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## Recovery Following Proximal Humerus Fracture

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A thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Health and Rehabilitation Sciences

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## Abstract

There is currently a glaring gap in the existing knowledge to address individuals' experiences while recovering from a proximal humeral fracture (PHF). The main objective of this dissertation was to understand better how *recovery* is perceived by individuals after PHF. This overarching objective aligned well with the broad conceptualization of the issue at hand as those provided by the International Classification of Functioning, Disability and Health (ICF). Three inter-linked studies were conducted to provide a broader picture of recovery after PHF. The first study was a systematic review of prognostic factors predicting recovery after PHF in adults. This review demonstrated the complexity of recovery through a range of multi-factorial biopsychosocial factors that are inter-connected. To describe recovery after PHF as well as facilitators/barriers and preferences to exercise from individuals' perspectives, two studies were performed: a descriptive cross-sectional survey and a semi-structured interview. A convenience sample of 59 individuals with PHF aged  $\geq 45$  participated in the survey study and completed three self-reported validated questionnaires. The most important outcomes for participants were tapped into the daily activities and social roles. Forty-seven out of 59 participants rated themselves 'unable' to perform recreational activities after PHF. The main facilitators and barriers to exercise belonged to the contextual (person-environment) factors. The semi-structured interview study provided an in-depth understanding of recovery as well as facilitators and barriers to exercise through interviewing 14 individuals with PHF as a subset of those who participated in the survey. Thematic analysis used to analyze participants' narratives revealed two core concepts: self and social connectedness. The interpretation process of interviews provided a deeper understanding of the experience of recovery, what it means and why it matters to individuals themselves. The integration of quantitative and qualitative data provided insight into the perceived recovery expectations, and a number of contextual factors that are involved in the process of recovery perceptions. One key message from this work was that person-environment factors deeply influence individuals' perceptions on recovery, and what facilitators and barriers to exercise are through their eyes.

## Keywords

Recovery, proximal humerus fracture, adults, perspectives, mixed methods study

## Summary for Lay Audience

Shoulder fracture is a common cause of disability among older adults. This injury may happen as a result of a simple fall in people with low bone density. Although people have moved past the bone healing stage, recovery can be slow and long after this injury. People might be unable to dress, bathe, or eat by themselves. To date, there is no study about the real-life problems from people's point of view in the recovery course. In this thesis, my goals were to find factors that increase the likelihood of recovery or non-recovery, and to know how people with this injury describe recovery. Since exercise is an important part of care after injury, I wanted to understand what things help or stop them from exercising. In the first study, I found 23 factors with positive or negative impact on future outcomes in shoulder fracture. Most of the factors leading to poor or non-recovery were health-related either in the past or post-fracture like shoulder surgery. Factors with positive impact on recovery were rehabilitation, general good health, and exercise. The second and third studies were done at St. Joseph Hospital-Hand and Upper Limb Center. In a survey, 59 patients with shoulder fracture aged 45-94 answered questions about their important outcomes, problems in daily life and exercising. In the third study, I interviewed 14 patients and asked them to describe in detail about their recovery expectations, and might help them recover faster. The results of the survey and interviews showed that although recovery may simply means "being able to run a normal life", but ways to running a normal life are different from one to another. This thesis was the first step to give voice to patients in the first year of shoulder fracture. The main messages of this study are paying more attention to patient's needs and preferences, and see what is more important for them in the course of recovery. Care and treatment plans for older adults needs to be more holistic, and adjustable to their condition.

## Co-Authorship Statement

Dr. Joy C. MacDermid guided this thesis, and contributed to designing the study, refining the research questions, preparing the manuscripts, and revising critically all chapters. Dr. Mike Szkeres and Dr. Trevor Birmingham, who served as my other committee members, provided substantive guidance and support, and revised all chapters.

All manuscripts were co-authored by Dr. Joy C. MacDermid, my supervisor- Dr. Mike Szekeres, and Dr. Trevor Birmingham, the other thesis defense committee members.

Dr. Kenneth Faber provided guidance and revision for manuscript 3 (chapter 4) and was also co-author of this manuscript.

Dr. Joy C. MacDermid and Dr. Mike Szkeres provided appraisal evaluations of studies included in the systematic review, manuscript 1(chapter 2).

I, Azar Varahrami Vigeh, am the first author for the entire work in this thesis. I arranged for the ethics approval of the study protocol, collected, analyzed, and interpreted data, and drafted the manuscripts.

## Acknowledgments

Challenges are what make life interesting and overcoming them is what makes life meaningful.

“Joshua J. Marine”

I would like to express my heartiest gratitude to the people who have supported me in my doctoral journey. Foremost, I would like to thank my supervisor, Dr. Joy C. MacDermid whose mentorship and expertise allowed me to move towards my goals. I had the privilege to be guided by Joy from half-way of my PhD studies. Much of my growth and learning can be credited to her. What I like about her most is the way she sees the potential in her students; that is a fascinating fact about Joy. She is open, flexible and very positive. In one-to-one meetings, if you show her an awful part of your work, she knows how to change things for progress and motivate you by saying “*it is getting better*”! Her knowledge and vast experience are crucial to finish PhD projects and make the whole process achievable. Thank you Joy, for guiding me patiently, and not giving up on me!

My dissertation committee members offered valuable guidance and thoughtful feedback. I am grateful to Dr. Mike Szekeres and Dr. Trevor Birmingham for their support during this process. Without their constructive comments and critiques, I could not have been able to make progress in my work.

To all patients of the Rothl McFarland Hand and Upper Limb Center (HULC) St. Joseph’s Health Care London, thanks for your contribution to the completion of this thesis. These people provided the foundations of my research, and enriched the content of this study. Learning about their stories was the most meaningful part of my work. They shared their valuable experiences and real-life problems with me. Throughout data collection and interviews, I was deeply touched by their challenges and insights. Without them, this project would never come to an end.

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## Dedication

To those women who are driving the positive change forward despite traditional family and social norms; their perseverance gives purpose to life change.

