UNIVERSITY OF CALGARY

Work Injuries and Mental Health

Final Report

WorkplaceNL
Health | Safety | Compensation

April 26, 2022
Principal Investigator: Nick Turner, PhD
Co-investigators: Steve Granger, MSc and Connie Deng, MSc

Table of Contents

List of Figures

List of Tables

Acknowledgements

This research was supported by WorkplaceNL. It was made possible in part by using the data/biospecimens collected by the Canadian Longitudinal Study on Aging (CLSA). Data are available from the CLSA (www.clsa-elcv.ca) for researchers who meet the criteria for access to de-identified CLSA data. Funding for the CLSA is provided by the Government of Canada through the Canadian Institutes of Health Research (CIHR) under grant reference: LSA 94473 and the Canada Foundation for Innovation as well as the following provinces, Newfoundland, Nova Scotia, Quebec, Ontario, Manitoba, Alberta, and British Columbia. This research has been conducted using the CLSA dataset [Baseline Tracking Dataset version 3.4, Comprehensive Dataset version 4.0, Follow-up 1 Tracking Dataset version 1.0, Comprehensive Dataset version 1.0], under Application Number 1909026. The CLSA is led by Drs. Parminder Raina, Christina Wolfson and Susan Kirkland. The opinions expressed in this manuscript are the author's own and do not reflect the views of the CLSA.

We wish to thank Eunice Mingollo and Mihret Girum for their assistance in coding articles for Study 1. We are also grateful to Aidan Dumaisnil, Alyssa Grocutt, Sandy Hershcovis, Kevin Kelloway, Zhanna Lyubykh, Babatunde Ogunfowora, Piers Steel, Natalie Valle, and Justin Weinhardt for feedback on earlier drafts of Study 1. We are grateful to Iain Ferguson who drafted the executive summary and implications sections. Finally, we are indebted to Sean Tucker who generously provided access to data used in Study 3 data for secondary analysis, collected as part of a research contract awarded by the Worker Compensation Board of Manitoba's 2011 Research and Innovation Program (Tucker & Turner, 2017).

The text of this unpublished report is based off of three manuscripts in preparation:

Granger, S., & Turner, N. (2022a). *Work injuries and mental health problems: A meta-analysis* [Manuscript in preparation]. Haskayne School of Business, University of Calgary.

Granger, S., & Turner, N. (2022b). *Work injuries and mental health problems: A test of cognitive mechanisms.* [Manuscript in preparation]. Haskayne School of Business, University of Calgary.

Granger, S., & Turner, N. (2022c). *Short-term trajectories of mental health around the work injury among young workers.* [Manuscript in preparation]. Haskayne School of Business, University of Calgary.

Study 1: A Meta-Analysis

Study 1: A Meta-Analysis

Introduction

Work injuries and mental health problems continue to impose serious costs to both organizations and societies—costs that include healthcare expenses, workers compensation payments, legal fees, lost productivity, training replacement employees, and lower employee morale, among many others. Apart from their high expense, these two problems share other troubling features. Far too many individuals suffer needlessly because of preventable work injuries and treatable mental health problems. Worse still, the majority of work injuries go unreported or unrecorded for fear of reprisal (among other reasons; Fagan & Hodgson, 2017), and an even larger majority of mental health problems go undisclosed, undiagnosed, and untreated because of stigma (Baumann, 2007). As a result, advancing our understanding of these two concerning phenomena could have substantial and widespread benefits.

The first critical step forward in addressing work injuries and mental health problems is to examine rigorously the relationship between them. While intuition and scattered evidence suggest a link between the two issues (e.g., J. Kim & Choi, 2016; Lin, Chu, et al., 2014), there is little agreement as to the magnitude or direction of the relationship. While we observe that most research has assumed the work injuries→mental health problems relationship, even research purporting to examine the mental health problems→work injuries relationship often inadvertently makes the work injuries→mental health problems assumption in their research design by having a substantially longer recall periods for the purported work injuries outcome than the purported mental health predictor (e.g., preceding 9 months and preceding 1 week, respectively; Frone, 1998). Further, there is little agreement as to what conditions shape the relationship between work injuries and mental health problems. Existing research has variously considered characteristics of the worker (e.g., gender; J. Kim & Choi, 2016) and their work (e.g., manual labor; H.-C. Kim et al., 2009), but this research is largely inconsistent, leaving many questions unanswered.

Accordingly, the goal of Study 1 is to provide the most comprehensive empirical summary of the relationship between work injuries and mental health problems to date. In doing so, the current study makes three specific contributions. First, this research offers the most robust estimate of an average effect size for the relationship between work injuries and mental health problems. Calculating aggregated effect sizes is crucial as they illustrate the magnitude and variation of relationships, providing a basis for future research and policy. The second contribution is to compare the magnitude of the relationship in time-separated research designs. Doing so makes it possible to infer differences in the relationship between work injuries and mental health problems by comparing effect sizes from (a) research designs in which work injuries are measured prior to mental health problems (i.e., work

injuries→mental health problems) and (b) research designs in which mental health problems are measured before work injuries (i.e., mental health problems→work injuries). The third contribution of this meta-analysis lies in identifying the conditions (moderators) under which the relationship between work injuries and mental health problems varies. This study is the first to aggregate and compare the effects of these conditions on the strength of the relationship.

Defining Work Injuries and Mental Health Problems

Research examining the relationship between work injuries and mental health problems is multidisciplinary, and has therefore defined and operationalized these two concepts in various ways. Thus, providing clear definitions and categories to classify these concepts is an important first step towards integrating and advancing our understanding of their relationship. A work injury is defined as "a wound or damage to the body resulting from unintentional or intentional acute exposure to energy (kinetic, chemical, thermal, electrical, and radiation) or from the acute absence of essential elements (e.g., heat, oxygen) caused by a specific event, incident, or series of events within a single workday or shift" (Barling & Frone, 2004, p. 5). This definition of work injury is comprehensive and functional in that it reflects the variety of ways that work injuries have been framed and measured. These variously include whether a person has experienced a work injury (i.e., presence/absence; Ramos et al., 2016), whether the work injury was minor or major (i.e., severity; Stice & Moore, 2005), and how many work injuries an individual has experienced (i.e., frequency; Turner et al., 2014). This definition of work injury also distinguishes it from chronic strain injuries (i.e., disability resulting from the accumulation of repetitive motions) and work accidents (i.e., unplanned events that may result in injury, but also include near misses that do not result in personal injury, as well as mechanical or environmental damages).

The definition of the term "mental health problem" requires similar clarification. Mental health is a higher-order concept used to describe the state and variation of an individual's psychological well-being and distress (Massé et al., 1998). Healthy cognitive, emotional, and social functioning and the absence of psychological distress (Keyes, 2005) reflect a complete state of mental health. Prolonged deviations from this complete state are conceived as mental health problems. More specifically, mental health problems arise with a noticeably prolonged shift in cognition, emotion, or behavior resulting in the experience of psychological distress. Like the definition of work injuries, this definition of mental health problems is comprehensive and functional as it encompasses the many ways in which mental health problems have been operationalized. Most commonly, they have been operationalized in terms of specific symptoms or patterns of poor mental health (e.g., depression; Keogh et al., 2000) or as an indicator of overall mental health (e.g., general mental health; Evanoff et al., 2002). In turn, measurement in quantitative research has largely been split between the use of scales (i.e., higher or lower levels; Siu et al., 2004) and clinical cut-offs (i.e., above or below a designated cut-off to be considered depressed or not; Jacobsen et al., 2013). These clinical cut-offs are established based on cumulative evidence, similar to the first goal of our study which is to establish the magnitude of the relationship between work injuries and mental health problems.

The Bidirectional Work Injuries–Mental Health Problems Relationship

Several studies have found an association between work injuries and mental health problems (Agh et al., 2014; J. Kim, 2013). However, the vast majority of these studies use cross-sectional research designs, which limit the strength of conclusions due to ambiguous directionality and confounding variables. Since the relationship between work injuries and mental health problems does not lend itself to the experimental control necessary to establish causality, any inferences about causality will need to rely on convergent evidence from various methodological approaches. One such approach is to assess and compare studies that employ longitudinal research methods.

The few longitudinal studies that have been conducted on the work injuries–mental health problems relationship appear to provide evidence for both directions, albeit with a higher prevalence and consistency for the work injuries→mental health problems direction than the alternative. For instance, there is some research tying work injuries to subsequent short- to long-term drops in mental health (e.g., from 8 days to 10 years; Dong et al., 2015; Evanoff et al., 2002; J. Kim & Choi, 2016; Lin, Shiao, et al., 2014). The long-term effects of a work injury on subsequent mental health problems appear to be partially reliant on the severity of the injury (Dong et al., 2015; Kuo et al., 2012) and potentially reliant on the frequency of injuries (Jacobsen et al., 2013). However, these points are difficult to assess, given that most studies do not distinguish the severity or frequency of injuries when measuring the presence or absence of an injury; do not untangle perceived severity (i.e., the lived experience of the injured worker) from "objective" severity (e.g., bruises vs. broken bones); and typically refer to a single injury as opposed to an accumulation of injuries.

Nevertheless, there are good reasons to argue that injury severity and frequency are key factors in potentially exacerbating subsequent mental health problems. One such reason is the research linking severe and frequent injuries to risk factors for mental health problems. Broadly, these risk factors can be summarized as *functional limitations* (i.e., difficulties with diverse physical activities) and *employment instability* (i.e., various indicators of involuntary turnover and unemployment). Baidwan et al. (2018) found in a longitudinal study that injured workers were more likely than non-injured workers to experience a wide range of functional limitations important to their occupations, while also experiencing higher rates of depression. Another longitudinal study by Chin et al. (2017) showed that unemployment following a work injury was related to depression and post-traumatic stress symptoms, while a higher number of different jobs held following a work injury was related to higher rates of depression. Thus, severe and frequent work injuries may alter how individuals feel about themselves in relation to the future.

At the same time, there is also some (albeit weaker, inconsistent, and less prevalent) evidence that prior mental health problems are related to an increased likelihood of experiencing a work injury. For example, a case–control study found that consultation for any psychiatric symptom was related to a

higher risk of later experiencing injury (Palmer et al., 2014). Other research has suggested that short- and long-term symptoms of poor mental health were slightly higher among those who were subsequently injured (H.-C. Kim et al., 2009; Salminen et al., 2010). However, one limitation of these findings is that there appears to be high comorbidity of symptoms found in the studies that measured more than one mental health problem indicator. As such, summarizing which mental health symptoms (or sets of symptoms) have been measured more often than others have and their respective associations with work injuries could yield significant insights. We therefore conduct this type of summarizing in the current study, highlighting the most common forms of mental health problems in this research.

Depression is the most common form of mental health problem measured within research on the work injury-mental health problems relationship (e.g., J. Kim, 2013), likely because of the relationship it has with factors that harm or inhibit self-preservation. For example, individuals who are depressed are more likely to consume greater levels of drugs and alcohol (e.g., Boden & Fergusson, 2011; Fergusson et al., 2003) and get less sleep (Tsuno et al., 2005)—both of which factors are related to work injuries (e.g., Zheng et al., 2010). The second most common form of mental health problems measured within research on work injuries is general mental health/psychological distress (e.g., Laal et al., 2016), followed by anxiety (Wall et al., 2007), and symptoms of post-traumatic stress (Lin, Chu, et al., 2014). Overall, the research on these mental health problems suggests they may cause physical and psychological vulnerabilities to injury.

> *Hypothesis 1: The form of work injury will moderate the relationship between work injuries and mental health problems, such that severe and frequent work injuries will have a stronger association with mental health problems than simply the presence of an injury.*
>
> *Hypothesis 2: The prospective measurement of work injuries and mental health problems will moderate the relationship between work injuries and mental health problems, such that the association will be stronger when work injuries are measured prior to mental health problems (i.e., work injuries →mental health problems) compared to when mental health problems are measured prior to work injuries (i.e., mental health problems →work injuries).*
>
> *Research Question 1: Will the form of mental health problems moderate the relationship between work injuries and mental health problems, such that the association will be stronger between depression and work injuries compared to other forms of mental health problems?*

Sample Characteristics and the Work Injuries–Mental Health Problems Relationship

As noted, research on the association between work injuries and mental health problems has also considered specific characteristics of those injured, with gender being the most studied of these characteristics. One study found that depression levels did not vary among injured and non-injured males, but that injured females were more depressed than their non-injured counterparts were (Peele & Tollerud, 2005). Further, in the opposite direction, depressed females were more likely to experience injuries, whereas depressed males were not (H.-C. Kim et al., 2009). However, different findings

appeared in a study with a much larger and representative sample, showing that males who experienced occupational injuries were more likely to show symptoms of depression than non-injured males and both injured and non-injured females (J. Kim & Choi, 2016).

Although superficially contradictory, these mixed findings are likely due to confounding factors such as higher depression rates among women in general (Nolen-Hoeksema & Girgus, 1994; Piccinelli & Wilkinson, 2000) and higher injury rates among men in general (Messing et al., 1994; Salminen et al., 1992). Indeed, a study by Asfaw and Souza (2012) confirmed this pattern, but also revealed that increased depression following an injury was higher among males than females, despite higher overall levels of depression among females. Given these results, it appears likely that males experience greater increases in depression following an injury while females experience higher levels of depression overall.

Other characteristics such as age, education, visible minority status, income, and marital status may play a role in linking the experiences of work injuries and mental health problems (Burke-Miller et al., 2006; Salminen, 2013). However, these characteristics may also simply describe the general workforce found within more physically hazardous jobs. Young, uneducated, single, low income, and visible minorities are more likely to work at temporary and manual labor jobs, which often feature inadequate safety training and supervision for physically hazardous work (Salminen, 2013; Smith & Mustard, 2010). A study by Chau et al. (2011) that examined the relationship between various hazards (i.e., biomechanical, physical, and psychological) and work injuries among those exhibiting depressive symptoms versus those who were symptom-free found that the relationship between occupational hazards and work injuries increased with the increase of depressive symptoms. Therefore, it is likely that aspects of the job (i.e., hazardous occupations or conditions) will differentiate the relationship between work injuries and mental health problems.

> *Hypothesis 3: Gender will moderate the relationship between work injuries and mental health problems such that work injuries will have a stronger relationship with mental health problems among males than females.*
>
> *Hypothesis 4: The degree to which an occupation is physically hazardous will moderate the relationship between work injuries and mental health problems such that the relationship will be stronger in samples drawn from occupations that are more hazardous.*
>
> *Research Question 2: Will the personal demographics of age, marital status, education, income, and visible minority status moderate the relationship between work injuries and mental health problems such that work injuries will have a stronger relationship with mental health problems among younger, single, less educated, lower income, and visible minorities?*

Method

Sample Collection

We gathered published and unpublished effect sizes from numerous sources for meta-analysis. Articles were primarily gathered from the online databases Web of Science, Google Scholar, PsycINFO, and MEDLINE. We further used relevant qualitative studies, reviews, and meta-analyses gathered from the online databases for citation leads. Additional efforts were made to gather grey literature, such as conference proceedings, white papers, theses, and dissertations, as well as government reports. Finally, we made calls for unpublished data to relevant management and occupational health and safety email list services. See Figure 1 for a summary of the sample identification, screening, and inclusion process.

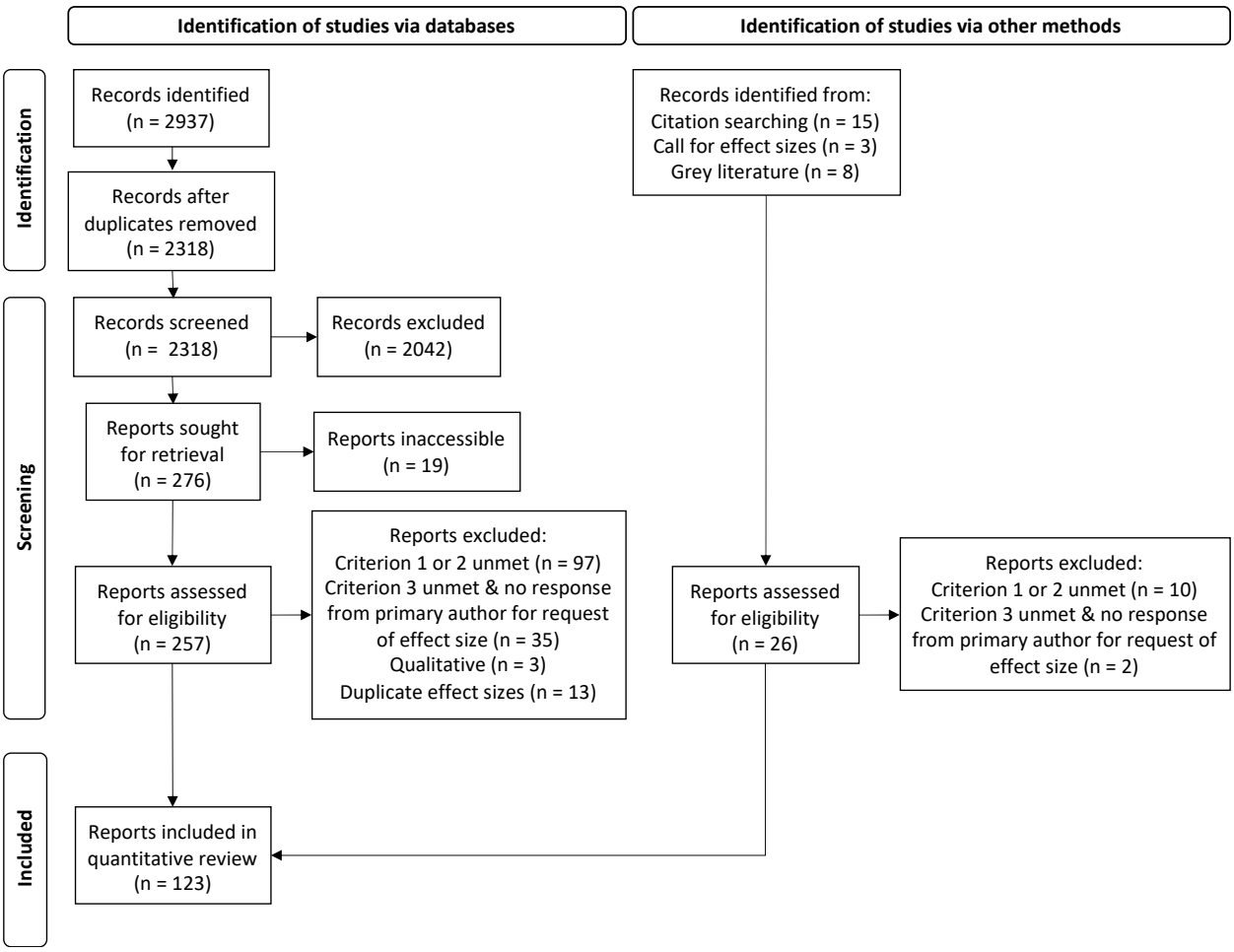


Figure 1. *Flow chart of article identification, screening, and inclusion process.*

Search terms for each database were compiled in collaboration with a professional librarian. The search terms combined with Boolean rules and conceptual blocks (and allowing for the gathering of correlated

terms) included the following: "*work**" or "*occupation**" or "*job*" *adjacent to* "*injur**" or "*accident**[1]" and "*mental health*" or "*stress*" or "*depression*" or "*suicidal ideation*" or "*distress*" or "*anxiety*" or "*posttraumatic stress disorder*" or "*emotional trauma*" or "*emotional disturbances*" or "*emotional exhaustion*" or "*burnout.*" Searches were limited from 1988 to 2019. All articles that contained at least one of these keywords (i.e., anything potentially relevant, even qualitative or review papers for further references) were retrieved from the databases.

For articles to be included in the meta-analysis, they had to meet the following pre-determined population, intervention, comparator, and outcome (PICO; Schardt et al., 2007) criteria:

(1) Work injuries were measured in any form (i.e., severity, frequency, or presence/absence).

(2) Mental health was measured prior to, at the time of, or following the work injury in any form.

(3) An effect size for the relationship between work injuries and mental health was measured and provided (or at least enough information to calculate an effect size was available).

For studies that met the criteria but did not include an effect size or effect sizes within the publication, we contacted the corresponding author through email. Furthermore, the file drawer problem (see Rosenthal, 1979) was mitigated by gathering all relevant unpublished data in the form of dissertations, conference papers, book chapters, and unpublished working papers through the original search process. The resulting effect sizes were then aggregated in four different ways: per independent sample (i.e., an overall injury and mental health effect size per sample), per injury form (i.e., an aggregate effect size for each form of injury within samples), per mental health form (i.e., an aggregate effect size for each mental health form within samples) and per prospective measurement (i.e., an overall injury and mental health effect size per prospective measurement).

Coding Procedure

All articles were vetted and coded by one of the authors and double coded by at least one research assistant. Rater agreement was calculated using Cohen's Kappa for categorical entries (Mean Kappa = .86) and overall agreement for numerical entries (Mean agreement = 95%). All disagreements were assessed and discussed by the coding author and the research assistant(s) to reach agreement. Details that were coded from each study are outlined below.

[1] While the broader category of accidents was excluded in this meta-analysis, "accident*" was still included as a search term because previous research on occupational safety has often treated work injuries and accidents as synonymous. Articles where it was clear that the authors were looking at work injuries but referred to them as accidents were included, whereas articles where it was unclear or it was clear they were using it appropriately as a broader category including near misses and non-personal damages were excluded.

Article characteristics. The full citation of each article that met the criteria was coded. In addition, publication status (published or unpublished), format of reference (e.g., journal article, dissertation, conference paper, etc.), and the region where research was conducted were coded.

