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Disability and Return to Work Following Musculoskeletal Injury

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A thesis submitted in partial fulfillment of the requirements for the degree in Doctor of
Philosophy

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Abstract

Musculoskeletal disorders (MSDs) are injuries, damage or disorders affecting the musculoskeletal system including muscles, ligaments, nerves, tendons, bones or cartilage etc. MSDs are highly prevalent and associated with sickness absence, reduced work efficiency, job changes and earlier retirement.. They also affect daily activity and social functioning. Although many MSDs are accompanied by minor symptoms and settled spontaneously, approximately 10% of the workforce with MSDs have difficulty resuming their original work or exit the workforce permanently. Return to work after MSDs is complex, and is influenced by many factors including physical, psychological, economic and social factors.

Although there are extensive studies on the association between MSDs and work, existing research on upper limb MSDs is not sufficient to guide management of the return to work process. Moreover, there is lack of evidence on how the work environment, especially the ergonomic system affects the injured workers' decision to return to work. In consideration of the aging workforce and resulting increasing burden of such studies are needed to guide to employers, clinicians and policymakers..

The purpose of this thesis is to better understand the work-related disability of MSDs of upper limbs and identify the factors which can be used to determine return to work. The key research objectives were: 1) To identify the prognostic factors for return to work after work-related traumatic hand injuries. This was achieved through a systematic review. 2) To evaluate the structure of a modified Organizational, Policies and Practices scale (OPP-14). Specifically, to examine the addition of 3 items on the Ergonomic Subscale in terms of internal consistency, construct validity and other psychometric characteristics by using confirmatory factor and Rasch analyses. 3) To identify the predictors of job changes in a sample of an aging population with rotator cuff syndrome during surgery wait times; and the disability progression during wait times in the same population.

From the existing literature, we found evidence that greater impairment in physical function was associated with a longer time to return to work following a work-related traumatic hand injury' whereas common predictors of RTW including age, gender and level of education demonstrated no consistent impact on RTW. Our modified OPP-14 proved to be robust in

factor structure on a sample of firefighters which we believe the scale can be used in assessing the workplace health and safety. We also found that average time to job changes for people wait for rotator cuff repair is 5.5 months. WSIB status was the only significant predictor for job changes; whereas, age had a trend of significance ($P=0.06$). The length of wait times had a minor impact on self-reported disabilities or muscle strength.

Our work enriches the literature of MSDs by identifying prognostic factors following hand injury, validating a better scale to measure workplace policy and safety, identifying potential prognostic factors for job changes, and evaluating the disability progression and its interaction with employment status in rotator cuff disorders.

Keywords

Musculoskeletal disease, upper limb, disability, return to work, prognostic factor, organizational policies and practices

Co-Authorship Statement

The thesis question and design of the studies were formulated by Qiyun Shi and her supervisor, Joy C MacDermid. Co-investigators were recruited when additional reviewer with specific expertise were required. The authors and specific roles for each component of the thesis are listed below:

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CHAPTER 2: A SYSTEMATIC REVIEW OF PROGNOSTIC FACTORS FOR RETURN TO WORK FOLLOWING WORK-RELATED TRAUMATIC HAND INJURY.

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CHAPTER 3: CONFIRMATORY FACTOR AND RASCH ANALYSES SUPPORT A REVISED VERSION OF THE WORKPLACE ORGANIZATIONAL POLICIES AND PRACTICES QUESTIONNAIRE (OPP-14)

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CHAPTER 6: GENERAL DISCUSSION AND FUTURE DIRECTION

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CHAPTER 1: INTRODUCTION

Musculoskeletal disorders (MSDs) are injuries, damage or disorders affecting musculoskeletal system include muscles, ligaments, nerves, tendons, bones or cartilage etc. ¹ Sprains, strains, tears, hernias, connective tissue injuries and pain associated with the above mentioned structures are all forms of MSDs. ¹ MSDs commonly occur in the back, shoulder, wrist, elbow and neck due to repetitive movements, prolonged sitting or standing, or sudden traumatic stroke. ² Certain professionals have a high prevalence of MSDs which leads to sick leave, reduced work efficiency, job changes and earlier retirement. ³⁻⁷

1.1.1 The Mechanism of MSDs

The underlying mechanism of MSDs is often due to an imbalance of external loading and the bearing capacity of the musculoskeletal system. ⁸ That is, the external load exceeds the body's capacity to resist biomechanical and physiological strain. Body type and size, age, sex and general health determine the body's bearing capacity. ⁹ The magnitude, duration and frequency of the external load will determine the physiological effect. ⁹ MSDs can be caused by one forcible stroke internally or externally which leads to misalignment of the musculoskeletal structure and consequently evoke direct injuries in the tissues. MSDs can also result from a chronic overloading, such as repetitive movement. For moderate continuous loading, human body will become less resistant to the load by reduction in muscular force and endurance if there is no sufficient recovery time. On the other hand, if the loading is continuously on a low level, the body will slowly adapt to this low level with weakening of tissues (e.g. muscles and tendons) which is one of the most important reasons to cause osteoporosis after a period of immobilization. ⁹

Nevertheless, the magnitude of overloading and the duration of exposure are the two most important factors in the development of MSDs. A short, temporary stretch usually

leads to acute pain and dysfunction, while prolonged repetitive movement or posture may cause irreversible health consequences.⁹

1.1.2. Risk factors for the development of MSDs

Age is one factor which may affect the body's ability to withstand external forces. With age tendons and ligaments lose elasticity, bones become more fragile, cartilage loses resilience, and muscle mass is reduced which all contribute to the body's reduced capacity to withstand external forces.¹⁰ Moreover, age related chronic inflammation is being considered as a key factor contributing to pathogenic changes in frailty and degenerative disorder. Elderly may be also prone to be resistant to anabolic stimuli which causes to loss of skeletal muscle mass with ageing.¹¹

Sex is another risk factor associated with development of MSDs. Women are more likely than men to have neck shoulder symptom.¹²⁻¹⁴ This distinction is likely a result of differences in anthropometrical and functional body characteristics, threshold of pain and stress as well as fatigue resistance.¹⁵ First, the relative difference in tolerance to biomechanical loads may be contributed to gender difference. Women are reported to have 30% less strength than men in spine.¹⁶ In another study, Lindman suggested women had smaller cross-sectional area of the trapezium muscle fiber which may indicate a lower functional capacity leading to MSDs in the neck and shoulder region.¹⁷ Second, women are also more sensitive to pain than men. With the lower pain thresholds, women are more likely to experience of discomfort of MSDs.¹³ Third, women may react more strongly to psychological stressors than men when facing physical and/or mental challenges. Increased mental stress may aggravate the muscular tension and less relaxation, especially in shoulder and neck pain.¹⁸

Obesity may play a role in the development and progression of MSDs, especially in weight bearing joints such as the hip, knee and ankle. The mechanical theories involve overloading of bones, joints and soft tissues which leads to chronic inflammation and injury. Such impact is more evident in weight-bearing activities such as walking. The cumulative repetitive daily activities eventually cause to permanent MSDs.^{19,20} In addition, people with obesity often face negative attitudes and stereotypes which links to

social and employment discrimination²¹ which may place them in the disadvantage position when job-hunting. As a result, obese people may be accept the job at risk of MSDs. On the other hand, obese men and women are more likely to report high job strain and low co-worker support²² which may deteriorate their physical and mental function if they experience MSDs.

Prior injuries also can contribute to the development of MSDs. In the USA, the median age of the labour force is expected to be 42.6 years in 2022 compared to 37.1 years in 1992.²³ In addition, more people are postponing retirement due to the increase in retirement age from 65 to 67 years old in Canada.²³ Given the increased working age, prior injuries are playing an increasingly important role in the development of MSDs, especially for people working in the manufacturing industry. In a study conducted by Choi and colleagues, steelworkers with a previous upper extremity injury were 2.2 times (95% CI 1.5-3.2) more likely to have an upper limb MSDs in comparison to those who did not have a previous upper extremity injury.²⁴ A study investigating the effects of previous injuries on MSDs among ironworkers showed similar results. Ironworkers who had previous injuries were more likely to develop MSDs (upper extremity OR = 4.6, 95% CI 3.1-6.8; lower extremity OR=5.1, 95% CI 3.5-7.2, lower back OR = 6.0, 95% CI 4.2-8.5).²⁵ On the other hand, aging working population is more likely to develop MSDs if prior injuries exist. The work-related MSDs are often caused by subtle, repetitive movements or postures which may be overlooked. However, the impact of such cumulative trauma is more apparent in aging population. In addition, effective return to work programs which offer ergonomic interventions, temporary alternate positions or modified work assignments are limited and difficult to implement for elder people.²⁶

Smoking may be associated with a higher prevalence of MSDs.²⁷⁻²⁹ The exact mechanism of the deleterious effects on the musculoskeletal system is complex and not fully understood. The possible etiologies are: direct toxic metabolism on bone density and indirect action on sex and adrenocortical hormones, mineral absorption such as vitamin D and calcium as well as decreased oxygen supply as a result of vascular constriction. It is also worth noting that smoking is highly prevalent in certain populations, such as manual/routine workers.^{28,29} The combined effects of the repetitive

movements and prolonged postures associated with these professions and a high prevalence of smoking put manual/routine workers at high risk for the development of MSDs.

Sedentary behavior is considered as a risk factor for MSDs. The musculoskeletal system needs regular activity to maintain its function.³⁰ A sedentary lifestyle may have negative impact on the metabolism, hormone, and molecular function that decrease the level of force that can be sustained by a muscle.³¹ If there is a sustainable loading, musculoskeletal system begins to fatigue and MSDs may occur even the force applied is subtle.³² On the other hand, regular activity can help increase bone density, allowing the musculoskeletal system to accommodate a heavier workload.^{30,32} In addition to increased bone health, exercises are an efficient method of pain relief which is a key dysfunction of MSDs.³³

1.1.3 The burden of MSDs

Pain and physical dysfunction are the two leading clinical presentations of MSDs. Pain can be caused by nerve impingement, tendonitis, tissue swelling, or psychological stress.³⁴ In the general population, the prevalence of musculoskeletal pain varies from 20.0% to 84.0%.³⁵ The differences in reports of pain prevalence are likely to be explained by different study population, study design and how pain is measured. As pain is often chronic, the accuracy of assessing first episodes is often difficult. Therefore, pain prevalence varies widely in literature. Nevertheless, lower back pain is one of the most common MSDs presenting pain.³⁵ MSDs pain is often associated with activity restriction, mood disturbance, fatigue, sleep disturbance and perceived disability.^{34,36} Mixed anxiety and depression are highly prevalent in populations with MSDs pain.^{37,38} One study shows that the prevalence of anxiety and mood disorders is 35.0% and 20.2% in populations with persistent low back pain, which is 2.0 and 2.2 times higher respectively than the general population.³⁹ Harrison and colleagues found that patients with MSDs pain have an increased risk of sleep disturbance (defined as waking up more than two or three times per week).⁴⁰ Sleep deprivation, fatigue and mood changes can aggravate the pain experience, further escalating the level of distress and dysfunction.⁴⁰

Physical dysfunctions such as weakness, stiffness, restriction of motion, and sensation changes are often associated with MSDs. These symptoms can be caused by tears of torn tendons due to acute or chronic injuries, previous scars, deconditioning due to prolonged immobilization, local inflammation or ruptured of cartilage or tendons. On the other hand, the psychological influences on MSDs can be traumatic and devastating. For example, Currie analyzed data from the Canadian Community Health Survey in over 110,000 household residents to explore the association between depression and back pain. The results suggested people with back pain were three times more likely to experience depression than those without back pain.⁴¹ It is worthy noticing that the direction of causation between psychological consequence and MSDs is uncertain, in this case, while depression may place individual at risk for development of chronic low back pain, it is certainly the case that pain can exacerbate depression, leading to chronic pain symptom.

The economic burden of MSDs remain one of most costly disease for Canadian women and third most costly disease for Canadian men in 1998, which representing over \$16.0 billion. The number increases to \$20.6 billion in 2005.⁴² In 2008, MSDs is the third highest expenditure in diagnostic categories which is following cardiovascular disease and neuropsychiatric condition.⁴³

Internationally, worldwide over the disability caused by MSDs were observed. It is estimated that annual losses approximate \$149 billion in the United States.^{44,45} In Australia, MSDs ranked as the second highest medical cost after cardiovascular disease.⁴⁶

Although most MSDs are accompanied by minor symptoms and settled spontaneously, approximately 10% of the workforce with MSDs have difficulty resuming their original work or even exit the workforce permanently.^{47 48} MSDs in workforce population is associated with a substantial financial burden to society as a whole due to temporary and permanent unemployment. In United States, over 107 million adults report MSDs and working population lost 12 days per year due to MSDs in 2005.⁴² In European Union, MSDs is estimated to affect 40 million workers and account for about half of all work-related disorders, representing an estimated cost up to 2% of gross domestic product.⁴⁹ In

the United Kingdom, 30 million work days were lost due to MSDs in 2013 according to data from national statistics.⁵⁰

In Canada, time lost in the workplace has declined both nationally⁵¹ and provincially.⁵² However, MSDs still remain the top cause of work-related lost-time claims and cost workplaces substantial amount of money from absenteeism and lost productivity.⁵³ In fact total compensation payments for injured workers have grown steadily between 2001 and 2005.⁵¹

1.2 Factors affecting return to work (RTW)

Returning to work (RTW) after MSDs is influenced by many factors including physical, psychological, economic and social factors.^{54,55}

The impact of MSDs is multidimensional. MSDs not only affects activities of daily living (ADL) but also social functioning. Work is an essential aspect of life for many people because it provides social status, financial independence and self-fulfillment. Work helps people maintain good mental health, create relationships with people from different backgrounds and most importantly, work shapes the infrastructure of society.⁵⁶

1.2.1 Physical health

Majority of the evidences show that physical function plays an important role on RTW. A recent systematic review focusing on low back pain suggested that “self-report disability”, “pain intensity” are both important prognostic factors on RTW.⁵⁷ The review which included 25 studies, mostly from industrialized countries indicated that the greater the self-reported pain and physical limitations, the slower for the worker RTW. As pain and physical dysfunction are commonly correlated, the authors also suggested pain and physical impairment should be assessed to better predict those at high risk of long duration absences. On the other hand, some researchers stated physical improvements such as restoration of strength, endurance or flexibility, appear to be minor factors when determining RTW.⁵⁸ Even though people with MSDs may be physically functional well,

they may be reluctant to return to the workforce.⁵⁸ A recent study of 92 employees with MSDs who participated in a multidisciplinary rehabilitation program showed that people who had higher levels of physical functioning were less likely to return to work.⁵⁹ One of the explanations of this discrepancy is that occupational functioning for RTW is not equivalent to physical functioning for daily activity. Occupational functioning often involves repetitive movements for longer periods of time which can either cause an old trauma to flare up, or aggravate an existing injury. For example, people with a rotator cuff injury may have no difficulty combing their hair but are unable to perform the duties of a painter which requires using their arm above their head for prolonged working hours.

1.2.2 Mental health

Psychological factors have a well-established link to work disability. As previously mentioned, pain is one of the most important presentations of MSDs. Pain causes psychological distress which in turn, aggravates the pain and consequently affects RTW. Psychological distress, such as depression and anxiety are highly associated with absence from work.⁶⁰ This finding highlights the importance of treatment for both mental and physical impairment as a result of MSDs in order to maximize the rate of RTW and retain employees in the workforce. As depression, anxiety and low self-esteem are highly prevalent in the MSDs population, the level of psychological distress may be worse than the physical dysfunction in some cases. RTW may be more heavily influenced by an individual's level of psychological distress than their physical functioning. In addition, an employee's perception of work environment and self-efficacy are also highly influential on the decision of RTW. Employees who have high self-efficacy and attitude toward work are more likely to RTW sooner.^{61,62}

1.2.3 Economic factors - Workers' Compensation

In most countries, especially industrial countries, workers' compensation systems have been well established. Workers' compensation programs protect employees from

financial hardships caused by work-related injuries. However, workers' compensation may have an adverse effect on claimants. In Canada, the workers' compensation system is "no-fault" compensation, which prohibits law suits against the employer for the work-related injury. This causes an imbalance of power between the employer and employee. Also workers' compensation claimants may have negative experiences including stigma and lack of social support.⁶³ Researchers have also found that workers' compensation is associated with less favorable outcomes such as a delay in RTW and poorer performance in work activity.^{64,65} This may be partially explained by the sociodemographic characteristics of the majority of workers' compensation recipients, who tend to be relatively younger, have lower levels of education, have a more strenuous work environment and lower levels of self-fulfillment.⁶⁶ Additional studies are needed to explore the underlying causes of the relationship between workers' compensation and RTW.

It is also worth noting that people without workers' compensation, may have more difficulty accessing physical, social and vocational rehabilitation programs unless they have some form of private insurance.^{67,68} In Canada, all residents have access to universal health care irrespective of the cause of their injuries.⁶⁹ While medical treatment is covered, those injured workers without enough savings or insurance may face financial strain if extended rehabilitation is required.