When I was six years old, I wanted to be a medical doctor. That dream never came true because I grew up in a traditional family where girls aspire to early marriage, and educational opportunities are closed off to them. Girls are urged to marry because their first role is to stay at home, prepare for the “real life”, and bring up children. When I was growing up, child marriage was often viewed much more valuable than education in my home country Iran. It still is. The first time, I married and had to drop out of school, I was just 13 years old. Since then, I never gave up on my education, despite many interruptions, some of them were my second marriage at the age of 17, the Islamic Revolution, and the closure of high schools, the Cultural Revolution and the closure of universities, the war with Iraq, the death of my second husband, ..... and my immigration to Canada with two children. My life ups and downs taught me how to swim against the current. After each gap, I went back to school, with more passion, determination and a strong motivation. It has been my desire that women around the world see the possibility of higher education, expand their worldview, and stand against obstacles in their life.

# Chapter 1

## Literature review

Proximal humerus fracture (PHF) is a common upper extremity injury, often occurring after a simple fall <sup>1</sup>. The incidence fluctuates with age and has substantial impact on daily activities and social functioning. A PHF is of special concern because the upper limb enables us to interact with the world around us <sup>1</sup>. Following a PHF, older patients have considerable difficulty using their involved hand for the most basic human needs. The inability to perform self-care and household chores can be debilitating, and increases the degree of social dependency <sup>2-4</sup>. A PHF can result in severe and prolonged disability in a “previously fit elderly independent person who was still *a net contributor to society*” according to Court-Brown et al. (2001, p.370). A loss of arm and hand functioning has significant short term and long term implications for older patients <sup>5,6</sup>. Published studies have reported that functional recovery continues throughout the first 6 to 12 months after the injury. Many authors state that individuals with PHF can make good to excellent recovery one year after the injury <sup>5,7</sup> while others argue that a significant proportion of patients may not fully be recovered, at one year <sup>8-11</sup> and even up to 18 months<sup>3,12</sup>.

### Incidence and risk factors of PHF

PHFs account for 6-7% of all fractures <sup>11</sup>, and are the third most common fragility fracture in people over the age of 60 after those of hip and distal radius <sup>10,13</sup>. In patients older than 65 years, PHFs account for 10% of all fractures <sup>14</sup>. The incidence is projected to rise exponentially at a rate of over 40% every 5 year at age 40 in females and age 60 in males <sup>15</sup>. As of 2008, the risk of sustaining a PHF was nearly 5 times greater for women ages 60–64 years and 21 times greater for women ages 80–84 years <sup>15</sup>. The susceptibility of women to PHFs is likely related to issues of menopause and osteoporosis <sup>10,13,14,16</sup>. On average, men with PHFs are 8 to 10 years younger than women <sup>17</sup>. The majority of PHFs are minimally displaced, or nondisplaced, indicating that a patient is treated on an outpatient basis consuming rehabilitation and/or care resources<sup>16</sup>. However, PHFs in the

elderly over 80 years of age, often require prolonged hospitalization indicating considerable health care costs<sup>2</sup>. Several studies reported that a PHF can be a risk for subsequent fractures, in particular, hip fractures<sup>18-20</sup>. Costs for the PHFs surgical treatment, rehospitalizations for subsequent fractures, and rehabilitation services amounted to €52 million in 2009 in France<sup>20</sup>. In Ontario, a study of fragility fractures, conducted at three community hospitals reported a 20% of total outpatient visits for PHFs<sup>21</sup>. In the United States, the number of patients presenting with humerus fractures reached to approximately 370,000 at the emergency departments. Fifty percent of these were PHFs<sup>15</sup>.

Age and gender were reported as major risk factors for PHF<sup>22</sup>. This data is consistent with a recent report that more than 70 percent of PHFs occur in patients over 60 years of age with the highest incidence among individuals between 73 to 78 year years, and three to four times more common in women than men<sup>23</sup>. The role of osteoporosis in increasing the risk of fragility fractures has been repeatedly pointed out in the literature<sup>13,23</sup>. PHF and the concomitant rise in osteoporosis and low BMD in the elderly have been confirmed<sup>2,24,25</sup>. Other factors that go along with developing PHF have been suggested as personal and maternal history of fractures<sup>25</sup>, neuromuscular impairments<sup>24</sup>, impaired vision and deafness<sup>13</sup> and lifestyle factors such as consumption of alcohol<sup>26</sup> and smoking<sup>8</sup>. Some investigators observed that winter months, mostly December and January are the peak risk of PHF incidence due to snow and ice on the streets as well as early darkness<sup>16,27,28</sup>. In a large study of risk factors for PH fractures, data showed that poor balance was related to increase PHF in elderly<sup>25</sup>. Evidence shows that the risk for falls, and further fractures are higher in patients within a year following PHF<sup>18,19</sup>. For example, the risk of a subsequent hip fracture after a PHF was highest within one year after PHF, with a hazard ratio of 5.68 (95% confidence interval, 3.7 to 8.7)<sup>19</sup>. Neuhaus et al.<sup>26</sup> stated that simultaneously occurring PHF and proximal femoral fractures is an explicit predictor for nursing home admission. Some scholars argued that a fracture of PH is less limiting because it does not prevent walking, but this fracture can substantially deprive individuals of their independence<sup>2</sup>. However, PHF and concomitant hip fracture

increase the risk of mortality in this population <sup>29</sup>. Given their predictive value, PHF should be regarded as an important warning sign forecasting subsequent injuries <sup>30</sup>.