Sample characteristics. Sample details were coded and included the exact sample size used in the analyses that produced relevant effect sizes (if unstated, the overall sample size of the sample was retrieved), mean age, sample scale (sample-based vs. population-based), and mean tenure. Open-ended industry was also recorded and industry-level non-fatal injury incidence rates (derived from the Bureau of Labor Statistics, 2019) were matched to samples drawn from a single industry as a proximate measurement of physical hazardousness. Further, the proportion of each sample categorized by the following sample details was coded (from 0 to 1): male, relative visible minority, not married, lowest income bracket, high school education or above, and working at time of primary study's data collection.

Work injury measurement. The format of work injury was coded into one of three categories: frequency, severity, or presence/absence. Additionally, whether the injury measure was dichotomized, the length of recall for injuries, the scale reliability, and measurement source (i.e., self-report or other-report, such as organizational records) were also recorded when provided.

Mental health problems measurement. The type of mental health problem that was measured was recorded and categorized into "depression," "anxiety," "post-traumatic stress," "general mental health," or "other." The specific scale used to measure mental health, whether mental health was dichotomized, the number of mental health measures within the sample, and the scale reliability were recorded in the dataset.

Association characteristics. All associations among work injury and mental health problems were recorded. Effect sizes were transformed into Pearson correlation coefficients if they were not already in this format. Correlation coefficients were also calculated when no effect sizes were reported but when there was enough information to do so manually (e.g., in studies where number of participants categorized into injured/not injured and depressed/not depressed were available; effect size formulas and calculators drawn from Card, 2015; Lenhard & Lenhard, 2016; Lipsey & Wilson, 2001). Finally, any reported covariates were also recorded.

Study design characteristics. Potentially influential aspects of the study design were also coded as potential moderators. These included the design of the study (i.e., concurrent, longitudinal, or case–control), the length of time between measurements if the study was longitudinal, whether mental health or work injuries were measured first, and the context where the study took place (i.e., research laboratory, field, or residence). In addition, the quality of each article was evaluated using a 3-point Likert-type scale (1 = *low quality*; 2 = *average quality*; 3 = *high quality*) based on the Ottawa-Newcastle quality assessment (Peterson et al., 2011).

Meta-Analytic Procedure

Analyses were conducted using the *metafor* package (Viechtbauer, 2010) in the statistical software R (R Core Team, 2018). First, a random-effects model with REML estimation was chosen for the calculation of the weighted mean effect size. Modeling for within- and between-study variance was deemed appropriate given the diversity of samples and their respective characteristics and study designs (Schmidt & Hunter, 2014). Second, all correlations derived from constructs that were measured through effect or reflective indicators (i.e., mental health measures and subjective injury severity measures) were disattenuated for unreliability when possible using methods suggested by Schmidt and Hunter (2014). When reliabilities for reflective scales were unavailable, an average reliability was used based on those that were provided; otherwise, reliability for measures of causal or formative indicators (i.e., injured or not, frequency of injuries, and objective severity ratings) were assumed to have perfect reliability for the purposes of disattenuation. Third, correlations were transformed to Fisher's *Z* prior to analysis and back-transformed to provide the mean weighted and corrected correlation for reporting (Borenstein et al., 2009). In addition, 95% confidence and credibility intervals were calculated, which represent the estimated variability around mean effect size and variability of effect sizes across studies, respectively.

Moderation analyses were conducted with mixed-effects meta-regression procedures (Gonzalez-Mulé & Aguinis, 2018; Viechtbauer, 2010) using the weighted corrected correlations to test Hypotheses 1 through 4, as well as to assess Research Questions 1 and 2. Pairwise comparisons for nominal moderators with three or more categories were analyzed with the *multcomp* package (Hothorn et al., 2008), which adjusts the resulting *p*-values using Holm's method (Holm, 1979).

Publication bias was addressed given the small number of unpublished effect sizes that were retrieved, which is typical of meta-analyses. The funnel plot technique was used to visualize potential publication bias (Viechtbauer, 2010). Supplemental analyses were also conducted because visual asymmetry of funnel plots may be due to factors other than publication bias (Quintana, 2015) and can be difficult to interpret accurately (Terrin et al., 2005). Therefore, Egger's regression test for funnel plot asymmetry (Egger et al., 1997) and a rank correlation test (Begg & Mazumdar, 1994) were also conducted to examine the potential role of publication bias. Finally, the "trim-and-fill" method was applied to estimate how many studies are missing because of potential publication bias (Duval & Tweedie, 2000).

Results

See Table 1 for the overall association between work injuries and mental health problems, as well as for the associations by work injury form, mental health form, and prospective measurement. Also, see Figure 2 for the forest plot of the overall association between work injuries and mental health problems. The average weighted corrected correlation for the overall association between work injuries and mental health is .21 (*k* = 129, 95% CI = .18, 24, 95% CR = -.10, .48). The test for heterogeneity for the overall analyses (*Q* [128] = 16,875.27, *p* < .001) and the wide credibility interval suggest there is a great deal of heterogeneity between samples. As such, exploratory moderation analyses were conducted in addition to the hypothesized moderation analyses, some of which are displayed in Tables 1 and 2.

Table 1. *The association between work injury and mental health problems.*

				$\bar{r}$ 95% interval			ρ 95% interval	
	k	*N*	$\bar{r}$	CI	CR	ρ	CI	CR
Overall association	129	1,407,827	.18	[.16, .21]	[-.07, .42]	.21	[.18, .24]	[-.10, .48]
Work injury form with overall mental health	142[a]							
Present (yes/no)	84	1,380,106	.15	[.13, .18]	[-.09, .40]	.17	[.14, .21]	[-.12, .44]
Frequency	25	16,988	.23	[.17, .29]	[-.05, .48]	.26	[.19, .32]	[-.07, .53]
Severity	33	20,013	.24	[.19, .28]	[-.00, .45]	.28	[.22, .33]	[-.05, .55]
Mental health form on overall work injury	176[a]							
Depression	73	1,099,034	.17	[.14, .20]	[-.07, .39]	.20	[.16, .23]	[-.09, .45]
Anxiety	15	46,521	.18	[.12, .25]	[-.04, .38]	.22	[.13, .29]	[-.07, .47]
Post-traumatic stress	9	548,050	.34	[.20, .46]	[-.08, .65]	.37	[.22, .51]	[-.11, .71]
General mental health	47	856,920	.20	[.15, .25]	[-.12, .48]	.23	[.17, .28]	[-.16, .55]
Other	32	597,656	.17	[.13, .21]	[-.06, .38]	.18	[.14, .23]	[-.07, .42]
Prospective measurement	140[a]							
Work injury→Mental health	36	965,525	.21	[.16, .27]	[-.09, .48]	.25	[.18, .31]	[-.12, .55]
Work injury←→Mental health	87	348,986	.20	[.17, .23]	[-.06, .43]	.23	[.19, .26]	[-.09, .50]
Work injury←Mental health	17	103,869	.09	[.03, .14]	[-.15, .31]	.10	[.03, .17]	[-.19, .37]

Note. *k* = number of samples, *N* = total sample size, $\bar{r}$ = weighted average correlation, CI = confidence interval, CR = credibility interval, ρ = weighted correlation corrected for attenuation, var1→var2 = var1 measured prior to var 2, var1←→var2 = var1 and var2 measured at same time, var1←var2 = var2 measured prior to var1. [a] Some studies measured multiple forms of injuries, mental health problems, and prospective associations. In such circumstances, multiple effect sizes were calculated to represent each form or prospective association, wherein they were previously aggregated together for the overall analyses. Therefore, *k* for these sub-analyses will be larger than the *k* for the overall association analysis.

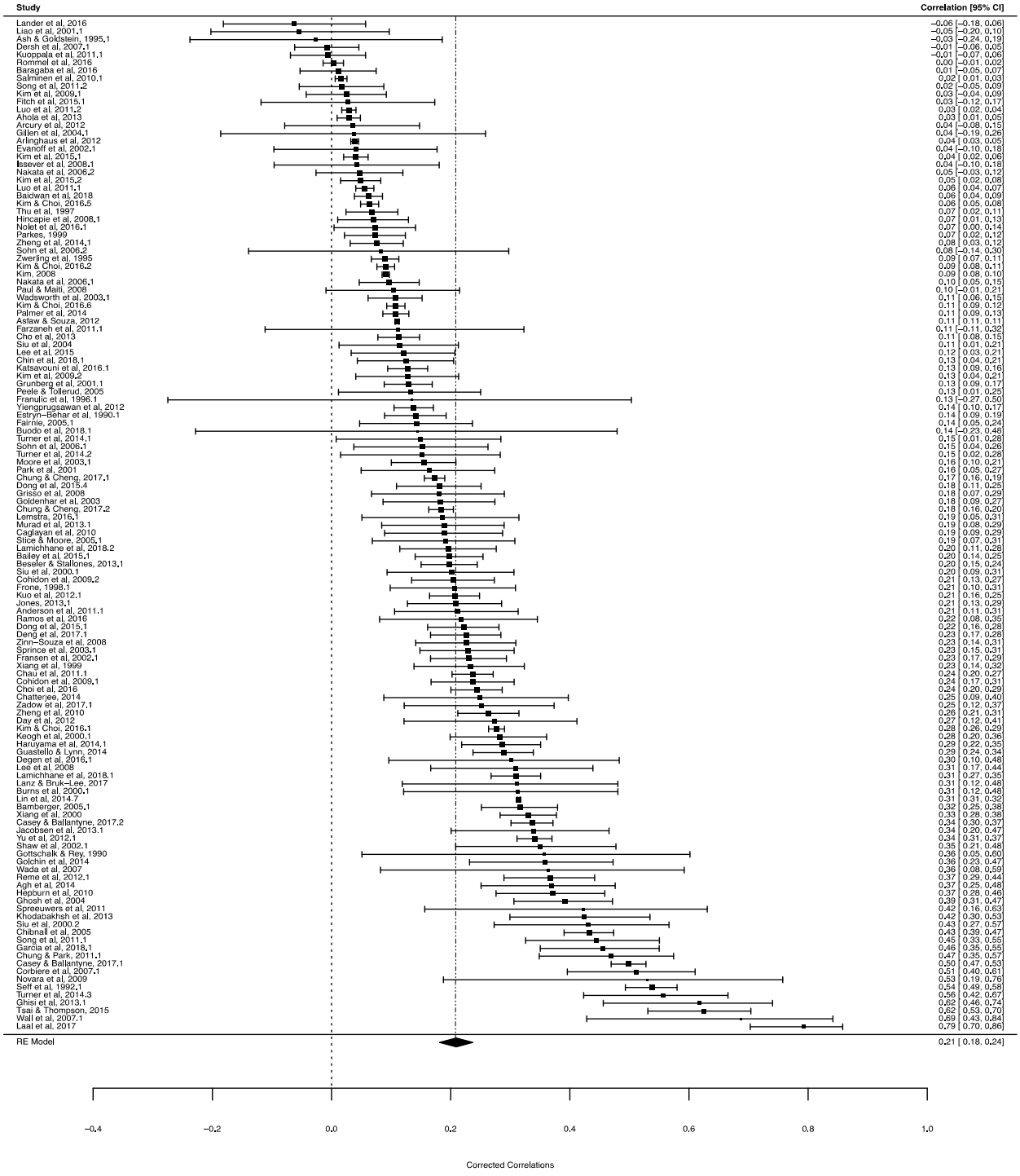


Figure 2. *Forest plot of aggregated corrected correlation coefficients.*

Table 2. *Categorical study and sample details on the overall association between work injury and mental health.*

				$\bar{r}$ 95% interval			ρ 95% interval	
	k	*N*	$\bar{r}$	CI	CR	ρ	CI	CR
Region								
North America	63	714,463	.18	[14, .21]	[-.08, .41]	.20	[.16, .24]	[-.10, .47]
Europe	17	83,710	.15	[.08, .21]	[-.11, .39]	.17	[.09, .25]	[-.14, .46]
Asia & Oceania	39	607,537	.18	[.14, .23]	[-.07, .42]	.20	[.15, .25]	[-.10, .48]
Africa & Middle East	7	1,358	.30	[.19, .39]	[.03, .52]	.35	[.23, .46]	[.03, .60]
South & Central America	3	759	.28	[.11, .44]	[-.02, .54]	.31	[.11, .49]	[-.05, .60]
Design								
Cross-sectional	80	848,349	.19	[.16, .22]	[-.07, .43]	.22	[.18, .25]	[-.10, .49]
Longitudinal	33	145,022	.17	[.13, .22]	[-.09, .41]	.19	[.14, .25]	[-.12, .47]
Case–Control	16	414,456	.18	[.11, .25]	[-.09, .43]	.21	[.12, 29]	[-.12, .49]
Setting								
Research laboratory	12	10,444	.23	[.14, .31]	[-.04, .46]	.27	[.17, 36]	[-.05, .54]
Field	52	414,348	.21	[.17, .24]	[-.05, .44]	.23	[.19, .28]	[-.07, .50]
Residence	65	983,035	.16	[.13, .19]	[-.10, .40]	.18	[.14, .22]	[-.13, .46]
Quality								
Low	12	9,815	.21	[.13, .28]	[-.06, .45]	.24	[.15, .33]	[-.08, .52]
Average	90	880,191	.17	[.14, .20]	[-.09, .41]	.19	[.16, .22]	[-.12, .47]
High	27	517,821	.22	[.17, .27]	[-.04, .45]	.26	[.20, .32]	[-.05, .52]
Sample scale								
Sample-based	106	93,677	.20	[.18, .23]	[-.04, .42]	.23	[.20, .26]	[-.06, .49]
Population-based	23	1,314,150	.10	[.05, .15]	[-.15, .33]	.11	[.05, .17]	[-.19, .39]

Note. *k* = number of samples, N = total sample size, $\bar{r}$= weighted average correlation, CI = confidence interval, CR = credibility interval, ρ = weighted correlation corrected for attenuation.

Moderation Analyses

Hypothesis testing. First, the form of injury moderated the relationship between work injuries and mental health problems (*k* = 142, *Q* [3] = 12.91, *p* = .002). Subsequent pairwise comparisons showed that the difference between presence of injury and frequent injuries was significantly different from zero (*z* = 2.28, *p* = .045), as was the difference between presence of injury and severe injuries (*z* = 3.26, *p* = .003). However, the difference between frequent injuries and severe injuries was not significantly different from zero (*z* = .58, *p* = .565).

Second, prospective measurement moderated the relationship between work injuries and mental health problems (*k* = 140, *Q* [3] = 9.69, *p* = .008). Pairwise comparisons revealed that the prospective measurement of previous mental health problems to subsequent work injuries was significantly smaller than the prospective measurement of previous work injuries to subsequent mental health problems (*z* = 2.93, *p* = .010) and smaller than the concurrent measurement of work injuries and mental health problems (*z* = 2.88, *p* = .010). Further, there was no difference between the concurrent measurement

and the prospective measurement of previous work injuries and subsequent mental health problems (z = .52, p = .602).

Third, gender did not moderate the association between work injuries and mental health problems. This factor was tested in two ways: (1) a meta-regression analysis using the proportion of males within samples (k = 102, Q [1] = .40, p = .53); and (2) a subgroup meta-regression analysis of studies that separated effect sizes by gender (k = 11, Q [1] = .001, p = .972).

Fourth, occupational hazard did not moderate the association between work injuries and mental health problems. Meta-regression analysis using the industry-level non-fatal injury incidence rate for samples drawn from a single industry revealed no significant effect (k = 59, Q [1] = 1.23, p = .267).

In summary, support was found for Hypotheses 1 and 2, while no support was found for Hypotheses 3 and 4. Below, additional moderation analyses are explored to address Research Questions 1 and 2, and for exploratory purposes.

Research questions. We assessed the form of mental health problem measured in order to answer Research Question 1. The form of problem measured marginally moderated the relationship (Q [4] = 8.88, p = .064), such that follow-up pairwise comparisons revealed that the difference between depression and post-traumatic stress was significantly different from zero (z = 2.80, p = .049) and that the difference between post-traumatic stress and "other" was significantly different from zero (z = 2.91, p = .049). In both cases, post-traumatic stress symptoms had a stronger association with work injuries than both depression and the "other" mental health problems category. Outside of these observations, no other pairwise comparisons between forms of mental health problems measured differed significantly.

Age, education, income, marital status, and visible minority status were assessed to address Research Question 2. Among these, only visible minority status moderated the relationship between work injuries and mental health problems (k = 42, Q [1] = 6.57, p = .010), such that samples consisting of a larger proportion of visible minorities showed a stronger relationship between work injuries and mental health problems (intercept [no visible minorities] = .10, SE = .04, p = .004, estimate [all visible minorities] = .24, SE = .09, p = .010).

Article and study details. Date, publication status, source of effect size (internal vs. external), region, study design, setting, and quality were assessed as potential article and study details shaping the average effect size. However, none of these article or study details were found to moderate the association between work injuries and mental health problems.

Sample details. Exploratory sample details tested include sample scale, work status, and work tenure. Among these, only sample scale moderated the relationship, such that large-scale population-based

studies are more likely to produce a smaller effect size (k = 129, Q [1] = 13.36, $p < .001$, intercept [sample-based] = .24, $p < .001$, estimate [population-based] = -.13, $SE = .04$, $p < .001$).

Work injury and mental health details. We explored the following as potential moderators: whether the work injury and mental health measures were dichotomized; the source of work injury measure; and time of recall for the injury variable. Both work injury dichotomization ($k = 142$, Q [1] = 16.79, $p < .001$) and mental health dichotomization ($k = 176$, Q [1] = 11.29, $p < .001$) moderated the association between work injuries and mental health problems. When either work injury or mental health was dichotomized, the association tended to be smaller (estimate = -.13, $SE = .03$, $p < .001$ and estimate = -.09, $SE = .03$, $p < .001$ for work injury and mental health dichotomization, respectively). Finally, neither the measurement source of injury nor the injury measure's length of recall moderated the relationship between work injury and mental health problems.

Analysis details. The type of statistical analysis, time lag between measures, and the presence of covariates were explored as potential analysis detail moderators. However, none of these analysis details moderated the association between work injuries and mental health problems.

Publication Bias

Funnel plots were generated to examine potential publication bias visually (see Figure 3). Upon visual inspection, there appears to be asymmetry present among the weighted corrected correlations. A subsequent Egger's regression test for funnel plot asymmetry ($z = 4.86$, $p < .001$) and a rank correlation test (Kendall's $\tau = .28$, $p < .001$) support this observation, suggesting the presence of potential publication bias. As such, the "trim-and-fill" method was conducted, but results from this approach suggest no studies are missing on the left side of the funnel plot. In sum, while there is evidence for the presence of publication bias, the impact of this bias appears minimal.

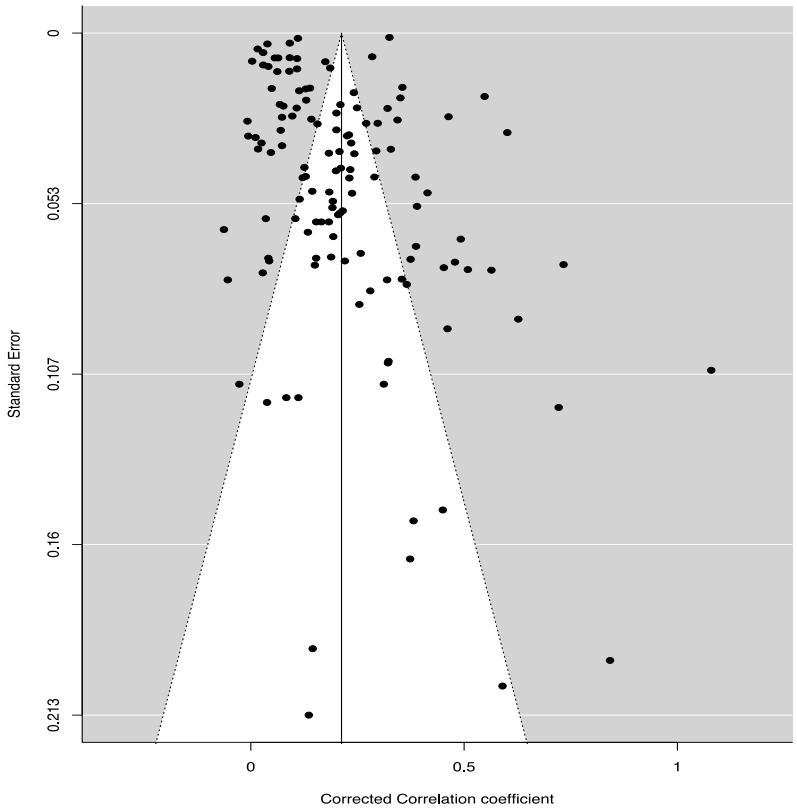


Figure 3. *Funnel plot corrected correlation coefficients.*

Discussion

The findings from the current meta-analysis reveal much about the relationship between work injuries and mental health problems. For one, there tends to be considerable variation in the average effect size across studies, suggesting a wide array of possible conditional factors shaping the relationship between work injuries and mental health problems. Among those hypothesized to shape this relationship, only the form of work injury and prospective measurement were significant moderators, whereas gender and the degree to which an occupation was hazardous were not. Exploratory moderation analyses further highlighted several other factors shaping the relationship, including the form of mental health problem, visible minority status, sample scale, and measurement dichotomization. We discuss these findings, as well as their implications and limitations, in greater detail below.