1.2.4 Work environment

A supportive work environment is not only beneficial for improved work productivity but it also reduces the time required to RTW. RTW is no longer simply considered as an individual decision, but rather a consequence of interaction between the worker and employer. A positive workplace and organizational environment such as offering work accommodations (e.g. schedule, task, equipment) and ergonomic adjustment accelerate the process of RTW.⁷⁰ Ask and Magnussen found that employers who adapt effective RTW strategies such as promoting well-being and a healthy work environment as well as providing early support and adjustment can facilitate early RTW.⁷¹ On the other hand,

unfavorable work environment delays RTW. Injured workers fear re-injury if returning to the original occupational conditioning without any modification. As repetitive movement and awkward postures are risk factors for MSDs, returning to the same work environment without appropriate modifications often leads to re-injury. Magnussen and colleagues found that study participants who had negative work experiences as well as those who reported a hostile work environment were less likely to RTW in comparison to participants who had positive work experiences and supportive work environments.⁷²

There is an increased awareness of the importance of creating favorable ergonomics in work environment by employer and other stakeholders.^{73,74} In a prospective two year cohort study done in six western countries, the ergonomic interventions were proved to be an effective intervention to RTW.⁷³

1.2.5 Social structure

Social support plays a vital role in helping people RTW. Except from workplace, the sources of support can come from family, friends or neighbours. Intimate relationships have the most beneficial effect on injured people,^{75,76} as family members are often core members of material aid, instrumental and emotional support.⁷⁷ Friends and neighbours, are also an important source of support for some people, especially to help protect against the impact of psychological stress.⁷⁸ All these support enhances the robustness of the individual to build better resilience and reduce impact of stress during the recovery of MSDs.

1.2.6 Early versus late return to work

The process of recovery for MSDs varies considerably for different people.^{79,80} It is not uncommon that for complete recovery requires to take several years.⁸⁰ Due to the long recovery process, RTW is often postponed to 6 months after injury.⁷⁹ Studies show 60% of people with minor MSDs did not observe significant improvement until 6 months.^{79,81} This finding echoes other longitudinal studies that found 20-40% people continue to experience poor physical function at 1 to 3 years post-injury.^{82,83} Therefore, employees, employers, clinicians and policymakers may use this timeframe when designing

rehabilitation programs and compensation systems. Most importantly, timely (i.e. within 6 months after injury) and effective delivery of relevant rehabilitation and settlement services to patients with MSDs should be made a priority for future policy and practice.

1.3 Gap of existing knowledge

Although there are extensive studies on the association between MSDs and RTW, most studies focus on work-related MSDs. Also, the mainly interests are restricted to a couple of topics such as lower back pain and carpal tunnel syndrome which are high prevalent in MSDs population. There are fewer studies focus on upper extremities. On the other hand, there are lack of scales in assessment of work environment, especially ergonomic system which is an important factor for MSDs development and aggravation. In Canada, as people with certain MSDs need to undergo surgery, we are interested the influence of MSDs on work status, particularly during wait times as well as the progression of MSDs during that period of time. We also feel the study on aging population with MSDs are worth investigating because not only the workforce population is aging but also this population is susceptible to MSDs.

1.4 Objectives of this dissertation

The purpose of this thesis is to provide evidence to better understand the disability of MSDs on upper limbs and identify factors to determine RTW. More specifically, a series of studies were conducted:

- 1) To identify the prognostic factors of RTW after work-related traumatic hand injuries in existing literature. Performed a systematic review to synthesize data and produce the evidence.
- 2) To evaluate the structure of a modified Organizational, Policies and Practices scale (OPP-14). Examine the additional 3 items on ergonomic component

structurally sound in internal consistency, construct validity and other psychometric characteristics by using confirmatory factor and Rasch analyses.

- 3) To identify the predictors of job changes while waiting for rotator cuff repair.
- 4) To examine the functional changes during wait times in population with rotator cuff syndrome (same sample of 3). This study is to enhance the understanding of physical functioning changes and its correlation with employment status and work efficiency.

1.5 Overview of this dissertation

Chapter 2 is a systematic review which aims to synthesize the knowledge of prognostic factors of RTW after work-related traumatic hand injuries. Social-demographics, psychological factors, injury types, worker's compensation and treatment related variables were examined. This is in line with the first objective. Chapter 3 focuses on measurement and method. It evaluates the factor structure of modified Organizational, Policies and Practices scale (OPP-14) which includes additional 3 items on ergonomic component. Confirmatory factor analysis was performed to assess the overall structure of the scale, following by Rasch analysis on 4 subscales and individual items. This achieves the second objective. Chapter 4 is a retrospective cohort study to identify the prognostic factors on job changes among rotator cuff patients during wait times to surgery, recruited from a tertiary medical center in London, Ontario. Kaplan-Meier estimates and Cox regression model were used in this study to accomplish the objective 3. Chapter 5 is a longitudinal prospective study with same population from chapter 4. The participants were assessed shoulder functioning every month up to 12 months or to surgery, whichever comes first. This study provides the useful information about patients physical functioning during wait times regardless employment status. This is in line with objective 4. Chapter 6 is a discussion section and overview of this dissertation. Also it discusses the strengths, limitations, clinical and policy implication, and future direction.

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CHAPTER 2 A SYSTEMATIC REVIEW OF PROGNOSTIC FACTORS FOR RETURN TO WORK FOLLOWING WORK-RELATED TRAUMATIC HAND INJURY

Abstract

Introduction: Traumatic hand injuries are a frequent cause of work related injuries and can result in prolonged durations of time lost from work.

Purpose: To systematically review available evidence to determine which prognostic factors predict return-to-work (RTW) following work-related traumatic hand injuries.

Methods: We searched Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL and PsychoINFO from 1980 to September 2013 and reference lists of articles. Studies investigating any prognostic factors of RTW after traumatic hand injury were included. Two reviewers performed study selection, assessment of methodological quality and data extraction independently of each other. Identified factors were grouped into conceptual prognostic factor categories.

Results: We assessed 8 studies, which addressed 11 potential prognostic factors (i.e., socio-demographic factors, occupation, worker's compensation status, treatment related factors, impairment severity, location of injury, etc.). The quality of the studies was low to moderate. Across all included studies, RTW (original or modified work) occurred in over 60% of individuals by 6 months. There was consistent low-moderate quality evidence that individuals with more severe impairments were less likely to RTW, and low-moderate quality evidence that age, gender and level of education had no impact on RTW. Evidence on other commonly cited prognostic factors were limited in the literature.

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Conclusion: Impairment severity and lower pre-injury income showed a consistent association with RTW following occupational hand injury, while other factors demonstrated no or variable effects across studies. Additional high-quality studies are warranted toward improving our understanding of the complex factors that mediate RTW following a traumatic work-related hand injury.

Level of Evidence: 2a.

Key words: hand injury, work-related, trauma, return to work, systematic review

2.1 Introduction

Work-related traumatic injuries impose a significant health and economic burden to patients and contribute to lost productivity.¹ An individual's hand is integral to many work activities and is vulnerable to work-related injuries ranging from 'simple' injuries such as isolated fractures to complex crush injuries. According to Statistics Canada,² approximately 630,000 Canadians suffered a work-related injury in 2003 and nearly 28% of all those injuries were related to the hand.

Return-to-work (RTW) following a work related injury is a complex process, which is not solely determined by physical readiness. Most countries support implementation of comprehensive rehabilitation programs to facilitate injured workers re-entering the work force. A recently published systematic review focusing on acute orthopedic trauma concluded higher level education, white collar employment, positive self-efficacy, less injury severity and lack of compensation were protective factors for prolonged work disability³. However, only one study is hand trauma.

To date, there has been no systematic review evaluating the prognostic factors following work-related traumatic hand injuries. Work-related traumatic hand injuries are characterized as serious and the mechanism of injury is typically a crush injury or amputation resulting from a worker-machine interaction. The employer, worker and health care team involved in the workers' treatment and RTW following a work related traumatic hand injury, experience the burden and consequences of these serious injuries. The lack of evidence of factors that predict RTW following traumatic hand injuries, limits health professionals, employers and policymakers from making accurate plans to accommodate the worker, or optimizing the use of resources by matching the RTW plan to the individual. Therefore, the aim of this systematic review is to determine which factors affect RTW in individuals with traumatic work-related hand injuries.

2.2 Methods

2.2.1 Search strategy and eligibility criteria

A literature search was undertaken to identify studies that assessed potential predictor(s) of RTW following a work-related traumatic hand injury. Five bibliographic databases were searched using standard medical subject headings (MeSH) and text words (search strategy is list in Appendix 1). These included: Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library Issue 11, 2012), MEDLINE, EMBASE, CINAHL and PsychINFO from 1980 to September 2013. References from previously retrieved articles and key journals relevant to this topic were hand searched for additional references.

Research articles were eligible if they met the following criteria:

1. The study participants worked in paid employment at the time of the injury, irrespective of type of employment (i.e., self-employed, public sector or private corporation).
2. The injury was work-related or was eligible for management under a worker's compensation program.
3. The injury was limited to hand.
4. The injury was defined as a traumatic work-related injury that involved bones, joints, or muscles
5. RTW was defined as return to employment (i.e. pre-injury job or modified job).
6. At least one variable was investigated as a potential predictor(s) of (RTW).
7. The study design included prospective, retrospective data collection or a cross-sectional design.

We excluded studies addressing populations with atypical employment such as military service and athletes, as the main purpose of this study was to identify factors and barriers

that delay or prevent RTW in the general employed population. We also excluded case reports or case series with sample size less than 20 because of the low quality and lack of precision of such studies. We restricted our selected studies to the English literature.

2.2.2 Study identification and synthesis

Study authors (QS and KS) independently performed the study selection, assessment of methodological quality and data abstraction. Disagreements between raters were resolved by discussion and a third reviewer (JM) was involved if disagreement remained.

Structured data extraction forms were used to extract data on the characteristics of individual studies. Information was collected on characteristics of study participants, data resource, type of injury, RTW rate and outcome measures.

2.2.3 Validity assessment

As there is no widely acceptable quality appraisal tool for prognostic studies, we developed an assessment tool (Appendix 2) specific for prognostic RTW studies. It comprises 13 items addressing the study quality of participant sampling, predictors and outcome measurement, attribution, statistical analysis, and interpretation of results derived from other systematic reviews³⁻⁶. Each question was answered "Yes", "no", or "unclear". If all items from each domain were scored 'Yes', high quality was assigned. If half of response or more items were "Yes", moderate quality was assigned. Otherwise, low quality was assigned. We decided not to calculate a summative score for each paper because we would have missed potentially important information for each item.⁷ Also this approach more accurately reflects quality of the papers⁸. As such, we reported the main quality domain rather than in the overall score.

Assessment of evidence

Levels of evidence were determined by using following rating system:

Strong evidence: consistent finding in most of studies with at least 2 of "sampling", "methodology" or "analysis" are ranked as high.

Moderate evidence: consistent finding in most of studies with at least 2 of “sampling”, “methodology” or “analysis” are ranked as moderate.

Low evidence: consistent finding in most of studies with at least 2 of “sampling”, “methodology” or “analysis” are ranked as low.

Insufficient evidence: only one study available or inconsistent findings in multiple studies.

2.3 Results

2.3.1 Studies identified

A total of 8 studies⁹⁻¹⁶ describing 11 prognostic factors were identified (Table 1, Figure 1). The most commonly investigated prognostic factors for RTW following a work-related traumatic hand injury were: age, gender, education, income, pre-injury occupation, worker’s compensation status, treatment related variables, impairment severity of injury, and location of injury. The summary of the methodological ranking for each study is presented in Table 2. Overall, studies had low to moderate quality in sampling and methodology; and moderate to high quality in analysis. Vague descriptions of the target population, lack of blinding to outcome assessor and lack of a validated outcome measure in predicting RTW were the main shortcomings contributing to low study quality. The range of average rate of return to original or modified work after 6 months across 6 studies was 57%-98%. Results of prognostic factors are presented in Table 4.

2.3.2 Prognostic factor

Age

There is low level of evidence indicated age was not a predictor for RTW. Four studies^{9-11,13} discussed how age influenced RTW. All studies suggested there was no statistically significant association between age and RTW. Among these, only two individual

studies^{10,12} reported numeric results. Those two studies identified adjusted OR scores close to 1 suggesting age was not a predictor for RTW.

Gender

There is low level of evidence indicated gender was not a predictor for RTW. Three studies^{10,11,14} investigated whether gender played a role in RTW prognosis. All studies claimed there was no statistically significant difference between gender as a prognostic factor for RTW, including two low quality cross-sectional studies^{10,11}.

Education

There is low level of evidence indicated education was not a predictor for RTW. Four studies^{10-12,15} reported that education had no impact on RTW. One study¹² categorized years of education into 3 levels while the other 2 studies used education level as a predictor. All three studies showed no statistical significance in multivariate analysis. However, two studies^{10,11} demonstrated low quality in sampling and methodology quality assessment.

Income

There is low level of evidence indicated high income promotes early RTW. Two studies^{12,15} discussed the influence of income before injury on RTW. Lee's study¹² which was conducted in Taiwan concluded people who received a higher income prior to their injury were 6.5 times more likely to RTW (Adj. OR: 6.5, 95% CI: 1.54, 27.46). Both studies^{12,15} found higher monthly salaries were associated with shorter absence durations.

Occupational Category

There is insufficient evidence of occupational category on RTW. One study¹² discussed how pre-accident job category (i.e., blue collar vs. white collar) predicted RTW following a work-related traumatic hand injury. This study found no difference between blue and white collar workers with regard to durations of time loss.

Workers' compensation status

There is moderate level of evidence indicated worker's compensation status was not a predictor of RTW. Workers' compensation claim status was evaluated as a predictor in two study^{12,15}. Both studies concluded active or denied workers' compensation status did not impact RTW.

Treatment related variables

There is insufficient evidence of treatment related variables on RTW. Two study examined the impact of treatment on the likelihood of RTW.^{13,15} Matsuzaki¹³ found that prolonged treatment delayed people from returning to their pre-injury job. On the other hand, Hu¹⁵ found that workers who received treatment solely in outpatient clinics are more likely to RTW faster.

Impairment severity of injury

There is moderate level of evidence indicated impairment severity of injury was a predictor for RTW. Seven studies¹⁰⁻¹⁶ investigated the impact of impairment severity on RTW. Three studies^{10,12,13 15,16} employed the hand injury severity score¹⁷ as a proxy measure for impairment. All studies reported that severe hand impairment and dysfunction leads to either prolonged time off or delayed return to original or modified work. However, the overall quality of those five studies was low-moderate.

Location of injury

There is insufficient evidence of location of injury on RTW. Three studies^{10,14,15} discussed whether location of injury impacted RTW. Skov¹⁴ found bone, joint and amputation injuries resulted in prolonged time off work, and Chang¹⁰ identified that injury to the dominant hand had no influence on RTW. Hu et al¹⁵ identified that type of injury was associated with absence duration where workers without skin avulsion, muscle trauma or ligament trauma were more likely to return to work.

Personal factors

There is insufficient evidence on this factor. Two studies^{11,16} considered how personal factors impact RTW following a traumatic hand injury. Chen et al¹¹ examined how

general health status scores measured by SF-36 impacted RTW. Better self-perceived physical functioning was associated with longer time to RTW; whereas poorer mental health was associated with faster RTW. Hu et al¹⁵ identified that locus of control was the strongest predictor of RTW where workers with an external locus of control were 5 times more likely to have a delayed RTW following a traumatic hand injury.

2.4 Discussion

This study results found consistent evidence that greater impairment measured as physical injury severity is associated with more prolonged time to RTW across different type of injury and occupational settings. Demographics including, age, gender, education level had demonstrated no consistent impact on RTW following a work-related traumatic hand injury. This review differed from previous reviews^{18 19} in that we focused specifically on factors that predicted RTW following work-related traumatic hand injury. While this made the findings more specific to the hand-injured population, our study findings were compromised by the small number of low-moderate quality studies upon which we could base conclusions.

Our findings are consistent with other studies^{3,15, 16-17} that also identified impairment severity as a prognostic factor. The need for greater healing and rehabilitation time following more severe injury provides a rationale for why injury severity could affect RTW.

Our findings agrees with the minority of studies that found education level has no impact on RTW^{20,21} however, the they are not consistent with the larger body of evidence that suggests a higher level of education facilitates RTW^{3,22-25}. There are many reasons why education might be a facilitator for better RTW following hand injury. Higher level of education is likely associated with higher and faster RTW rates because higher education has been associated with better treatment adherence and improved access to health and support resources²⁶. Furthermore, individuals with higher education may have occupations that are less physically demanding, involving less manual labor. Employers may be more likely to facilitate RTW accommodations for individuals with higher levels

of education or specialty training to retain their “corporate talent”. Finally, individuals with higher education or specialized training are associated with more flexible employment opportunities and successful vocational rehabilitation strategies. Vocational rehabilitation strategies are employed to identify suitable alternative occupations, when individuals are unable to return to their pre-injury employment or employer. Those with higher levels of education have more options in a retraining situation. Individuals who experience traumatic hand injuries may be less likely to return to their pre-injury employment; therefore, education level is a relevant outcome in identifying suitable work post-injury.

Our systematic review findings also support previous studies^{19,27,28} that found higher-income workers were more likely to RTW sooner compared to their low-income counterparts. It is likely that individuals receiving higher-income have access to more comprehensive treatment and support to accelerate their recovery. Furthermore, it is likely that individuals receiving higher income levels have a greater discrepancy between their work-income and injury-compensation income, which may motivate a quicker RTW. Although blue collar workers are facing higher physical demands, which may delay their RTW, they might take advantage of alternative jobs that may be more available in market if injured workers decided to re-enter the workforce. On the other hand, factors related to occupation such as union status, workplace environment, supervisor and peer relationship and job accommodation may influence RTW as well²⁹. These were not assessed in this review.