### Mechanism of injury

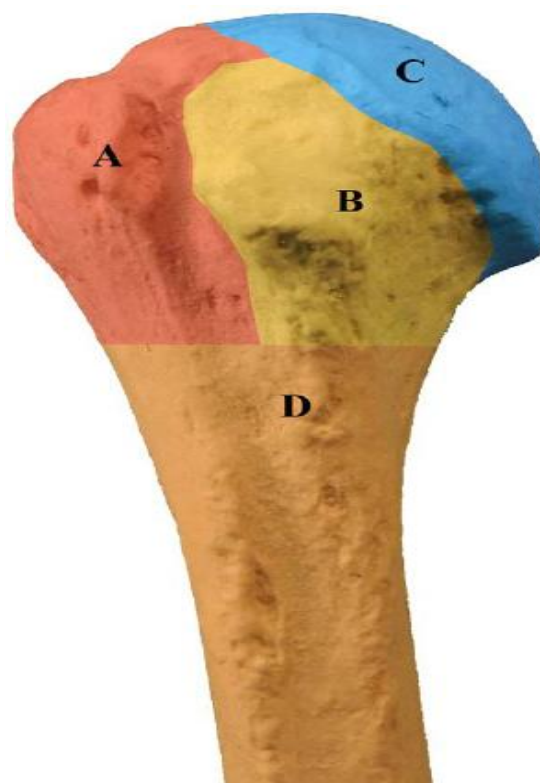
In the elderly, the most common cause of PHF is a simple fall from standing height or lower directly onto the shoulder, called 'low energy trauma'<sup>13,16,31</sup>. PHFs may occur as a result of high-energy trauma in younger population. Younger patients are more susceptible in high energy PHFs such as motor vehicle accident, seizures, electric shock and fall from greater than a standing height <sup>13,31,32</sup>. The mechanism of PHF appears to be more similar to that of hip fractures; they occur when the individual is unable to break his or her forward or oblique fall, and therefore lands directly onto the shoulder or hip <sup>33</sup>. Inability to break the falls with the upper/lower limb represents delayed reaction time, impaired balance, and poor vision <sup>24,33</sup>. Studies have also shown that patients who sustain PHFs have slower neuromuscular response, and cannot raise their arm quickly to break a fall <sup>25</sup>. Research on mechanism of falling in PHF is not available, most studies cover general falls and no study exists specifically related to PHF falls and prevention strategies.

### Basic anatomy of proximal humerus bone

The humerus is the largest bone in the upper extremity, and instrumental in supporting many of the arm's function. The humerus is marked by two tubercles- the greater and lesser, a rounded head, and the humeral shaft <sup>34</sup> (Figure 1).

Proximally, the humerus articulates with the glenoid cavity of the scapula forming the glenohumeral joint. The humerus head is covered in articular cartilage (a slippery covering that allows bone to move smoothly on bone) and articulates (moves against) with the socket of the shoulder joint, the glenoid. The rotator cuff consists of four muscles and their tendons are dynamic stabilizers that are distributed evenly around the humeral head, and actively hold the head of the humerus securely in its shallow socket, and provide range of motion (ROM) at the shoulder. The subscapularis muscle forms the anterior part of the cuff, the infraspinatus and teres minor form the posterior part and supraspinatus forms the superior part. As a general rule, the muscles that pass in front of

the shoulder joint flex or internally rotate the humerus, whereas the muscles behind the shoulder joint extend or laterally rotate the humerus. Based on the location, humerus fractures are divided into fractures of proximal humerus (PH), shaft humerus, and distal humerus, however, the main focus of this thesis work is PH<sup>35</sup>.



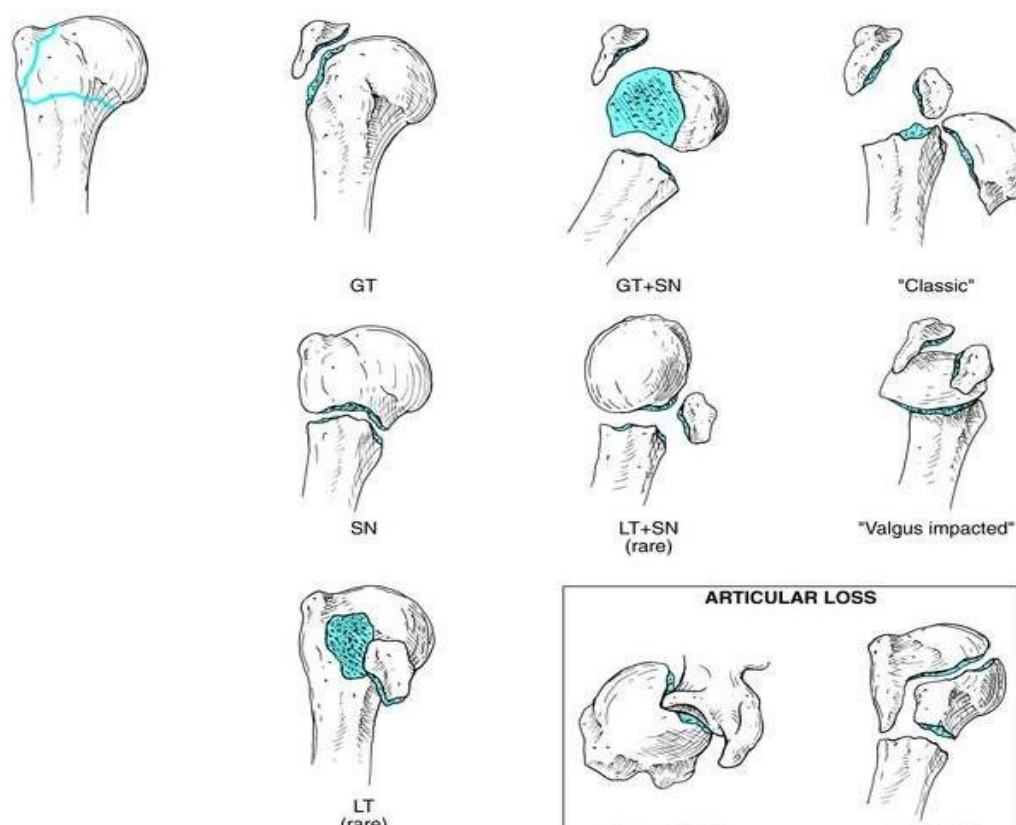
**Figure 1 Anatomy of proximal humerus**

Schematic drawing of the 4-part proximal humerus bone as described by Codman: (A) greater tuberosity, (B) lesser tuberosity, (C) anatomic head, and (D) humeral shaft. Reprinted from “A Guide to Improving the Care of Patients with Fragility Fracture” by S. Kates, and S. Mears. 2011, *Geriatrics Orthopaedic Surgery & Rehabilitation* 2 (1), p.17. Reprinted with permission.

### Classifications of PHF

In 1934, Codman introduced a 4-part fracture classification subdivided into 16 patterns of PHF<sup>36</sup>. Codman stated that fracture lines of the PH reproducibly occurred between four major fragments of the humeral head, the greater tuberosity, the lesser tuberosity, and the

humeral shaft<sup>37</sup>. In 1970s, Neer developed an easy-to-apply classification system based on the Codman's observation<sup>38</sup>. Analyzing 300 radiographs of various fracture patterns, Neer added the idea of displacement and angulation of fracture rather than the location of fracture lines. According to Neer, *displaced* fractures were defined as those in which a segment is displaced  $>1$  cm or angulated  $>45^\circ$  from the normal anatomical position, and *nondisplaced* fractures were of  $<1$  cm and rotation  $<45^\circ$  and were commonly called one-part fractures. Two-part fractures involved any of the 4 parts and include 1 fragment that was displaced. Three-part fractures included a displaced fracture of the surgical neck in addition to either a displaced greater tuberosity or lesser tuberosity fracture. Four-part fractures included displaced fractures of the surgical neck and both tuberosities (Figure 2).