Conditions Shaping the Work Injuries–Mental Health Problems Relationship

Among the factors hypothesized and explored as moderators of the work injuries–mental health problems relationship, the most insightful was the difference between longitudinal measurements: studies that measured work injury prior to or at the same time as mental health had a larger effect size than studies that measured work injury after measuring mental health problems. While directionality cannot be concluded from this evidence, it at least suggests that mental health problems are more likely to be present following, as opposed to preceding, a work injury. On the one hand, given this finding, mental health problems are likely a distal antecedent of work injuries, intermediated by various factors resulting from mental health problems and more proximal to work injuries. On the other hand, the prospective measurement of work injuries prior to mental health problems does suggest that mental health problems can be expected as one of the potential troubling consequences of work injuries.

The reason why mental health problems may be more likely to arise after an injury is likely a function of the form of work injury. As was hypothesized, the severity and frequency of injuries tended to show a stronger association with mental health problems than simply the presence of a work injury. These findings suggest that researchers studying workplace injuries should, whenever possible, measure beyond the mere presence of an injury and capture the severity and/or frequency of injuries as well. Further, the form of mental health problem is also an important consideration. Post-traumatic stress symptoms were found to be especially related to work injuries (relative to depression). However, a common practice among studies that measured depression was to use clinical cut-off scores to categorize participants as “depressed” or “not depressed.” This tendency to dichotomize continuous mental health measures affected the variation in these variables, and thus the average effect sizes tended to be smaller.

The prevalence of dichotomizing mental health problems and work injuries points to a larger concern. While it is pragmatic to use established clinical cut-offs (e.g., to align measurement with analytical assumptions or for drawing out intuitive practical and policy-related implications), and efficient to capture only whether a participant experienced an injury or not (e.g., minimize burden on participants), this meta-analysis should serve as a basis for guiding choices around measurement and reporting in future studies. The issues around dichotomizing continuous variables are widely documented (e.g., Altman & Royston, 2006; MacCallum et al., 2002), but most importantly, doing so removes variation vital to detecting and predicting variables, and in turn limits the potential of meta-analyses to explore these variables.

Moving beyond characteristics of work injuries and mental health, the findings from this meta-analysis highlight various sample characteristics found to be either uninformative or informative to the relationship between work injuries and mental health problems. First, evidence clearly suggests that gender did not moderate the relationship. As mentioned in the literature review and hypothesis development, there are many issues with considering gender as a moderator of this relationship. While it may be true that males tend to experience more work injuries and that females tend to experience higher levels of depression, this study was not able to assess the change in magnitude of the relationship by gender, but rather whether there were any differences to be seen in the overall

relationship (i.e., either by proportion of males in the sample or between samples that separate genders). In neither case did gender play a conditional role in the relationship.

Further, the degree to which the sample occupations were physically hazardous did not moderate the relationship as hypothesized. However, there are some notable issues that may explain this lack of finding. First, there were very few samples drawn from occupations with low injury incidence rates or those that would otherwise be considered "low hazard"; this makes sense as the work injuries–mental health problems relationship is rarely researched within these types of samples. Second, this analysis was limited to samples drawn from a single occupation or industry, with most of the excluded samples consisting of individuals from a myriad of occupations that range widely in terms of their physical hazardousness. Hence, it is conceivable that physical hazardousness is still a potential moderator, but the current study was unable to detect the potential threshold (i.e., comparing low- and high-hazard occupations) where a hazard factor may influence the relationship between work injuries and mental health problems.

With respect to the other sample characteristics tested in this meta-analysis, neither age, education, income, marital status, tenure, or work status explained variation in the effect sizes across samples. However, the proportion of visible minorities in a sample moderated the relationship between work injuries and mental health problems, such that the greater the proportion of minorities in the sample, the stronger the relationship. This finding is important in that among populations known to be vulnerable to work injuries (e.g., younger, less educated, and single individuals), visible minority status was the only characteristic to emerge as one that magnified the relationship between work injuries and mental health problems. There is a long history of research on the health disparities experienced by minorities (e.g., Nelson, 2002; Williams & Mohammed, 2009) and this finding contributes to this line of research.

Research and Practical Implications

Studying the relationship between work injuries and mental health problems has many valuable implications for research and practice in (but not limited to) occupational health and safety. First, this meta-analysis should serve as a measurement guide for future researchers examining either or both work injuries and mental health problems. Sufficient research has been conducted on the presence or absence of injury; in the future, researchers should opt to enrich dichotomous measures (e.g., by having numerous dichotomous measures increasing in severity of injury that could be combined into an index) or capture follow-up details on a present injury (e.g., its perceived severity as an injured worker's experience compared to an objective rating is likely more strongly associated with their prior and subsequent mental health). Similarly, researchers should avoid relying solely on dichotomizing continuous mental health measures. Whether researchers ultimately choose to dichotomize a

continuous variable, the descriptive statistics of and correlations with its continuous form should be provided to enable future meta-analyses.

Second, this meta-analysis demonstrates that the association between previous work injuries and subsequent mental health problems is stronger than the association between previous mental health problems and subsequent work injuries. Accordingly, this finding should encourage research examining the outcomes of work injuries. Most research on work injuries has understandably treated them as outcomes to be measured, managed, and mitigated. However, studies examining the potential consequences of work injuries, such as the current meta-analysis, are crucial for providing evidence to support or guide institutional practices following work injuries. For instance, the current meta-analysis provides evidence that a greater emphasis on psychological rehabilitation in conjunction with physical rehabilitation in return-to-work programs is warranted.

Third, the finding that visible minority status magnifies the association between work injuries and mental health problems is significant for future research, practice, and policy. Research is needed to parse out the exact reasons why samples with a greater proportion of visible minorities showed a stronger relationship between the experience of work injuries and mental health problems. From a practical perspective, organizations that employ greater numbers of visible minorities need to be aware of this precarity and, depending on worker rights in their jurisdiction, ensure their employees are aware of their right to report injuries. Further, organizations may benefit by providing resources and support during the post-injury process (e.g., communicating the importance of and advice on completing workers' compensation claims where this option is available). From a policy perspective, governing bodies may want to direct limited resources to ensuring employers are providing these protections to minority workers through inspections and enforcement.

Limitations and Future Directions

While this comprehensive meta-analytic review of the work injuries–mental health problems relationship represents a valuable step forward, it features certain limitations. First, a meta-analysis is a blunt tool, blending not only different operationalizations of variables, but also study designs that range in their quality, measures that range in their validity and reliability, and statistical analyses that range in their sophistication and assumptions (Sharpe, 1997). This is especially the case for the current meta-analysis, which blends research from a wide range of disciplines. While a blunt tool is useful for integrating a large body of evidence—and steps were taken to account for the quality of studies and unreliability in measures—it still limits the nuance that is required to fully appreciate the complex relationship between work injuries and mental health problems.

Future studies seeking to address this limitation will need to focus on improving the extensiveness of measures and the quality of study designs. As previously emphasized, there is a widespread overreliance on dichotomization. At the same time, there is also a pressing need for more diverse study designs, especially longitudinal and experience sampling research. Much could still be learned by studying evaluations of work injuries and mental health problems in shorter intervals. For instance, monthly measures are as ideal and pragmatic as it gets for measuring injuries (Andersen & Mikkelsen, 2008) and

would allow for researchers to examine the fluctuation of mental health prior to and after the experience of a work injury.

Another limitation to the current meta-analysis is that it only focused on acute work injuries and did examine other pernicious work-related physical ailments, such as chronic injuries or disease. Indeed, there is ample reason to believe chronic injuries and disease are strongly related to mental health problems (Dersh et al., 2002; Gatchel, 2004). As such, there is opportunity for researchers to assess the difference between acute and chronic injuries in terms of their association with mental health problems. Finally, while research on chronic injuries and mental health problems is less common than research on acute injuries, there may be opportunity for researchers to empirically synthesize this literature in the coming years.

Conclusion

This multidisciplinary meta-analysis summarizes the existing quantitative literature on the relationship between work injuries and mental health problems to determine two things: what we know thus far, and where we should be headed in terms of future research, practice, and policy. The results confirm a small to moderate association between work injuries and mental health problems, but this effect size is bound to vary due to numerous conditions. Specifically, this study highlights prospective measurement, the form and measurement of work injuries and mental health problems, and visible minority status as key conditions on the work injuries–mental health problems relationship. It is our hope that this meta-analysis will serve as an important basis for several promising lines of research and evidence-based practices.

References

Agh, M., Mirzaei, R., & Mohammadi, M. (2014). Study of the relationship between life quality and occupational accidents in wood industry. *Health Scope*, *3*(1), 1–5. https://doi.org/10.17795/jhealthscope-13934

Altman, D. G., & Royston, P. (2006). The cost of dichotomising continuous variables. *British Medical Journal*, *332*(7549), 1080. https://doi.org/10.1136/bmj.332.7549.1080

Andersen, L. P., & Mikkelsen, K. L. (2008). Recall of occupational injuries: A comparison of questionnaire and diary data. *Safety Science*, *46*(2), 255–260. https://doi.org/10.1016/j.ssci.2007.06.014

Asfaw, A., & Souza, K. (2012). Incidence and cost of depression after occupational injury. *Journal of Occupational and Environmental Medicine*, *54*(9), 1086–1091. https://doi.org/10.1097/JOM.0b013e3182636e29

Baidwan, N. K., Gerberich, S. G., Kim, H., Ryan, A. D., Church, T. R., & Capistrant, B. (2018). A longitudinal study of work-related injuries: Comparisons of health and work-related consequences between injured and uninjured aging United States adults. *Injury Epidemiology*, *5*(1), 35. https://doi.org/10.1186/s40621-018-0166-7

Barling, J., & Frone, M. R. (2004). Occupational injuries: Setting the stage. In *The Psychology of Workplace Safety* (pp. 3–12). American Psychological Association Washington, DC.

Baumann, A. E. (2007). Stigmatization, social distance and exclusion because of mental illness: The individual with mental illness as a 'stranger.' *International Review of Psychiatry*, *19*(2), 131–135. https://doi.org/10.1080/09540260701278739

Begg, C. B., & Mazumdar, M. (1994). Operating characteristics of a rank correlation test for publication bias. *Biometrics*, *50*(4), 1088–1101. https://doi.org/10.2307/2533446

Boden, J. M., & Fergusson, D. M. (2011). Alcohol and depression. *Addiction*, *106*(5), 906–914. https://doi.org/10.1111/j.1360-0443.2010.03351.x

Borenstein, M., Hedges, L. V, Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis* (1st ed.). John Wiley & Sons.

Bureau of Labor Statistics. (2019). *Injuries, illnesses, and fatalities*. https://www.bls.gov/iif/oshwc/osh/os/summ1_00_2019.htm

Burke-Miller, J. K., Cook, J. A., Grey, D. D., Razzano, L. A., Blyler, C. R., Leff, H. S., Gold, P. B., Goldberg, R. W., Mueser, K. T., & Cook, W. L. (2006). Demographic characteristics and employment among people with severe mental illness in a multisite study. *Community Mental Health Journal*, *42*(2), 143–159. https://doi.org/10.1007/s10597-005-9017-4

Card, N. A. (2015). *Applied meta-analysis for social science research*. Guilford Press.

Chau, N., Lemogne, C., Legleye, S., Choquet, M., Falissard, B., Fossati, P., & Group, L. (2011). Are occupational factors and mental difficulty associated with occupational injury? *Journal of Occupational and Environmental Medicine*, *53*(12), 1452–1459. https://doi.org/10.1097/JOM.0b013e318237a14b

Chin, W.-S., Shiao, J. S.-C., Liao, S.-C., Kuo, C.-Y., Chen, C.-C., & Guo, Y. L. (2017). Depressive, anxiety and post-traumatic stress disorders at six years after occupational injuries. *European Archives of Psychiatry and Clinical Neuroscience*, *267*(6), 507–516. https://doi.org/10.1007/s00406-016-0762-x

Dersh, J., Polatin, P. B., & Gatchel, R. J. (2002). Chronic pain and psychopathology: Research findings and theoretical considerations. *Psychosomatic Medicine*, *64*(5), 773–786. https://doi.org/10.1097/01.PSY.0000024232.11538.54

Dong, X. S., Wang, X., Largay, J. A., & Sokas, R. (2015). Long-term health outcomes of work-related injuries among construction workers—findings from the National Longitudinal Survey of Youth. *American Journal of Industrial Medicine*, *58*(3), 308–318. https://doi.org/10.1002/ajim.22415

Duval, S., & Tweedie, R. (2000). Trim and fill: A simple funnel-plot–based method of testing and adjusting for publication bias in meta-analysis. *Biometrics*, *56*(2), 455–463. https://doi.org/10.1111/j.0006-341X.2000.00455.x

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *British Medical Journal*, *315*(7109), 629–634. https://doi.org/10.1136/bmj.315.7109.629

Evanoff, B., Abedin, S., Grayson, D., Dale, A. M., Wolf, L., & Bohr, P. (2002). Is disability underreported following work injury? *Journal of Occupational Rehabilitation*, *12*(3), 139–150. https://doi.org/10.1023/A:10168385

Fagan, K. M., & Hodgson, M. J. (2017). Under-recording of work-related injuries and illnesses: An OSHA priority. *Journal of Safety Research*, *60*, 79–83. https://doi.org/10.1016/j.jsr.2016.12.002

Fergusson, D. M., Goodwin, R. D., & Horwood, L. J. (2003). Major depression and cigarette smoking: Results of a 21-year longitudinal study. *Psychological Medicine*, *33*(8), 1357–1367. https://doi.org/10.1017/S0033291703008596

Frone, M. R. (1998). Predictors of work injuries among employed adolescents. *Journal of Applied Psychology*, *83*(4), 565–576. https://doi.org/10.1037/0021-9010.83.4.565

Gatchel, R. J. (2004). Comorbidity of chronic pain and mental health disorders: the biopsychosocial perspective. *American Psychologist*, *59*(8), 795. https://doi.org/10.1037/0003-066X.59.8.795

Gonzalez-Mulé, E., & Aguinis, H. (2018). Advancing theory by assessing boundary conditions with metaregression: A critical review and best-practice recommendations. *Journal of Management*, *44*(6), 2246–2273. https://doi.org/10.1177/0149206317710723

Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics*, 65–70. https://www.jstor.org/stable/4615733

Hothorn, T., Bretz, F., & Westfall, P. (2008). Simultaneous inference in general parametric models. *Biometrical Journal*, *50*(3), 346–363. https://doi.org/10.1002/bimj.200810425

Jacobsen, H. B., Caban-Martinez, A., Onyebeke, L. C., Sorensen, G., Dennerlein, J. T., & Reme, S. E. (2013). Construction workers struggle with a high prevalence of mental distress and this is associated with their pain and injuries. *Journal of Occupational and Environmental Medicine*, *55*(10), 1197–1204. https://doi.org/10.1097/JOM.0b013e31829c76b3

Keogh, J. P., Nuwayhid, I., Gordon, J. L., & Gucer, P. W. (2000). The impact of occupational injury on injured worker and family: Outcomes of upper extremity cumulative trauma disorders in Maryland workers. *American Journal of Industrial Medicine*, *38*(5), 498–506. https://doi.org/10.1002/1097-0274(200011)38:5<498::AID-AJIM2>3.0.CO;2-I

Keyes, C. L. M. (2005). Mental illness and/or mental health? Investigating axioms of the complete state model of health. *Journal of Consulting and Clinical Psychology*, *73*(3), 539–548. https://doi.org/10.1037/0022-006X.73.3.539

Kim, H.-C., Park, S.-G., Min, K.-B., & Yoon, K.-J. (2009). Depressive symptoms and self-reported occupational injury in small and medium-sized companies. *International Archives of Occupational and Environmental Health*, *82*(6), 715–721. https://doi.org/10.1007/s00420-008-0365-6

Kim, J. (2013). Depression as a psychosocial consequence of occupational injury in the US working population: Findings from the medical expenditure panel survey. *BMC Public Health*, *13*(1), 303. https://doi.org/10.1186/1471-2458-13-303

Kim, J., & Choi, Y. (2016). Gender differences in the longitudinal association between work-related injury and depression. *International Journal of Environmental Research and Public Health*, *13*(11), 1077. https://doi.org/10.3390/ijerph13111077

Kuo, C.-Y., Liao, S.-C., Lin, K.-H., Wu, C.-L., Lee, M.-B., Guo, N.-W., & Guo, Y. L. (2012). Predictors for suicidal ideation after occupational injury. *Psychiatry Research*, *198*(3), 430–435. https://doi.org/10.1016/j.psychres.2012.02.011

Laal, F., Modrek, M. J., Balarak, D., Mohammadi, M., Rakhshani, M., & Rigi, N. (2016). Relationship between quality of life and occupational accidents in South-East of Iran (Zahedan). *Global Journal of Health Science*, *9*(2), 112–118. https://doi.org/10.5539/gjhs.v9n2p112

Lenhard, W., & Lenhard, A. (2016). *Calculation of effect sizes*. Psychometrica. https://doi.org/10.13140/RG.2.2.17823.92329

Lin, K.-H., Chu, P.-C., Kuo, C.-Y., Hwang, Y.-H., Wu, S.-C., & Guo, Y. L. (2014). Psychiatric disorders after occupational injury among National Health Insurance enrollees in Taiwan. *Psychiatry Research*, *219*(3), 645–650. https://doi.org/10.1016/j.psychres.2014.06.015

Lin, K.-H., Shiao, J. S.-C., Guo, N.-W., Liao, S.-C., Kuo, C.-Y., Hu, P.-Y., Hsu, J.-H., Hwang, Y.-H., & Guo, Y. L. (2014). Long-term psychological outcome of workers after occupational injury: Prevalence and risk factors. *Journal of Occupational Rehabilitation*, *24*(1), 1–10. https://doi.org/10.1007/s10926-013-9431-3

Lipsey, M. W., & Wilson, D. B. (2001). *Practical meta-analysis*. SAGE publications, Inc.

MacCallum, R. C., Zhang, S., Preacher, K. J., & Rucker, D. D. (2002). On the practice of dichotomization of quantitative variables. *Psychological Methods*, *7*(1), 19–40. https://doi.org/10.1037//1082-989X.7.1.19

Massé, R., Poulin, C., Dassa, C., Lambert, J., Bélair, S., & Battaglini, A. (1998). The structure of mental health: Higher-order confirmatory factor analyses of psychological distress and well-being measures. *Social Indicators Research*, *45*(1–3), 475–504. https://doi.org/10.1023/A:1006992032387

Messing, K., Courville, J., Boucher, M., Dumais, L., & Seifert, A. M. (1994). Can safety risks of blue-collar jobs be compared by gender? *Safety Science*, *18*(2), 95–112. https://doi.org/10.1016/0925-7535(94)90019-1

Nelson, A. (2002). Unequal treatment: Confronting racial and ethnic disparities in health care. *Journal of the National Medical Association*, *94*(8), 666–668. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2594273/pdf/jnma00325-0024.pdf

Nolen-Hoeksema, S., & Girgus, J. S. (1994). The emergence of gender differences in depression during adolescence. *Psychological Bulletin*, *115*(3), 424–443. https://doi.org/10.1037/0033-2909.115.3.424

Palmer, K. T., D'angelo, S., Harris, E. C., Linaker, C., & Coggon, D. (2014). The role of mental health problems and common psychotropic drug treatments in accidental injury at work: A case–control study. *Occupational and Environmental Medicine*, 308–312. https://doi.org/10.1136/oemed2013-101948

Peele, P. B., & Tollerud, D. J. (2005). Depression and occupational injury: Results of a pilot investigation. *Journal of Occupational and Environmental Medicine*, *47*(4), 424–427. https://doi.org/10.1097/01.jom.0000158700.50594.0f

Peterson, J., Welch, V., Losos, M., & Tugwell, P. (2011). The Newcastle-Ottawa scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. *Ottawa: Ottawa Hospital Research Institute*.

Piccinelli, M., & Wilkinson, G. (2000). Gender differences in depression: Critical review. *The British Journal of Psychiatry*, *177*(6), 486–492. https://doi.org/10.1192/bjp.177.6.486

Quintana, D. S. (2015). From pre-registration to publication: A non-technical primer for conducting a meta-analysis to synthesize correlational data. *Frontiers in Psychology*, *6*, 1–9. https://doi.org/10.3389/fpsyg.2015.01549

R Core Team. (2018). *R: A language and environment for statistical computing, R Foundation for Statistical Computing, Vienna, Austria.* URL http://www. R-project.org.

Ramos, A. K., Carlo, G., Grant, K., Trinidad, N., & Correa, A. (2016). Stress, depression, and occupational injury among migrant farmworkers in Nebraska. *Safety*, *2*(4), 1–11. https://doi.org/10.3390/safety2040023

Rosenthal, R. (1979). The file drawer problem and tolerance for null results. *Psychological Bulletin*, *86*(3), 638–641. https://doi.org/10.1037/0033-2909.86.3.638

Salminen, S. (2013). Occupational accidents: Prevalence, risk factors and health outcomes. *Journal of Risk and Governance*, *4*(3), 219–234. https://doi.org/1938929676?accountid=9838

Salminen, S., Oksanen, T., Vahtera, J., Sallinen, M., Härmä, M., Salo, P., Virtanen, M., & Kivimäki, M. (2010). Sleep disturbances as a predictor of occupational injuries among public sector workers. *Journal of Sleep Research*, *19*, 207–213. https://doi.org/10.1111/j.1365-2869.2009.00780.x

Salminen, S., Saari, J., Saarela, K. L., & Räsänen, T. (1992). Fatal and non-fatal occupational accidents: Identical versus differential causation. *Safety Science*, *15*(2), 109–118. https://doi.org/10.1016/0925-7535(92)90011-N

Schardt, C., Adams, M. B., Owens, T., Keitz, S., & Fontelo, P. (2007). Utilization of the PICO framework to improve searching PubMed for clinical questions. *BMC Medical Informatics and Decision Making*, *7*(16), 1–6. https://doi.org/10.1186/1472-6947-7-16

Schmidt, F. L., & Hunter, J. E. (2014). *Methods of meta-analysis: Correcting error and bias in research findings* (3rd ed.). Sage Publications.