Our study found conflicting evidence regarding commonly cited predictors of RTW following a work-related injury such as age and workers’ compensation. Our study showed age did not affect RTW prognosis. This findings are in contrast to the literature which clearly demonstrate that younger age was associated with faster RTW in general orthopedic trauma³ and people who had lower limb amputation²⁷. The discrepancy between studies may be partially explained by the relatively low quality of included studies. It is also possible that age effects may interact with physical demands of occupation and jurisdiction. There are multiple, sometimes competing influences that might determine how age would affect RTW. The nature of work may be affected by

age. Older people may have less physical resources. Finally, there may be a “cohort effect” that affects attitudes around to RTW. For example, older people may have more difficulty with physical recovery, but they have a stronger return to work ethic or self-efficacy around returning prior to full recovery.

Workers’ compensation benefits are factors to affect RTW. While the worker compensation boards’ mandate is to ensure workers are supported in their RTW post injury, some studies suggest that the system encourages people to stay on benefits rather than re-enter employment^{30,31}. Our study failed to show association between workers’ compensation status and RTW, which is based on single included study.

Variations between jurisdictions in terms of compensation for work injury may have contributed to RTW rates; but with a limited number of studies it is not possible to test for such effects.

The primary limitation in our review was the limited number of studies and heterogeneity in the workplace context. Without a large pool of studies it is not possible to conduct subgroup analysis to test the impact of contextual differences. The discrepancies between our studies and some of existing literature may result from differences in characteristics of participants, methodological quality, jurisdiction, time of outcome assessment and compensation systems. Our review attempted to narrow the research question by focusing on identifying prognostic RTW factors following work-related injuries rather RTW following injuries caused by other factors, (i.e., traffic accidents or sporting accidents). This resulted in fewer studies which identified traumatic hand injuries directly related to work activity.

Overall, the methodologic quality of included studies was moderate. One of the most common shortcomings was an insufficient description of recruited participants. This is particularly problematic since occupational context is so important in RTW. Failure to provide a detailed description of the sample makes it difficult for users to determine whether a given study is similar to their population. Some cohorts are assembled on the basis of case identification of the location of injury. For example, injuries defined at a specialized upper extremity unit may be different than those from community-based

hospitals or occupational health clinics. Other cohorts could be defined on the basis of the occupational setting and include different types of injury. Since sample recruitment and characteristics of participants are important factors for prognosis, those should be clearly and accurately reported.

In terms of methodology, common flaws in study design were that the outcome assessors were not blinded to the presence or absence of prognostic factors, high drop-out rates and lack of rigorous design in the measurement of RTW. A lack of statistical power was a common shortcoming in all analyses. Few studies demonstrated either a calculation of sample size or analysis of statistical power. Given limitations in the number of studies and the methods of reporting, we were unable to complete a meta-analysis to resolve this shortcoming. Furthermore, few included studies performed interaction analysis which, as we discussed, are anticipated explanations for why some factors showed variable effects across studies.

2.5 Conclusion

Overall, our study findings suggest that low to moderate level of evidence that impairment severity is an important prognostic factor for successful RTW following a traumatic work-related injury. There are low levels of evidence that other common predictors such as age, gender, level of education have no influence on RTW although due to the limitations in the number and quality of studies it is likely that future high quality study would change the size and/or direction of the current estimated effects. Health care professionals, employers and workers including implementation of safety management programs acting on current best evidence may wish to insure that adequate rehabilitation is in place that considers hand injury severity and pull from the broader evidence-based when considering other factors that promote early and safe RTW. Additional high-quality studies are warranted for further understanding of the complex factors that impact RTW following a work-related traumatic hand injury and to provide higher quality hand-specific data.

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Table 1: Characteristics of studies included in systematic review

Author year	Place of study	Data source	Study design	Sample size	Mean age	Percentage of RTW/time off(%)	Length of follow-up (months)	Outcome definition
Skov. (1999)	Denmark	Questionnaire	Retrospective cohort	802	N/A	57	12	Duration of time off work
Matsuzaki (2009)	Japan	Medical record	Retrospective cohort	50	43	62	36	Duration of time off work
Cabral (2010)	Brazil	Medical record	Retrospective cohort	35	37	85.7	36	Self-reported RTW work
Lee (2010)	Taiwan	Medical record	Retrospective cohort	140	42.6	71.4	At least 6 months	Self-reported RTW
Chang (2011)	Taiwan	Medical record	Cross-sectional	96	40.2	97.8	Mean: 11.3	Self-reported RTW with or without job change
Chen (2012)	Taiwan	Medical record	Cross-sectional	120	35.7	N/A	At least 8 months	Duration of time off work
Hu (2013)	China	Direct interview	Prospective cohort	246	33	78.1	8	Self-reported RTW
Roesler (2013)	Australia	Direct interview/medical record	Prospective cohort	192	35.1	84.3	3	Delay RTW after 12 weeks

RTW: return-to-work

WCB: worker compensation board

N/A: not reported

Table 2: Description of quality assessment in selected studies

Author year	Sampling					Methodology							Analysis				Results
	S1	S2	S3	S4	Total	M1	M2	M3	M4	M5	M6	Total	A1	A2	A3	Total	R1
Skov 1999	Unclear	No	No	Yes	Low	Unclear	Unclear	No	Unclear	Yes	Yes	Low	Yes	Yes	Yes	high	Yes
Matsuzaki 2009	Unclear	No	No	Yes	Low	Yes	Unclear	Unclear	Unclear	Yes	Yes	Moderate	No	No	No	Low	Yes
Cabral 2010	Yes	No	No	Yes	Moderate	Unclear	Unclear	Yes	No	Yes	Yes	Moderate	Yes	No	Yes	Moderate	No
Lee 2010	No	Yes	No	Yes	Moderate	Yes	Unclear	No	No	Unclear	Yes	Low	Yes	Yes	Yes	high	Yes
Chang 2011	No	Yes	No	No	Low	Yes	Unclear	Unclear	No	Yes	No	Low	Yes	No	Yes	Moderate	No
Chen 2012	Unclear	Yes	No	No	Low	Unclear	Unclear	Unclear	Unclear	Yes	No	Low	Yes	No	Yes	Moderate	Yes
Hu (2013)	Yes	Yes	Yes	Yes	High	Yes	No	Yes	No	Yes	Yes	Moderate	Yes	Yes	Yes	High	Yes
Roesler (2013)	Unclear	no	no	Yes	Moderate	Yes	Unclear	no	Yes	Yes	Yes	Moderate	Yes	Yes	Yes	High	Yes

High quality: all answers is "Yes"

Moderate: half or more answers are "Yes"

Low: less than half of answers are "Yes"

Table 3: Potential predictor(s) of RTW from multivariate analysis

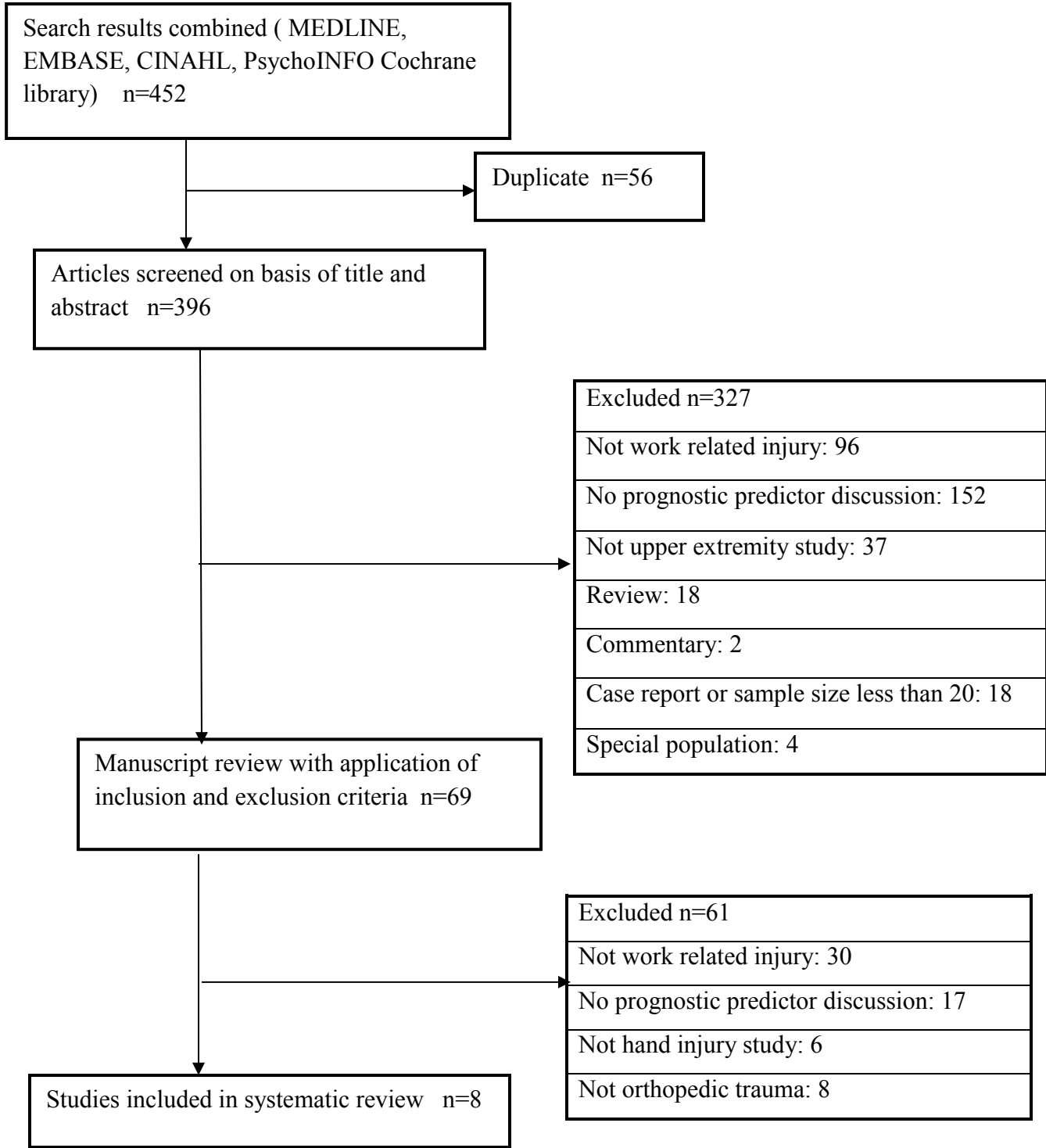
Study	Predictor(s)	Point estimates (adjusted odds ratio, 95%CI)	Association of early RTW	Evidence consistency
	Sociodemographic			
	Age			Yes
Lee 2010	Age (yr)	1.03(0.98, 1.08)	No	
Chang 2011	Age (yr)	0.96(0.90,1.03)	No	
	Gender			Yes
Lee 2010	Female vs. male	1.10 (0.43, 2.81)	No	
Chang 2011	Gender	0.18 (0.03,1.02)	No	
	Years of education			Yes
Lee 2010	10-12 vs <10	1.31 (0.42, 4.09)	No	
	≥13vs <10	1.59 (0.44, 5.79)	No	
Chang 2011	Education level	1.39(0.63,3.11)	No	
Chen 2012†	Education level	β=-1.08	No	
Hu 2013	Education level	N/A	No	
	Marriage			N/A
Lee 2010	Married vs. unmarried	1.45 (0.47, 4.44)	No	
	Income before injury			Yes
Lee 2010	≥900 USD vs.<600 USD	6.50 (1.54, 27.46)*	Higher income positive association	
Hu 2013	≤ 1000 RMB vs. 1001-2000 RMB vs. 2001+ RMB	N/A	Higher income positive association	
	Worker's compensation			Yes
Lee 2010	Yes vs. no	1.34 (0.53, 3.39)	No	
Hu 2013	Yes vs. no	N/A	No	
	Occupation			N/A
Lee 2010	Blue vs. white collar	0.88 (0.31, 2.52)	No	
	Treatment related variable			N/A
Matsuzaki 2009†	Duration of treatment	Negative correlation	Short duration positive association	
Hu 2013	Receiving treatment only at outpatient clinics	N/A		
	Impairment severity			Yes
Chang 2011	Palmar-pinch power loss Lateral pinch power loss	0.92 (0.86, 0.98)* 1.08 (1.01, 1.14)* 1.08 (0.99,1.18)	Positive association	

	Hand impairment ratio			
Skov 1999†	Impairment symptoms	1.7*	Positive association	
Chen 2012†	Modified hand injury severity score	$\beta=0.39^*$	Positive association	
Lee 2010	Hand injury severity score Moderate (21-50) vs.<mild (21) Severe (51-100) vs.<mild (21) Major (≥ 101) vs.<mild (21)	0.15 (0.03,0.70)* 0.13(0.02,0.75)* 0.07(0.01,0.36)*	Positive association	
Matsuzaki 2009†	Hand injury severity score (mean score)	Correlation $r=0.34^*$	Positive association	
Hu 2013	Hand injury severity score	N/A	Positive association	
Roesler 2013	Modified hand injury severity score	$\beta=1.66^*$	Positive association	
	Location of injury			N/A
Chang 2011	Dominant hand injured	1.86 (0.55,6.31)	No	
	Miscellaneous			N/A
Chen 2012†	Physical functioning (SF-36)	$\beta=-0.31^*$	Positive association	
	Mental health (SF-36)	$\beta=0.17^*$	Positive association	
Roesler 2013	Locus of control	$\beta=1.7^*$	Positive association	
	Negative effect	$\beta=0.19^*$	Positive association	
	Number of people in household	$\beta= -2.59^*$	Negative association	

† Time off work as outcome

* $p < 0.05$

Figure 1: Schema of systematic review



CHAPTER 3 CONFIRMATORY FACTOR AND RASCH ANALYSES SUPPORT A REVISED VERSION OF THE WORKPLACE ORGANIZATIONAL POLICIES AND PRACTICES SCALE (OPP-14)

Abstract

Background: The long version of the Organizational, Policies and Practices (OPP) had a high burden and short versions were developed to solve this drawback. The 11-item version showed promise, but the ergonomic subscale was deficient. The OPP-14 was developed by adding three additional items to the ergonomics subscale. The aim of this study is to evaluate the factor structure using confirmatory factor and Rasch analyses in active firefighters.

Methods: A sample of 261 firefighters (Mean age 42 years, 95% male) were sampled. A confirmatory factor and Rasch analyses were used to assess the internal consistency, factor structure and other psychometric characteristics of revised OPP-14.

Results: The OPP-14 demonstrates sound construct validity and internal consistency in firefighters. Confirmatory factor analysis confirmed the consistency of the original 4-domain structure (CFI =0.97, TLI =0.96, and RMSEA = 0.053). The 5 items showing misfit initially with disordered thresholds were rescored. The four subscales satisfied Rasch expectations with well target and acceptable reliability.

Conclusions: The OPP-14 scale shows a promising factor structure in this sample and remediated deficits found in OPP-11. This version may be preferable for musculoskeletal concerns or work applications where ergonomic indicators are relevant.

Keywords: organizational policies and practices; work disability; confirmatory factor analysis; Rasch analysis.

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3.1 Background

Workplace organizational policies and practices (OPPs) play a pivotal role in building healthy working environments and promoting worker health and safety. The establishment of occupational health and safety committees,¹ active return-to-work programs, early communication between injured employees and stakeholders, positive relationships between management and union and supportive employer participation² can reduce injuries and facilitate injured workers early return to work-force.³⁻⁶

A validated and feasible measure of OPP can help evaluate organizational structures and behaviors across work sectors. This can be useful for identifying areas needing improvement and response to interventions to improve worker health and safety through better OPP. For this purpose, a 95-item OPPs was initially developed by Habeck and colleagues.^{7,8} Although this measure was widely used, this many items can be a barrier to practical use. Short versions of the OPP^{9,10} have been developed based on the original and have retained the 4 -domain conceptual framework that includes: Safety Practices (SP; i.e. active safety leadership, safety training, safety diligence), Ergonomic Practices (EP; i.e. design of physical work environment and promoting use of work tools), Disability Management (DM; i.e. administrative handling of work injuries and proactive return to work programs) and People–Oriented Culture (POC; i.e. management promoting positive and supportive workplace environment).

Although the OPP-11 is the shortest version and showed some positive measurement properties,¹⁰ one drawback of this questionnaire is that only one item examines the EP. A single item is not typically a viable subscale and in the OPP-11, this was the only subscale that did not show acceptable measurement traits.¹⁰ There is a concern for valid assessment of context in occupations and workplaces where ergonomics may be a major factor in work injuries or where musculoskeletal disorders are prevalent. The ergonomic demands are extremely relevant to firefighter health and safety. For example, firefighters are required to climb ladders, carry heavy equipment and work quickly in awkward positions when fighting fires. Therefore, how the workplace deals with these exposures is an important issue. While EP is important in many contexts, we focused on firefighters as

an example of a unique context for this tool. It was also important to know whether this tool would be valid for future research in this population.

The aim of this paper is, therefore, to examine the psychometrics of a modified OPP in a sample of active firefighters. Specifically, we are interested in the internal consistency, factor structure and the measurement properties tested by Rasch analysis (i.e. Model fit diagnostics, differential item functioning, unidimensionality, local independence and targeting). We hypothesized that the OPP-14 would retain the integrity of its original domain structure, fit the Rasch model with minor adjustments and demonstrate adequate performance of all four subscales with the enhancement to the EP subscale that we have proposed.