**Figure 2 Classification of PH fractures**

The classification of the proximal humerus fracture developed by Neer. From *Fracture Guide for Patients*, by Arun Pal Singh, <https://boneandspine.com/proximal-humerus-fracture/>. Reprinted by permission.

Neer classification, although yet widely used, has been criticized for a low interobserver and intraobserver reproducibility<sup>10,11</sup>. Others assessed Neer's classification with a moderate degree of concordance between observers<sup>39</sup>. However, Broson et al.<sup>40</sup> claimed that that interobserver agreement on the Neer's classification can be improved by systematic training, and ultimately agreement among experienced shoulder surgeons is more important. To date, attempts to develop additional classifications have failed in giving a clear guideline for treatment<sup>41</sup>. One possible explanation is the complexity nature of the shoulder anatomy and fracture patterns which makes it challenging to provide an ideal classification system for PHFs.

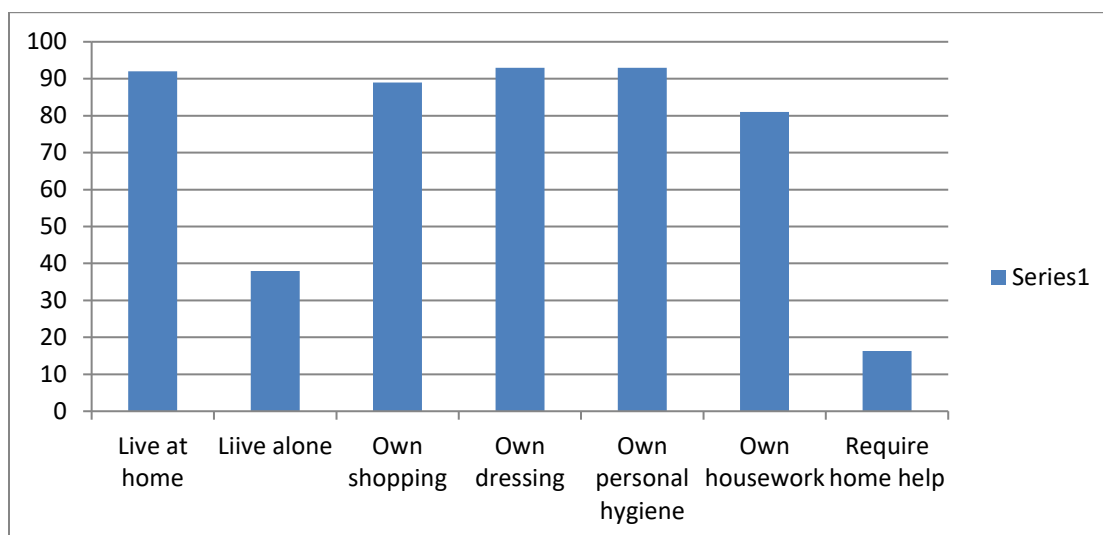
### Living with a PHF

Following a PHF, people may be unable to dress, bathe, or even feed themselves<sup>42</sup>. The first few weeks after fracture are characterized by pain and activity limitations<sup>41</sup>. The experience of pain is reported severe, debilitating and aggravated through shoulder motion. Significant swelling and bruising may appear in the first 24-48 hours after the injury and may last for several days<sup>35</sup>. Patients report difficulty with sleeping on a bed after PHFs. Some are more comfortable to sleep in the sitting position using a recliner<sup>10,13,43</sup>. Functional disability after a PHF is often experienced and can include difficulty in performing simple tasks such as placing objects into high cupboards, cutting food, self-care, and carrying items<sup>44</sup>. Inability to perform daily activities is debilitating<sup>45</sup>. Prolonged immobilization leads to shoulder stiffness, and thus to long term functional loss<sup>24</sup>. If stiffness is not tolerated, it leads to further limitations in the range of motion<sup>46</sup>. Evidence shows that PH injury affects individuals who are leading active lifestyles and participating in social roles<sup>47</sup>. In a 5-year epidemiological study, Court-Brown et al.<sup>5</sup> showed that 90% of patients with a PHF were generally fit, lived at home, and took care of their own self-care before the onset of this fracture (Figure 3).

Similarly, other scholars confirmed that around 80% of patients live independently at home with the ability to perform household tasks, shop independently and perform recreational activities pre-fracture<sup>29,48,49</sup>. Muhm et al.<sup>50</sup> stated that the typical patient with a PHF is an '*autonomous*' elderly person who still participates in everyday life.

Limitations in daily activities might reduce independence and potentially influence level of social roles<sup>29,30,51</sup> while it imposes substantial cost in the use of health care services<sup>2,52</sup>. Disability and pain experienced by patients may have psychological impact<sup>53</sup>. The intensity of shoulder pain after fracture has been found to be strongly influenced by depressive symptoms<sup>54</sup>. When patients suffer from depression or pain anxiety they may not be capable of adapting to and managing painful upper extremity problems. They may perceive themselves more disabled than would be expected on the basis of objective (clinical) assessments<sup>53</sup>. Data concerning the magnitude of disability caused by a PHF and its psychological effects (such as emotional distress and coping strategies) following a PHF is scarce. However, one recent systematic review of disability after upper extremity injuries showed that psychological factors were more consistently associated with disability than factors related to upper extremity impairment<sup>45</sup>. In this review, disability after upper extremity injury was most consistently associated with: symptoms of depression, pain catastrophizing, anxiety and negative cognitive behavior, and other psychological factors such as fear of movement, nonadaptive pain thoughts, and stress after trauma. Psychological factors, specifically depression, pain catastrophizing, pain self-efficacy, pain interference, and pain anxiety, along with certain social factors (work, education, marital status) and pain intensity are consistently associated with the magnitude of disability. Ring et al.<sup>53</sup> reported the correlation between depression and DASH score for patients with a variety of arm problems. In this study, the authors claimed that self-assessed disability is related as much or more to illness behavior than to pathophysiology. In particular, adequate coping mechanisms were important in both the experience of pain and perception of recovery. Other scholars found that positive psychological illness impact had association with disability suggesting that an upper extremity illness is less limiting to the extent that one can regard it in a positive, adaptive manner<sup>55</sup>. Nota et al.<sup>55</sup> observed that patients who are able to look at a stressful or traumatic situation through an adaptive lens find positives such as insight into one's own ability to cope, appreciation for support from others, sense of peace, acceptance, and trust in one's ability to adapt have better health outcomes compared with those who do not.