Sharpe, D. (1997). Of apples and oranges, file drawers and garbage: Why validity issues in meta-analysis will not go away. *Clinical Psychology Review*, *17*(8), 881–901. https://doi.org/10.1016/S0272-7358(97)00056-1

Siu, O., Phillips, D. R., & Leung, T. (2004). Safety climate and safety performance among construction workers in Hong Kong: The role of psychological strains as mediators. *Accident Analysis & Prevention*, *36*(3), 359–366. https://doi.org/10.1016/S0001-4575(03)00016-2

Smith, P. M., & Mustard, C. A. (2010). The unequal distribution of occupational health and safety risks among immigrants to Canada compared to Canadian-born labour market participants: 1993–2005. *Safety Science*, *48*(10), 1296–1303. https://doi.org/10.1016/j.ssci.2010.03.020

Stice, D. C., & Moore, C. L. (2005). A study of the relationship of the characteristics of injured workers receiving vocational rehabilitation services and their depression levels. *Journal of Rehabilitation*, *71*(4), 12–22. https://doi.org/236232784?accountid=167

Terrin, N., Schmid, C. H., & Lau, J. (2005). In an empirical evaluation of the funnel plot, researchers could not visually identify publication bias. *Journal of Clinical Epidemiology*, *58*(9), 894–901. https://doi.org/10.1016/j.jclinepi.2005.01.006

Tsuno, N., Besset, A., & Ritchie, K. (2005). Sleep and depression. *The Journal of Clinical Psychiatry*, *66*(10), 1254–1269. https://doi.org/10.4088/JCP.v66n1008

Turner, N., Hershcovis, M. S., Reich, T. C., & Totterdell, P. (2014). Work–family interference, psychological distress, and workplace injuries. *Journal of Occupational and Organizational Psychology*, *87*(4), 715–732.

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*, *36*(3), 1–48.

Wall, C. L., Ogloff, J. R. P., & Morrissey, S. A. (2007). Psychological consequences of work injury: Personality, trauma and psychological distress symptoms of noninjured workers and injured workers returning to, or remaining at work. *International Journal of Disability Management*, *2*(2), 37–46. https://doi.org/10.1375/jdmr.2.2.37

Williams, D. R., & Mohammed, S. A. (2009). Discrimination and racial disparities in health: Evidence and needed research. *Journal of Behavioral Medicine*, *32*(1), 20–47. https://doi.org/10.1007/s10865-008-9185-0

Zheng, L., Xiang, H., Song, X., & Wang, Z. (2010). Nonfatal unintentional injuries and related factors among male construction workers in central China. *American Journal of Industrial Medicine*, *53*(6), 588–595. https://doi.org/10.1002/ajim.20833

Study 2: A Test of Mechanisms

Study 2: A Test of Mechanisms

Introduction

Work injuries and mental health problems bare immense costs on workers and organizations—costs that rise exponentially when workers experience both concurrently (e.g., Anderson et al., 2011). Despite these exponential costs, we still have a limited understanding of how work injuries and mental health problems are connected. Indeed, the theoretical conversation on the relationship between work injuries and mental health problems has increasingly become atheoretical (e.g., Patten et al., 2010; Kim & Choi, 2016). This concerning trend leaves us with little idea about how to treat or disrupt the linkage between work injuries and mental health problems, and ultimately reduce their associated costs.

It is therefore our intention to reignite the theoretical conversation on the psychological processes underlying the work injury experience and the role of mental health problems prior to and following a work injury. We apply cognitive theories to examine and distinguish the bi-directional relationship between work injuries and mental health problems. Importantly, we propose that the cognitive mechanisms underlying each direction of the relationship (i.e., mental health problems→work injuries and work injuries→mental health problems) are distinct. Here we draw on theories of cognitive resources (e.g., resource allocation model; Ellis & Ashbrook, 1988) and maladaptive cognitions (e.g., information processing model; Beck & Clark, 1988) to propose two such mechanisms: cognitive functioning as the mechanism linking prior mental health problems to future work injury and negative cognitions as the mechanism linking prior work injury and future mental health problems.

We examine these cognitive mechanisms by drawing on data collected from the Canadian Longitudinal Study on Aging (CLSA; Raina et al., 2009); a large, rigorous, and comprehensive multi-wave study. There are important research design features of the CLSA that will enable stronger inferences on the relationship between work injuries and mental health problems. For one, work injuries, particularly those of greater severity examined in the present study, are relatively infrequent and are consequently better examined within larger samples. Second, the larger sample size of the CLSA will be important for detecting the expected smaller effect sizes informed by previous research, particularly regarding the association between prior mental health problems and future work injury (see Study 1). Third, the longitudinal repeated-measures design of the CLSA provides the opportunity to examine the associations across time separation and account for variance explained by prior work injuries or prior mental health problems.

One of the core contributions of the present study will be to examine theoretically informed mechanisms (i.e., mediators) that link work injuries and mental health problems. This undertaking will trace and advance theory around why the relationship arises, as well as provide research vital to evidence-based interventions and management practices for addressing this issue. A second core contribution of the present study will be to improve our understanding of the impact of work injuries and mental health problems on older workers. The median age of the work force in developed countries

is increasing and the average age of retirement continues to rise (Fisher et al., 2016; Rudolph et al., 2018). As such, it is increasingly important to research the impact of adversity on workers who are in their peak earning years.

In summary, advancing our limited understanding of the relationship between work injuries and mental health problems is timely and consequential. As such, we explore the progression of thinking around the cognitive processes occurring across the relationship between work injuries and mental health problems to carry the theoretical conversation forward. We then detail the underlying mechanisms linking previous mental health problems with future work injuries and previous work injuries to future mental health problems.

Theoretical Development on the Work Injuries—Mental Health Problems Relationship

Occupational and industrial psychologists have considered the relationship between work injuries and mental health problems since the 1930s. Research by Hersey (1932, 1936) focused on what he called low emotional states or vigor and their relation to accidents and injuries at work. Hersey observed that a disproportionate number of accidents, up to forty percent, occurred around periodic fluctuations of these low emotional states. He reasoned low emotional states were disruptive by lowering emotional resistance and rendering workers less vigilant towards environmental hazards.

While this research was ahead of its time, especially with regards to its humane approach towards workers and their relationship with the environment, it occurred before the widespread adoption of conceptual refinement of mental health indicators and without any attempt to refer to or develop theory beyond speculation. Many of the details outlined in Hersey's (1932, 1936) research represent what are commonly known today as depression, anxiety, traumatic stress, and more. There was also a great deal of overlap between these indicators of mental health in his idea of emotional states with their physiological counterparts such as fatigue and lethargy. As such, a major limitation to Hersey's work was the unclear conceptualization of his idea of emotional states, resulting largely from the absence of theory at the time about indicators of mental health.

Hersey's (1932, 1936) analysis of emotional states also tended to blend across the injury process. Crucially, there was no clear indication of the extent to which low emotional states increased the likelihood of a work injury or whether work injury increased the likelihood of experiencing low emotional states. While there was a clear motivation in Hersey's (1936) work to predict and prevent injuries from occurring, he also spent some time discussing the experience of being involved in or witnessing injuries at work (Hersey, 1932). Hersey noted that there appeared to be variation of low emotional states following an injury but did not pursue the matter in depth given that his subjects appeared to recover quickly. Nonetheless, the post-injury relationship to low emotional states was taken for granted and no formal hypotheses or theoretical rationale was developed.

It would not be until the 1950s that organizational psychologists began investigating the psychological processes occurring before and after work injuries. Hill and Trist (1953) proposed and tested what they called the withdrawal hypothesis, whereby individuals consciously or unconsciously treat work injuries as a means of certified withdrawal. In other words, individuals act out internal difficulties in ways that remove personal responsibility and are socially sanctioned to their organization. Hill and Trist presented evidence to suggest that individuals who experienced injuries were more likely to also have more unsanctioned absences (i.e., no or unacceptable excuses provided for absence) and less likely to have sanctioned absences (i.e., permission for absence provided).

Clinical psychologists Hirschfeld and Behan (1963) would follow this work by introducing theory to the psychological processes of experiencing work injuries. Hirschfeld and Behan explained that signs of mental health problems occurring prior to an injury were a result of deeper unaddressed psychological problems. Failure to address these psychological problems was thought to lead to self-destructive behavior and, ultimately, injury. They proposed that psychological problems expressed themselves in ways that ensured they would continue to go unaddressed by shifting focus towards physical pain (Hirschfeld & Behan, 1963). Hirschfeld and Behan then argued that the expression of psychological problems following a work injury were maintained, exasperated, or exaggerated in efforts to ensure that the injured individual was adequately compensated for his or her damages. Hirschfeld and Behan called this 'attitudinal pathosis,' which is now referred to as malingering (Conroy & Kwartner, 2006; Cooper et al., 2021).

The study by Hirschfeld and Behan (1963) was a provocative step forward in the examination of the relationship. The pre- and post-injury psychological process was examined in depth and theoretically driven. However, the theoretical basis was also deeply problematic. For one, there was no attempt to develop theory that could be tested, which limits the utility of the theory. There was also a bias towards placing the blame of accidents and injuries on workers. The idea that physical injuries were an expression of a troubled psyche suggests that individuals who get injured at work are at fault for ignoring some underlying psychiatric problems.

Researchers in the late 1970s would attempt to improve upon the work of Hirschfeld and Behan by proposing testable theories. A study by Allodi and Montgomery (1979) attempted to test three theories that, at least in measurement, examined both the mental health-to-work injury and work injury-to-mental health relationships. In particular, they tested accident proneness theory (i.e., certain individuals are predisposed to be injured more often than others), sociogenic theory (i.e., pre-existing social stress, such as dissatisfaction with their job, will exacerbate the negative consequences of an injury), and life events theory (i.e., stress caused by life events, like work injuries, will contribute to the genesis of mental health problems).

While accident proneness theory is not a theory on the relationship between mental health problems and work injury, the way that it was measured by Allodi and Montgomery (1979) allowed for this inference. Indeed, Allodi and Montgomery examined previous psychiatric health problems, including symptoms, episodes, and hospitalizations, and compared injured and non-injured individuals on these measures. Results from just under 500 interviews provided support for higher rates of psychiatric

symptoms (but not psychiatric episodes or hospitalizations) among those who were injured in comparison to controls. Meanwhile, individuals in the accident group showed a modest relationship between their mental health and job dissatisfaction to seemingly support the sociogenic theory. Finally, no significant direct relationship was found between the experience of injuries and subsequent mental health problems, offering no support for the life events theory.

While a strength of the study by Allodi and Montgomery (1979) is that they proposed testable theories, there were still a number of important limitations. First, the test of accident proneness only captured the relationship between prior experience of psychological problems with later experience of injury. Realistically, this does not prove anything about the disposition of individuals any more than a set of experiences that may increase vulnerability. Second, the test of sociogenic theory was only examined for those who were injured, but not compared to those who were not injured. It is likely that non-injured workers would also show a positive relationship between job dissatisfaction and mental health problems, putting the presented results into question. Finally, the results testing the life events theory were not even reported beyond the authors mentioning that they were not significant. Displaying the results would have been important, considering it is not clear how they tested the theory or even what type of analyses they conducted.

In summary, this progression of empirical work examining the entire pre- to post-work injury process has gone from theoretical speculation to theoretical testing. However, limitations to existing theoretical work are evident, such as non-falsifiability and inadequate or improper testing. Meanwhile, research since Allodi and Montgomery (1979) on the bi-directional relationship between work injuries and mental health problems has ignored theory altogether (e.g., Kim & Choi, 2016; Patten et al., 2010) and has taken a unidirectional approach (i.e., only examining the link between prior mental health problems and subsequent work injuries or between prior work injuries and subsequent mental health problems). As such, we propose to update previous theorizing on the psychological processes surrounding the work injury experience in the following sections. We begin by theorizing about the cognitive mechanisms linking prior mental health problems and subsequent work injuries. We then theorize about different cognitive mechanisms explaining the opposite direction.

The Link Between Prior Mental Health Problems and Subsequent Work Injury

We propose that mental health problems can increase vulnerability to work injuries. This is not because people are engaging in self-destructive behavior to avoid addressing underlying psychiatric problems (Hirschfeld & Behan, 1963) or because people are inherently prone to get hurt at work (Allodi & Montgomery, 1979). We argue instead that coping with mental health problems comes with a cost: the cognitive load associated with mental health problems take away from limited cognitive resources that would normally contribute to risk reduction through the avoidance of hazards. We refer to this as a form of injury vulnerability or individual variation in current or continued mental health problems that reduce

cognitive functioning, affecting attentiveness, memory, and decision-making that would otherwise reduce the likelihood of injuries.

The idea of this vulnerability to injury as a result of coping with mental health problems arises from models of cognitive resource allocation (Ellis & Ashbrook, 1988; Levens et al., 2009) and extensions of cognitive load theory (Hawthorne et al., 2019; Plass & Kalyuga, 2019). These theories claim that individuals have limited cognitive resources at their disposal at any given time and these cognitive resources are influenced by an individual's mental health and well-being. Drawing from these models, we propose that mental health problems increase injury vulnerability because cognitive resources that are consumed when coping affect cognitive functioning vital to reducing the likelihood of injury. These include resources that contribute to executive functioning and working memory important to meeting or reducing the pressure from work demands such as ensuring safety and reducing errors.

In general, diminished cognitive functioning will increase the likelihood that individuals will feel overwhelmed from demands they face at work. For example, mental health problems have been found to be positively associated with psychosocial factors such as high demands, low control, and low support (Sanne et al., 2005; Van der Doef & Maes, 1999), which have also been found to be related to the occurrence of injuries (Nahrgang et al., 2011). Further, mental health problems consume cognitive resources that are needed to be vigilant or fully attentive to environmental stimuli to prevent injuries. For example, a comprehensive meta-analysis has found that individuals with major depression were slower in their ability to shift between tasks, process information, and react to stimuli (Snyder, 2013), cognitive functions important to recognizing and avoiding hazards at work (Anstey et al., 2005). The resources consumed by mental health problems can also increase the occurrence of errors. For example, individuals suffering from mental health problems are more likely to experience cognitive failures (Broadbent et al., 1982), which in turn are related to an increased likelihood of experiencing work injuries (Simpson et al., 2005; Wallace & Vodanovich, 2003).

In summary, we propose that the cognitive load of coping with mental health problems consumes finite cognitive resources that also function to reduce the likelihood that individuals will experience work injuries. As a result, mental health problems will give rise to the vulnerability of experiencing injuries at work by hampering cognitive functioning.

> *Hypothesis 1: The relationship between prior mental health problems and future work injury will be mediated through cognitive functioning, such that prior mental health problems will be negatively associated with cognitive functioning, which in turn will be negatively associated with future work injury.*

The Link Between Prior Work Injuries and Subsequent Mental Health Problems

While mental health problems should be related to subsequent work injuries by increasing vulnerabilities, we propose that a different mechanism will explain the opposite direction. Building from the work of Allodi and Montgomery (1979), we argue that the convergence of stressful life events theory and sociogenic theory is a useful theoretical starting point, but one that must be complemented

with additional theory. A feature central to cognitive theories of mental health such as information processing theory is that stressful life events, like work injuries, can initiate a change in how people think and feel (Beck, 1967; Beck & Clark, 1988). This can happen in at least two ways. First, work injuries can have a direct role in flaring up mental health problems. Second, work injuries can elicit negative cognitions that are harmful to mental health. We expand on these pathways between work injuries and mental health problems below.

The experience of a stressful life event, such as a work injury, can elicit or exacerbate symptoms of poor mental health as proposed in diathesis-stressor models (Monroe & Simons, 1991). The idea is that some people are predisposed to experience psychological symptoms (i.e., diathesis) under the right conditions (i.e., stressor). These models are often used to explain why individuals who experience the same event may have completely different outcomes (Belsky & Pluess, 2009). While this approach is helpful in explaining why two people who experience the same injury do not experience the same detriments to mental health, there are numerous mechanisms that may also link work injury with long-term effects on mental health, even for individuals who are not predisposed to experience mental health problems.

The experience of work injury can change how we think and feel about ourselves and the world around us (Francis et al., 2014; Zare et al., 2019). In turn, this change in thinking can lead to worse symptoms of mental health. A host of cognitive mechanisms have been found to link stressful life events to worse mental health. These include rumination (Aldao et al., 2010; Michl et al., 2013), catastrophizing (Lee et al., 2008), helplessness (Abramson et al., 1989), self-blame (Schulz & Decker, 1985), excessive upward counterfactual thinking, and regret (Broomhall et al., 2017). The experience of stressful life events, like a work injury, may also damage or shatter positive illusions known to buffer mental health, including "unrealistically positive self-evaluations, exaggerated perceptions of control or mastery, and unrealistic optimism" (Taylor & Brown, 1988, p. 193). These harmful cognitions are potential means through which the experience of work injury may be related to a rise in symptoms of poor mental health.

Control theory (Carver & Scheier, 1982) helps to further the case for why work injuries as stressful life events will be associated with mental health through the maladaptive cognitive mechanisms outlined above. The idea behind control theory is that individuals are frequently monitoring and comparing their current state of conditions with a desired or 'normal' state of conditions (Carver & Scheier, 1982). When there are discrepancies between what one considers to be a normal state and their current state, they will be motivated to reduce this discrepancy. However, discrepancy reduction can be obstructed when it comes to stressful life events like work injuries, where temporary or even permanent impairment often occurs. This lack of control over discrepancy reduction does not stop people from thinking about the gap between their current state and their desired state. Hence individuals will be susceptible to many of the maladaptive cognitive mechanisms outlined above, such as rumination (Michl et al., 2013), one of the most robust predictors of worse mental health (Aldao et al., 2010).

In summary, framing work injuries as potentially stressful life events shaped in part by sociogenic factors like prior theory has suggested (e.g., Allodi & Montgomery, 1979) can help to explain why the experience of a work injury would be related to a mental health problems. However, it is necessary to expand on the basic argument of stressful life events by adding cognitive and affective models of diathesis-stressor and discrepancy reduction. The former model suggests that work injuries may directly elicit or exacerbate already existing symptoms of poor mental health in the short term, while the latter model suggests that work injuries will elicit maladaptive or negative cognitions, such as rumination, which in turn give rise to symptoms of worse mental health over time. As such, there is good theoretical reason to support the idea that work injuries are associated with subsequent mental health problems through negative cognitions. Based on the review of the literature and the theoretical reasoning above, we propose the following hypothesis:

> *Hypothesis 2: The relationship between prior work injury and future mental health problems will be mediated through negative cognitions, such that prior work injury will be positively associated with negative cognitions, which in turn will then be positively associated with future mental health problems.*

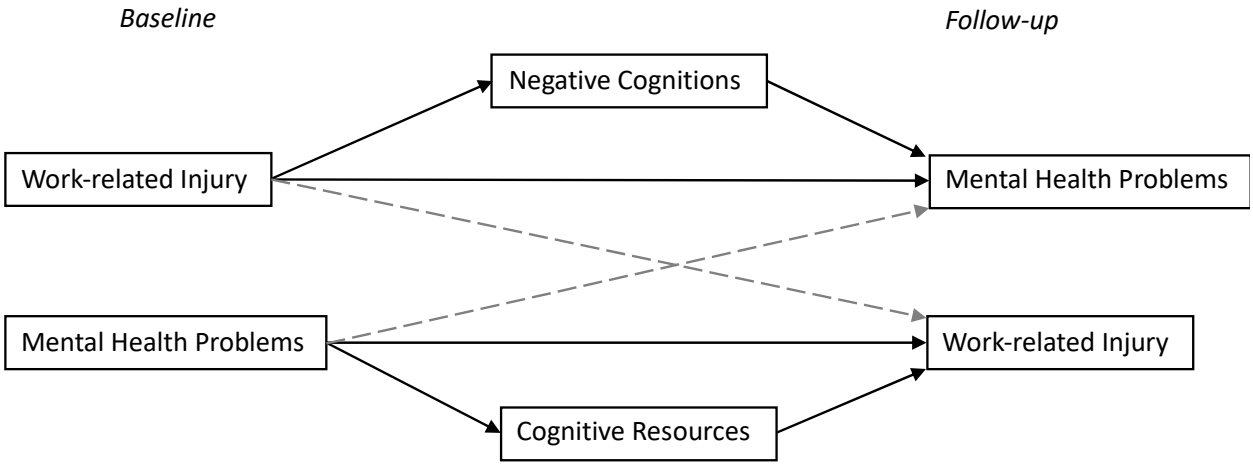


Figure 4. *Proposed model.*

Methods

Data from the Canadian Longitudinal Study on Aging (CLSA; Raina et al., 2009) were acquired and used to test the proposed hypotheses. The CLSA is a large, comprehensive, and rigorous cohort study on aging and well-being. The purpose of the CLSA is to identify various influences on health and well-being to promote the longevity and general well-being of Canadians. In particular, the CLSA is a longitudinal study of a large, nationally representative sample of roughly 51,000 randomly selected Canadians aged 45-85 years old and who could read and speak either French or English at the time of recruitment.

Individuals will be followed for a period of 20 years until 2033 or death and the first two waves of data collection were available to examine for the purposes of this study.