3.2 Methods

Development of the OPP-14: The second author (JMD), with permission of the developer revised the EP subscale considering items from the original long version, the literature on ergonomic factors that contribute to work-related injury and our experience with injured workers. Posture, force and repetition are the three major ergonomic risk factors – particularly for musculoskeletal disorders.¹¹ Two items were modified from items that were in the long version of the OPP,^{7,8} and posture was added as a new item given its importance in musculoskeletal disorders. Adding three items to the EP of the OPP-11 resulted in an OPP-14 with the items listed in Appendix 1. (“1. Jobs are designed to reduce heavy lifting.” 2. “Jobs are designed to reduce repetitive movements.” 3. “Jobs are designed to reduce awkward positions/postures.”) Conceptually, the OPP-14 incorporates the same 4 major domains: safety practice (SP: 3 items), ergonomic practices (EP: 4 items), disability management (DM: 5 items) and people-oriented culture (POC: 2 items). All scale items retain a 5-point Likert scale scoring of responses, ranging from strongly disagree (score=1, lowest), disagree (score=2), neutral (score=3), agree (score=4), and strongly agree (score=5, highest). The higher scores indicate a favorable level of organizational policy and practices to worker safety. The total scores of

OPP-14 and each subscales are composite scores that are calculated by all items with the range from 14-70 for total score.

3.2.1 Participants

From January to December 2012, firefighters across Hamilton, Canada were surveyed. The Inclusion criteria were: 1) active firefighters in the Hamilton District 2) fluent in English. From a total of 300 eligible firefighters, a research assistant collected demographic characteristics, years of service and rank, and the OPP-14 questionnaire on the 281 firefighters who consented to participate.

3.2.2 Data analysis

Data were entered and a random subset of the sample was examined against original records to identify data entry errors. No data entry errors were identified and this dataset was used for all descriptive and analytical statistics. Then confirmatory factor and Rasch analyses were used to explore the measurement properties of the OPP-14. All analyses except CFA and Rasch were conducted by SAS (version 9.3, SAS Institute Inc, Cary, NC, USA). We used IBM SPSS v20 Amos statistical software for confirmatory factor analysis. Rasch analysis was performed using RUMM 2030 software (RUMM laboratory Pty Ltd, Duncraig, WA, Australia). The weighted least squares method of estimation was used for continuous variables. If there were less than 3 missing items, we replaced missing data with the mean score. If more than 3 items or demographic related variables were missed in the questionnaire, the data were excluded from this analysis.

3.2.3 Scaling properties

Score distributions were tested by Shapiro-Wilk test.¹² Floor/ceiling effects, determined answers >15% of scores at minimum or maximum scale/subscale were also assessed.¹³ Internal consistency was evaluated by Cronbach's alpha, where >0.7 is considered as a minimum.^{14 15}

Initially, CFA was applied to verify the factorial validity/dimensionality of the OPP-14. Once the factor structure is established, Rasch analysis was applied for each defined

subscale to further detail item-level psychometric properties towards the goal of optimizing the scoring structure to meet interval scaling expectations.

Conducting both CFA and Rasch together was useful as allowed us to confirm findings on OPP-14 and complement the results of a single analytical approach. CFA is necessary to confirm the dimensionality of the OPP-14 while Rasch approach further explores psychometric aspects of each individual item such as appropriate ordering of the response options, differential item functioning (DIF), and the assumption of local independence. We feel, if the results from confirmatory factor and Rasch analysis are comparable, it will strengthen our conclusions.

3.2.4 Confirmatory factor analysis

For CFA analysis, we examined our proposed 4-domain model. We considered the 14 items from the questionnaire as first-order factors (indicator variables), and the four conceptual domains (SP, EP, DM, POC) were tested as second-order factors (latent variables). All parameters were freely estimated (derived from the analysis) and indicators were allowed to cross load (represent multiple latent variables).

We evaluated the model fit with a number of goodness-of-fit statistics including Root Mean Square Error of Approximation (RMSEA<0.06), chi-square test ($P>0.05$), comparative fit index (CFI ≥ 0.95), and Tucker Lewis Index (TLI ≥ 0.95)¹⁶⁻¹⁸. We considered RMSEA, CFI and TLI as primary statistics because chi-square is more sensitive to sample size¹⁸. We also examined modification indices to identify the potential to improve the model (overall model RMSEA decreased, if proposed modification is performed). We modified our model when it was indicated by theory and statistics¹⁹. We considered standardized coefficients (i.e., factor loadings) ≥ 0.30 ($P<0.05$) as ‘representing’ a hypothesized dimension.²⁰

3.2.5 Rasch analysis

Next, we conducted analyses against Rasch model to assess the psychometric properties of OPP-14.²¹ The Rasch model assesses the appropriateness of the response categories, the overall unidimensional nature of scales (or subscales), the potential for item reduction

and whether scales are appropriately targeted. If the data fits the Rasch model, the model is allowed to transform into a linear, interval scale in the unit of logit. A person with a higher logit value is assessed as having a higher level of ability in the construct being measured.^{22,23} We employed Rasch approach to evaluate the unidimensionality and structure of four subscales (SP, EP, DM, POC).

For the current study, we set up prior criteria to test overall fit of Rasch model.^{24,25}

- 1) The expected model is accordance of data structure to Guttman scaling (i.e. follows hierarchical ordering of items)²⁶; 2) demonstration of unidimensionality (i.e. all individual items contribute to a common latent construct)²⁷, and lack of local dependency (i.e. items within each latent construct are not redundant).^{28,29}

Details of each step were as follows:

Model fits diagnostics were assessed using a set of 3 statistics described below:

First, overall Item-trait interaction as indicated by the chi-square value was evaluated. This was an indicator to reflect invariance across the trait.²⁵ If the chi-square value is significant (i.e. $P < 0.05$ for overall model), it suggests the presence of variance across the trait for hierarchical ordering of the items, compromising the required property of invariance.³⁰ We also used category probability curves of each item to check for disordered threshold responses.³¹⁻³³ If disordered thresholds exist, it indicates respondents have difficulty discriminating between the response options provided. For example, some respondents may have difficulty differentiating “Disagree” or “Strongly disagree”. In that case, we could correct this problem by collapsing categories to a single response for disagree to improve overall fit to model.

Second, individual item-and person-fit statistics were assessed. We considered that the items and persons fitted the model if the mean was approximately zero with a SD of 1 and the residuals ranged between ± 2.5 .²⁷

Third, Person-Separation-Index (PSI) were evaluated as an indicator of ability to discriminate amongst the respondents^{29,34,35}. We used a value of 0.7 as this is a conventional minimum accepted level of PSI.

3.2.5.1 Differential item functioning

Differential item functioning (DIF)³⁶ was tested to identify the possibility of OPP-14 items operate in a different way for the underlying characteristics such as age group (<30, 30-39, 40-49, ≥50 years), years of service (<10, 10-19, ≥20 years), and job category. DIF can be assessed graphically (Item characteristic curves, ICC) and statistically (ANOVA)³⁶. Typically, two types of DIF are present: uniform DIF, where group shows a consistent systematic difference in item response whereas non-uniform, where difference varies across item responses (i.e. nonparallel set of ICC, age interacts with class interval). For this study, we considered DIF existed if ANOVA results confirmed statistical significance for residuals for class interval and above mentioned factors. Uniform DIF would be corrected by splitting the file by underlying factors while non-uniform DIF would require further analysis, that would either modify the item or discard it from the item panel.³⁷

3.2.5.2 Unidimensionality and local independence

The scale was considered unidimensional if the percentage of significant tests (i.e. outside ± 1.96 ; 95% confidence interval) was less than 5%³⁸. Four domains (SP, EP, DM, and POC) of OPP-14 were evaluated separately on unidimensionality.

Local dependence occurs when item responses are correlated not only to their trait level but also to other test items³⁹. It is also considered as a violation of unidimensionality.^{29,40} We considered that local dependence existed if residual correlation ≥ 0.3 for any pair of two items.⁴¹

3.2.5.3 Targeting

We assessed the targeting of OPP-14 by plotting person-item location thresholds distribution graph with persons distribution on the top half while item thresholds at the

bottom half. Scales with an ideal scale would present slightly more difficult to the targeted population.

3.2.5.4 Sample size estimation

Our primary hypothesized structural include factor loadings and error variances for each of the indicator variables ($n=14$), plus latent variable variances ($n=4$) and parameter estimates between latent variables and second-order variables ($n=4$). Hence, our model has 22 unknown parameter estimates required at least 110 observations for our analysis.

For Rasch analysis, sample size was determined by scale targeting. A sample size of 64 is required to estimates of person and item locations (95% confidence of locations being within 0.5 logits) for a well-target population and 144 for poorly-target one. Our sample of 281 participants met the requirement of both analyses.

3.3 Results

3.3.1 Sample characteristics

In total, 281 firefighters completed our questionnaire. Twenty people were excluded from the analysis because they were missing more than 3 items in OPP or demographic/service information. Thus, 261 firefighters were finally analyzed. The sample was predominantly male (98.5%). The mean age of participants was 42.56 years (SD: 9.77 years). The average of years' service as a professional firefighter was 14.8 years. The ranks were distributed as follows: 9 new recruits, 198 active duty firefighters, 40 captains, 10 acting captains and 4 chiefs (Table 1).

3.3.2 Scaling properties

Table 2 presents a summary of the item-level properties of OPP-14. The mean score of each item in OPP-14 was 2.40 (SD: 0.53), with no obvious floor/ceiling effects. The mean scores of four subscales ranged from 2 to 3.02. SP demonstrated a marginal floor effect where 14.7% of the sample had the lowest score. All subscales and scale achieved acceptable internal consistency ($\alpha=0.76$ to 0.89).

3.3.3 Factor structure

The Initial second-order model did not initially achieve adequate model fit criteria ($\chi^2=210.80$, $df=73$, $P<0.001$, $CFI=0.92$, $TLI=0.90$, $RMSEA=0.085$). Modification indices suggested overall model fit would be improved if the two pairs of scale items in DM were allowed to be correlated and “Purchase” item cross-loaded to SP domain. After we applied these modifications, goodness-of-fit statistics demonstrated excellent statistical criteria ($\chi^2=121.87$, $df=70$, $P<0.001$, $CFI=0.97$, $TLI=0.96$, $RMSEA=0.053$). All standardized coefficients significantly represented a hypothesized dimension. The final second-order model is presented in Figure 1.

3.3.4 Rasch approach

A summary of model fit statistics for all Rasch analyses is presented in Table 3. The initial model demonstrated poor data fit in SP (item-trait interaction chi-square=22.04, $P<0.04$, $PSI=0.71$) and DM (item-trait interaction chi-square=43.37, $P=0.001$, $PSI=0.72$). After checking threshold maps for all items, 5 items (item “Money”, ‘Equipment’, ‘Modify’ ‘RTW’ and ‘Retrain’ were disordered and subsequently rescored (detail of rescoring were in appendix 2). The chi-square of revised OPP-14 reduced and met the criteria of acceptable fit against Rasch model (SP: item-trait interaction chi-square=16.14, $P=0.06$, $PSI=0.79$; DM: chi-square=24.49, $P=0.08$, $PSI=0.75$).

There was no breach of the properties of invariance or local dependence for four domains. PSI were 0.79, 0.85, 0.75 and 0.71 for four subscales (SP, EP, DM and POC), which were all acceptable. Individual item fit is presented on Table 4. Some items were demonstrated to be located in the either low or high extremity of difficulty (deviated away from 0). For instance, item ‘flexible’ presented possible misfit as fit residual exceeded 2.5. However, this was not a serious concern given that the P -value was insignificant. [24,25]

We found no evidence of either uniform or non-uniform DIF associated with age, service year or ranking except for the items ‘modify’ and ‘cooperative’. The ‘modify’ item

(“Company modifies jobs and provides alternative jobs to help injured workers return to work”) presented non-uniform DIF for age which indicated there were differences among age groups in response to item but this difference could not be adjusted (i.e. senior firefighters scored higher). On the other hand, uniform DIF of the ‘cooperative’ item (“Working relationships are cooperative”) suggests firefighters with different age and service year groups responded differently.

Distribution of item location estimates (item ‘difficulty’) and person location estimates (person ‘ability’) is presented in Figure 2. Item location was centered at mean of zero, which was higher than mean person location (mean=-1.15, SD=1.38). Therefore, it suggested the OPP-14 well targeted to our study population.

3.4 Discussion

We found OPP-14 demonstrates promising psychometric properties in working firefighters with robust factor construct and internal consistency. Confirmatory factor analysis confirmed the consistency of the original 4-domain structure. The OPP-14 with an additional three items to the EP performed well in comparison to previous “short-version” studies (OPP-20, [9], OPP-18, [44] OPP-11[10]) in that it demonstrated a sound structure, and provided a better evaluation of the EP component. Thus, this version seems to have an optimal balance between respondent burden and rigour of measurement.

Further, the fact that the Rasch analysis indicated it was well targeted is important given the unique nature of firefighting in terms of the way that workplace policies are enacted, the extent to which exposures can be controlled and the overall health of the workforce.

Our proposed modification were based on prior studies and the fact that ergonomic factors are fundamental to primary and secondary prevention of musculoskeletal work-related disorders, and a large proportion of work disability relates to these disorders.^{42,43} This is certainly the case in firefighters.^{44,45} Therefore, we considered its importance to insure that this domain was adequately measured in future research.

The selection of the three new items combined prior work on the OPP and theoretical underpinnings. The main exposures of concern are force, repetition, and posture; and the ergonomic practices of interest would include reduction of these exposures where possible. Three of the items relate to exposure reduction, but do not specify the methods that indicate exposure reduction is a priority for the organization. The unique aspect of the equipment purchase item, is a specific action the organization might take to mitigate ergonomic risks. Thus, it might be more clearly linked to the construct or organizational policies and practices. Equipment might be a very salient issue in firefighter safety given that they rely on protective equipment. The three new items added to EP demonstrated slightly higher mean scores (3.0-3.2) to the original single EP item 'Repetitive' which is 2.8, suggesting that the items we added were of importance in our sample. The overall mean of EP score of our study is 3.0 (SD=0.77) is consistent with that of other studies [2,9,45] (mean=3.1, SD=1), suggesting our findings are generalizable. Rasch analysis suggested the four EP items had similar item locations which mean our respondents considered these questions at the same 'difficulty' level compared to others. The strength of our study is that we expanded the EP domain with additional items providing better representation of variations in EP which might help differentiate different work sectors or areas requiring attention. We modified two of these items from the full OPP and created a new item on posture as we know that load, repetitive and posture are the three main risks factors for musculoskeletal disorders;⁴⁶⁻⁴⁸ and that organizational ergonomic practices should ideally consider all three in job design.

Our confirmatory factor analysis suggested item "purchase" was cross-loading both SP and EP. This cross-loading has not been previously reported and may reflect the unique context of firefighters since personal safety equipment in firefighters is critical to protection, but also imposes a hazard given that the equipment is heavy (high packs weight 50 lbs). Thus, we think it may not be overly concerning that the cross-loading occurred in our sample. We believe overall our results suggest that our modification to an OPP-14 was successful.

Our CFA analysis suggested POC contributed the most to OPP while DM is the least. This may be generalizable or reflect the unique context of our research. Firefighters

typically share a clear and common vision of their work, are team-oriented and stay in the same district for their career suggesting that social constructs of work are very important.⁴⁹ Further, since our sample included active firefighters they may have had less exposure to the disability management in their workplace and thus be less able to judge whether these policies and practices are in place.

To further evaluate the psychometric of OPP-14, we conducted Rasch analysis. We found our sample responded differently on 'cooperative' by age and number of service years. As age and number of years of service are correlated, it is difficult to know which one is the primary driver for this difference. We assumed that the number of years of service year might have an impact on people's conception on 'cooperative' since team bonds may take time to form. The need for, or willingness to accept, help with heavy tasks may increase with experience. Age-related changes to the musculoskeletal system may also be a factor since firefighters may require more assistance as they age. There is also a relationship between years of service and role within the fire service. More senior roles may be more likely to support the importance of a cooperative environment in the workplace, if management is within their responsibility. Thus, it might be differences in the occupational roles (managers versus frontline firefighting) that underlie the differences we observed.

Our study had some strengths, the power was adequate, the use of a single fire service reduced variation due to context and we had an occupational context where the constructs were relevant. On the other hand, our study had limitations that should be considered. Firstly, since our sample was restricted to firefighters, the results may not be generalizable to other work contexts. Secondly, we did not validate the scale against external criteria such as such as return to work, injury prevention etc. and these are important aspects of evaluation. Thirdly, the 2-item POC can only establish a single correlation which may not adequate to assess factor loading on the factor.⁵⁰ Last, the newly added EP subscale used repetitive wording like "Jobs are designed to reduce...", This may be a strength if it allowed respondents to focus on the key concept within each statement, or a negative factor if the similar structure inflated internal consistency between these items.

In conclusion, we developed and cross-sectionally evaluated an optimized 14-item version of the OPP. It is also worth pointing out that the scale measures an individual's perceptions of organizational efforts to maintain health and safety in these four domains and many not reflect actually policies and procedures; or differentiates excellent practices in challenging situations from inherently less risky work. Further testing and assessment of predictive and discriminative validity across different contexts is recommended.