**Figure 3 Pre-fracture functional characteristics**

Functional characteristics of patients before proximal humerus fracture- The bar chart was created by extracting data from the Court-Brown et al. study (2001)<sup>5</sup>

## Treatment options

Management of treatment after PHF is a multidisciplinary approach with an ongoing debate over the optimal option(s)<sup>4</sup>. Recent literature shows that the optimal treatment has not yet been standardized<sup>7,56-58</sup>. An updated Cochrane systematic review of 31 randomized trials involving 1941 participants failed to support superiority of surgical over non-surgical treatment<sup>59</sup>. Other systematic reviews reported that optimal treatment methods are unclear due to low quality of evidence<sup>37,60</sup>. To date, no consensus exists on whether surgery is the gold standard when treating PHF operatively<sup>52</sup>. With the correlation of osteoporosis and PHFs in advanced age, more randomized controlled trials are needed to provide evidence in terms of optimal treatment after PHF.

## Non-operative treatment

Most fractures of PH (up to 80%) are non-displaced or minimally displaced PHFs and heal functionally with conservative treatment<sup>7,30,61,62</sup>. Conservative treatment typically consists of sling immobilization immediately after fracture followed by a progressive rehabilitation program<sup>57,62</sup>. A systematic review<sup>63</sup> of 12 studies including 650 patients

with a mean age of 65.5 years (range, 51-75) on the nonoperative treatment of PHFs demonstrated high rates of radiographic union (98%) and a modest complications rate (13%). The results of this systematic review supported the nonoperative management of one and two-part PHFs lending support to its use as the mainstay of treatment. Earlier, Court-Brown et al.<sup>5</sup> showed that 80% of the elderly patients had good to excellent results treated nonoperatively although residual deficits in strength and ROM were noticed. Similarly, Hanson et al.<sup>8</sup> provided robust evidence that non-operative treatment is safe and effective, mainly in nondisplaced, one and two-part fractures of PH. However, non-operative management of severe displaced fractures was associated with poor outcome<sup>64</sup>. Similarly, De Kruijf et al.<sup>65</sup> reported that in severe PHFs, poor functional recovery of nonsurgical treatment can be anticipated and surgical intervention must be considered. However, the results of a 10-year retrospective cohort study of 150 patients revealed that surgical intervention of displaced 3- and 4-part PHFs did not yield significantly better outcomes than nonoperative treatment in patients over the age of 65 in terms of health-related quality of life, function, pain, social participation and complications<sup>49</sup>. There is significant heterogeneity between studies, so making conclusions is difficult. Schumaier et al.<sup>11</sup>, claimed that patients with low recovery expectation, and those who are poor candidates for surgery, should be treated non-operatively. The rationale is that older adults have limited functional expectations, and do not always require a full range of motion to perform their daily activities. Restricted movement, shoulder stiffness, and persistent pain, however, have been reported as complications of nonoperative treatment of PHF<sup>49</sup>.

### Operative treatment

The role of operative treatment for fractures of the PH is debated<sup>66</sup>. To date, the data is contradictory and inconclusive<sup>59</sup>. Surgery is considered for approximately one in five patients, but there is no consensus on which fractures benefit from surgery or which procedure to perform<sup>59</sup>. Operative treatment has been preferred in active, younger and healthier patients with a PHF<sup>26</sup>, and will result in faster recovery<sup>56</sup>. Brouver et al.<sup>49</sup> found a trend toward better social participation after PHF operation indicating that older patients reported fewer problems with social participation, although problems related to

dressing, pain, sleep disturbance, and pain were still reported. The literature describes several surgical approaches to address PHF. These treatments include various options reaching from reconstructive procedures like implanting minimal invasive K-wires<sup>67</sup>, locking plates<sup>68,69</sup>, or PH nails<sup>69</sup> to performing arthroplasty either in terms of implanting an anatomic or reverse prosthesis<sup>70</sup>.

Considering the severity as well as morphology of PHF, clinicians should consider several patients characteristics such as pre-injury activity level and their expected physical demand when making decision regarding surgical intervention<sup>56</sup>. Similarly, Tamimi et al.<sup>69</sup> stated that indications for the best treatment should be based on the characteristics of patients such as age, comorbidities, level of independence, bone quality, post-operative complications. Others noted that occupation status, hobbies, and Individuals' lifestyle can be major determinant of decision making<sup>65</sup>. However, Launonen et al.<sup>52</sup> stated that since the superiority of single treatment has not been confirmed, patients should be advised of the high rate of complications that is associated with choosing surgical treatment.

*Postoperative complications.* The complications of PHFs may occur as a result of the injury, or secondary to operative treatment. Early complications may include nervous or vascular lesions that occur during trauma as a result of dislocation of bony fragments, and concomitant rotator cuff lesions<sup>71</sup>. Non-union is another possible complication that could evolve into late complications, if it is not treated or does not resolve spontaneously. Late complications, which are generally the most serious ones, include three main clinical conditions: a) avascular necrosis of the humeral head; the frequency of this complication is 7%, and there are no obvious differences in outcome between surgical and non-surgical treatment<sup>71</sup>; b) sepsis; the incidence of infection is really variable in the literature, ranging from just above 0% to 10%; and c) non-union; the incidence of non-union in proximal humeral fractures is 1.1%, although it increases to 8% in those cases with metaphyseal comminution and to 10% if more than one-third of the surgical neck is involved<sup>71</sup>. While operative treatment methods seek to reduce the incidence of malunion, they introduce the complications of infection, iatrogenic neurologic or vascular injury,

and hardware migration and failure<sup>68</sup>. Arthroplasty is indicated in severe cases where rates of avascular necrosis are high and fracture fixation is ill-advised, but it brings its own set of challenges and complications. Tuberosity malunion or nonunion, leading to rotator cuff dysfunction, is a primary complication leading to poor outcomes<sup>72</sup>. However, component malposition, instability, heterotopic ossification, periprosthetic fracture, glenoid erosion, infection, and nerve injury are not uncommon after hemiarthroplasty for PHF<sup>73</sup>. With reverse total shoulder arthroplasty, the complication list also includes scapular notching and glenoid loosening<sup>74</sup>.