Participants

There are two cohorts that make up the overall sample of the CLSA. The first cohort is referred to as the Tracking Cohort (TR). The TR cohort consists of a random sample of Canadians aged 45-85 years recruited from the ten provinces (*N* = 21,241). The second cohort is referred to as the Comprehensive Cohort (CO). The CO cohort includes a random sample of Canadians aged 45-85 years selected from the populations residing in ten cities and within 25 kilometers of what are referred to as the Data Collection Sites (*N* = 30,097). Data from the baseline interview and first follow-up interview for the CLSA were available for both cohorts and used for this study. Because the focus is on work-related injuries, this study only looks at CLSA participants who completed both time waves and were currently working at the baseline or reported experiencing a work-related injury but were not currently working at the baseline (Total *N* = 18,239; TR *N* = 6,854, CO *N* = 11,385).

Participants who met inclusion criteria were on average 54.90 years old (*SD* = 6.54). The sample was roughly half female (48.4%) and half male (51.6%), with 4.8% of the sample considered as relative visible minorities. Majority of participants had completed secondary school or higher (97.3%) and majority of the sample were married or cohabiting (74.9%). Reported personal income was stratified, with 6.7% earning less than $20,000, 27.9% earning between $20,000 and $49,999, 42.6% earning between $50,000 and $99,999, 14.5% earning between $100,000 and $149,999, and 8.3% earning $150,000 or more. Among participants currently working at the baseline (99.7%), 17.1% reported working more than one job or at more than one business.

In addition to the above inclusion criteria, analyses were also conducted on the Newfoundland and Labrador subsample (*N* = 484). The average age of this subsample was 54.26 (*SD* = 6.56), with a slightly higher percentage of males (52.5%) than females (47.5%). Only 2.7% of the Newfoundland and Labrador subsample were considered visible minorities. Majority of subsample had completed secondary school or higher (87.4%) and majority of the sample were married or cohabiting (71.9%). Personal income within the Newfoundland and Labrador subsample was stratified such that 8.5% earning less than $20,000, 42.9% earning between $20,000 and $49,999, 36.7% earning between $50,000 and $99,999, 9.1% earning between $100,000 and $149,999, and 2.8% earning $150,000 or more. Finally, 99.8% reported working at the baseline, with 16.8% reporting to be working more than one job at the baseline.

Measures

The CLSA collected a wide range of data through telephone surveys (e.g., information on socio-demographic characteristics), as well as clinical (e.g., cognitive tests) and physical examinations (e.g.,

bone density test). On the CLSA baseline telephone surveys, numerous questions were asked regarding workplace injuries, physical and mental health problems including depression and symptoms of post-traumatic stress that may result from injury, as well as cognitive functioning and negative cognitions. At this point (as of October 2021), the CLSA participants had a baseline assessment, a maintaining contact assessment, and one follow-up assessment. In this study, we used the following measures from the CLSA baseline and follow-up surveys to address the stated research hypotheses.

Work characteristics and personal demographics. Work characteristics asked of participants included current and previous labour force involvement, multiple job holding, work schedule, job tenure, open-ended type of work, and open-ended industry. Participant's labour force involvement was particularly important for determining their eligibility for the current study. Age, sex, visible minority status, marital status, education, personal income, as well as alcohol and cigarette consumption were gathered to provide a description of the study population, to compare those who were absent from the follow-up questionnaire for any differences that might influence the focal relationships in this study, and to include as potential covariates in the tests of hypotheses.

Work injury. Participants responded to a yes-or-no question asking about whether they had experienced any injuries in the last 12 months at the baseline and follow-up. If participants responded yes, they were then asked several follow-up questions. In particular, participants were asked how frequently they were injured in the past 12 months (range is 1 to 30), whether their most serious injury occurred in the workplace or whether it occurred while working at a job or business (including travel to and from work), how it happened, and the location of the injury. Finally, participants were asked what type of injury they had, whether it involved any broken or fractured bones, and the part of the body that was fractured or broken. From these measures, we will be able to examine the presence or absence of a relatively severe work-related injury.

Mental Health. Two self-reported mental health scales were measured across both cohorts. Depression was measured across both time waves and post-traumatic stress symptoms were measured at the baseline only.

Depression was measured through the Center for Epidemiological Studies – Depression (CES-D; Radloff, 1977) 10 item scale. Participants were asked to think about the extent to which they felt particular ways in the past week. Sample items include, "how often did you feel depressed" and "how often did you have trouble keeping your mind on what you were doing?". Responses to these items were captured on a 4-point scale, with 1 representing rarely or never (less than 1 day) and 4 representing all of the time (5-7 days). Responses to the items showed acceptable reliability (a = .77 at baseline, a = .79 at follow-up).

Post-traumatic stress symptoms were captured at the baseline using a scale adapted from the primary care – post-traumatic stress disorder screening scale (Prins et al., 2003). Participants are asked to reflect upon whether an event in their life has led to symptoms arising in the previous month. Sample symptoms include, "have had nightmares about it or thought about it when you did not want to?" and "tried hard not to think about it or went out of your way to avoid situations that reminded you of it?".

Participants were then asked to respond with either “yes” (1) or “no” (0). Responses to the post-traumatic stress items showed acceptable reliability (α = .71 at baseline).

Mechanisms. Negative cognitions and measures of cognitive functioning were the key mechanisms linking work injuries and mental health captured in the current study. Negative cognitions was captured using the reverse-scored satisfaction with life scale (SLS; Diener, 2006; Diener et al., 1985), which is a 5-item scale that asks participants about the extent to which they are satisfied with the conditions and outcomes of their life. Sample items include, “If I could live my life over, I would change almost nothing” and “the conditions of my life are excellent,” which were measured from 1 (Strongly agree) to 7 (Strongly disagree). While not a direct measure of negative cognitions, prior research has found this scale to be strongly related to a range of broad (e.g., negative automatic thoughts; Netemeyer et al., 2002) and specific forms of negative cognitions (e.g., rumination; Sukhodolsky et al., 2001). Responses to the satisfaction with life items showed good reliability (α = .84 at baseline, α = .85 at follow-up).

Cognitive tests were conducted at baseline and meta-memory issues were measured at follow-up in the current study as operationalizations of cognitive functioning and will be used to test the link between baseline mental health problems and follow-up work injuries. The cognitive tests measured at baseline include the Rey Auditory Verbal Learning Test (RAVLT; Schmidt, 1996), the animal fluency test (AFT; Rosen, 1980), and the Mental Alternations Test (MAT; Salib & McCarthy, 2002; Teng, 1995). The first task involved asking participants to listen to a list of words and then recall as many words as possible immediately and at the end of the cognitive testing session to capture immediate- and delayed-recall. The second task involved asking participants to generate a list of thematic words (i.e., list as many animals as you can in 60 seconds) to capture categorical verbal fluency. The third task involved asking participants to first count to 20, second list the alphabet, and last alternate consecutive numbers with letters (i.e., 1-A, 2-B, etc.) to capture mental alternation. Each participant had two RAVLT scores, two AFT scores, and one MAT score, which were then each standardized. The two RAVLT scores and the two AFT scores were then combined to form a single RAVLT and AFT score respectively, such that each participants cognitive functioning score was a latent expression of their attention and recall, verbal fluency, and mental alternation scores (correlations between scores: RAVLT and AFT, $r = .32$, $p < .001$; RAVLT and MAT, $r = .25$, $p < .001$; AFT and MAT, $r = .37$, $p < .001$).

Finally, meta memory issues was measured at follow-up with a 20-item scale gauging the extent to which participants have complaints about their own memory. Participants are given a variety of items, including “how often do you misplace something you use daily, like your keys or glasses?” and “how often do you forget what you were just about to do; for example, walk into a room and forget what you went there to do?” and asked to rate frequency from 1 (never) to 5 (all the time). Responses to the meta memory scale were highly reliable (α = .88).

Procedures

Two waves of data were available for the current study. Wave 1 consisted of the CLSA baseline questionnaire, which was used to collect data at the baseline for the CLSA Tracking Cohort via computer-assisted telephone interviews (CATI) conducted at four CATI sites. For the CLSA Comprehensive cohort, the baseline information was gathered using the CLSA baseline questionnaire, which was completed through in-home visits using CATI, and at the Data Collection Sites gathering physical, biological, and clinical data. Individuals living in long-term care institutions and those with cognitive impairment were excluded at the CLSA baseline.

About 18 months after the CLSA baseline interview, the Maintaining Contact Questionnaire was used to collect additional information for both the CLSA Tracking Cohort and the CLSA Comprehensive Cohort. Following the Maintaining Contact Questionnaire, Wave 2 of the study was collected for the two cohorts and was completed in 2018. For the purpose of this study, data from the baseline interview and follow-up interview will be used. However, because we are focusing on work-related injuries, we will limit the study sample to the CLSA participants who reported working, either part-time, or full-time at the time of their baseline interview or who had experienced a work-related injury but was not currently working at baseline. Cross-sectional and longitudinal data available for the CLSA participants who meet the study sample criteria will be analyzed to address the stated research hypotheses.

Analytical Procedure

Mplus version 8 (L. K. Muthén & Muthén, 2017) was used to test the hypothesized mediation models through latent variable structural equation modeling with maximum likelihood (B. Muthén, 2011; B. Muthén & Asparouhov, 2015). In all analyses, mental health problems and the cognitive mechanisms were modelled as latent variables, whereas the binary work-related injury variable was modelled as an observed variable. When work injury was the outcome, it was treated as categorical and thus a logistic structural equation model was performed in these analyses (B. Muthén, 2011). Prior to model testing, confirmatory factor analyses were run to test the proposed measurement models.

There were six possible models with the available data to test the two hypotheses. Four of these models were tests of Hypothesis 1: H1.1) baseline depression → baseline cognitive functioning → follow-up work injury; H1.2) baseline posttraumatic stress → baseline cognitive functioning → follow-up work injury; H1.3) baseline depression → follow-up meta-memory issues → follow-up work injury; and H1.4) baseline posttraumatic stress → follow-up meta-memory issues → follow-up work injury. The two remaining models were tests of Hypothesis 2: H2.1) baseline work-injury → baseline negative cognitions → follow-up depression; and H2.2) baseline work-injury → follow-up negative cognitions → follow-up depression. All models were run in three steps. The first step involved modeling only the proposed variables without covariates. The second step involved adding baseline levels of the outcome as a covariate to isolate the effect of prior levels of the outcome and how this affects the proposed models. The final step involved adding all relevant socio-demographic characteristics to the mental health problems-work injury relationship as covariates. Results for step 3 are reported in the hypotheses testing below.

Results

See Table 3 for the descriptives, correlations, and reliabilities for study variables.

Participant Attrition

Participants who did not complete the follow-up survey but met all other inclusion criteria in the baseline (N = 1973) were more likely to have been from the tracking cohort (t [20210] = -25.98, p < .001), lower income (t [19649] = -11.80, p < .001), a relative visible minority (t [20210] = -6.05, p < .001), not married or cohabiting (t [20202] = -3.93, p < .001), less educated (t [20178] = -18.07, p < .001), and less likely to have been working at baseline (t [20063] = -3.30, p = .001). However, there were no statistical differences regarding age (t [20210] = .52, p = .604), gender (t [20210] = 1.74, p = .081), or working more than one job or at more than one business at the baseline (t [20018] = -.96, p = .338). Interpretation of the results should therefore keep in mind the differences (i.e., income, relative minority status, marital status, education, and working status) and lack of differences (i.e., age, gender, and multi-job holding status) between participants who did and did not complete both waves of data collection. Participant attrition was not assessed for the Newfoundland and Labrador subsample given the relatively smaller sample size of this subsample.

Measurement Models

Measurement models for each of the six proposed tests of the two hypotheses were assessed prior to hypotheses testing. Models including depression were modified to allow a correlation between the errors for the two reverse-scored items (item 5 and item 8) to rule out measurement artifacts impacting model fit (Brown, 2015) demonstrated in previous research using the CES-D Scale (e.g., Mohebbi et al., 2018; Wood et al., 2010). Each of the proposed models were found to have satisfactory-to-good model fit and the model fit indices (i.e., χ^2 test of model fit, root mean square error of approximation [RMSEA], comparative fit index [CFI], and the standardized root mean square residual [SRMR]) and measurement model results are available upon request.

Table 3. *Means, standard deviations, sample size, internal reliabilities, and correlations between study variables.*

					Baseline (t1)								
	Variable	*M*	*SD*	*N*	1	2	3	4	5	6	7	8	9
Baseline (t1)	1. Cohort	1.62	.48	18239	-								
	2. Gender	.52	.50	18239	.01	-							
	3. Age	54.90	6.54	18239	.04***	.07***	-						
	4. White	.95	.21	18239	-.03***	-.02*	.03**	-					
	5. Income	2.90	1.01	17747	.08***	.30***	-.03***	.02**	-				
	6. Married	.75	.43	18231	-.02**	.15***	-.07***	-.01	.11***	-			
	7. Education	7.59	2.12	18216	.13***	.02*	-.07***	-.05***	.32***	.04***	-		
	8. Drinker	2.69	.63	17843	.03***	.06***	-.05***	.11***	.15***	.05***	.10***	-	
	9. Smoker	2.37	1.39	18164	-.03***	.00	.03***	.06***	-.11***	-.10***	-.23***	.00	-
	10. Work injury	.04	.21	18239	-.02*	.01	.03**	.00	-.08***	-.03***	-.07***	-.02*	.05***
	11. Posttraumatic stress	.39	.86	18153	-.04***	-.10***	-.04***	-.01	-.11***	-.10***	-.06***	-.05***	.07***
	12. Depression	5.01	4.38	18189	-.01	-.09***	-.03***	-.01	-.16***	-.14***	-.08***	-.06***	.09***
	13. Cognitive functioning	.27	.66	17919	-.01	-.08***	-.21***	.14***	.13***	.05***	.27***	.07***	-.09***
	14. Negative cognitions	11.91	6.29	18090	.05***	.00	.02*	-.04***	-.18***	-.25***	-.09***	-.09***	.11***
Follow-up (t2)	15. Work injury	.04	.21	14759	-.02*	.00	-.03**	.00	-.06***	-.03**	-.06***	-.03***	.04***
	16. Depression	4.93	4.64	17666	-.05***	-.09***	-.02*	-.01	-.16***	-.12***	-.09***	-.07***	.10***
	17. Metamemory issues	2.09	.47	18068	-.04***	-.06***	.03**	-.02**	-.08***	-.01	-.05***	-.02*	.04***
	18. Negative cognitions	11.49	6.31	17975	.02**	.01	.01	-.02**	-.17***	-.20***	-.09***	-.10***	.12***

Table 3 continued

		Baseline (t1)					Follow-up (t2)			
	Variable	10	11	12	13	14	15	16	17	18
Baseline (t1)	10. Work injury	-								
	11. Posttraumatic stress	.06***	(.71)							
	12. Depression	.07***	.31***	(.77)						
	13. Cognitive functioning	-.03***	-.03***	-.07***	-					
	14. Negative cognitions	.05***	.23***	.45***	-.06***	(.84)				
Follow-up (t2)	15. Work injury	.09***	.04***	.06***	-.02*	.06***	-			
	16. Depression	.06***	.25***	.51***	-.07***	.37***	.06***	(.79)		
	17. Metamemory issues	.04***	.11***	.27***	-.07***	.17***	.04***	.30***	(.88)	
	18. Negative cognitions	.06***	.19***	.39***	-.06***	.67***	.06***	.49***	.20***	(.85)

Note. * $p < .05$, ** $p < .01$, *** $p < .001$. Cronbach Alphas reported along the diagonal. Cohort (1 = tracking, 2 = comprehensive); Gender (0 = female, 1 = male); White (0 = no, 1 = yes); income (5 ordinal categories, from 1= less than $20,000 to 5 = more than $150,000), married (0 = no, 1 = yes); education (11 ordinal categories, from 1 = grade 8 or lower to 11 = university degree or certificate above bachelor degree); Drinker (3 ordinal categories, from 1 = no drinks in last 12 months to 3 = regular drinker [at least once a month]); work injury (0 = no, 1 = yes).

Hypothesis Testing

Hypothesis 1. It was hypothesized that baseline mental health problems would be associated with follow-up work-related injury through the mechanism of cognitive functioning. The results provided mixed support for this hypothesis. When the baseline cognitive tests were treated as the mediator, neither baseline depression nor baseline posttraumatic stress symptoms were indirectly associated with follow-up work injury (β = .000, *SE* = .004, *p* = .970, 95% CI: -.01, .01 and β = .00, *SE* = .00, *p* = .928, 95% CI: -.00, .00, respectively). However, when metamemory issues were treated as the mediator, both baseline depression and baseline posttraumatic stress symptoms were indirectly associated with work injury (β = .02, *SE* = .01, *p* = .002, 95% CI: .01, .04 and β = .01, *SE* = .003, *p* = .001, 95% CI: .01, .02, respectively). While the baseline cognitive tests did not mediate the effect of baseline depression nor baseline posttraumatic stress, both measures of mental health problems continued to have a direct effect on follow-up work injury when all covariates were added to the model (β = .10, *SE* = .02, *p* < .001, 95% CI: .05, .14 and β = .06, *SE* = .02, *p* = .006, 95% CI: .02, .11, respectively).

Similar to the results for the entire Canadian population, neither baseline depression nor baseline posttraumatic stress symptoms among the Newfoundland and Labrador subsample were indirectly associated with follow-up work injury through baseline cognitive testes (β = .04, *SE* = .03, *p* = .160, 95% CI: -.02, .10 and β = .02, *SE* = .02, *p* = .230, 95% CI: -.01, .06, respectively). However, unlike the results for the entire Canadian population, baseline depression and baseline posttraumatic stress symptoms were also not indirectly associated with work injury at follow-up through meta-memory issues (β = -.02, *SE* = .02, *p* = .453, 95% CI: -.06, .03 and β = -.01, *SE* = .01, *p* = .600, 95% CI: -.04, .02, respectively). Further, baseline depression and posttraumatic stress symptoms did not have a direct effect on follow-up work injury when all covariates were added to the model (*p*s > .156).

Hypothesis 2. It was hypothesized that baseline work-related injury would be associated with follow-up mental health problems through the mechanism of negative cognitions. Results show an indirect effect from baseline work-related injury to follow-up mental health problems through baseline negative cognitions (β = .01, *SE* = .002, *p* < .001, 95% CI: .01, .03). These results were replicated when baseline negative cognitions are replaced with follow-up negative cognitions as the mediator (β = .03, *SE* = .004, *p* < .001, 95% CI: .02, .03). Both results provide support for Hypothesis 2.

Contrary to the findings for the rest of the Canadian population, there was no indirect effect from baseline work-related injury to follow-up mental health problems through baseline negative cognitions within the Newfoundland and Labrador subsample (β = .004, *SE* = .006, *p* = .500, 95% CI: -.01, .02); nor was there an indirect effect from baseline work-related injury to follow-up mental health problems through follow-up negative cognitions (β = -.01, *SE* = .03, *p* = .808, 95% CI: .01, .03).

Discussion

The results for the full sample of the current study replicate prior research showing a bi-directional relationship between work injuries and mental health problems. More importantly, the current findings

largely lend support for both proposed mechanisms in the relationship between work injuries and mental health problems. Specifically, prior levels of depression and posttraumatic stress symptoms were found to be indirectly associated with future work injury at follow-up through self-reported memory-related cognitive functioning issues (but not higher levels of cognitive functioning based on tests of cognition). Further, prior work injury was related to follow-up depression through maladaptive negative cognitions, both at baseline and at follow-up. However, none of these results replicated within the smaller Newfoundland and Labrador subsample.

First considering the prior mental health problems to subsequent work injury relationship, the inconsistent findings highlight the importance of working memory in resource allocation and cognitive load models (Levens et al., 2009; Plass & Kalyuga, 2019). Importantly, the results from this study highlight that among older workers, issues around memory may be more important to predicting work injuries than broad cognitive functioning issues as captured in the cognitive tests. While prior research on cognitive failures typically combines these forms of cognitive functioning in their operationalization (e.g., attention, memory, and intended action; Day et al., 2012; Petitta et al., 2019), separating the particular components may lend insight into the relationship between prior mental health problems and subsequent work injuries.

While the component of memory issues may be particularly important among older workers in the relationship between mental health problems and work injuries, there are other potential reasons for the non-significant results around the cognitive tests. For instance, there were no quantitative measures of safety salience or the degree to which participants were occupied in moderate- to high-hazard jobs where attention and executive functions such as mental alternation are especially important for minimizing occupational hazards. As such, the results include individuals from all job types and workplaces, which may have resulted in more conservative estimates given that lapses in cognitive functioning stemming from mental health problems are less likely to lead to work injuries among those in safer occupational environments.

Considering next the prior work injury to later mental health problems association, full support was found. These findings highlight how stressful life events when combined with information processing and control theory cognitive models (Beck & Clark, 1988; Carver & Scheier, 1982) can lead to worse mental health outcomes through maladaptive cognitions. These findings reinforce the importance of cognitive reactions to work injuries, and aligns with other studies highlighting the importance of fair treatment and support following a work injury in shaping subsequent attitudes (e.g., Francis et al., 2014; Hepburn et al., 2010).

Finally, there are several potential explanations for the lack of findings within the Newfoundland and Labrador subsample. First and most likely is the combination of smaller sample size and rare occurrence of work-related injuries within this subsample. Without sufficient statistical power and variation, there

are decreasing odds that relationships will emerge even if they exist as is suggested in the analyses of the larger population sample. Second, these results may point to a difference in this subsample with regard to the work injury-mental health relationship. Evidence for this idea comes from the lack of direct effects between baseline depression and post-traumatic stress symptoms with follow-up work injury.