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Table 3 Demographic characteristics of participants in OPP-14 (N=261)

Demographic characteristics	
Age by years (mean, SD)	42.6(9.8)
<30yrs (n, %)	35(13.4)
30-39yrs (n, %)	61(23.4)
40-49yrs (n, %)	92(35.2)
≥50yrs (n, %)	73(28)
Sex	
Male (n, %)	257(98.5)
Female (n, %)	4(1.5)
Years of service (mean, SD)	14.8 (10.2)
<10 (n, %)	97(37.2)
10-19 (n, %)	50(19.2)
≥20 (n, %)	114(43.7)
Ranking	
New recruit (n, %)	9(3.4)
Firefighter (n, %)	198(75.9)
Captain (n, %)	40(15.3)
Acting captain (n, %)	10(3.8)
Chief (n, %)	4(1.5)

Table 4 Descriptive statistics of the OPP-14, Scaling Properties and Internal Consistency (n=261)

Scale	Item	Item mean(SD)	Median	Subscale mean(SD)	Floor%	Ceiling%	Cronbach's alpha at subscale level
Safety practices (SP)	Money	1.92 (0.72)	2.00	2.00(0.64)	14.6	0.8	0.79
	Equipment	2.03(0.81)	2.00				
	Unsafe	2.05(0.76)	2.00				
Ergonomic practices(EP)	Purchase	2.82(1.04)	3.00	3.02(0.77)	1.9	1.5	0.86
	Lifting	3.07(0.90)	3.00				
	Repetitive	3.02(0.81)	3.00				
	Postures	3.16(0.88)	3.00				
Disability management (DM)	RTW	2.12(0.77)	2.00	2.15(0.57)	4.6	0.4	0.77
	Duration	2.47(0.85)	3.00				
	Modify	1.79(0.74)	2.00				
	Flexible	2.02(0.75)	2.00				
	Retrain	2.34(0.78)	2.00				
People oriented culture	Cooperative	2.17(0.76)	2.00	2.40(0.79)	9.6	0.4	0.76
	Voice	2.62(1.00)	3.00				
OPP-14	Full version	-----	2.42	2.40(0.53)	1.1	0.8	0.89

Table 5 Summary fit statistics of OPP-14 (n=261)

Subscale	Analysis	Item fit residual		Person Fit residual		Item-trait interaction		PSI
		Mean	SD	Mean	SD	Chi square	P value	
SP*	Initial	-0.42	0.43	-0.2	1.23	22.04	0.04	0.71
	Final	-0.31	0.72	-0.46	1.03	16.14	0.06	0.79
EP	Initial	0.25	1.09	-0.41	1.23	15.62	0.07	0.85
DM⁺	Initial	-0.2	1.36	-0.51	1.09	43.37	0.001	0.72
	Final	-0.3	0.72	-0.46	1.03	24.49	0.08	0.75
POC	Initial	-0.18	0.90	-0.38	1.26	9.73	0.14	0.71
Ideal measure		0	1	0	1	Small	>0.05	≥0.7

SP: safety practices; EP: ergonomic practices; DM: disability management ; POC: people oriented climate

* rescored item 'Money' and 'Equipment'

+ rescored item 'Modify' 'RTW' and 'Retrain'

Table 6 OPP-14 item-fit statistics (n=261)

Item	Location	SE	Fit residual	DF	Chi Square	DF	P
<i>SP- a. Money</i>	1.98	0.10	-1.44	248	3.36	3	0.34
SP- b. Equipment	0.32	0.09	-0.44	248	0.39	3	0.94
SP-c. Unsafe	0.77	0.10	-0.96	248	0.83	3	0.84
EP-d. Purchasing	-0.91	0.08	-0.98	248	2.09	3	0.55
<i>EP-e. lifting</i>	<i>-1.43</i>	0.09	-0.52	248	1.91	3	0.59
<i>EP-f. Repetitive</i>	<i>-1.54</i>	0.10	0.49	248	1.15	3	0.77
<i>EP-g. Postures</i>	<i>-1.76</i>	0.09	0.35	248	3.08	3	0.38
DM-h. RTW	0.32	0.10	0.81	248	3.20	3	0.36
DM-i. Duration	-0.15	0.09	-0.29	248	9.05	3	0.03
DM-j. Modify	0.79	0.11	1.41	248	2.06	3	0.56
<i>DM-k. Flexible</i>	1.77	0.10	4.30	248	4.12	3	0.25
DM-l. Retrain	0.05	0.11	1.81	248	6.06	3	0.11
POC-m. Cooperative	0.43	0.10	-0.44	248	1.26	3	0.74
POC-n. Voice	-0.63	0.08	-0.81	248	2.69	3	0.44
Ideal measure	0	±1	±2.5	----	----	---	≥0.05

Items exhibiting high Fit residual are bolded; Items exhibiting high or low difficulty are italicized

FIGURE 1. Standardized parameter estimates for the OPP-14 factor structure model.

Rectangles represent the scale items and ellipses represent the proposed factor constructs. Values on the single-headed arrows leading from the factors are standardized factor loadings. Values on the curved double-headed arrows between rectangles are correlations between error terms. Values on the curved double-headed arrows between ellipses are correlations between latent variables.

SP: safety practices; EP: ergonomic practices; DM: disability management; POC: people oriented climate

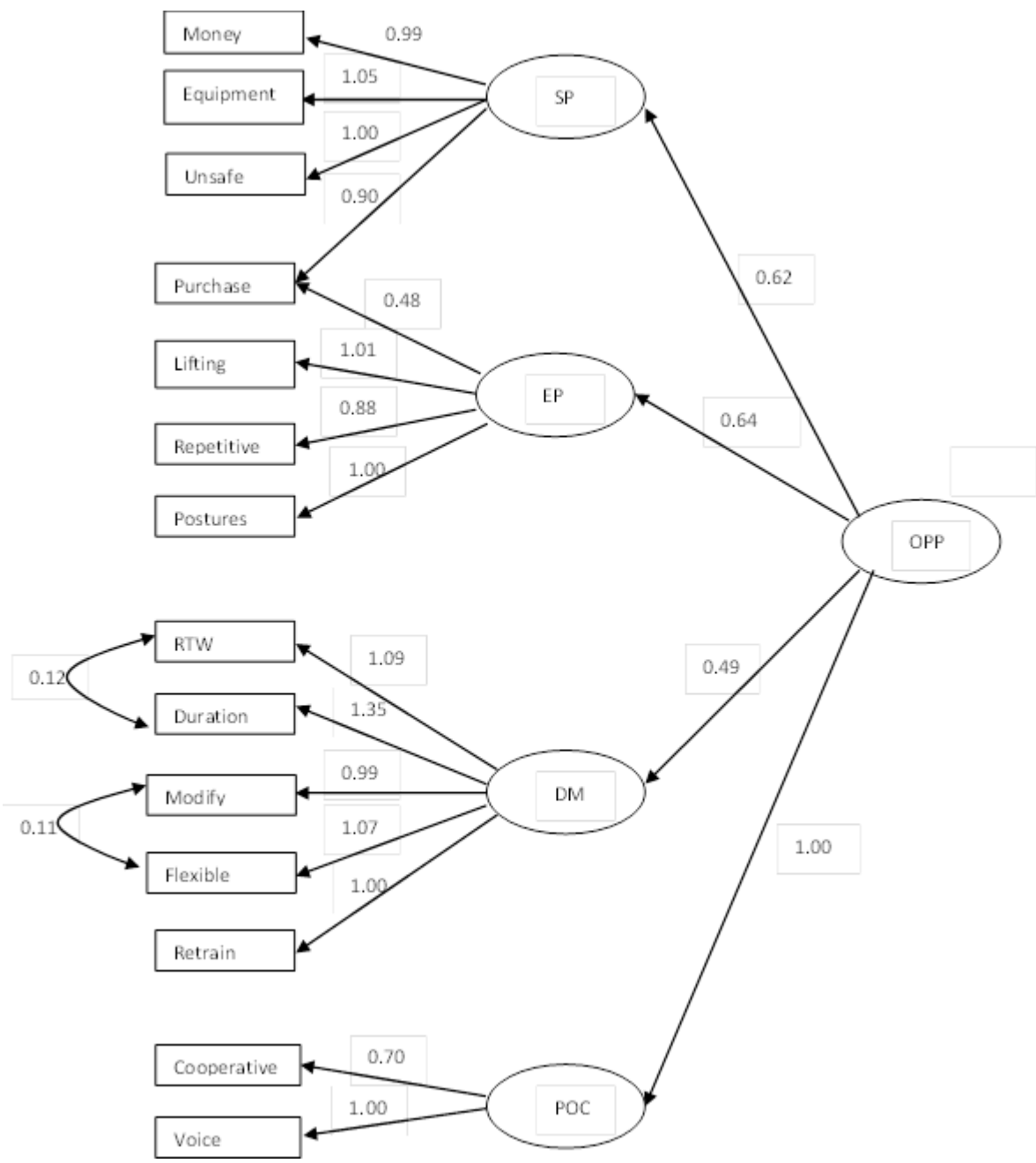


Figure 2 Person and item location parameters of OPP-14 in 261 firefighters

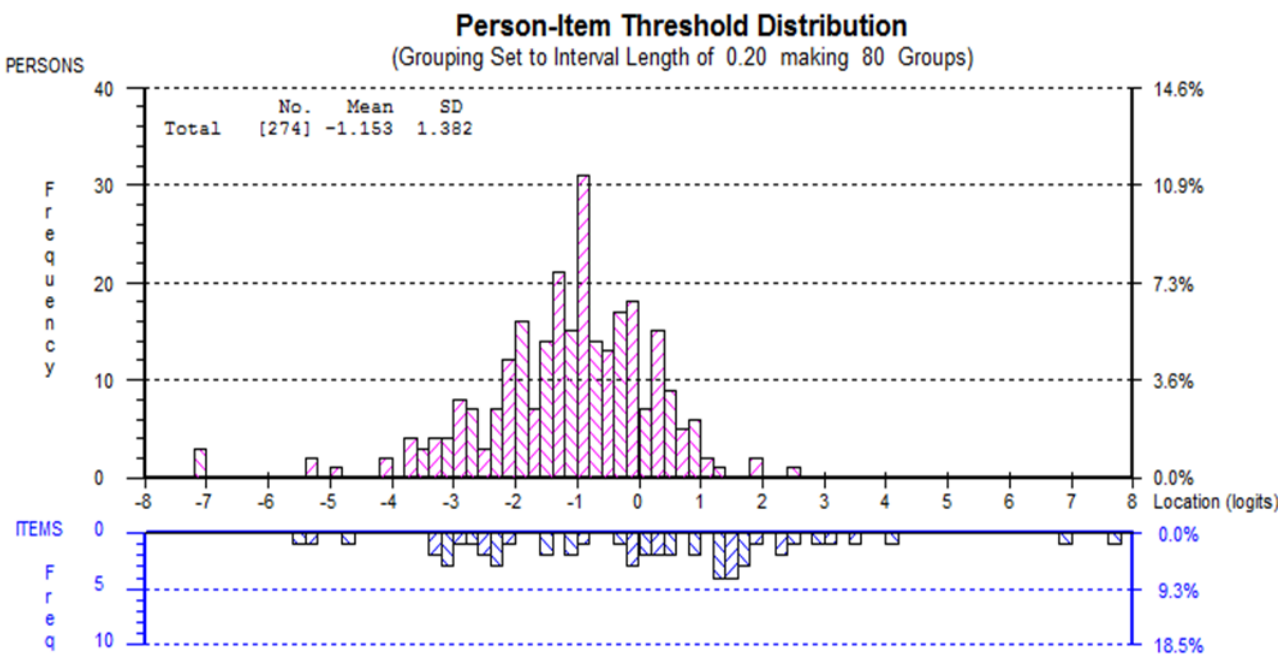
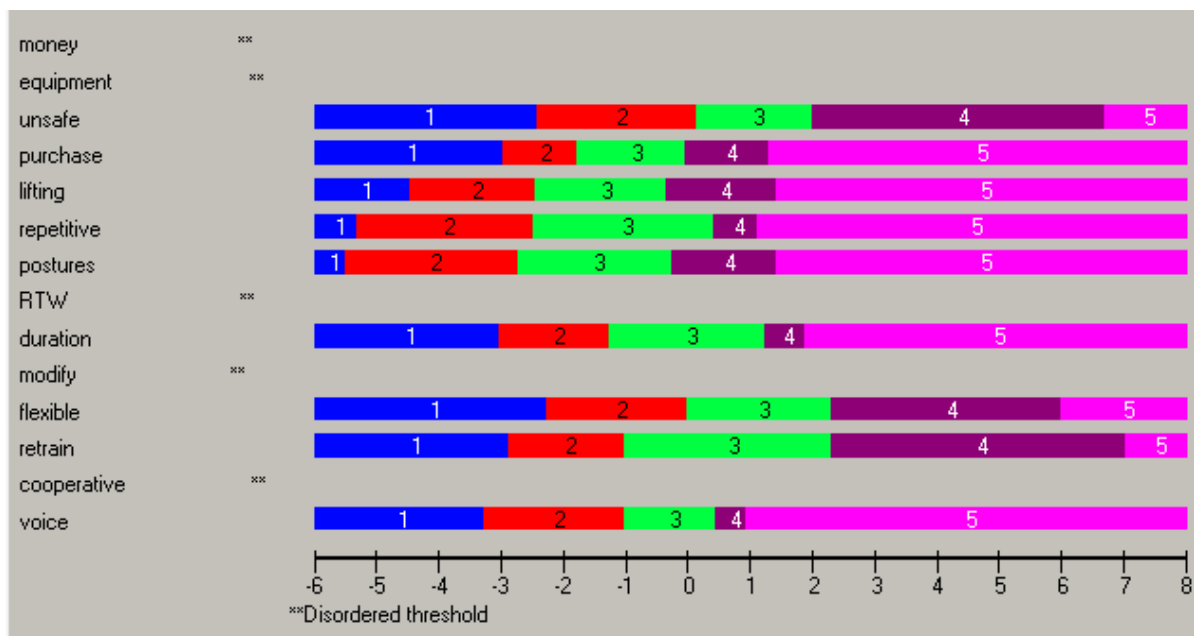


Figure 3: Threshold maps for 5 rescored items

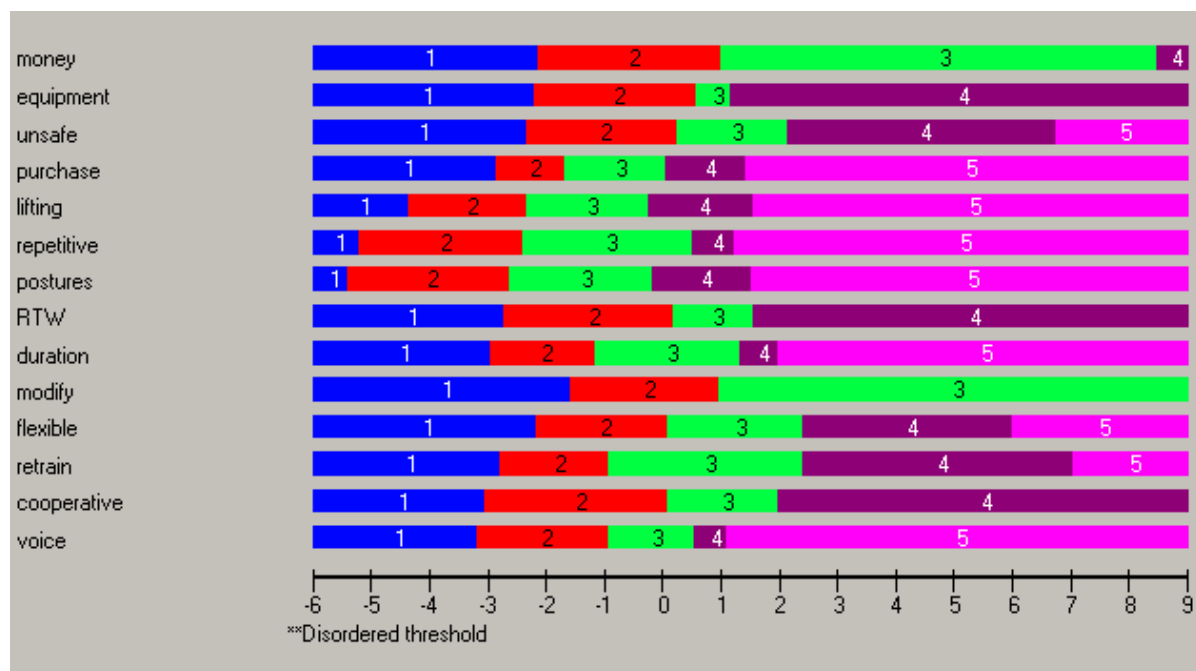
Initial threshold map:



Rescoring;

Item	Scoring
Original	1 2 3 4 5
Money	1 2 3 3 4
Equipment	1 2 3 4 4
RTW	1 2 3 4 4
Modify	1 2 3 3 3
Cooperative	1 2 3 4 4

Threshold after rescaling



CHAPTER 4 EMPLOYMENT STATUS CHANGES DURING WAIT TIMES AMONG PATIENTS WITH ROTATOR CUFF TEARS

Background: Rotator cuff tears are common problems that often require surgery. In Canada, there are often wait times for orthopaedic consultation and surgery. The objective of this study is to evaluate self-reported work status changes while waiting for surgery. A secondary purpose was to determine whether organizational policies and practices were viewed differently in those who changed jobs.

Methods: A retrospective cohort study was conducted in a tertiary hospital in London, Ontario, Canada. On the first surgical consultation, participants were asked whether there was an employment status change since the injury. Participants also were assessed for flexion, abduction and extension range of motion, shoulder external rotation isometric strength. Self-reported shoulder function and workplace health and safety questionnaires were also administered. Cox regression model was used to identify the predictors of job changes that occurred during wait-times.

Results: A total of 101 patients (average age 60.7 year; 66 male) with rotator cuff disorders were recruited at first pre-operation surgical consultation. Nine participants reported job changes. The median time of job changes was at 167 (SD: 3) days. Patient receiving WSIB benefits had increased risk of job changes: hazard ratio 0.004, (95% CI: 0, 0.47, P=0.02). Their job changes were both more often and earlier: 39% of the WSIB cases changed their job, at a mean of 138 days; while 3% of the Non-WSIB cases changed their job at a mean of 162 days. There was a trend that people of older age were less likely to changes jobs: hazard ratio 0.74 (95%CI: 0.54, 1.02, P=0.06).