## Rehabilitation

Rehabilitation has been central to re-establish normal shoulder motion and function following both operative and nonoperatively treatment PHFs<sup>75</sup>. Studies have indicated the benefit from early mobilization on improving outcomes<sup>10,24,42,76,77</sup>, pain<sup>42</sup>, and ROM<sup>24</sup>. A recent systematic review of patients with PHF who were treated conservatively, addressed the question of early mobilization as early as within the first week of the injury and concluded that patients with shorter immobilization time recovered faster functionally than those with a longer immobilization<sup>77</sup>. Despite this, a scoping review of 26 papers did not provide sufficient evidence in terms of the effectiveness of rehabilitation and /or delivering rehabilitation services<sup>77</sup>. One study investigated in-home tele-rehabilitation as a novel approach, and a way of access to a rapid less expensive satisfactory and effective rehabilitation services at home<sup>75</sup>. The feasibility of tele-rehabilitation was confirmed in a pilot study where the upper extremity function measured by the DASH questionnaire were more than twice as good after the program than prior to it<sup>78</sup>. In this study, seventeen patients with PHFs received an 8-week period videoconferencing system and the global score for user satisfaction with the health services was 82%.

## Exercise

Regardless of treatment plans (i.e., surgical and non-surgical), an essential part of successful rehabilitation is planned exercises that maintain motion and increase strength as bone healing allows following PHF<sup>9,13,60</sup>. In a systematic review conducted by Bruder

et al.<sup>77</sup>, early mobilization and exercises commenced within the first weeks of nondisplaced PHFs reduced pain in the short term and improved shoulder activity in the short-to-medium term compared with delayed mobilization and exercises. Results in two randomized controlled trials showed that the early mobilization group had significantly reduced pain compared with the conventional treatment group for non-operatively treated PHFs<sup>24,42</sup>. Hodgson et al.<sup>24</sup> stated that active elbow, wrist, and hand exercises should be initiated immediately after PHFs. Similarly, immediate passive joint mobilization resulted in a more rapid gain in overall shoulder functional status compared with the conventional three-week immobilization<sup>42</sup>. Overall, the effect of exercise has been clearly reported in relation with impairments in the literature. In an updated systematic review, generating data on 22 trials and 1299 participants, the authors suggested that current prescribed exercise is not effective in making changes in moving the arm in everyday living<sup>77</sup>. In this systematic review, the authors concluded that the current exercise prescriptions are poorly described in terms of duration, intensity and progression and are not sufficient to clearly show the effectiveness of exercise in daily life following PHF. One explanation might be the variation in individuals' factors, fractures severity and complications and other health-related factors. In an environmental scan of Canadian physiotherapy practice pattern, the results showed that evidence-based protocols to guide PHF rehabilitation exercise are lacking<sup>79</sup>.

### Outcome measurements

Historically, PHF functional outcomes relied on scales that were assessed by clinicians; the vast majority of literature shows assessment of radiographic images, post-operative complications, range of motion, and muscular strength following PHF. To date, in line with the growing tendency toward patients' reported outcomes (PROs), the most extensively patient-reported functional outcome assessments that measure disability after PHF are the Disabilities of the Arm, Shoulder and Hand (DASH)<sup>80</sup>, the American Shoulder and Elbow surgeons (ASES)<sup>81</sup>, Oxford Shoulder Scale (OSS)<sup>82</sup>, the University of California Los Angeles (UCLA) Shoulder rating score<sup>83</sup>, and Neer Criteria<sup>84</sup>. Despite the abundance of shoulder assessment scales, the majority are not specifically developed for measuring changes for a fracture population<sup>85</sup>. Slobogean et al.<sup>85</sup> examined four

commonly used shoulder outcome instruments including ASES, Constant-Murley shoulder score (CMS)<sup>86</sup>, DASH and OSS for validity, reliability, responsiveness, and interpretability. As stated by the authors, the psychometric evidence of these measures (i.e., ASES, CMS, DASH, and OSS) help clinicians in selecting an appropriate tool for use in shoulder fracture populations. However, there is a paucity of direct evidence to describe their psychometric values for one's target populations. Hence it is difficult to select the best functional outcome tool for shoulder fracture patients and caution should be exercised when using an instrument that has not been fully evaluated in fracture populations.

### Measurement challenges

As noted above, self-reported scales are extensively used in measuring functional outcomes in patients with PHF. Several problems arise when attempts are made to measure the impact of the injury on the overall health and quality of life subjectively. First of all, the definition of outcome is confusing because it can be perceived differently based on individuals' mindset, needs and preferences. 'Return to pre-injury status' is often considered a desirable outcome following a PHF. Since a prospective collection of preinjury health-related quality of life data is not possible, the clinicians' interpretation is based on patient's recall of preinjury status or a comparison with standardized population figures<sup>87</sup>. This stresses the methodologic difficulties of obtaining valid baseline values after a PHF<sup>8</sup>. As a remedy, satisfaction recovery index (SRI) developed by Walton et al.<sup>88</sup> take a positive view by recognizing patients' sense of recovery and satisfaction as opposed to symptoms or function with no comparison between current and pre-injury state. The SRI accounts phenomenon of response shift, while patients' priorities or importance of life domains may change over time. SRI allows for the respondents' shifting priorities and how they can feel 'satisfactorily recovered' over the course of recovery. Secondly, current shoulder outcome measures are multi-items, and multiple constructs such as pain, ROM, strength and function are combined as sub-scores into one single score<sup>88</sup>. This may obscure outcomes in the different domains. In their recent work, van de Water et al.<sup>44</sup> argued that if ongoing disability after a PHF is experienced as limitations in performing activities, these activities should be measured and monitored as

single construct. However, none of the currently used outcome measures in people with PHF measure the single construct of activity limitations.