Implications

The current study has several practical and theoretical implications. Regarding practical implications, this study highlights the importance of cognition in explaining the bi-directional work injury-mental health problems relationship. As such, psychological rehabilitation following physical injuries may help improve recovery and reduce the associated costs when work injury and mental health problems arise together. In preparing psychological rehabilitation, the cognitive mechanisms examined in this study should be targeted for intervention, especially negative and maladaptive cognitions. By outlining these specific malleable mechanisms, it may be possible to interrupt the association between a physical injury and dealing with problems of mental health.

Regarding theoretical implications, the way we think about physical injury may be limiting our ability to better understand the psychological experience of work injuries. Recent research on moral injuries (see Griffin et al., 2019 for a review) and the growing rate of individuals claiming compensation for mental health-related disabilities (Dewa et al., 2010) require us to rethink the barrier of physical and psychological well-being and the role of work and employment in shaping how the two are associated. Like the elusive yet pragmatically important phenomenon of fatigue (Noy et al., 2011; Williamson et al., 2011), physical and psychological health is important for the safe and productive conduct at work.

Limitations and Future Directions

The evidence of the current study from the entire population compared to prior research is strong given the sample size, quality of most measures, ability to account for prior levels of the mental health problems and work injury in analyses, as well as a wide range of relevant sociodemographic characteristics such as age, gender, minority status, income, marital status, drinking status, and smoking status. While this large and comprehensive two-wave population study contributes to the nuance around the relationship between work injuries and mental health, it also has its own limitations. The first set of limitations involve the study population in both its restricted age range and attrition from baseline to follow-up. The restricted age range of the sample (45+) potentially limits our ability to make generalizations to younger samples in that older samples likely differ on the key variables of this study (i.e., work injuries and mental health) and therefore must be taken into consideration when estimating the generalization of the resulting model. Further, the differences between those who completed both waves and only the first wave may have resulted in more conservative estimates such that those who did not complete the second wave had sociodemographic characteristics that were for the most part associated with both work injury and mental health problems in this study.

The second set of limitations come around measurement of the mechanisms. The use of a reverse-scored life satisfaction measure as a proxy of negative cognitions is a potential limitation of

correspondence. While the measure also captures a more stable and global assessment of one's circumstances in relation to the past, it has been found to be sensitive to shifts in life satisfaction because of recent life events (Suh et al., 1996). Further, the use of brief cognitive screening tests may have limited the ability to adequately test the resource allocation and cognitive load theories. Future research may want to adopt other measures of negative cognition (e.g., rumination, counterfactual thinking, etc.) and more comprehensive tests of cognitive functioning to better test these hypotheses.

Conclusion

This study attempted to revive the theoretical narrative around the work injury-mental health problems association, particularly the psychological processes surrounding the work injury experience. This study hypothesized and tested distinct psychological mechanisms underlying the relationship that mental health problems had to prior and future work-related injuries. Results from the study do suggest that negative cognitions, a form of maladaptive thinking, has important implications for subsequent mental health problems. Further, some evidence was found for the role that cognitive functioning has in explaining how dealing with mental health problems may create vulnerabilities via memory-related issues associated with experiencing work-related injuries in the future. Together, this study serves as a basis for thinking about the psychological processes of the work injury experience.

References

Abramson, L. Y., Metalsky, G. I., & Alloy, L. B. (1989). Hopelessness depression: A theory-based subtype of depression. *Psychological Review*, *96*(2), 358–372. https://doi.org/10.1037/0033-295X.96.2.358

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review*, *30*(2), 217–237. https://doi.org/10.1016/j.cpr.2009.11.004

Allodi, F., & Montgomery, R. (1979). Psychosocial aspects of occupational injury. *Social Psychiatry*, *14*(1), 25–29. https://doi.org/10.1007/BF00583570

Anstey, K. J., Wood, J., Lord, S., & Walker, J. G. (2005). Cognitive, sensory and physical factors enabling driving safety in older adults. *Clinical Psychology Review*, *25*(1), 45–65. https://doi.org/10.1016/j.cpr.2004.07.008

Beck, A. T. (1967). *Depression: Clinical, experimental, and theoretical aspects*. University of Pennsylvania Press.

Beck, A. T., & Clark, D. A. (1988). Anxiety and depression: An information processing perspective. *Anxiety Research*, *1*(1), 23–36. https://doi.org/10.1080/10615808808248218

Belsky, J., & Pluess, M. (2009). Beyond diathesis stress: Differential susceptibility to environmental influences. *Psychological Bulletin*, *135*(6), 885–908. https://doi.org/10.1037/a0017376

Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The cognitive failures questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology*, *21*(1), 1–16. https://doi.org/10.1111/j.2044-8260.1982.tb01421.x

Broomhall, A. G., Phillips, W. J., Hine, D. W., & Loi, N. M. (2017). Upward counterfactual thinking and depression: A meta-analysis. *Clinical Psychology Review*, *55*, 56–73. https://doi.org/10.1016/j.cpr.2017.04.010

Brown, T. A. (2015). *Confirmatory factor analysis for applied research*. Guilford publications.

Carver, C. S., & Scheier, M. F. (1982). Control theory: A useful conceptual framework for personality–social, clinical, and health psychology. *Psychological Bulletin*, *92*(1), 111–135. https://doi.org/10.1037/0033-2909.92.1.111

Conroy, M. A., & Kwartner, P. P. (2006). The definition of malingering. *Applied Psychology in Criminal Justice*, *2*(3), 30–51.

Cooper, D. A., Slaughter, J. E., & Gilliland, S. W. (2021). Reducing injuries, malingering, and Workers' Compensation costs by implementing overt integrity testing. *Journal of Business and Psychology*, *36*(3), 495–512. https://doi.org/10.1007/s10869-020-09681-9

Day, A. J., Brasher, K., & Bridger, R. S. (2012). Accident proneness revisited: The role of psychological stress and cognitive failure. *Accident Analysis & Prevention*, *49*, 532–535. https://doi.org/10.1016/j.aap.2012.03.028

Dewa, C. S., Chau, N., & Dermer, S. (2010). Examining the comparative incidence and costs of physical and mental health-related disabilities in an employed population. *Journal of Occupational and Environmental Medicine*, *52*(7), 758–762. https://doi.org/10.1097/JOM.0b013e3181e8cfb5

Diener, E. D. (2006). *Understanding scores on the satisfaction with life scale*.

Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment*, *49*(1), 71–75. https://doi.org/10.1207/s15327752jpa4901_13

Ellis, H. C., & Ashbrook, P. W. (1988). Resource allocation model of the effects of depressed mood states. In K. Fiedler & J. Forgas (Eds.), *Affect, Cognition, and Social Behavior* (pp. 22–43). Hogrefe.

Fisher, G. G., Chaffee, D. S., & Sonnega, A. (2016). Retirement timing: A review and recommendations for future research. *Work, Aging and Retirement*, *2*(2), 230–261. https://doi.org/10.1093/workar/waw001

Francis, L., Cameron, J. E., Kelloway, E. K., Catano, V. M., Day, A. L., & Hepburn, C. G. (2014). The working wounded: Stigma and return to work. In P. Y. Chen & C. L. Cooper (Eds.), *Wellbeing: A complete reference guide* (pp. 339–356). Wiley-Blackwell.

Griffin, B. J., Purcell, N., Burkman, K., Litz, B. T., Bryan, C. J., Schmitz, M., Villierme, C., Walsh, J., & Maguen, S. (2019). Moral injury: An integrative review. *Journal of Traumatic Stress*, *32*(3), 350–362. https://doi.org/10.1002/jts.22362

Hawthorne, B., Vella-Brodrick, D., & Hattie, J. (2019). Well-being as a cognitive load reducing agent: A review of the literature. *Frontiers in Education*, *4*(121), 1–11. https://doi.org/10.3389/feduc.2019.00121

Hepburn, C. G., Kelloway, E. K., & Franche, R.-L. (2010). Early employer response to workplace injury: What injured workers perceive as fair and why these perceptions matter. *Journal of Occupational Health Psychology*, *15*(4), 409–420.

Hersey, R. B. (1932). *Workers' emotions in shop and home: A study of individual workers from the psychological and physiological standpoint.* University of Pennsylvania Press.

Hersey, R. B. (1936). Emotional factors in accidents. *Personnel Journal*, *15*, 59–65.

Hill, J. M. M., & Trist, E. L. (1953). A consideration of industrial accidents as a means of withdrawal from the work situation: A study of their relation to other absences in an iron and steel works. *Human Relations*, *6*(4), 357–380. https://doi.org/10.1177/001872675300600404

Hirschfeld, A. H., & Behan, R. C. (1963). The accident process: I. Etiological considerations of industrial injuries. *Journal of the American Medical Association*, *186*(3), 193–199. https://doi.org/10.1001/jama.1963.03710030033005

Kim, J., & Choi, Y. (2016). Gender differences in the longitudinal association between work-related injury and depression. *International Journal of Environmental Research and Public Health*, *13*(11), 1077. https://doi.org/10.3390/ijerph13111077

Lee, E.-J., Wu, M.-Y., Lee, G. K., Cheing, G., & Chan, F. (2008). Catastrophizing as a cognitive vulnerability factor related to depression in workers' compensation patients with chronic musculoskeletal pain. *Journal of Clinical Psychology in Medical Settings*, *15*(3), 182–192. https://doi.org/10.1007/s10880-008-9118-7

Levens, S. M., Muhtadie, L., & Gotlib, I. H. (2009). Rumination and Impaired Resource Allocation in Depression. *Journal of Abnormal Psychology*, *118*(4), 757–766. https://doi.org/10.1037/a0017206

Michl, L. C., McLaughlin, K. A., Shepherd, K., & Nolen-Hoeksema, S. (2013). Rumination as a mechanism linking stressful life events to symptoms of depression and anxiety: Longitudinal evidence in early adolescents and adults. *Journal of Abnormal Psychology*, *122*(2), 339–352. https://doi.org/10.1037/a0031994

Mohebbi, M., Nguyen, V., McNeil, J. J., Woods, R. L., Nelson, M. R., Shah, R. C., Storey, E., Murray, A. M., Reid, C. M., & Kirpach, B. (2018). Psychometric properties of a short form of the Center for Epidemiologic Studies Depression (CES-D-10) scale for screening depressive symptoms in healthy community dwelling older adults. *General Hospital Psychiatry*, *51*, 118–125. https://doi.org/10.1016/j.genhosppsych.2017.08.002

Monroe, S. M., & Simons, A. D. (1991). Diathesis-stress theories in the context of life stress research: Implications for the depressive disorders. *Psychological Bulletin*, *110*(3), 406–425. https://doi.org/10.1037/0033-2909.110.3.406

Muthén, B. (2011). *Applications of causally defined direct and indirect effects in mediation analysis using SEM in Mplus*. Los Angeles, CA.

Muthén, B., & Asparouhov, T. (2015). Causal effects in mediation modeling: An introduction with applications to latent variables. *Structural Equation Modeling: A Multidisciplinary Journal*, *22*(1), 12–23.

Muthén, L. K., & Muthén, B. O. (2017). *Mplus user's guide: Statistical analysis with latent variables* (No. 8th). https://doi.org/10.1111/j.1600-0447.2011.01711.x

Nahrgang, J. D., Morgeson, F. P., & Hofmann, D. A. (2011). Safety at work: A meta-analytic investigation of the link between job demands, job resources, burnout, engagement, and safety outcomes. *Journal of Applied Psychology*, *96*(1), 71–94. https://doi.org/10.1037/a0021484

Netemeyer, R. G., Williamson, D. A., Burton, S., Biswas, D., Jindal, S., Landreth, S., Mills, G., & Primeaux, S. (2002). Psychometric properties of shortened versions of the Automatic Thoughts Questionnaire. *Educational and Psychological Measurement*, *62*(1), 111–129. https://doi.org/10.1177/0013164402062001008

Noy, Y. I., Horrey, W. J., Popkin, S. M., Folkard, S., Howarth, H. D., & Courtney, T. K. (2011). Future directions in fatigue and safety research. *Accident Analysis & Prevention*, *43*(2), 495–497.

Patten, S. B., Williams, J. V. A., Lavorato, D. H., & Eliasziw, M. (2010). Major depression and injury risk. *The Canadian Journal of Psychiatry*, *55*(5), 313–318. https://doi.org/10.1177/070674371005500507

Petitta, L., Probst, T. M., Ghezzi, V., & Barbaranelli, C. (2019). Cognitive failures in response to emotional contagion: Their effects on workplace accidents. *Accident Analysis & Prevention*, *125*, 165–173. https://doi.org/10.1016/j.aap.2019.01.018

Plass, J. L., & Kalyuga, S. (2019). Four Ways of Considering Emotion in Cognitive Load Theory. *Educational Psychology Review*, *31*(2), 339–359. https://doi.org/10.1007/s10648-019-09473-5

Prins, A., Ouimette, P., Kimerling, R., Cameron, R., Hugelshofer, D., Shaw-Hegwer, J., Thraikill, A., Gusman, F., & Sheikh, J. (2003). The primary care PTSD Screen (PTSD): Development and operating characteristics. *Primary Care Psychiatry*, *9*(1), 9–14. https://doi.org/10.1185/135525703125002360

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*(3), 385–401. https://doi.org/10.1177/014662167700100306

Raina, P. S., Wolfson, C., Kirkland, S. A., Griffith, L. E., Oremus, M., Patterson, C., Tuokko, H., Penning, M., Balion, C. M., & Hogan, D. (2009). The Canadian longitudinal study on aging (CLSA). *Canadian Journal on Aging*, *28*(3), 221–229. https://doi.org/10.1017/S0714980809990055

Rosen, W. G. (1980). Verbal fluency in aging and dementia. *Journal of Clinical and Experimental Neuropsychology*, *2*(2), 135–146. https://doi.org/10.1080/01688638008403788

Rudolph, C. W., Marcus, J., & Zacher, H. (2018). Global issues in work, aging, and retirement. In K. S. Shultz & G. A. Adams (Eds.), *Aging and Work in the 21st Century* (2nd ed., pp. 292–324). Taylor & Francis.

Salib, E., & McCarthy, J. (2002). Mental Alternation Test (MAT): A rapid and valid screening tool for dementia in primary care. *International Journal of Geriatric Psychiatry*, *17*(12), 1157–1161. https://doi.org/10.1002/gps.738

Sanne, B., Mykletun, A., Dahl, A. A., Moen, B. E., & Tell, G. S. (2005). Testing the job demand–control–support model with anxiety and depression as outcomes: The Hordaland Health Study. *Occupational Medicine*, *55*(6), 463–473. https://doi.org/10.1093/occmed/kqi071

Schmidt, M. (1996). *Rey auditory verbal learning test: A handbook*. Western Psychological Services.

Schulz, R., & Decker, S. (1985). Long-term adjustment to physical disability: The role of social support, perceived control, and self-blame. *Journal of Personality and Social Psychology*, *48*(5), 1162–1172. https://doi.org/10.1037/0022-3514.48.5.1162

Simpson, S. A., Wadsworth, E. J. K., Moss, S. C., & Smith, A. P. (2005). Minor injuries, cognitive failures and accidents at work: Incidence and associated features. *Occupational Medicine*, *55*(2), 99–108. https://doi.org/10.1093/occmed/kqi035

Snyder, H. R. (2013). Major depressive disorder is associated with broad impairments on neuropsychological measures of executive function: A meta-analysis and review. *Psychological Bulletin*, *139*(1), 81–132. https://doi.org/10.1037/a0028727

Suh, E., Diener, E., & Fujita, F. (1996). Events and subjective well-being: Only recent events matter. *Journal of Personality and Social Psychology*, *70*(5), 1091–1102. https://doi.org/10.1037/0022-3514.70.5.1091

Sukhodolsky, D. G., Golub, A., & Cromwell, E. N. (2001). Development and validation of the anger rumination scale. *Personality and Individual Differences*, *31*(5), 689–700. https://doi.org/10.1016/S0191-8869(00)00171-9

Taylor, S. E., & Brown, J. D. (1988). Illusion and well-being: A social psychological perspective on mental health. *Psychological Bulletin*, *103*(2), 193–210. https://doi.org/10.1037/0033-2909.103.2.193

Teng, E. (1995). The Mental Alternations Test (MAT). *The Clinical Neuropsychologist*, 9(3), 287.

Van der Doef, M., & Maes, S. (1999). The job demand-control (-support) model and psychological well-being: A review of 20 years of empirical research. *Work & Stress*, *13*(2), 87–114. https://doi.org/10.1080/026783799296084

Wallace, J. C., & Vodanovich, S. J. (2003). Workplace safety performance: Conscientiousness, cognitive failure, and their interaction. *Journal of Occupational Health Psychology*, *8*(4), 316. https://doi.org/10.1037/1076-8998.8.4.316

Williamson, A., Lombardi, D. A., Folkard, S., Stutts, J., Courtney, T. K., & Connor, J. L. (2011). The link between fatigue and safety. *Accident Analysis & Prevention*, *43*(2), 498–515.

Wood, A. M., Taylor, P. J., & Joseph, S. (2010). Does the CES-D measure a continuum from depression to happiness? Comparing substantive and artifactual models. *Psychiatry Research*, *177*(1–2), 120–123.

Zare, Z., Sadeghi-Bazargani, H., Stark Ekman, D., Ranjbar, F., Ekman, R., Farahbakhsh, M., & Maghsoudi, H. (2019). Cognitive distortions as trauma-specific irrational beliefs among burn patients. *Journal of Burn Care & Research*, *40*(3), 361–367. https://doi.org/10.1093/jbcr/irz026

Study 3: A Test of Mental Health Trajectories

Study 3: A Test of Mental Health Trajectories

Introduction

This study is an extension of the first two studies of this report. The prior studies systematically establish that there is a relatively robust association between work injuries and mental health problems (Study 1), emphasize important conditions of the relationship (Study 1), and highlight specific mechanisms linking these two concerning phenomena (Study 2). The next step in this research program is to start examining the trajectory of mental health following and prior to work injuries to understand better this bidirectional relationship. By understanding the timing and the lasting effects of work injuries on mental health, and the potential variation and change in mental health prior to work injuries, we are better positioned to tackle these phenomena through more effective preventative and reparative efforts.

Existing longitudinal research has primarily focused on long-term outcomes, typically ranging from 1 year (e.g., Lin, Shiao, et al., 2014) through to 12 years (e.g., Ahola et al., 2013; Dong et al., 2015). The few shorter-term quantitative longitudinal studies assessing mental health and work injuries have primarily measured mental health and work injuries at one time point (e.g., 6 months; Hepburn et al., 2010). Even fewer studies have captured multiple measures within a shorter period and these studies have provided relatively inconsistent findings that require a careful assessment (e.g., Asfaw & Souza, 2012; Chin et al., 2018; Evanoff et al., 2002; Gillen et al., 2004). As such, one of the main goals of this study is to systematically review these studies and build off our best knowledge about the mental health trajectory following and preceding work injuries.

Beyond the short-term trajectory of mental health following and prior to a work injury, research on the relationship between work injuries and mental health among young workers has also provided mixed results. For instance, Frone (1998) found there to be no relationship between work injuries and mental health after controlling for a host of individual and job-related characteristics. These multivariate conditions add a caveat to the findings from other research that have found a bivariate relationship between work injuries and mental health (e.g., Caglayan et al., 2010), and adds further complexity to those where other conditions have been found to shape the relationship (e.g., minority status as a condition on the work injury-mental health problem relationship among high-school students; Song et al., 2011). As such, the current study lends insight into the population of young workers who have been especially underexamined within the literature on the relationship between work injuries and mental health.

We first briefly review the research examining the work injury-mental health problems relationship among young workers to get a sense of the expected relationship within this population. We then

carefully review the existing work injury-mental health literature applying short-term longitudinal research designs. We then examine this process in a multi-wave study of young workers.

Work Injuries and Mental Health Among Young Workers

The relationship between work injuries and mental health has been highly understudied among young workers. This is perhaps a result of the most prominent study to date finding no relationship between work injuries and mental health among young workers after controlling for demographics, personality, employment, and substance use (Frone, 1998). However, a study by Caglayan and colleagues (2010) on young workers (between 14 and 18 years of age) from an apprenticeship school in Turkey found contrary results. Specifically, Caglayan et al. found that 57% of young workers who scored high on mental health problems experienced work injuries, compared to 43% of young workers who scored low on mental health problems experiencing work injuries. While this finding was significant, it did not account for any covariates as was done by Frone (1998).

A third study of working high-school students may offer some reconciliation between the differences previously found. Research by Song and colleagues (2011) found both significant and non-significant relationships between work injuries and depression when their sample was split between ethnic minority students and ethnic majority students. In particular, they found that among Asian students, a work injury was related to depression, whereas this was not the case among Caucasian students. However, again, Song et al. did not account for covariates in their analyses beyond ethnicity, though these group disparities may lend some insight into when the relationship between work injuries and mental health may emerge among young workers.

Health disparities between majority and minority groups have been pervasive in research on population health and health care (e.g., Nelson, 2002; Williams & Mohammed, 2009) and these types of disparities may also be reflected in the previous studies based on the findings from Song et al.'s (2011) research. Frone's (1998) sample was primarily drawn from an affluent population, whereas Caglayan et al.'s (2010) sample was primarily drawn from a much less affluent population. As such, there are likely important sociodemographic conditions on the relationship between work injuries and mental health among young workers. Yet, given the specific focus on the bivariate relationship in this study, we anticipate there will be a relationship between mental health and work injury among young workers as found in other bivariate studies.

