation are important predictors of work absence at both 12- and 24-months following injury is consistent with a growing body of longitudinal evidence.[8,10,40] Differing financial incentives, commonly substituted low remuneration work skills, the physical nature of work and practical difficulties in providing work accommodations to trade/manual workers are possible income and occupational barriers to work participation. Our finding that the presence of several pre-existing co-

morbidities is an important health-related risk factor for work absence at both time periods extends the findings of previous studies observing co-morbid conditions associated with a delayed return-to-work up to six months following injury.[41,42] Workers with several comorbid conditions experience an impaired health state prior to injury, and following the injury itself this may limit a person's ability to engage with the injury rehabilitation process, or to manage their chronic conditions, resulting in difficulties maintaining work. The prevalence of multimorbidity in developed nations is increasing rapidly[43], therefore, further analysis is warranted to examine the long-term influence of co-morbidity on the risk of work disability following injury.

Job satisfaction emerged as the only important pre-injury psychosocial factor predictive of work status at 24 months following injury. Recent evidence that job satisfaction is not predictive of return-to work following injury or musculoskeletal disorders is limited by short follow-up periods up to 12 months following injury.[35,17] Our findings suggest studies with follow-up beyond 12 months should consider job satisfaction as a possible risk factor for prolonged work absence. Psychosocial factors have been identified as predictive of work absence in other injury studies [8,10], however, this evidence is limited by the lack of multivariable analysis and the narrow range of potential pre-injury predictors and co-variates examined, potentially explaining why our findings differ from others.

Finally, changes in the predictive value of risk factors over time has significant implications for the types and timing of interventions required to prevent the development of work disability. [8,34] While our findings highlight the importance of distinguishing time dependent predictors we did identify a consistent set of potentially modifiable pre-injury and injury-related risk factors that are present regardless of the disability phase that are prime for early intervention. Risk factors consistently identified in our current analysis at 12-and 24-months and in our previous analysis at three months

following injury include workers with low incomes, trade/manual occupations, temporary employment contracts, over-demanding work schedules and an injury perceived to be a threat to life.[12] Given our study identified few unique time-dependent risk factors our findings suggest that interventions primarily targeting workers with these consistent pre-injury and injury risk factors should be made in the first few months following injury as early interventions targeting improvements in employment status can potentially change the progression of both short-term and long-term work absence.[44]

This study has some limitations. Firstly pre-injury factors and baseline pre-injury work status were collected through self-report at the first interview (on average 3 months following injury) and may be subject to recall bias, particularly in those variables of a subjective nature such as the psychosocial factors. The self-reported pre-injury work absence measure was found to be accurate by verifying self-reported data against ACC injury claims data about paid employment, with greater than 99% concordance. Secondly, use of single item constructs for many psychosocial factors, such as optimism and job security, may be a limitation. However, good reliability and validity has been demonstrated with parsimonious measures while reducing the interview burden on participants.[17] Thirdly, the capture of all types of work absence (more commonly for disability or unemployment) could potentially explain the shift in patterns of risk factors overtime as the longer a worker is absent from work the greater the likelihood of unemployment or redundancy. The relative proportion of officially unemployment in our work-absent participant at 12- (15%) and 24-months (18%) was small and was unlikely to be the substantial driver of the time dependent shift in risk factors that we observed. Finally, this analysis uses two slightly different groups of individuals followed up at two separate time points following the original injury using complete case analysis. While 90% of participants who completed the 12 month interview also completed the 24 month interview this analysis is sensitive to interview missingness, as well as item missingness for those who completed

12 & 24 month interviews. Sensitivity analyses, undertaken to assess the impact of being included in the final multivariable models in comparison to the baseline interview, found very few variables had a meaningful increase in effect size (ie. > 10% change) and only one, working part-time hours was significant in the final 12-month multivariable model.

Our study offers a number of strengths that overcome some of the limitations of previous studies including: the collection of comprehensive pre-injury information at 12- and 24-months following injury across a broad multi-dimensional perspective; a large sample size with acceptable follow-up to 24 months (79%); the inclusion of non-hospitalised injured participants; the measurement of outcomes at time periods independent of the time periods for measurement of exposure measures; and combined multi-dimensional analysis examining a comprehensive range of risk factors for work disability. A further key strength is the measurement of pre- and early-injury exposures which provide opportunity for identifying early interventions to influence long-term work disability outcomes. The use of two point-in-time measures of work participation is also a strength as it best captures long-term outcomes since follow-up occurs regardless of previous work status and of previous non-response. Finally, we have been able to examine within NZ's universal no-fault injury rehabilitation and compensation scheme the early predictors of long-term work disability for all injured workers, regardless of whether the injury was sustained at work or not. This is a strength as being absent from the workplace, irrespective of where the injury occurred, has substantial socio-economic costs to individuals, employers and to society. Our findings are generalizable to those injury rehabilitation and compensation systems with similar coverage of work and non-work injury.