Conclusions: Success of WSIB in helping injured workers retain in workforce. Early stage conservative therapy especially within 6 months can improve the outcome of rotator cuff symptom and minimize the exit from workforce.

Keywords: rotator cuff, time to surgery, employment changes

4.1 Introduction

Rotator cuff is a group of muscles and tendons involved in shoulder stabilization and movement. Progressive degeneration due to aging, repetitive overhead activity, traumatic injury and development of bone spurs in the bone around shoulder are common causes for rotator cuff tears.¹ Rotator cuff tears are common in general population with the incidence between 5% to 40%.²⁻⁴ Patients with rotator cuff deficits often suffer from persistent pain and weakness of the affected arm. The physical dysfunction may compromise occupational performance especially for those jobs requiring prolonged overhead motions. Painters, carpenters and laborers workers with rotator cuff tears are more likely to change their jobs due to impaired shoulder function.⁵

Although mild and chronic tears can be treated conservatively, a significant number of patients need to undergo surgery eventually.⁶ In Canada, although the length of wait times for rotator cuff tears can vary across the provinces depends on the urgency of surgery and availability of resources, some Canadians have to wait more than 15 months to receive the surgery.^{7,8} However, few studies have investigated the influence of rotator cuff injury on work status, particularly during wait times. Therefore, the aim of this study is to evaluate self-reported work status change during the wait time interval between the injuries to surgical consultation on patient with rotator cuff tears. A secondary purpose was to evaluate how these jobs were perceived by assessing differences in perceptions of organizational policies and practices between those who changed jobs and those who did not.

4.2 Methods

4.2.1. Participant selection

We conducted a retrospective cohort study between January 2003 and April 2008 at the Hand and Upper Limb Centre (HULC), London, Ontario. Ethics approval for the study was provided by the Western's Research Ethics Boards.

Patients met following inclusion and exclusion criteria were approached by research assistant at their first visit to HULC: Inclusion criteria: (1) Referrals to the HULC with a suspected or proven rotator cuff tear; (2) Age between 18-70 years old; (3) Employed as full time, part-time employee before injury. Exclusion criteria: (1) Inability to complete testing and questionnaires; (2) Major medical illness, psychiatric disorders, cognitive impairment, or other health condition which precludes initial and follow-up assessment; (3) Refusal to attend the study.

4.2.2 Baseline assessment

The patient's age, gender, dominant hand, causes of rotator cuff tears, whether WSIB case, self-reported medical history and length of time referral from general practitioner to HULC were recorded at first visit to HULC. Occupation and employment status were determined by patient self-reported status before the injury. Patients were interviewed directly asking whether and when job changes after injury during the first visit to HULC ("Have you changed your job because of your present problem?" "If Yes, when?").

4.2.2.1. Clinical assessment:

Once participants consented to the study, measurements of shoulder flexion/abduction/extension and rotation range-of-motion (ROM) were assessed by a trained research assistant using standard goniometry.⁹ Strength measures on external rotation were taken with a LIDO Active Isokinetic Multi-Joint Dynamometer by Loredan Biomedical (West Sacramento, CA). This system has been proven to be a valid and reliable to test ROM.^{10,11} Both arms were tested. The deficit of flexion/abduction/external rotation ROM and external rotation strength impairment were calculated as a ratio using the ROM/strength on the affected arm divided by unaffected arm to adjust the heterogeneity across individuals.

4.2.2.2 Instruments

Western Ontario Rotator Cuff (WORC) Index: The WORC questionnaire is a 21-item quality-of-life scale that focuses on rotator cuff pathology. The items are scored on a visual analog scale and are presented in 5 subscales that focus on physical symptoms,

work, recreation/sports, lifestyle, and emotional context. The total score, ranges from 0-2100, is computed by adding up five individual subscales. Higher score of WORC reflects more severe dysfunction. The reliability and validity and implementation have also been published.^{12,13}

Organizational policies & practices questionnaire 11-item version (OPP-11): The OPP-11 questionnaire¹⁴ is a short version of OPP-20¹⁵ which measures organizational structures and behaviors towards occupational health, safety and attitude to injured workers. The scale includes four components: safety practices (safety leadership, training and diligence), ergonomic practices (physical work environment design and work tools promoting use); disability management (work injuries administration and return to work program activation); and people oriented culture (positive and supportive workplace environment to promote occupational health and safety). It has 11 items, each with a 5-point Likert scale. The total score (ranges 11-55) is computed by adding up five individual subscales. A higher OPP-11 score reflects a better occupational environment.

4.3. Data analysis

Descriptive statistics were obtained for all variables. We conducted following analyses: 1) We analyzed the difference in demographics, ROM and muscle strength, WORC score, OPP-11 and WSIB status compared people with job changes to those without job changes, using student t-test for continuous variables and Chi-squares for dichotomous variables; 2) Kaplan-Meier estimates were constructed and log-rank test used to compare the group with WSIB claims to those without claims on the time of job changes, which is defined by the time of injury to first visit to HULC; 3) Multivariable Cox regression was performed to identify the following covariates: age (continuous variable), gender (male vs. female), WSIB (yes/ no), WORC score (continuous variable), and OPP-11 score (continuous variable) to predict job changes. We used SAS (version 9.3, SAS Institute Inc, Cary, NC, USA) for analyses.

4.4 Results

The study included 101 participants with an average age 60.7 (SD: 6.9) years; approximately 2/3 were male (n=66). Forty-one participants (41%) stated their work required the use of the arms (e.g. farmers, factory workers, construction workers or hair stylists) while 56 (55%) were categorized as mental workers (e.g. managers, administrators). There were 18 WSIB cases. The mean score of OPP-11 was 27.8, which was half of the maximal possible score. This may reflect relatively safe occupational environment. The average time from family physician referral to surgery consultation at HULC was 166 (SD: 120) days. Nine people had changed jobs since general practitioner referred.

Overall, the participants in our sample demonstrated moderate to severe self-reported functional impairment and objective physical dysfunction. The average of baseline WORC was 1042 out of 2100. The flexion, abduction and external rotation ROM ratio were 65%, 72% and 66% whereas the external rotation strength was about sixty percent of normal range.

Compared to job retainers, job switchers were more likely to have poor shoulder function, have a better working environment and be a WSIB case. However, as only nine participants reported job changes, the actual difference between two groups may be underestimated. A detailed comparison job switchers and job retainers is presented in Table 1.

The median time of job changes was at 166.7 (SD: 2.9) days. Probabilities of a patient remaining at their original job are 95% at 100 days, 90% at 155 days, 85% at 174 days, respectively. For the 18 cases who claimed WSIB benefits, 7 (39%) changed their jobs, at a mean job change time of 138 days. For the 59 non-WSIB cases, 2 (3%) changed their jobs at a mean job change time is 162 days. Plot of survival estimates by WSIB status was presented in figure 1.

The result of the cox regression analysis was represented in Table 2. We found that only WSIB status was associated with job changes. Participants without WSIB involvement

had a 99% decrease in the hazard rate for job changes compare to the reference group who had a WSIB case (hazard ratio 0.004, 95% CI: 0, 0.47). Also, we found there is a trend that participants of older age were less likely to change jobs, hazard ratio 0.74 (95% CI: 0.54, 1.02, P=0.06).

Participants who changed jobs had a higher OPP score reflecting a more positive view of their workplace policies (36/55 versus 26/55, p<0.01).

4.5 Discussion

In current study, we found that WSIB status was associated with earlier and higher odds of job changes. Overall, 9% of the participants in our sample experienced work change at a median time of 5.5 months. The majority of these changes occurred in the WSIB group, and only WSIB status was statistically significant as a predictor. However, older age was very close to achieving statistical significance (p=0.06).

The change in work role status for workers with upper extremity injuries has been addressed in only a few studies. Tang conducted a study on injured workers with chronic work-related upper extremity disorders in Toronto, Canada.¹⁶ Among 280 individuals who completed the study, 22% had transitioned out of work by the 3 month follow-up, and 11% at 6 months. Another larger observational study focused on upper limb muscular disorders in France showed 21% work cessation rate at the end of fifth year¹⁷. Our job change rate at 6 months is 9 percent, which is lower than Tang's study, but higher than Sérazin's. This discrepancy can be explained by differences in the demographics of the study populations, severity of shoulder dysfunction, proportion of WSIB cases and differences in the social and medical system contexts.

We did not collect precise information regarding validation of job changes, but relied on self-report. Further, we have no data on the nature of the job changes. We do not have the ability to distinguish people who quit/were laid off because of their injury from those who received appropriate modified position. Therefore, the exact cessation rate may be

lower than 9 percent. However, understanding the extent to which participants were unable to fulfill their usual work roles is important.

In our study, only WSIB status was a significant predictor for job changes. In Ontario, the WSIB system receives contributions from employers and provides compensation to employees, if the injury occurs in the workplace. WSIB coordinates the process by which injured workers, clinicians and employers work together to reestablish health productive work for individual patients. It may be appropriate to implement modified or reduced work hours for an injured worker to avoid further injury. In fact modified work has been shown as a positive predictor of retention of the work role.¹⁸ Our study showed that WSIB cases perceived better workplace organizational policies and practices despite poorer shoulder function when compared to non WSIB cases. This suggests that the job changes may have been positive, allowing an accommodation for shoulder disability. Since accommodation is a requirement for employers, even cases where WSIB is not involved should be offering accommodation. This data may suggest that WSIB performs an important function to facilitate accommodation, and that the employers who work with WSIB provide a more supportive environment to facilitate work for injured people.

We found a trend that older individuals were less likely to experience job changes. One explanation for this might be that it may take longer for older workers to find new suitable jobs, especially for those working in manual labor or manufacturing sectors. It is also possible that older individuals are reluctant to change job as they may be firmly vested in pension, and worry about the inability to retain that pension or regain similar employment. It is also possible that older individuals are working as “bridge employment” which refers to a slowdown of workload between full time employment and retirement and are happy to transition when a shoulder injury develops.¹⁹ There have been studies showing a generational effect, where older individuals are less likely to take time off work,²⁰ and thus attitudes about work role and loyalty to an individual employer may also be a factor contributing to age effects. Also, as workers approach 65 years of age, they may choose to retire instead of looking for other jobs. Other studies have suggested that people with advanced age are less likely to return to work, which

would involve some of the same issues as this study, although we study change in work status.^{21,22}

The strength of this study is that we conducted a time-event analysis to quantify of the time to job change for patients waiting for surgical consultation. It provides a better understanding of the work role changes experienced by participants in a common workplace injury - rotator cuff syndrome. The average 5.5 months change in work role can serve as a benchmark for employers, clinicians, work transition specialists and policy makers to determine if interventions to reduce the time to accommodate injury have been successful. Early stage conservative therapy such as physiotherapy, medication and local injection can improve the outcome of rotator cuff symptoms and minimize exit from workforce.²³⁻²⁵ In addition, our findings support the success of WSIB in helping injured workers achieve work role changes that are positively perceived. An appropriate work reallocation and work environment support can build a stronger healthy workforce and eventually be beneficial to economy.

One of our limitations is the relatively small sample size and small proportion of people who changed jobs during our observation period. This may reduce the power of the study. Further, we did not gather information regarding the nature or rationale for the job changes; nor who was the primary driver behind the changes. Thus, we cannot evaluate whether the changes were positive or negative. However, our findings comparing the OPP in WSIB and non WSIB cases suggest the possibility that the work role changes may have been to achieve accommodation to retain work role function. We may have missed some changes due to the self-report nature of our study, and the fact that job changes may have occurred prior to seeking healthcare.

In summary, our study shows a small proportion of people with moderate severity rotator cuff disease waiting for surgery will experience job changes because of their shoulder condition. People with WSIB status are more likely to change jobs and the job change was associated with higher perceptions' of workplace policies and practices. More detailed studies of how and why individuals change work roles while waiting for surgery are needed; as are interventions to optimize work role function.

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Table 7 Demographic characteristics of participants (N=101)

	Total (n=101)	Job switcher (n=9)	Job retainer (n=92)	P value
Age (mean, SD)	60.7 (6.9)	60.0 (4.9)	60.8 (7.1)	0.72
Gender (male) (n,%)	66 (65.3%)	4 (44.4%)	62 (67.4%)	0.16
Affected arm is dominant (n,%)	32 (34.4%)	2 (22.2%)	30 (35.7%)	0.71
Rotator cuff tears by injury (n,%)	67 (78.8%)	7 (78.8%)	60 (78.9%)	0.94
ROM (%)				
Flexion rotation ratio	65.2	61.8	74.7	0.15
Abduction rotation ratio	71.5	61.8	74.7	0.13
External rotation ratio	66.2	46.0	69.2	0.01*
External rotation strength vs. normal	61.2	56.3	66.4	0.18
OPP-11 (mean, SD)	27.8 (7.6)	36.4 (11.6)	26.3 (5.8)	<0.01*
WORC (mean, SD)	1042.3 (641.7)	1388.0 (345.9)	1007 (655.7)	<0.01*
WSIB cases (n, %)	18 (23.4%)	7 (77.8%)	11 (16.2%)	<0.01*

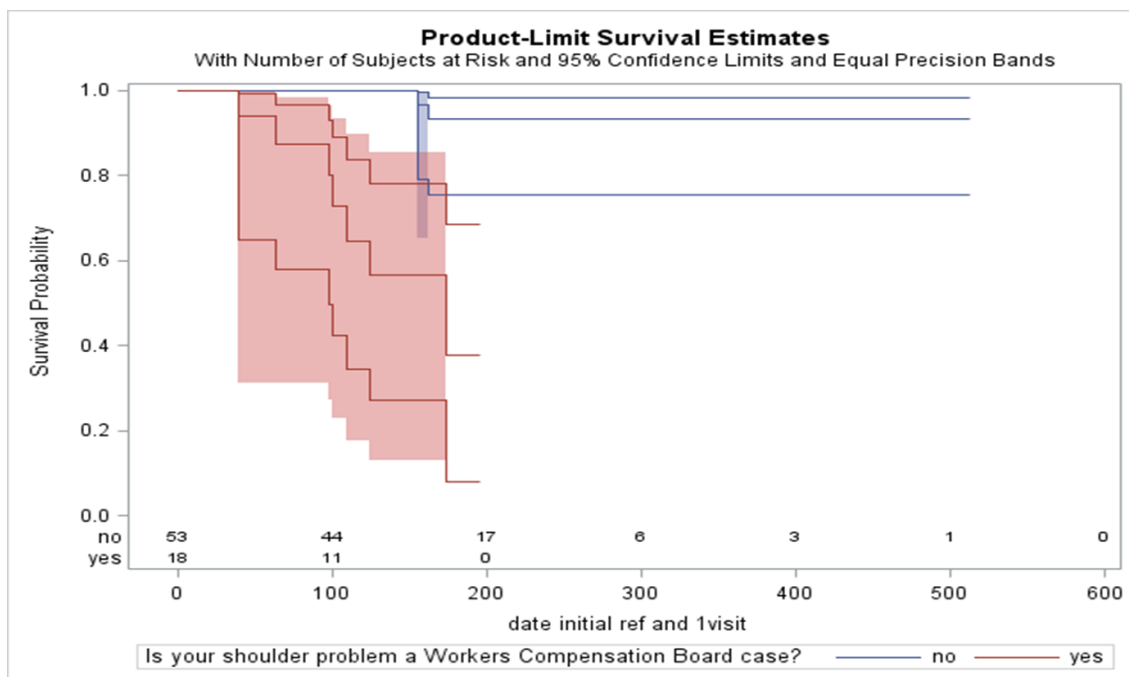
*P<0.05

Table 8 Result from Cox regression analysis (n=101)

	Hazard ratio (95%CI)	P value
Age	0.74 (0.54,1.02)	0.06
Gender (female)	5.74 (0.21, 160.42)	0.29
WSIB case	0.004 (0, 0.47)	0.02*
OPP-11 score	1.03 (0.83,1.30)	0.76
WORC score	1.001 (0.99, 1.006)	0.56

***P<0.05**

Figure 1: Comparison of WSIB cases vs. non WSIB cases on time of job changes



CHAPTER 5 FUNCTIONAL CHANGES DURING WAIT TIMES IN PATIENTS WITH ROTATOR CUFF TEARS

Abstract

Background: Rotator cuff tears are common problems that often require surgery. In Canada, there are often wait times for orthopaedic consultation and surgery. The objective of this study is to evaluate functional changes during the wait times on patients with rotator cuff tears.

Methods: A total of 135 patients (average age=65 year) with rotator cuff disorders were recruited from a surgical consultation list and followed prospectively while waiting for surgery. Participants were assessed for range of motion, shoulder strength, patient-reported pain and disability, as well as health status at baseline and 1, 2, 3, 4, 5, 6, 12 months follow-up they received surgery. Functional changes in patient-reported outcomes and strength were analyzed.

Results: The average wait times of patients to receive surgery was 154 (SD: 71) days. Patients with severe injury were more likely to undergo surgery before 3 months. The length of wait times had a minor impact on self-reported disabilities and muscle strength.

Conclusions: Surgeons are triaging patients with more severe problems to receive earlier surgical intervention and thereby mitigating the disability burden of the waiting cohort. Patients experience small further declines in function during a six-month surgical waiting time. Further studies are needed to explore earlier stage in the clinical course; and the impact of waiting on return to work.