Short-term Mental Health Trajectories and Work Injuries

There have been a few longitudinal studies with shorter time intervals of measurement (e.g., within months or less than a year after injury) that provide a general sense of the short-term changes of mental health following a work injury (see Table 4 for overview). Earlier research was dedicated to establishing the short-term relationship, with mixed findings for both directions (e.g., Asfaw & Souza, 2012; Dersh et al., 2002; Franulic et al., 1996). Later research was dedicated to highlighting mechanisms and conditions that are likely important for linking work injuries to mental health problems to explain these inconsistent results. These have included pain associated with the injury (e.g., Hepburn et al., 2010),

objective severity of the injury (e.g., Anderson et al., 2011), subjective severity and brooding over the injury (García et al., 2018), and sociodemographic characteristics (e.g., the interaction of gender and occupation; Kim et al., 2009).

Table 4. *Summary of existing short-term longitudinal studies on work injuries and mental health.*

Study	Prospective Measurement	Sample and Scale Details	Key Findings
Anderson et al., 2011	1 measurement: 32% of claims made within 30 days, 55% from 2 months to a year	Sample: 329 hospitalized workers with burn injuries (modal age group = 25-54, 10% female). Scale: International Classification of Diseases, Ninth Revision (ICD-9).	Roughly 1/5 of participants had a psychiatric diagnosis. Claims with psychiatric diagnoses had higher medical costs and more days of time lost than those without psychiatric diagnoses. Burn type, body part burnt, and total body surface burnt were important conditions of psychiatric diagnosis.
Asfaw et al., 2012	1 measurement: 3 months post-injury (or post-pseudo-injury period)	Sample: 6513 injured workers (M_{age} = 43.9, 49.5% female) and 361,368 non-injured workers (M_{age} = 43, 37.8% female) Scale: ICD-9	Injured workers more likely to experience depression at 3 months post-injury than non-injured workers over the same period.
Chin et al, 2018	3 measurements: 3 months, 12 month, and 6 years post-injury	Sample: 2001 injured works at 3 months (M_{age} = 42, 26.9% female), 1233 injured workers at 12 months (M_{age} = 42.6, 28.5% female), 570 injured workers at 6 years (M_{age} = 47.7, 32.6% female). Scale: Posttraumatic Symptom Checklist (PTSC) & 5-item Brief Symptom Rating Scale (BSRS-5).	Post-traumatic stress and psychopathology rates u-shaped, such that they are relatively higher at 3 months, lower at 12 months, and then high again at 6 years. Suicidal ideation relatively stable within first year following injury, significantly higher at 6 years post-injury. Whether injury affect physical appearance, additional injuries, employment instability, and reduced salary associated with higher levels of post-injury suicidal ideation.
Dersh et al., 2007	1 measurement: ~4 months post injury	Sample: 1323 workers with work-injury related chronic disabling occupational spinal	Participants far more likely to experience a psychiatric disorder compared to population estimates, particularly major depression and

		disorders (M_{age} = 41.9, 38.3% female) Scale: Structured Clinical Interview for DSM-Non-Patient Version (SCID-I NP).	drug dependence disorder. Major depression and opioid dependence disorder more likely to have occurred after the work injury experience, whereas posttraumatic stress disorder, alcohol abuse disorder, and alcohol dependence disorder more likely to be pre-existing.
Evanoff et al., 2002	2 measurements: baseline (~8 days) and follow-up (~6 months) post-injury	Sample: 205 injured workers (M_{age} = 42, 66% female). Scale: Short-Form 36 (SF-36) & Short-Form 12 (SF-12) mental health subscales.	Study sample experienced significantly lower mental health at the baseline and significantly higher mental health at the follow-up compared to the population mean, suggesting a short-term dip in mental health and a mid-term recovery. Mental health recovery dependent on follow-up work status, with those off work and with restricted duties at follow-up continuing to experience lower mental health.
Fransen et al., 2002	1 measurement: upon initial injury claim	Sample: 854 injured workers (modal age group = 31-45, 26% female) Scale: 28-item General Health Questionnaire (GHQ-28)	Chronicity of claimant status at 3 months post-injury predicted by general mental health (and 4/5 subscales: anxiety/insomnia, social dysfunction, & severe depression).
Franulic et al., 1996	1 measurement: 1 week post-injury	Sample: 25 patients with burn-related work injuries	No significant association between severity of injury and anxiety or depression.
García et al., 2018	2 measurements: baseline (less than 1 month post -injury) and follow-up (6 months from baseline).	Sample: T1 = 244 injured workers (M_{age} = 39.37, 23.4% female). T2 = 216 injured workers (M_{age} = 39.92, 24.1% female). Scale: Center for Epidemiologic Studies – Depression scale (CES-D).	Depressive symptoms much higher at time 1 (42%) compared to time 2 (29%): 49% had no depressive symptoms across both waves, 22% went from showing depressive symptoms at t1 to not showing depressive symptoms at t2, 20% maintained depressive symptoms across both waves, 9% showed emergent depressive symptoms at t2 only. Subjective severity and brooding appears to be an important mechanisms.
Gillen et al., 2004	4 measurements: 1 week, 2 weeks, 1	Sample: 78 injured workers (M_{age} = 46.6, 44% female).	Study sample experienced non-significantly lower mental health 1 week, 2 weeks, and 1 month post-

	month, and 3 months post-injury	Scale: SF-36 mental health subscale.	injury, and significantly higher mental health 3 months post-injury compared to the population mean.
Hepburn et al., 2010	2 measurements: 1 month post injury (pain), 6 months post-injury (depression)	Sample: 344 injured workers Scale: 1-item pain measure & CES-D	Pain appears to be an important predictor of depressive symptoms at 6 months following an injury.
Kim et al., 2009	2 measurements: baseline (mental health) and follow-up (injury) at 6 months	Sample: 1,350 workers (modal age group = 40-49, 37% female) Scale: CES-D (at baseline), single-item binary injury measure (follow-up)	Males with depressive symptoms no more likely to experience later work injuries than males without depressive symptoms. Females with depressive symptoms more likely to experience work injuries than females without depressive symptoms. However, both males and females from blue collar occupations were more likely to experience a work injury when they experienced depressive symptoms compared to their respective counterparts without depressive symptoms.
Lin et al., 2012	1 measurement: 3 months post-injury	Sample: 2001 injured workers (M_{age} = 42, 26.9% female). Scale: BSRS-50 & PTSC	Posttraumatic-stress symptoms and major depressive symptoms present among injured workers, and while no direct comparison available, prevalence rates higher than several different samples of general population.
Lin et al., 2014	Up to 12 measurements: baseline (sought care for injury) and monthly rates of psychiatric visits within 1 year after injury	Sample: 1038 occupational injury patients (M_{age} = 35.6, 37.9% female), 6891 non-occupational injury patients (M_{age} = 38, 43% female), and 534279 non-injury patients (M_{age} = 37.7, 52.4% female) Scale: ICD-9.	Prevalence of any psychiatric disorder significantly highest among occupational injuries, then non-occupational injuries, and then any disease. This includes PTSD, major depression, and neurotic disorders.

More fine-grained research on the trajectory of mental health following a work injury have been notably inconsistent. A study by Evanoff and colleagues (2002) measured mental health around 8 days after

injury and then again at 6 months. Results from this study show that there were signs of an initial decline in mental health, which was then found to rebound and exceed population norms at 6 months. Similar findings emerged in a study by Gillens et al. (2004), who found no decrease in mental health within two weeks following a work injury and found an increase in mental health compared to the general population at 3 months post-injury.

Adding more nuance to these studies, Chin et al. (2018) found within a larger sample that the mental health problems trajectory following an injury appeared to take a U-shape, such that mental health problems were higher at 3 months post-injury compared to 12 months post-injury, and that mental health problems were higher yet at 6 years post-injury compared to 12 months post injury. Further, García et al. (2018) found notably higher levels of depression 1 month after a work injury within their sample. Following these initial depression levels, 22% of participants in their sample recovered in 6 months, but 20% remained depressed, and 9% became depressed who were not previously depressed. These findings highlight that the trajectory of mental health following a work injury is likely to vary substantially between people.

There are several notable observations across these short-term longitudinal studies. The first observation considers the role of comparison groups: some studies examined only within samples of injured workers (e.g., Chin et al., 2018; García et al., 2018), some studies compared injured individuals with population estimates (e.g., Evanoff et al., 2002; Gillen et al., 2004), and others compared injured individuals with non-injured individuals (e.g., Asfaw & Souza, 2012; Lin, Chu, et al., 2014). Across these types of comparisons, comparing to population estimates tended to result in more inconsistent findings, likely for reasons of sampling (e.g., were the samples reflective of the general populations?) and repeated measures (e.g., what effect does completing the same scale multiple times have for values selected?). A second observation is that the studies that compared population estimates also tended to have smaller sample sizes. This increases the likelihood that the sample they have is unlikely to reflect the general population. On the contrary, studies with larger sample sizes tended to provide more stable estimates. Based on these findings, we propose the following hypotheses:

> *Hypothesis 1. Work injury will be associated with the intercept of the mental health trajectory, such that individuals who experience a work injury at time 1 will start with worse mental health compared to those who do not experience a work injury at time 1.*
>
> *Hypothesis 2. The experience of work injury at time 1 will be associated with the slope of the mental health trajectory, such that individuals who experience a work injury at time 1 will have a greater rate of change in mental health problems following a work injury than those who do not experience a work injury at time 1.*

Finally, there are no studies in the extant literature that examine the trajectory of mental health proceeding work injury experience (especially among young workers). As such, our goal is to explore the bivariate relationship that mental health problems have with later work injury based on our existing knowledge that there is a smaller relationship between prior mental health problems and later work injuries (see Study 1).

Research question 1. Will the slope of mental health problems be positively associated with the experience of work injury at time 5, such that rate of change in mental health problems will be associated with the experience a work injury?

The Present Study

Data from a WCB Manitoba-funded longitudinal study of young workers and safety (Tucker & Turner, 2017) were analyzed to address research hypotheses. The original purpose of the data was to understand the safety experiences of young people during early stages of employment, a period marked for its high rate of injuries (Breslin & Smith, 2006). However, the study also included measures of mental health at each study wave. In particular, young Canadian workers completed monthly surveys (for up to 15 consecutive months) containing questions about their work-related injuries, mental health, and other aspects of their work and non-work lives (e.g., safety attitudes and beliefs). We examine these data to get a better sense of the trajectory of mental health prior to and following a work injury. To the best of our knowledge, there is no comparable published research that examines this.

Methods

Participants

Young workers from Western Canada who participated in Tucker and Turner (2017) were the source of data for the current study. The young workers were recruited either in-person, through contacts at high schools, or through advertisements in a magazine. For those who met the age inclusion criteria (i.e., between 15-19 years old) and consented to participate, a monetary incentive was provided to increase the likelihood of participation and retention at each wave. At each wave, participants completed online surveys about individual and work-related questions, with primary variables of interest (i.e., work injuries and mental health) measured at each time wave. A total of 162 teenagers signed up to participate in the study, with 106 teenagers completing at least five consecutive surveys while employed within the 15 waves of data collection. Given that only the first survey at the start of the 15 waves of data collection contained questions about demographics, including age and gender, this information was only available for 90 of the 106 participants. The average age of these 90 participants was 17.22 years old (*SD* = 1.17 years) at the first survey, with 56.7% reporting to be female and 43.3% reporting to be male.

Materials

Descriptives. Participants responded to various descriptive questions at the initial wave of data collection. These included their age in years, their gender (male, female), and their current employment status. In each of the waves of data collection following the initial survey, participants were asked whether they experienced a change in their employment status (e.g., whether they were still employed

and whether they started a new main job). Age and gender were used for descriptive purposes and employment status was used to prepare the data to be analyzed.

Work injuries. Participants responded to questions asking about whether they experienced any number of common work-related injuries within the previous month. Among the types of injuries were strain or sprain; scratch or abrasion; cut, laceration, or puncture; work-related burn or scald; and bruise or contusion. Participants rated the frequency of these common injuries from 0 (never) to 4 (more than five times). Both a binary and mean scale score were derived to test the proposed hypotheses and for descriptive purposes, respectively.

Mental health. Participants responded to five questions from the General Health Questionnaire (Shevlin & Adamson, 2005) asking about their general mental health within the previous month at each month. Participants rated their response to items such as "felt reasonably happy" and "enjoyed day-to-day activities" from 1 (never) to 5 (always). The scale was reversed, such that higher scores reflected worse mental health. The internal reliability for the mental health scale was high (ω_{time1} = .83, ω_{time2} = .84, ω_{time3} = .87, ω_{time4} = .89, ω_{time5} = .91). McDonald's (1999) Omega (ω) was calculated to examine internal reliability as recommended by Cortina and colleagues (2020), with scores above .70 representing internally consistent responses (Viladrich et al., 2017).

Procedure

High school students, aged 15-19, were recruited from across the province of Manitoba between April and June 2011, with the majority residing in Winnipeg. This time was chosen to attract interest in the study as it was just before students began summer jobs. High school principals were contacted and asked to identify suitable grade 11 and 12 classes. In some cases, this involved a research assistant visiting classrooms to explain the study to potential student participants.

To be eligible for the study, participants either had a job at the time of recruitment or indicated that they were or would be searching for a job in the near future. Students were offered $10 for each completed survey and multiple follow-up emails and phone calls were used each month to maximize participant retention on a monthly basis. Participants received a cheque in the mail every three months for up to a maximum of $30 (i.e., $10 per survey completion). Surveys were completed on-line, outside of school hours, and took approximately 15 minutes to complete.

The survey was structured so that participants who were unemployed or were in-between jobs in any given month were directed to respond to a unique set of survey questions appropriate for their situation (e.g., related to their job search behaviours). Participants who were new to a job in a given month were asked to fill out additional questions about their new position (e.g., sector, job title, nature of job-related safety training) in addition to the regular questions employed participants completed each month. All survey questions were asked in relation to the young worker's main job (i.e., the job they work the most hours at).

The first survey was administered June 2011 (referred to as Wave 1) and the final survey was offered in August 2012 (referred to as Wave 15). The participants' surveys consisted of two broad categories of variables: (1) those that were asked each month (these included work-related injuries and mental health) and (2) those that were asked once or at regular intervals (e.g., once every three months). Across the 15 months, participant surveys included questions related to 73 different variables. Variables could be a single survey question/statement or comprised by multiple items from a validated measure. For the purposes of the current study, only the stated demographic, employment, work injury, and mental health variables were assessed.

Analytic Procedure

Descriptive analyses were conducted first to determine rate of attrition and resulting usable data across the 15-waves of data collection. Latent curve modeling within a structural equation framework (Bollen & Curran, 2006) was chosen to test the proposed hypotheses. Latent growth curve modeling offers flexible solutions to analyzing change over time, such as easily testing different trajectories of change and comparison of change across groups. Work injury was treated as a time-invariant covariate (i.e., whether or not participants experienced an injury at time 1 and at time 5). As such, mental health and work injuries were modelled to explain variance in residuals beyond that accounted for by the growth curve of mental health throughout the course of the study (Curran et al., 2010). Analyses were conducted using the software Mplus 8.4 (Muthén & Muthén, 2017).

Based on the retention rate, as well as recommendations for minimum number of time points (Preacher et al., 2008) and sample size (MacCallum et al., 1996) for latent growth modelling, a total of five consecutive time waves were used in the analyses to provide a sample size of over 100 participants. Prior to analyses, the dataset was prepared in a hierarchical manner such that participants could have multiple waves depending on variation in their employment status (11 participants of the final 106 had 2 observations, resulting in 117 observations for the current study). In the repurposed dataset, time 1 refers to the first survey completed by the participant upon initial employment (e.g., if a participant started working at wave 3, this was considered time 1) or the first survey completed after any change in employment (i.e., if a participant started a new main job or if a participant experienced a period of unemployment between waves). Finally, any discontinuity in survey completion (i.e., incomplete waves) reset a participant to time 1 upon their next employed survey completion given the high rate of unemployment and job change over the course of data collection (See Table 5).

Table 5. *Completion rate, employment, and job change per wave (in percentage [%])*

Month	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Wave	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Completed	85.8	66.4	70.5	70.5	67.8	63.2	61.3	56.3	58.6	60.9	59.8	55.2	53.3	49.8	51.7
Employed	81.5	77.8	69.8	68.3	67.4	68.1	67.8	64.6	68.7	69.4	67.8	70.2	81.2	80.5	74.6
Job change	---	21.9	13.4	15.9	11.0	13.5	10.2	5.3	6.7	8.3	6.8	12.1	17.9	15.5	7.0

Note. Total N = 261 for completed, where percentage employed is only among those who completed survey, and percentage job change is only among those who are employed.

Results

See Table 6 for mental health and injury statistics over the course of the five time-points for participants who met inclusion criteria. Further, see Figure 5 for the display of average scores on mental health across the five consecutive time waves separated by whether participants had experienced an injury within the period of the first time point or the final time point.

The study hypotheses proposed that the experience of a work injury at time 1 would be associated with the intercept (Hypothesis 1) and slope (Hypothesis 2) of mental health, and that the slope of mental health would be associated with the experience of work injury in time 5 (Research Question 1). Prior to testing these hypotheses, a series of models were analyzed to assess the mean and variance for both the intercept and slope of the mental health trajectory (see Table 2). Results from these models suggest significant variance in the intercept between participants (*estimate* = .27, $p < .001$), but no significant variance in the slope between participants (*estimate* = .01, $p = .253$). Consequently, there is insufficient variance in the slope of mental health to test Hypothesis 2 and Research Question 1 via latent growth curve modelling. Therefore, no support for Hypotheses 2 and Research Question 1 will be found in subsequent analyses without significant variance, and subsequent analyses will be limited to testing Hypothesis 1.

Results for the model fit for the latent growth model testing Hypothesis 1 showed good fit to the data: χ^2 (18) = 26.07, $p = .098$, comparative fit index (CFI) = .95, root mean square error of approximation (RMSEA) = .06, standardized root mean square residual (SRMR) = .07. Further, results show that the experience of an injury at time 1 was positively associated with the intercept of the mental health trajectory (*estimate* = .21, $p = .038$).

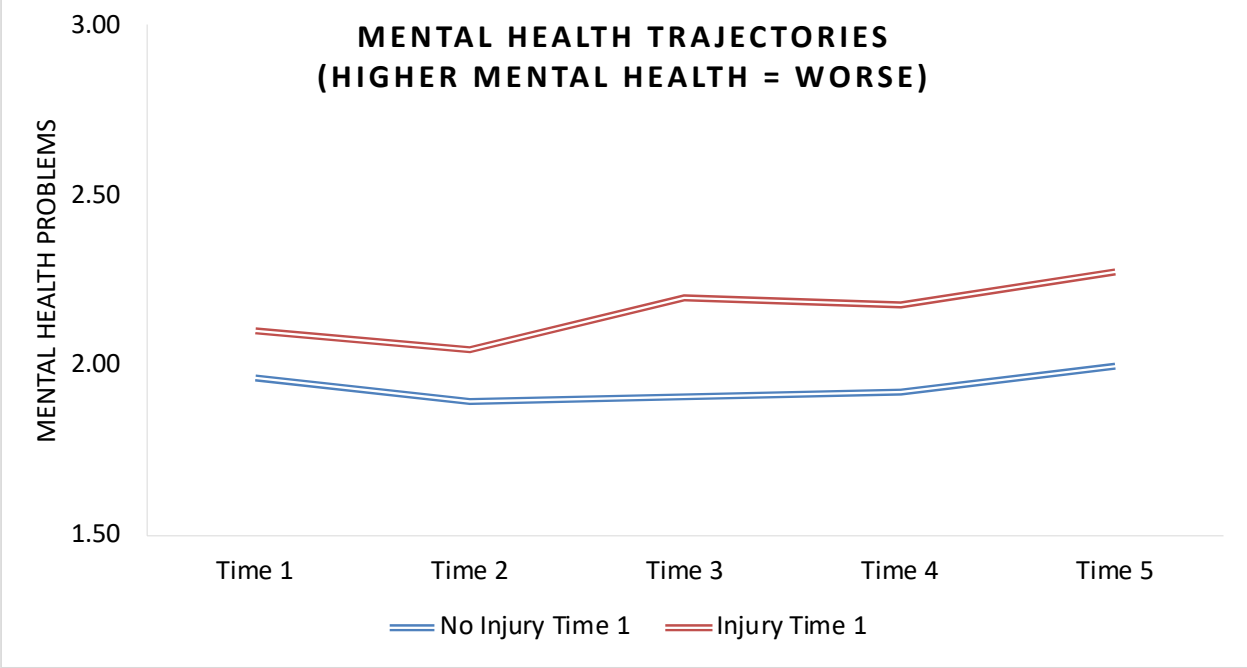
Table 6. *Means, standard deviations, and correlations between study variables.*

					Time 1					Time 2			Time 3			Time 4			Time 5	
	Variable	M	SD	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Time 1	1. Age	17.21	1.18	98	-															
	2. Gender	.43	.50	99	-.01	-														
	3. Mental Health	2.04	.73	117	.32**	.05	-													
	4. Injury (mean)	.33	.54	117	.14	.13	.10	-												
	5. Injury (binary)	.57	.50	117	.07	-.05	.09	.54***	-											
Time 2	6. Mental Health	1.98	.66	117	.07	.12	.49***	.05	.11	-										
	7. Injury (mean)	.28	.37	117	-.07	.11	.07	.57***	.48***	.04	-									
	8. Injury (binary)	.56	.50	117	-.06	-.08	.02	.37***	.55***	.01	.70***	-								
Time 3	9. Mental Health	2.08	.70	117	.17♦	.05	.62***	.07	.20*	.69***	.08	.09	-							
	10. Injury (mean)	.23	.30	117	-.02	.02	.06	.43***	.53***	.12	.62***	.48***	.17	-						
	11. Injury (binary)	.52	.50	117	.10	-.11	.01	.42***	.63***	.00	.40***	.42***	.07	.74***	-					
Time 4	12. Mental Health	2.07	.70	117	.24*	.06	.48***	.10	.18♦	.49***	.22*	.19*	.47***	.17♦	.10	-				
	13. Injury (mean)	.26	.41	117	-.10	-.03	-.02	.27**	.31***	.03	.47***	.41***	-.02	.60***	.43***	.05	-			
	14. Injury (binary)	.50	.50	117	-.10	-.02	-.04	.33***	.49***	.04	.40***	.46***	.06	.54***	.49***	.11	.64***	-		
Time 5	15. Mental Health	2.16	.77	117	.14	.05	.47***	.23*	.18♦	.65***	.19*	.20*	.64***	.18♦	.14	.58***	.02	.11	-	
	16. Injury (mean)	.32	.46	117	-.07	.07	.04	.22*	.31***	.15	.48***	.35***	.16♦	.60	.49***	.15	.53***	.54***	.17♦	-
	17. Injury (binary)	.54	.50	117	.03	.01	-.05	.33***	.45***	.06	.37***	.41***	.03	.54	.55***	.10	.54***	.73***	.11	.64***

Note. ♦ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 7. Means and variances of intercept and slope of mental health trajectory.