### Gaps of existing knowledge

Thus far, the pathophysiology of PHF has become well understood, and this understanding has been widely used in clinical practice. Despite the novel surgical approaches, and outstanding technology advances in surgical treatments, we still have a narrow view of how this injury may influence patients' life from their own perspectives. This literature review underlined the need for clarity of patient's insight into their recovery journey and the need to move beyond biomedical and clinical aspects of PHF. One glaring gap in the existing knowledge is to understand the impact of PHF on the persons and their perceptions of important outcomes. Further insight into the course of recovery, within the context of person-environment may help to identify factors in the background of recovery that are overlooked and required more elaboration.

### Objectives of this dissertation

This thesis aims to provide evidence to a better understanding of recovery following PHF, with the focus on individuals' perspectives. The overarching research question of this study is:

What are the perspectives and mediators of patient perceived recovery and outcomes following PHF?

The specific research sub-questions are:

1. What prognostic factors predict recovery after PHF? A systematic review of prognostic factors predicting recovery in adults following a PHF (Manuscript 1)
2. What are the barriers/facilitators, experiences and priorities regarding recovery in patients recovering from a PHF? A cross-sectional descriptive analysis (Manuscript 2)
3. What are the barriers/facilitators, experiences and priorities regarding recovery in patients recovering from a PHF? An interpretive qualitative study (Manuscript 3)

## Overview of this dissertation

This dissertation contains three manuscripts with a separate chapter for overall discussion and conclusions. This current chapter (chapter 1) provides a brief review of previous studies on PHF and recovery to identify recent existing knowledge as they are relevant to the current study. The review of literature establishes a context for a mixed methods research in this area and serves as the backbone of this thesis. Chapter one concludes with an overview of the dissertation, the purpose of the current study and the research questions. Chapter two is a systematic review aiming to synthesize evidence of prognostic factors of recovery following a PHF, and map the identified factors into this the World Health Organization's International Classification of Functioning, Disability and Health (ICF). This systematic review provides evidence to flesh out our understanding about modifiability of factors that predict recovery after PHF. Chapter three is a cross-sectional descriptive survey study to identify experiences, facilitators and barriers presumed to be linked to recovery and exercise from patients' perspectives. Chapter four represents an in-depth insight into individuals' perceptions of recovery and exercise preferences via semi-structured interviews. Chapter five is the study's final chapter and contains an overall discussion of the results and brings together a holistic picture of this thesis work. Chapter five also covers the study's limitations, and three lay summaries of each manuscript. The chapter concludes with recommendations (implications) for further studies. Figure 4 shows the hierarchical steps of performing this thesis work.