Keywords: rotator cuff, time to surgery, functional changes, WSIB

5.1 Introduction

Rotator cuff tears are a common shoulder problem in the general population with the incidence between 5% to 40%, mostly as a result from aging and degeneration.¹⁻³ However, this rate might be underestimated as the presentation can be subclinical.^{4,5} Although mild and chronic tears can be treated conservatively, significant numbers of patients need to undergo surgery eventually. It is reported that nearly 300,000 rotator cuff operations are performed in the United States annually, and the number is increasing as the population is aging.⁶ In Canada, although the length of wait times for rotator cuff tears can vary across the provinces depends on the urgency of surgery and availability of resources, some Canadians have to wait more than 15 months to receive surgery.⁷ Wait times can occur at several transitions throughout the healthcare system including the time between patients experiencing symptoms and treatment from their family physicians, the time when patients are being managed by family physicians or physical therapists for conservative management of rotator cuff tears, the time waiting for surgical consultation and the time waiting for rotator cuff surgery. It can be difficult to determine the impact of this trajectory on outcomes. Despite multiple studies examine the impact of wait times on surgical outcomes,⁸⁻¹⁰ few studies have addressed how patients functionally change during this waiting period. The aim of this study is to evaluate self-reported and objective physical functional changes during the wait time interval between surgical consultation and surgery completed on patients with rotator cuff tears.

5.2 Methods

5.2.1. Participant selection

We conducted a prospective cohort study between January 2003 and April 2008 at the Hand and Upper Limb Centre (HULC), London, Ontario. Ethics approval for the study was provided by the Western's Research Ethics Boards.

Patients who met the following inclusion and exclusion criteria were approached by a research assistant at their first visit to HULC. Inclusion criteria were (1) Referrals to the HULC with a suspected or proven rotator cuff tear; (2) Age between 18-70 years old.

Exclusion criteria were (1) Previous surgical intervention to the affected shoulder; (2) Inability to complete testing and questionnaires; (3) Major medical illness, psychiatric disorders, cognitive impairment, or other health condition which precludes initial and follow-up assessment; (4) Refusal to attend the study.

5.2.2 Baseline assessment

The patient's age, gender, occupation, dominant hand, causes of rotator cuff tears, self-reported medical history and length of time referral to HULC were recorded. Occupation was defined based on the patient's self-reported job for the previous 6 months.

5.2.2.1. Clinical assessment:

Once participants consented to the study, measurements of shoulder flexion/abduction/extension and rotation range-of-motion (ROM) were assessed by a trained research assistant using standard goniometry¹¹. Strength measures on external rotation were taken with a LIDO Active Isokinetic Multi-Joint Dynamometer by Loredan Biomedical (West Sacramento, CA). This system has been proven to be a valid and reliable to test ROM.^{12,13} Both arms were tested. The deficit of flexion/abduction/external rotation ROM and external rotation strength impairment were calculated as a ratio using the ROM/strength on the affected arm divided by unaffected arm to adjust the heterogeneity across individuals.

5.2.2.2 Instruments

Upper extremity disability measured by the Disability, Arm Shoulder and Hand (DASH) scale^{14,15}, rotator cuff specific quality-of-life measured by the Western Ontario Rotator Cuff scale (WORC)¹⁶ and general health status (SF-12)¹⁷ were completed by the patient. The WORC is specific to rotator cuff disease and has high levels of reliability, validity and responsiveness¹⁸⁻²². The more generic regional disability measure, the DASH scale^{18-20,23} has been validated in comparison to the WORC, and the SF-12 was previously reported for rotator cuff tears population.^{24,25}

The DASH questionnaire is a 30-item questionnaire designed to measure physical function and symptoms in upper limbs. A single total score is computed, ranging from 0

to 100. The higher score reflects more severe disability. Reliability and validity are well documented.²⁶⁻²⁸ The scale has been used in patients with rotator cuff disorders.¹⁸

The WORC questionnaire is a 21-item quality-of-life scale that focuses on rotator cuff pathology. The items are scored on a visual analog scale and are presented in 5 subscales that focus on physical symptoms, work, recreation/sports, lifestyle, and emotional context. The total score, ranges from 0-2100, is computed by adding up five individual subscales. Similar to the DASH, higher scores on the WORC reflect more severe dysfunction. The reliability and validity and implementation have also been published.^{16,29}

The SF-12 is a 12-item, Likert-scaled generic health status questionnaire that is a short form of the SF-36, that can provide physical and mental health summary scores.¹⁷ The SF-12 is expected to be less responsive than upper extremity measures but may provide better understanding of general health status not directly addressed by upper extremity scales.^{30,31}

5.2.2.3 Follow-up:

Patients were re-examined at regular intervals while waiting for surgery and re-measured for external rotation strength assessment and subjective questionnaires. These were repeated every month for the first 6 and 12 months after initial evaluation.

Wait times were defined as the time between the first consultation and completion of surgery. The visiting and surgery date was retrieved from the electronic medical record.

5.3 Data analysis

Descriptive statistics were obtained on all variables. ANOVA was performed for DASH, WORC and ratio of external rotation strength to examine differences over time. We employed Generalized Estimating Equations (GEE)³² to examine the potential factors influencing objective and subjective functional changes (ratio of external rotation strength, DASH, and WORC) over 12-month wait times. We identified predictor

variables prior to the data collection that we believed those are associated with our outcomes of interest based on theoretical frameworks and clinical experience.^{19,33} The following independent variables were included GEE models: age(continuous variable), gender (male vs. female), dominated affected arm (yes/ no), rotator cuff tears by injury (yes/ no), length of waiting (days), and SF-12 physical health at baseline, which serves as a surrogate of physical health status.

We used SAS (version 9.3, SAS Institute Inc, Cary, NC, USA) for analysis.

5.4 Results

The study included 135 participants with average age 65.1 (SD: 10.0) years; approximately 2/3 were male. Forty percent of the sample was employed at the time of consultation. The average time from family physician referral to surgery consultation at HULC was 163 (SD: 112) days and wait times from surgical consultation on until completion of surgery was an additional 154 (SD: 71) days. Sixty-six participants (49%) received physical therapy before their initial surgical consultation assessment. Detailed description of demographics can be found in Table 1.

The number of participants evaluated decreased over time as participants proceeded to surgery: 135 participants at baseline, 82 completed subjective and objective assessments at the 2- month visit, 45 at the 4-month, 15 at the 6-months and 12 at 12- month visits.

Overall, participants in our sample demonstrated moderate to severe self-reported functional impairment and objective physical dysfunction. The average of baseline DASH and WORC were 41.23 out of 100 and 1248.7 out of 2100 respectively. The flexion, abduction and external rotation ROM ratio were 76%, 73% and 72% compared to normal arm whereas the external rotation strength was about one half of normal side (56%).

The functional changes during 12 months were represented in Table 2. We found a slight increase in DASH score during the first 3 months, and then a decline in the remaining group score after that point. This can be partially explained by the fact that patients with

more severe symptoms received earlier surgery leaving the healthier cohort as time went on. The further analysis of the small number of patients that remained in the study indicated no significant deleteriousness of shoulder function at 12 months (baseline DASH: 30.37, 12 month: 29.89, $P=0.85$)

For WORC and the external rotation strength ratio, there are no clear patterns of functional changes during the wait time. Although again, we observed better function at the 12 months follow-up, this was anticipated given the removal of the more impaired patients earlier for surgery. Functional changes of DASH and WORC as well as external rotation ratio were presented in Figure 1.

Identification of determinants of self-reported dysfunction and poorer external rotation strength relative to the other side were evaluated using multivariate (adjusted) GEE models as presented in Table 3. Poorer patient reported function measured by the DASH was associated with older age, dominance of the affected arm, longer wait times and poor baseline general health. Less favorable WORC scores were associated with longer wait times and poor baseline general health. On the other hand, external rotation strength deficit was only associated with the nature of the tear being traumatic rather than a gradual onset factor. Wait times were significantly associated with self-reported functional changes by 0.04/per day on the 100-point DASH (95% CI: 0.03, 0.05) and 0.08/per day on the 2100-point WORC (95% CI: 0.04, 0.12). The clinical relevance of these changes cannot be determined. No relationship was identified between wait times and external rotation deficit in this study.

5.5 Discussion

This longitudinal study found that with appropriate prioritization of surgical cases by surgeons, the length of wait times had no deleterious effects on patient's self-perceived function. No consistent impact on impairments in strength was observed. In our study, the average wait time was 5 months which accounted for approximately 6 points degradation (6%) of DASH score and 12 points (0.05%) on the WORC. These deficits were not evident when looking at the raw data, graphs or analysis of variance because of the

selective withdrawal of more severe patients earlier for surgery. This indicates the value of using GEE to study wait times. Our data suggests that appropriate triaging of patients for surgery is currently in place despite a lack of clear mechanisms for this to occur. We expect that the expertise of specialized upper extremity surgeons contributed to appropriate triaging.

Although we were able to identify degradation of scores after controlling for sociodemographic variables and initial severity, we are unable to determine the clinical significance of this. In some studies clinically important differences are used to establish treatment effectiveness, but it is unclear whether these parameters are useful benchmarks for monitoring decline when treatment is not taking place.³⁴ Our findings are similar to those reported in a systematic review – included 788 hip and 858 knee patients, which suggested small amounts of change in pain and function while waiting for surgery if the wait times less than 6 months.³⁵

Few studies have examined the impact of waiting for rotator cuff surgery. Although the importance of waiting for surgery has been acknowledged and prioritized, most studies and efforts have targeted hip and knee replacement^{36,37} Our study provides evidence that some progression of disability can be anticipated during a six-month wait for shoulder surgery; but we were unable to determine the clinical importance of this decline. Further since patients were not evaluated earlier in their disease process when being managed by family physicians or physiotherapists, it is unclear how much decline had occurred prior to their consultation with an orthopedic surgeon. We only examined the wait time between the surgical consultation and completion of surgery, not the other components of wait time that could occur due to delays in seeking consultation with family physicians, during the conservative management process, or while processing consultations. Given that strength declines rapidly with disuse,³⁸ it is likely that much of the impairment and strength loss would have occurred prior to surgical consultation and the lack of further decline may be because patients had reached a stable state of disability. The fact that strength and motion were substantially impaired supports this hypothesis. Although our study may miss a critical time where early management might have benefited patients, it is also important for surgeons who receive referrals to know that they are appropriate

triaging and that only mild progression of rotator cuff tears can be expected between surgical consultation and surgery execution within six months. We acknowledge that our data is unstable because of the smaller numbers at later time points, but this limited data does suggest that more substantial decline can be expected after this time point. This would require further investigation with larger samples.

We observed both DASH and WORC scores improved after three months, which we attribute to appropriate selection of more severely disabled patients as being a higher priority for early surgery. This would suggest that surgical practice correctly prioritizes available resources and that any improvement in management should be directed at decreasing wait times rather than changing current prioritization processes. Similarly, we found that the external rotation strength did not change in first 6 months, which again was attributed to early selection of patients with more substantial loss of motion; and that impairments in motion and strength may have occurred earlier in the clinical course. We chose to analyze strength scores rather than motions scores to avoid creating too many models, and assuming that the larger strengths deficits and more direct relationship to musculotendinous function made the strength deficits a more important impairment to focus on.

We found that elderly patients were more likely to have higher levels of pain and disability while waiting for surgery. This finding is supported by both basic and clinical research.³⁹⁻⁴¹ Degeneration of muscle or tendon as part of the aging process, may contribute to less capacity for healing and recovery in older individuals.⁴²

Some of our findings suggest potential avenues to mitigate disability in patients waiting for cuff repair. Firstly, although failure of conservative management is typically considered an indication for surgery, less than half of our sample reported having a physical therapy rehabilitation program prior to their surgical consultation. Thus, it is unclear if these patients would have either benefited from rehabilitation sufficiently to avoid surgery, or benefit from exercise programs that would have mitigated loss of strength, motion and function while waiting for surgery (pre-rehab). Since patients presented with substantial loss of strength, motion and functional impairment; and since

physical therapy has been shown to be effective in patients with rotator cuff tears,⁴³ the lack of a preoperative course of physical therapy may represent a practice or health service accessibility gap that could be targeted for improving outcomes.

We found that arm dominance of the injured side was associated with poorer health outcomes suggesting that the impact of the injury on the ability to use the dominant hand is an important consideration. Some of the patients in our study may have presented with partial tears, where continued use of the impaired arm could result in potential increases to the size of the tear patients if personal or work duties were not appropriately modified. Patients with partial tears are more likely to be managed conservatively or by family physicians for a period of time prior to surgical consultation and interventions that would improve patient's knowledge about appropriate personal and work activities; as well as appropriate exercise program may mitigate both functional decline and risk of advancement of the tear. Since we did not directly study the progression of tear size, our hypotheses about the nature of partial tear progression in working and nonworking patient should be explored in future research.

While the extent of worsening that occurred during surgical waiting times was relatively small, it is important to consider the amount of burden present at baseline. Patients presented with moderate levels of disability pre-surgery that did not improve and a substantial number were unable to work. Substantial impairments in range of motion and strength were present by the time patients presented for surgical consultation. Thus, the lack of adequate rehabilitation and the surgical wait-times meant that patients were held in a disabled state for substantial periods of time. The personal suffering and economic losses due to inability to work during this wait interval would be substantial. Factors such as anxiety about surgery and lost quality of life while waiting can substantially influence surgical outcomes.^{44,45} When considering these factors together, the total economic cost of wait times is substantial.⁴⁶

Our data suggests patients face waits of five months to see specialist for initial consultation and then further another five months for the surgery. Therefore, early screening of surgical wait-lists to re-direct patients who have not had an appropriate trial

of conservative management may reduce burden and overall waiting time. As changes in access to funded physical therapy have declined in Canada over the past decade, this may account for the higher than anticipated number of patients who presented for surgery having not completed a course of conservative management.

There are several limitations worth noting. (1) We did not measure, or control for tear size. However we expect that our functional measures provided some indication of severity as the association between severity of functional complaints and tear size has been documented. (2) We had a small sample that completed 12 month follow up, because the majority had already progressed to surgery. Thus the confidence in our results declines over time and we are unable to make definitive conclusions about what happened at 12 months. However, despite these limitations the key conclusions that surgeons are appropriately triaging patients based on functional impact, that there is substantial pain, disability and impacts on health status during the waiting time; and that there are small declines in functional status during the waiting time between surgical consultations and completion surgery are robust and important findings.

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Table 1. Characteristics of 135 participants

Characteristics	N (%)
Age	
37-50	10 (7.4)
51-60	30 (22.2)
61-70	58 (43.0)
71-80	26 (19.3)
81-90	11 (0.8)
Gender (male)	89 (65)
Affected arm is dominant	83 (62)
Rotator cuff tears by injury	82 (61)
Employment	
Full time/par time employed	53 (39.3)
Unable to work because of rotator cuff injury	9 (7.0)
Homemaker/retired	39 (28.9)
Missing	34 (25.2)
Highest education level	
High school	29 (21.5)
College	33 (24.4)
University and above	33 (24.4)
Missing	40 (29.6)
Wait times (mean, SD)	
First surgery consultation at HULC	163 (112) days
Surgery executed (mean, SD)	154 (71) days

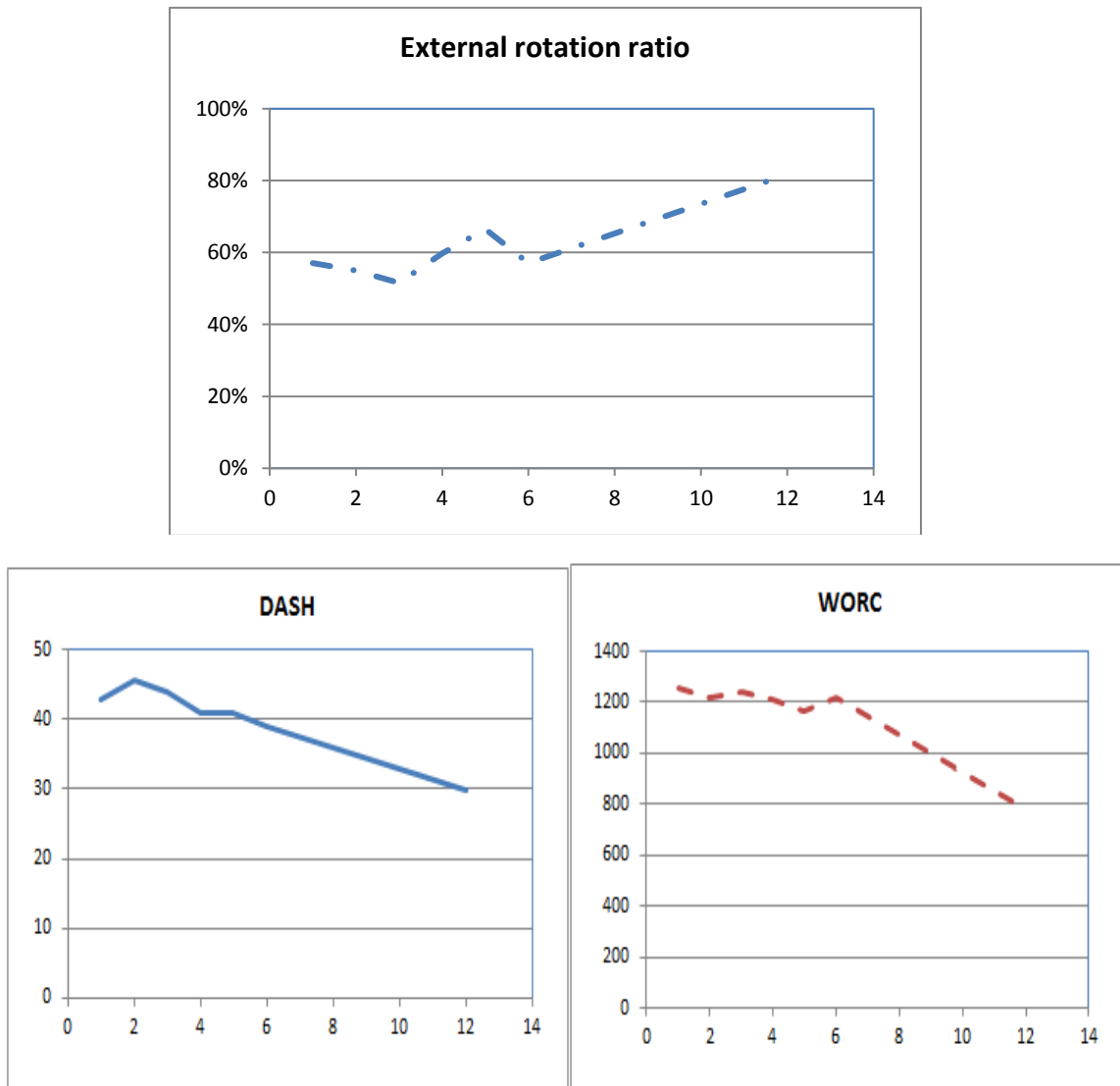
Table 2. Comparison of DASH, WORC and external rotation ratio changes in 12 months