Model	χ^2, df	$\Delta\chi^2$	Intercept mean	Intercept variance	Slope mean	Slope variance	Intercept-Slope covar'	Residual variance	Δresidual variance
1. fixed intercept, no slope	195.00, 18	-----	2.065	-----	-----	-----	-----	.507	-----
2. Intercept variance, no slope	27.66, 17	167.34 $p <$ .001	2.065	.279	-----	-----	-----	.228	55%
3. Intercept variance, fixed slope	24.07, 16	3.59, $p < .10$	2.002	.279	.032	-----	-----	.226	.4%
4. Intercept and slope variance	21.97, 14	2.1, $p > .10$	2.002	.273	.032	.007	-.004	.209	3.4%



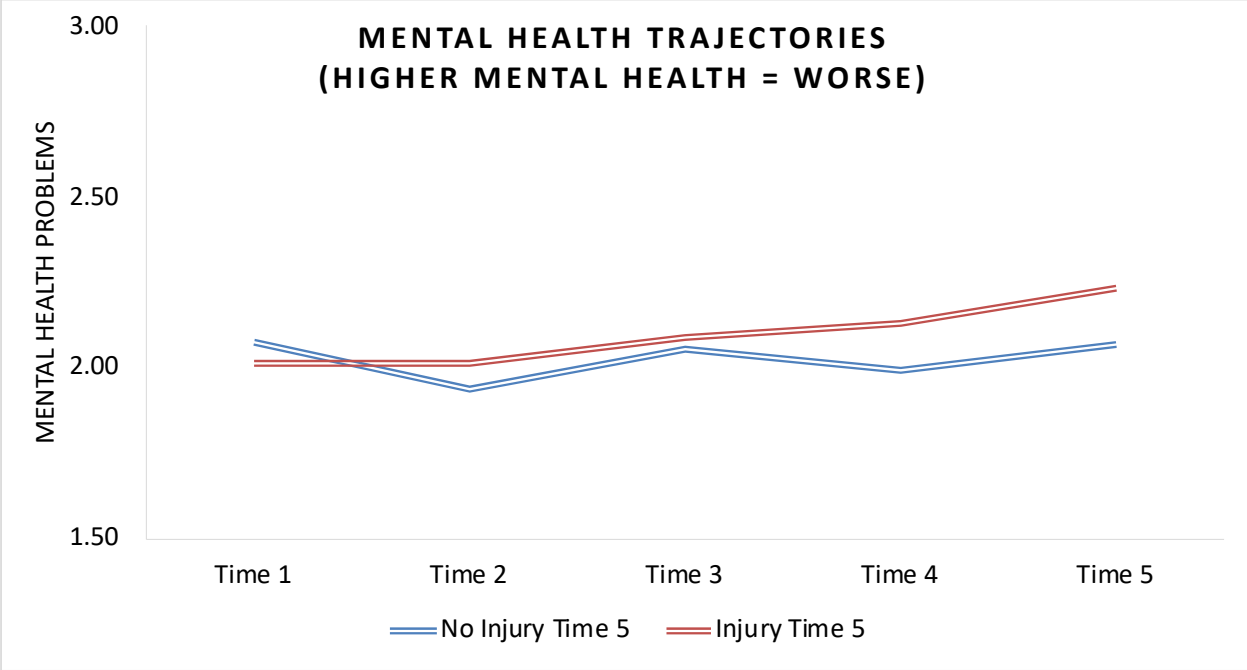
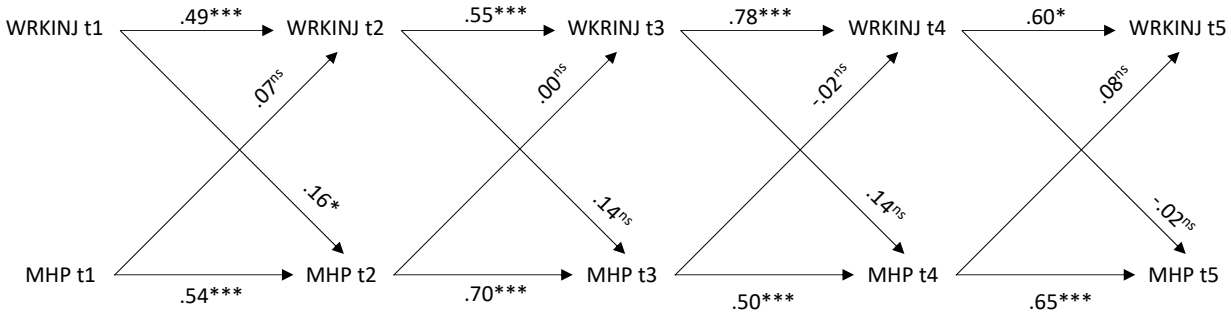


Figure 5. *Mental health trajectories by initial injury status (top) and final injury status (bottom)*

Supplemental Analyses

Given the lack of variance in the slope of mental health, a cross-lagged model between work injuries and mental health was examined to test the bi-directional relationship between mental health and work injuries on a month-to-month basis while accounting for auto-regressive (i.e., prior levels) effects. Given it is not necessary for all participants to have completed consecutive survey for this type of analysis (i.e., allowing for missing data) and the capacity for regressions to handle missing data, the sample for this analysis included 169 young workers. Results of the cross-lagged model can be found in Figure 6. As can be seen, only one significant cross-lagged effect emerged between time 1 work injury and time 2 mental health problems (*estimate* = .16, *SE* = .06, *p* = .011, 95% CI: .04, .29). Overall, these results lend some evidence for Hypothesis 1, but again do not provide any support for Hypothesis 2. Further, the lack of association between prior mental health problems and subsequent injury adds evidence to an answer for Research Question 1.



*Note. * p < .05, ** p < .01, *** p < .001. WRKINJ = work injury, MHP = mental health problems.*
Figure 6. *Cross-lagged model between work injuries and mental health problems.*

Discussion

Results from the current study suggest that across five time points, young workers may have different levels of mental health, but the change in mental health over the course of five months does not differ significantly between participants. Importantly, individuals who experienced work injury at time 1 also experienced worse mental health, both in terms of the starting point of the trajectory (i.e., the intercept) and after one-month post-injury. However, the experience of work injury was unrelated to the trajectory of mental health over the course of the study, while the trajectory of mental health was unrelated to the experience of work injury at time 5.

The largest limiting factor of the current study was the lack of variance between participants in the slope of their mental health over the course of the study. One potential explanation for this is the power of the current study to detect such variation in change given the sample size and number of waves available to test the latent growth curve of mental health. In other words, the lack of findings in the current study may be a result of the statistical power to test the proposed hypotheses. This is particularly clear in Figure 5 given the visual distinction in mental health over the course of the five waves between participants who experienced a work injury at time 1 and those who did not experience

an injury at time 1. Further, as was highlighted in the literature review, the studies that tended to find to differences in mental health following an injury over shorter periods of time were those studies that had smaller sample sizes.

Despite the lack of findings with the latent growth curve model, this study nevertheless adds important information about the frequency and variation of work injuries and mental health over the course of consecutive employment among younger workers. It is noteworthy that the number of injuries experienced by young workers was substantial in the current study and warrants further attention in future research. Indeed, over half of the sample experienced at least one work injury at each time wave (range: 50.4% to 57.3%).

While the trend in injuries is worrisome, the trend of mental health across the five waves does suggest that the sample was relatively stable and tended to experience good mental health (average mean ranged from 1.98 to 2.15 on a scale from 1 to 5, with lower scores reflecting better mental health). However, this trend was among those participants who were consistently employed across at least five waves of data collection. Future research is needed to better understand the role that the frequent unemployment and employment instability within young workers has on both their mental health and their tendency to experience work injuries because of this variation. While not the focus of the current study, this trend was noticed in data preparation and worthy of attention at another time.

Limitations and Future Directions

This study addresses the limitations of the meta-analysis (i.e., lack of nuance) and the population study (i.e., older age range), but again also has its own limitations. First, this study is limited to young workers only, resulting in a similar but complementary limitation to Study 2 in its focus on older workers. Second, while there was a sufficient sample size to examine five time-points, the resulting statistical power may have limited the ability to detect smaller effect sizes. Finally, the analyses were limited to those participants who were consistently employed throughout the course of the five time points. This in turn means that any injuries severe enough to warrant temporary unemployment were excluded. This study primarily focused on minor injuries, which may be less impactful on young worker mental health than more severe work injuries would be.

Conclusion

In this study, we summarized the existing longitudinal research examining shorter time intervals studies of the relationship between mental health problems and work injuries. Beyond this contribution, we also tested the mental health trajectory of young workers and found that there was variation in mental health within our sample, but only at individual time points, whereas the slope of mental health or the rate of change of mental health between young workers in our sample, was found not to vary

significantly. This study provides insight into the mental health of young workers and their experiences of work injury.

References

Ahola, K., Salminen, S., Toppinen-Tanner, S., Koskinen, A., & Väänänen, A. (2013). Occupational burnout and severe injuries: An eight-year prospective cohort study among Finnish forest industry workers. *Journal of Occupational Health*, *55*, 450–457.

Andersen, L. P., & Mikkelsen, K. L. (2008). Recall of occupational injuries: A comparison of questionnaire and diary data. *Safety Science*, *46*(2), 255–260. https://doi.org/10.1016/j.ssci.2007.06.014

Anderson, N. J., Bonauto, D. K., & Adams, D. (2011). Psychiatric diagnoses after hospitalization with work-related burn injuries in Washington State. *Journal of Burn Care & Research*, *32*(3), 369–378.

Asfaw, A., & Souza, K. (2012). Incidence and cost of depression after occupational injury. *Journal of Occupational and Environmental Medicine*, *54*(9), 1086–1091. https://doi.org/10.1097/JOM.0b013e3182636e29

Bollen, K. A., & Curran, P. J. (2006). *Latent curve models: A structural equation perspective*. John Wiley & Sons, Ltd.

Breslin, F. C., & Smith, P. (2006). Trial by fire: A multivariate examination of the relation between job tenure and work injuries. *Occupational and Environmental Medicine*, *63*(1), 27–32. https://doi.org/10.1136/oem.2005.021006

Caglayan, C., Hamzaoglu, O., Yavuz, C. I., & Yüksel, S. (2010). Working conditions and health status of child workers: Cross-sectional study of the students at an apprenticeship school in Kocaeli. *Pediatrics International*, *52*(1), 6–12.

Chin, W.-S., Guo, Y. L., Liao, S.-C., Lin, K.-H., Kuo, C.-Y., Chen, C.-C., & Shiao, J. S. C. (2018). Suicidality 6 years after occupational injury. *The Journal of Cinical Psychiatry*, *79*(5), 1–7.

Cortina, J. M., Sheng, Z., Keener, S. K., Keeler, K. R., Grubb, L. K., Schmitt, N., Tonidandel, S., Summerville, K. M., Heggestad, E. D., & Banks, G. C. (2020). From alpha to omega and beyond! A look at the past, present, and (possible) future of psychometric soundness in the Journal of Applied Psychology. *Journal of Applied Psychology*, *105*(12), 1351–1381.

Curran, P. J., Obeidat, K., & Losardo, D. (2010). Twelve frequently asked questions about growth curve modeling. *Journal of Cognition and Development*, *11*(2), 121–136. https://doi.org/10.1080/15248371003699969

Dersh, J., Polatin, P. B., & Gatchel, R. J. (2002). Chronic pain and psychopathology: Research findings and theoretical considerations. *Psychosomatic Medicine*, *64*(5), 773–786. https://doi.org/10.1097/01.PSY.0000024232.11538.54

Dong, X. S., Wang, X., Largay, J. A., & Sokas, R. (2015). Long-term health outcomes of work-related injuries among construction workers—findings from the National Longitudinal Survey of Youth. *American Journal of Industrial Medicine*, *58*(3), 308–318. https://doi.org/10.1002/ajim.22415

Evanoff, B., Abedin, S., Grayson, D., Dale, A. M., Wolf, L., & Bohr, P. (2002). Is disability underreported following work injury? *Journal of Occupational Rehabilitation*, *12*(3), 139–150. https://doi.org/10.1023/A:10168385

Franulic, A., Gonzalez, X., Trucco, M., & Vallejos, F. (1996). Emotional and psychosocial factors in burn patients during hospitalization. *Burns*, *22*(8), 618–622.

Frone, M. R. (1998). Predictors of work injuries among employed adolescents. *Journal of Applied Psychology*, *83*(4), 565–576. https://doi.org/10.1037/0021-9010.83.4.565

García, F. E., Cova, F., Páez, D., & Miranda, F. (2018). Brooding as moderator of depressive symptoms after a work accident: A longitudinal study. *Scandinavian Journal of Psychology*, *59*(2), 236–242.

Gillen, M., Jewell, S. A., Faucett, J. A., & Yelin, E. (2004). Functional limitations and well-being in injured municipal workers: A longitudinal study. *Journal of Occupational Rehabilitation*, *14*(2), 89–105.

Hepburn, C. G., Kelloway, E. K., & Franche, R.-L. (2010). Early employer response to workplace injury: What injured workers perceive as fair and why these perceptions matter. *Journal of Occupational Health Psychology*, *15*(4), 409–420.

Kim, H.-C., Park, S.-G., Min, K.-B., & Yoon, K.-J. (2009). Depressive symptoms and self-reported occupational injury in small and medium-sized companies. *International Archives of Occupational and Environmental Health*, *82*(6), 715–721. https://doi.org/10.1007/s00420-008-0365-6

Lin, K.-H., Chu, P.-C., Kuo, C.-Y., Hwang, Y.-H., Wu, S.-C., & Guo, Y. L. (2014). Psychiatric disorders after occupational injury among National Health Insurance enrollees in Taiwan. *Psychiatry Research*, *219*(3), 645–650. https://doi.org/10.1016/j.psychres.2014.06.015

Lin, K.-H., Shiao, J. S.-C., Guo, N.-W., Liao, S.-C., Kuo, C.-Y., Hu, P.-Y., Hsu, J.-H., Hwang, Y.-H., & Guo, Y. L. (2014). Long-term psychological outcome of workers after occupational injury: Prevalence and risk factors. *Journal of Occupational Rehabilitation*, *24*(1), 1–10. https://doi.org/10.1007/s10926-013-9431-3

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods*, *1*(2), 130–149.

McDonald, R. P. (1999). *Test theory: A unified treatment*. Lawrence Erlbaum Associates, Inc., Publishers.

Muthén, L. K., & Muthén, B. O. (2017). *Mplus user's guide: Statistical analysis with latent variables* (No. 8th). https://doi.org/10.1111/j.1600-0447.2011.01711.x

Nelson, A. (2002). Unequal treatment: Confronting racial and ethnic disparities in health care. *Journal of the National Medical Association*, *94*(8), 666–668. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2594273/pdf/jnma00325-0024.pdf

Preacher, K. J., Wichman, A. L., MacCallum, R. C., & Briggs, N. E. (2008). *Latent growth curve modeling* (Issue 157). Sage Publications.

Shevlin, M., & Adamson, G. (2005). Alternative factor models and factorial invariance of the GHQ-12: A large sample analysis using confirmatory factor analysis. *Psychological Assessment*, *17*(2), 231-236.

Song, S. J., Ziegler, R., Arsenault, L., Fried, L. E., & Hacker, K. (2011). Asian student depression in American high schools: Differences in risk factors. *The Journal of School Nursing*, *27*(6), 455–462.

Tucker, S., & Turner, N. (2017). *Young workers responses to workplace hazards, responsibility for safety, and workplace injuries across time* [Technical report]. Workers' Compensation Board of Manitoba, Winnipeg, Canada. Available at https://www.wcb.mb.ca/sites/default/files/files/Young%20workers%20responses%20to%20hazards%20-%20final%20report%20(2).pdf

Viladrich, C., Angulo-Brunet, A., & Doval, E. (2017). A journey around alpha and omega to estimate internal consistency reliability. *Annals of Psychology*, *33*(3), 755–782.

Williams, D. R., & Mohammed, S. A. (2009). Discrimination and racial disparities in health: Evidence and needed research. *Journal of Behavioral Medicine*, *32*(1), 20–47. https://doi.org/10.1007/s10865-008-9185-0

Implications from the Three Studies into Workplace Injury and Mental Health

Implications from the Three Studies into Workplace Injury and Mental Health

Advancing a more holistic assessment of physical and mental health in the workplace

The three studies commissioned by WorkplaceNL lead us to take a more holistic and nuanced view of the relationship between workplace injury and mental health. The implications for ongoing research and for practical intervention in occupational health and safety are detailed below.

Research and practical implications from Study 1: A meta-analysis of existing knowledge

Maintain the nuance of continuous experiences

First, the meta-analysis (Study 1) can be a guide for future researchers measuring both work injuries and mental health problems. In future studies, researchers should try to enrich binary measures of workplace injuries:

- by having more meaningful measures that capture both the perceived and clinical severity of injuries,
- or by capturing follow-up details on a present injury such as its perceived severity as rated by the worker compared to objective independent ratings (e.g., from medical professionals) to find which is more strongly associated with prior and subsequent mental health problems.

Similarly, researchers should avoid oversimplifying continuous mental health measures, such as pain or injury severity, into a binary output. Even if researchers choose to dichotomize a continuous variable, the descriptive statistics of and correlations with its continuous form should also be provided to inform future meta-analyses.

Consider short and long-term effects of injuries

Second, this meta-analysis demonstrates that the linkage between previous work injuries and subsequent mental health problems is stronger than the linkage between previous mental health problems and subsequent work injuries. Accordingly, this finding should encourage research examining the short and long-term impacts of work injuries.

Typically, research on work injuries has treated them as physical events to be measured, managed, and mitigated. However, studies examining the potential psychological consequences of work injuries point the way towards new occupational health practices.

- For instance, the current meta-analysis provides evidence that a greater emphasis on psychological rehabilitation alongside physical rehabilitation in return-to-work programs would be appropriate.

Consider visible minority status as a determinant of vulnerability

Third, since visible minority status magnifies the association between work injuries and mental health problems, more research is needed to find out why.

- In practical terms, organizations which employ greater numbers of visible minorities need to be more aware of this lack of protection, and employees should be made aware of their right to report injuries.
- Further, organizations could highlight opportunities for support during the post-injury process such as advice on completing workers' compensation claims. From a policy perspective, governing bodies may want to direct limited resources to ensuring employers are providing these protections to minority workers through inspections and enforcement.

Research and practical implications from Study 2: two-way influence of psychological states and injury

Study 2 highlights the importance of cognition in explaining the two-way relationship between work injuries and mental health problems which has theoretical and practical implications for occupational health and safety, and for rehabilitation.

- Psychological rehabilitation following physical injuries may help improve recovery and reduce associated costs.
- In preparing psychological interventions, the cognitive mechanisms examined in this study should be targeted, especially negative and maladaptive cognitions. By visualizing these changeable mechanisms, it may be possible to counteract the association between work injuries and subsequent mental health challenges.

From a theoretical point of view, the way we think about physical injuries may be limiting our ability to better understand the psychological experience of them.

- Recent research into moral injuries — "the extent to which individuals appraise themselves as victims of another's transgressive behavior, leading to betrayal-based problems" (Griffin et al., 2019) — and the growing rate of compensation claims for mental health-related disabilities require us to rethink the boundaries between physical and psychological well-being and how work and employment shapes the connection.
- A better understanding of physical and psychological health is important for safe and productive workplaces.
- Study 2 raised concerns that we have insufficient insight into the specific experience of older workers when it comes to workplace injury and mental health problems. Similarly, the research

raises questions around the types of workplaces where injuries are more likely to take place. Future research might be directed to answering these broader questions.

Research implications from Study 3: tracking the prevalence of mental health problems over time amongst young workers

Study 3 offers insight into the frequency and variation of work injuries and mental health among younger workers over 15 months: over half of the sample experienced at least one work injury at each time wave. Such a significant rate of injury warrants further attention in future research of young workers.

- The trend of mental health across time does suggest that the group experienced good mental health. But this trend was among employed participants. Future research should seek to better understand the impact of frequent unemployment and employment instability on young workers' physical and mental health.