In conclusion, in this study we identified a number of known and new socio-demographic, work organisational, health and injury-related factors predictive of work absence at 12- and 24-months following injury in a cohort of New Zealand workers. Our study confirmed and extended previous

observations of a time dependent pattern of predictors of work disability following injury, however, there was a consistent set of socio-demographic, work organisational, health and injury-related factors present regardless of the timing of follow-up that are prime for early intervention to prevent the development of long term work disability. Understanding the multi-dimensional and time dependent patterns of predictors of long-term disability and how they may, or may not, differ by time is important if we are to develop and optimally target early interventions to reduce the significant personal and social burden and costs of long-term work disability.

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Contributions

RL was the lead author and is guarantor of this paper. RL analysed the data. GD and SD contributed to the study design, interpretation of the results, and the review and editing of the manuscript. RL, GD, SD approved the submitted manuscript.

Competing Interests

None declared.

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Ethics approval

The New Zealand Multi-Region Ethics Committee granted ethical approval for this study (MEC/07/07/093). Informed consent was obtained from all participants.

Data sharing statement

We have a data sharing policy and would consider requests on a case by case basis. Please contact sarah.derrett@otago.ac.nz.

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27

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Appendix 1. Socio-demographic and injury characteristics of POIS workforce active cohort at baseline, 12 and 24-month interviews.

	Baseline interview N=2 626	12 month interview N=2 092	Relative difference[a] (%)	24 month interview N=2 082	Relative difference[a] (%)
Age					
18-29	635	435	-31	427	-33
30-49	1 230	988	-20	991	-19
50-64	761	669	-8	664	-13
Gender					
Female	1 671	1 285	-23	1 271	-24
Male	955	807	-15	811	-15
Occupation					
Professional	914	772	-16	773	-15
Semi-professional	548	449	-18	445	-19
Trade or manual	1 058	798	-25	785	-26
Unclassified	85	64	-25	65	-24
Missing	21		9		
Region					
Auckland	866	686	-21	686	-21
Manukau	732	555	-24	555	-24
Gisborne	190	141	-26	134	-29
Otago	537	467	-13	455	-15
Southland	301	243	-19	252	-16
Anatomical injury severity – NISS					

1-3	1 101	864	-22	855	-22
4-6	1 179	956	-19	948	-20
>6	263	213	-19	217	-17
Missing	83	59			
Earnings-related compensation					
Yes	2 169	1 709	-21	1 694	-22
No	457	383	-16	388	-15
Lower extremity fracture					
No	2 206	1 739	-21	1 746	-21
Yes	420	353	-16	336	-20
Upper extremity fracture					
No	2 169	1 728	-20	1 717	-21
Yes	457	364	-20	365	-20
Lower extremity dislocation, sprain, strain					
No	2 031	1 608	-21	1 587	-22
Yes	595	484	-19	495	-17
Upper extremity dislocation, sprain, strain					
No	2 263	1 819	-20	1 804	-20
Yes	363	273	-25	278	-23
Spine dislocation, sprain, strain					
No	2 195	1 754	-20	1 743	-21
Yes	431	338	-22	339	-21
Head, neck and intracranial					

No	2 535	2 018	-20	2 003	-21
Yes	91	74	-19	79	-13
Lower extremity open wound					
No	2 522	2 007	-20	1 999	-21
Yes	104	85	-18	83	-20
Upper extremity open wound					
No	2 463	1 963	-20	1 966	-20
Yes	163	129	-21	116	-29
Lower extremity superficial					
No	2 446	1 950	-20	1 938	-21
Yes	180	142	-21	144	-20
Upper extremity superficial					
No	2 499	1 991	-20	1 988	-20
Yes	127	101	-20	94	-26
Head, neck superficial					
No	2 538	2 020	-20	2 011	-21
Yes	88	72	-18	71	-19
Other region					
No	2 175	1 724	-21	1 711	-21
Yes	451	368	-18	371	-18

[a] relative difference compared to baseline interview cohort

STROBE Statement: checklist of items included in reports of observational studies

	Item No	Recommendation	Check list
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	YES p2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	YES p2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	YES p4
Objectives	3	State specific objectives, including any prespecified hypotheses	YES p5
Methods			
Study design	4	Present key elements of study design early in the paper	YES p6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	YES p5-6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	YES p5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	YES p11
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	YES p6-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	YES table 1
Bias	9	Describe any efforts to address potential sources of bias	YES p11
Study size	10	Explain how the study size was arrived at	YES p11, refs 10,11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	YES table1
Statistical methods	12	(*a*) Describe all statistical methods, including control for confounding	YES p10-11
		(*b*) Describe any methods used to examine subgroups and interactions	YES p10-11
		(*c*) Explain how missing data were addressed	YES p11
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	YES p11

		(*e*) Describe any sensitivity analyses	YES p11
Results			**Check list**
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	YES p11, table 1
		(b) Give reasons for non-participation at each stage	YES p12
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	YES p12, table 3
		(b) Indicate number of participants with missing data for each variable of interest	YES p12, table 3
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	YES – 12 & 24 months
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	YES p11, table 1
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	YES tables 4&5
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	YES p20
Discussion			
Key results	18	Summarise key results with reference to study objectives	YES p21
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	YES p25
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	YES p21-26
Generalisability	21	Discuss the generalisability (external validity) of the study results	YES p26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	YES p27