	Baseline	Months							P value
		1	2	3	4	5	6	12	
DASH	41.23 (21.34)	42.84 (20.59)	45.51 (23.28)	43.84 (18.84)	40.79 (19.78)	40.84 (22.92)	38.95 (14.64)	29.89 (27.81)	0.25
WORC	1248.7 (496.8)	1256.9 (481.1)	1219.6 (518.9)	1238.9 (533.9)	1212.7 (567.7)	1168.5 (539.4)	1214.6 (243.0)	777.0 (644.6)	0.07
External rotation ratio	56.22 (34.17)	57.03 (35.24)	55.00 (37.95)	51.55 (34.90)	59.77 (37.63)	66.48 (36.03)	57.10 (31.97)	81.73 (15.65)	0.32

Table 3. Multivariate analyses of DASH, WORC and external rotation ratio

	DASH			WORC			External rotation ratio		
	Adjusted β (95% CI)	P value		Adjusted OR (95% CI)	P value		Adjusted OR (95% CI)	P value	
Age	0.70 (0.18, 0.37)	0.001*		0.49 (-0.80, 1.77)	0.46		-0.01 (-0.02, 0.002)	0.14	
Gender (female)	0.54 (-1.51, 12.39)	0.13		6.48 (-14.55, 27.50)	0.55		0.08 (-0.09, 0.25)	0.38	
Affected arm is dominated	7.94 (0.74, 15.15)	0.03*		7.78 (-12.28, 27.86)	0.48		0.001 (-0.15, 0.15)	0.99	
Caused by injury	4.34 (-2.30, 10.99)	0.20		17.98 (-0.35, 36.31)	0.06		-0.21 (-0.36, -0.07)	0.004*	
Wait times	0.04 (0.03, 0.05)	0.001*		0.08 (0.04, 0.12)	0.001*		-0.03 (-0.08, 0.08)	0.94	
SF-12	-0.58 (-0.86, -0.28)	0.001*		-1.28 (-2.08, -0.47)	0.002*		-0.002 (-0.007, 0.004)	0.59	

Figure 1. Comparison of External rotation ratio, DASH and WORC score changes in 12 months



CHAPTER 6 GENERAL DISCUSSION AND FUTURE DIRECTION

6.1 Overview of this dissertation

The purpose of this thesis is to provide evidence to better understand the disability of musculoskeletal disorders (MSDs) on upper limb and the factors which determine RTW. MSDs often present as pain and physical dysfunction with prolonged disease progression.^{1,2} There are several important factors which affect RTW for patients with MSD, including physical, psychological, economic and social factors. With understanding the complexities of RTW for patients with MSDs as an objective, we conducted a thorough literature review on the disability with a focus on upper limb to identify existing gaps in the literature. We conducted five studies to investigate disability, employment status and possible interactions between them.

The first study we looked at was a systematic review on the prognostic factors of RTW after work-related hand injuries. We assessed eight studies which addressed eleven potential prognostic factors (e.g. socio-demographic factors, occupation, worker's compensation status, treatment related factors, impairment severity, location of injury). We found that 40% of people with work-related hand injuries were out of the workforce 6 months after injury. There was low-moderate quality evidence that individuals with more severe impairments were less likely to RTW sooner, whereas age, gender and level of education had no impact on RTW.

The second study focused on workplace health and safety assessment. The OPP-14 was developed by adding three additional items to the ergonomics subscale on the basis of the original OPP-11 scale. The scale was evaluated on 261 firefighters. A confirmatory factor and Rasch analyses were used to assess the internal consistency, construct validity and other psychometric characteristics of the OPP-14. Our findings confirmed four components of OPP-14, safety practice, ergonomic practices, disability management and people –oriented culture with the ergonomic practices component having the better performance compared to OPP-11 by the two analytical methods.

The third study was a retrospective cohort study to identify the prognostic factors of job changes to rotator cuff patients during wait times for surgery. Participants were assessed for physical function both range of motion and strength (e.g. flexion, abduction and extension range of

motion, shoulder external rotation isometric strength). Self-reported shoulder function and workplace health and safety questionnaires were also administered. We found the average time for job changes occurred at 5.5 months. Only WSIB status was associated with job changes while old age showed a trend toward significance.

The fourth study was a longitudinal prospective study to evaluate self-report shoulder disability progression during surgical wait times. Through a one year follow-up, people with severe shoulder dysfunction were more likely to receive early surgery, usually within 3 months. We observed patients who continued to live with substantial pain and disability, physical impairment, and loss of work with minimal further declines in function occurring during a six-month surgical waiting time.

6.2 Clinical and research implication

In our first study, systematic review on RTW following a work-related traumatic hand injury, we found consistent evidence that severe physical impairment was associated with delays in RTW. Common demographic factors including, age, gender, education level had no consistent impact on RTW. Therefore, key issues for traumatic patients should focus on effective intervention strategies during acute stages of injury.³ Also, 6 months after injury, 40% of injured workers remain out of the workforce. This finding is consistent with other studies on MSDs and traffic crash injuries.^{4,5} Therefore, it might be practical for clinicians and policy makers to establish RTW protocols after a period of 6 months post-injury. Health care professionals, employers and other shareholders may wish to insure that adequate rehabilitation is provided during this 6 months period for employees who have suffered a hand injury.

In a second study of measurement, we evaluated the factor structure of OPP-14, a modified scale to assess organizational structures and behaviors across work sectors. Three items: “Jobs are designed to reduce heavy lifting”, “Jobs are designed to reduce repetitive movements” and “Jobs are designed to reduce awkward positions/postures” along with one original item were used to form this new ergonomic subscale. We recruited firefighters because they are sensitive to this modified scale due to the high ergonomics in firefighting. OPP-14 demonstrates promising

psychometric properties in working firefighters with robust factor construct and internal consistency. Our proposed modification were based on the fact that ergonomic factors are fundamental to primary and secondary prevention of MSDs, and a large proportion of work disability relates to these disorders. We expanded the ergonomic domain with additional items to obtain a better representation of variations in EP, which may be useful in other work sectors.

The study on job changes during wait times is a retrospective cohort study which examined the potential factors which affect the determination of employment status changes on patients with rotator cuff syndrome. We recruited participants from a tertiary medical center in London, Ontario and assessed them at their first visit to an orthopedic clinic. Our sample is comprised of a senior population (average age = 61 years) with half of them being trade or manufacturing workers. We found only 10% of participants experienced job changes at an average of 5.5 months. Our results are consistent with findings from previous studies where job changes most frequently occurred 6 months following injury.⁵ Our findings also support the success of WSIB in helping injured workers remain in the workforce. Appropriate work reallocation and a supportive work environment can build a stronger and healthier workforce and will be beneficial to the economy in the long-run. We found elderly patients were more likely to retain in the same job. This finding highlights the importance of workplace assessment to prevent re-injury. If a worker prefers to stay in their original position, the employer, and the rehabilitation specialist should coordinate to provide a suitable work environment for the worker to avoid further injury. Physicians should also be involved the in a management plan to help the injured employee go back to work safely and quickly.

The last study on rotator cuff syndrome provides useful information about disability progression for surgical candidates while waiting for rotator cuff repair. We followed a cohort of patients every month for the first 6 months and at 12 months after first surgical consultation. We found the length of surgery wait times had a minor impact on self-reported disabilities, as well as muscle strength. This finding can be partially explained by the fact that patients with a severe injury were more likely to undergo surgery during the first 3 months following consultation. These findings indicate that in our clinical health center, surgeons are triaging patients with more severe problems to earlier treatment. The current medical management plan is appropriate and

efficient. On the other hand, we observed that patients continue to live with substantial pain and disability, physical impairment, and loss of work with small further declines in function occurring during a six-month surgical wait time. Considering the average wait times for rotator cuff syndrome in our study was five months, patients with partial tears are more likely to be managed conservatively or by family physicians for that period of time. While waiting for surgery, interventions that would improve the patient's knowledge about appropriate personal and work activities; as well as appropriate exercise programs may mitigate both functional decline and risk of advancement of the tears.

6.3 Limitation

In this dissertation, we conducted four studies to disentangle the research question on the association between disability and employment status on patients with MSDs, focusing on upper limb injuries. Although we have some interesting findings on MSDs, there is limited research on the identification of prognostic factors, assessment of workplace policy and safety, and disability progression during surgical wait times and its effects on employment status.

First, the results of this review investigating the effect of prognostic factors on RTW, restricted to work-related traumatic hand injuries were derived from a limited number of low quality studies with a high degree of heterogeneity in the workplace context. Therefore, we were unable to perform a meta-analysis to quantify the extent of each prognostic factor on RTW. Due to the limited number of studies, it was also not possible to test the impact of contextual differences. We performed quality assessment using a newly developed quality assessment tool for prognostic studies when we conducted this review. However, the full validation of the tool has not yet been performed.

Second, we modified OPP-14 by adding three additional items to the ergonomic domain. Our results proved robust psychometric characteristics of this modified scale with an improved structure, especially for the ergonomic subscale by two statistical methods. We chose active firefighters, whose jobs have higher levels of ergonomic demands, to better evaluate the modified scale. However, our homogenous sample of firefighters makes it difficult to generalize our findings to other work contexts. In addition, we only conducted studies on the evaluation of

factor structure and not full validation process due to a lack of data. Therefore, future studies predicting relative outcomes, such as return to work or injury prevention are warranted.

We performed two separate secondary data analyses using our rotator cuff database. One of the limitations of both studies is the small sample size which reduced the power of the studies. In our study which examined the prognostic factors of job changes, only WSIB status demonstrated statistical significance, whereas the alpha level of age was 0.06. It is possible that there is an existing type II error due to the small sample size. Our second paper focused on functional changes during wait times had the same power issue. As a very small number of participants remained in the study after six months, the impact of wait times on physical functioning during a prolonged period found in our study may underestimate the true impact of wait times on physical functioning.

6.4 Future direction

There is a lack of high quality studies focused on the disability of MSDs of upper limbs and its impact on RTW. Although many researchers agree that multiple factors determine RTW which includes but is not limited to physical functioning, psychological distress, economic compensation system, attitudes from employer and social support, few studies investigated all of the above mentioned factors. Even when efforts were made to include as many variables as possible, due to the small sample size of each individual study, the statistical models were often unstable and may have produced misleading results.

Ergonomic factors are an important component affecting the MSD progression, as well as RTW. A validated workplace safety scale which includes ergonomic assessment is essential to evaluate the health of workstations. A validated workplace safety scale provides self-perception of appropriate design and promotes an ergonomic workstation arrangement specific to the employee. We encourage researchers to use our modified OPP-14 in different contexts to test its performance.

We feel the existing body of literature on the aging working population and employment is insufficient. Given an aging workforce is a global phenomenon especially in industrial countries, study on older workers is highly warranted. Both results from our systematic review and prognostic study demonstrate old workers are more likely to RTW or remain in the same position after injury. Although we respect these workers' commitment to continue working, further studies focused on elderly employees which explore the factors that affect disability and employment could produce valuable information about the older working population.

Timing of RTW is also worthy of further investigation. Currently, we found six months after injury may be a useful cut off point to be concerned about outcomes and employment status after injury. Having age, gender, condition and job-specific data on return to work would help employers and rehabilitation specialists support injured workers to quickly and safely return to work. Moreover, separate rehabilitation programs might be developed to support employees who have a delay in RTW compared to those who are back to work within the expected time frames.

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Appendices

Appendix 1

Chapter 2: Search Strategy:

- 1 exp Upper Extremity/ or exp Arm Injuries/ or exp Hand Injuries/ or exp Finger Injuries/ or upper extremity injury.mp.
- 2 wrist injury.mp. or exp Wrist Injuries/
- 3 exp Thumb/ or thumb injuries.mp. or exp Metacarpophalangeal Joint/
- 4 1 or 2 or 3
- 5 exp Fractures, Bone/
- 6 exp Amputation, Traumatic/
- 7 exp Multiple Trauma/ or exp "Wounds and Injuries"/ or orthopaedic injury.mp. (630681)
- 8 exp Tendon Injuries/
- 9 exp Orthopedics/
- 10 orthopaedic trauma.mp.
- 11 muscle injury.mp.
- 12 5 or 6 or 7 or 8 or 9 or 10 or 11
- 13 exp Work Capacity Evaluation/ or exp Work/
- 14 exp Occupational Health Services/ or exp Occupational Diseases/ or exp Case Management/ or disability management.mp. or exp Disability Evaluation/ or exp Employment/
- 15 work return.mp.
- 16 exp Rehabilitation, Vocational/ or exp "Recovery of Function"/ or return to employment.mp. or exp Employment, Supported/
- 17 exp Sick Leave/ or work resumption.mp.
- 18 exp Absenteeism/
- 19 exp Rehabilitation, Vocational/ or exp Occupational Therapy/ or work hardening.mp.
- 20 13 or 14 or 15 or 16 or 17 or 18 or 19
- 21 4 and 12 and 20
- 22 exp Accidents, Occupational/

- 23 work injury.mp. or exp Occupational Diseases/
- 24 22 or 23
- 25 21 and 24
- 26 exp Retrospective Studies/
- 27 exp Prospective Studies/
- 28 exp Follow-Up Studies/
- 29 predict\$.mp.
- 30 Determ\$.mp.
- 31 prognostic.mp.
- 32 26 or 27 or 28 or 29 or 30 or 31
- 33 25 and 32

Appendix 2

Chapter 2: Quality assessment tool for return to work prognostic study

Sampling	<i>Yes</i>	<i>No</i>	<i>Unclear</i>
S1. The study was an inception cohort			
S2. Study provides clearly defined inclusion and exclusion criteria			
S3. The study used representative sampling techniques			
S4. The setting and study site were clearly described			
Methodology			
M1. The exposure to the prognostic factor(s) were measured by validated instruments (eg: secure record, structured interview)			
M2. The assessment of prognostic factor(s) was blinded to outcome(s)			
M3. The data was complete for at least 80% of the sample at baseline.			
M4. Return to work outcome was independently measured (e.g.: record linkage)			
M5. Participants were follow-up at least 3 months after injury			
M6. Study was designed as a cohort study			
Analysis			
A1. Appropriate analysis was techniques employed (e.g. multiple regression analysis, survival analysis, multivariate analysis etc.)			
A2. Sample size was large enough for the variables investigated.			
A3. Confounders from at least 3 different domains were adjusted in analysis*			
Results			
R1. The results were reported appropriately			

* Individual characteristics, general health status, social environment, working environment, clinical exam findings/ severity of injury, type of compensation.

Appendix 3

Chapter 3: OPP-14 scale

Domains	Label	Item
Safety practices (SP)	Money	a. The company spends time and money on improving safety.
	Equipment	b. Equipment is well maintained.
	Unsafe	c. Unsafe working conditions are identified and improved promptly.
Ergonomic practices (EP)	Purchase	d. Ergonomic factors are considered in purchasing new tools, equipment, or furniture.
	Lifting	e. Jobs are designed to reduce heavy lifting.
	Repetitive	f. Jobs are designed to reduce repetitive movements.
	Postures	g. Jobs are designed to reduce awkward positions/postures.
Disability management (DM)	RTW	h. Injured workers are evaluated regularly for potential return to work.
	Duration	i. The company monitors the duration of disability in order to identify workers in greatest need of rehabilitation and other services.
	Modify	j. Company modifies jobs and provides alternative jobs to help injured workers return to work.
	Flexible	k. Company offers special equipment or flexible hours to allow injured workers to return to work.
	Retrain	l. When injured workers can't return to their jobs the company provides retraining.
People-oriented climate(POC)	Cooperative	m. Working relationships are cooperative.
	Voice	n. Communication is open and employees feel free to voice concerns or make suggestions.

Curriculum Vitae

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Publications:

1. **Shi, Q**, MacDermid, J. C, Tang, K, Sinden, K. E, Walton, D, & Grewal, R. (2016). Confirmatory Factor and Rasch Analyses Support a Revised 14-Item Version of the Organizational, Policies, and Practices (OPP) Scale. *Journal of Occupational Rehabilitation*, 1-10.
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