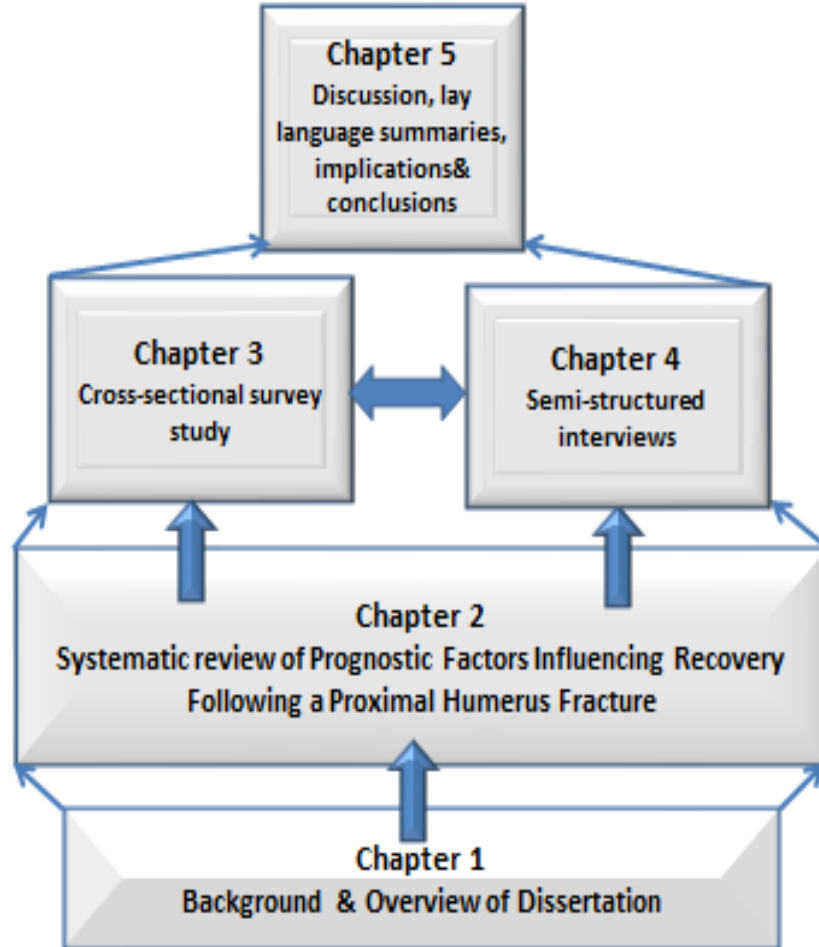


Figure 4 Schematic overview of dissertation

## References

1. Horan MA, Clague JE. Injury in the aging: Recovery and rehabilitation. *Br Med Bull.* 1999;55(4):895-909. doi:10.1258/0007142991902709
2. Lübbeke A, Stern R, Grab B, Herrmann F, Michel JP, Hoffmeyer P. Upper extremity fractures in the elderly: Consequences on utilization of rehabilitation care. *Aging Clin Exp Res.* 2005;17(4):276-280. doi:10.1007/BF03324610
3. Holloway KL, Bucki-Smith G, Morse AG, et al. Humeral fractures in South-Eastern Australia: Epidemiology and risk factors. *Calcif Tissue Int.* 2015;97(5):453-465. doi:10.1007/s00223-015-0039-9
4. Canbora MK, Kose O, Polat A, Konukoglu L, Gorgec M. Relationship between the functional outcomes and radiological results of conservatively treated displaced proximal humerus fractures in the elderly : A prospective study. 2013;7(3):105-109.
5. Court-Brown CM, Garg A, McQueen MM. The epidemiology of proximal humeral fractures. *Acta Orthop.* 2001;72(4):365-371. doi:10.1080/000164701753542023
6. Slobogean GP, Johal H, Lefavre KA, et al. A scoping review of the proximal humerus fracture literature Orthopedics and biomechanics. *BMC Musculoskelet Disord.* 2015;16(1):1-10. doi:10.1186/s12891-015-0564-8
7. Kruithof RN, Formijne Jonkers HA, van der Ven DJC, van Olden GDJ, Timmers TK. Functional and quality of life outcome after non-operatively managed proximal humeral fractures. *J Orthop Traumatol.* 2017;18(4):423-430. doi:10.1007/s10195-017-0468-5
8. Hanson B, Neidenbach P, de Boer P, Stengel D. Functional outcomes after nonoperative management of fractures of the proximal humerus. *J Shoulder Elb Surg.* 2009;18(4):612-621. doi:10.1016/j.jse.2009.03.024
9. Hodgson SA, Mawson SJ, Stanley D. Rehabilitation after two-part fractures of the neck of the humerus. *J Bone Jt Surg.* 2003;85(3):419-422.
10. Price MC, Horn PL, Latshaw JC. Proximal humerus fractures. *Orthop Nurs.* 2013;32(5):251-258. doi:10.1097/NOR.0b013e3182a39b20
11. Schumaier A, Grawe B. Proximal Humerus Fractures: Evaluation and management in the elderly patient. *Geriatr Orthop Surg Rehabil.* 2018;9:215145851775051. doi:10.1177/2151458517750516
12. Abimanyi-Ochom J, Watts JJ, Borgström F, et al. Changes in quality of life associated with fragility fractures: Australian arm of the international cost and utility related to osteoporotic fractures study (AusICUROS). *Osteoporos Int.* 2015;26(6):1781-1790. doi:10.1007/s00198-015-3088-z
13. Twiss T. (2015). Nonoperative treatment of proximal humerus fractures.(p. 23-42) In Crosby L., Neviasser R.(eds) Proximal humerus fracture.Springer,Cham
14. Han RJ, Sing DC, Feeley BT, Ma CB, Zhang AL. Proximal humerus fragility

- fractures: Recent trends in nonoperative and operative treatment in the Medicare population. *J Shoulder Elb Surg.* 2016;25(2):256-261. doi:10.1016/j.jse.2015.07.015
15. Kim SH, Szabo RM, Marder RA. Epidemiology of humerus fractures in the United States: Nationwide emergency department sample, 2008. *Arthritis Care Res.* 2012;64(3):407-414. doi:10.1002/acr.21563
  16. Launon AP, Lepola V, Saranko A, Flinkkilä T, Laitinen M, Mattila VM. Epidemiology of proximal humerus fractures. *Arch Osteoporos.* 2015;10:209. doi:10.1007/s11657-015-0209-4
  17. Olsson C, Nordqvist A, Petersson CJ. Increased fragility in patients with fracture of the proximal humerus: A case control study. *Bone.* 2004;34(6):1072-1077. doi:10.1016/j.bone.2004.01.009
  18. Lauritzen, J. Schqarz, P. McNair, B. Transbol I. Radial and humeral fractures as predictors of subsequent hip, radial or humeral fractures in women, and their seasonal variation. *Osteoporos Int.* 1993:133-134.
  19. Clinton J, Franta A, Polissar NL, et al. Proximal humeral fracture as a risk factor for subsequent hip fractures. *J Bone Jt Surgery-American Vol.* 2009;91(3):503-511. doi:10.2106/JBJS.G.01529
  20. Maravic M, Briot K, Roux C. Burden of proximal humerus fractures in the French National Hospital Database. *Orthop Traumatol Surg Res.* 2014;100(8):931-934. doi:10.1016/j.otsr.2014.09.017
  21. Hajcsar EE, Hawker G, Bogoch ER. Investigation and treatment of osteoporosis in patients with fragility fractures. *Cmaj.* 2000;163(7):819-822.
  22. Kannus P, Palvanen M, Niemi S, Sievänen H, Parkkari J. Rate of proximal humeral fractures in older Finnish women between 1970 and 2007. *Bone.* 2009;44(4):656-659. doi:10.1016/j.bone.2008.12.007
  23. Bahrs C, Bauer M, Blumenstock G, Eingartner C, Bahrs SD. The complexity of proximal humeral fractures is age and gender specific. 2013:465-470. doi:10.1007/s00776-013-0361-x
  24. Hodgson S. Proximal humerus fracture rehabilitaiton. *Clin Orthop Relat Res.* 2006;(442):131-138. doi:10.1097/01.blo.0000194677.02506.45
  25. Lee SH, Dargent-Molina P, Bréart G. Risk factors for fractures of the proximal humerus: Results from the EPIDOS prospective study. *J Bone Miner Res.* 2002;17(5):817-825. doi:10.1359/jbmr.2002.17.5.817
  26. Neuhaus V, Swellengrebel CHJ, Bossen JKJ, Ring D. What are the factors influencing outcome among patients admitted to a hospital with a proximal humeral fracture? *Clin Orthop Relat Res.* 2013;471(5):1698-1706. doi:10.1007/s11999-013-2876-z
  27. Lind T, Kroner K, Jensen J. The epidemiology of fractures of the proximal humerus. *Arch Orthop Trauma Surg.* 1989;108:285-287. doi:10.1007/BF00932316

28. Passaretti D, Candela V, Sessa P, Gumina S. Epidemiology of proximal humeral fractures: a detailed survey of 711 patients in a metropolitan area. *J Shoulder Elb Surg.* 2017;26(12):2117-2124. doi:10.1016/j.jse.2017.05.029
29. Clement ND, Duckworth AD, McQueen MM, Court-Brown CM. The outcome of proximal humeral fractures in the elderly: predictors of mortality and function. *Bone Joint J.* 2014;96-B(7):970-977. doi:10.1302/0301-620X.96B7.32894
30. Calvo E, Morcillo D, Foruria AM, Redondo-Santamaría E, Osorio-Picorne F, Caeiro JR. Nondisplaced proximal humeral fractures: High incidence among outpatient-treated osteoporotic fractures and severe impact on upper extremity function and patient subjective health perception. *J Shoulder Elb Surg.* 2011;20(5):795-801. doi:10.1016/j.jse.2010.09.008
31. Choi C, Cuomo F. Proximal humeral fractures. *Current Opinion in Orthopedics.* 2000;11:256-263.
32. Chu SP. Risk factors for proximal humerus fracture. *Am J Epidemiol.* 2004;160(4):360-367. doi:10.1093/aje/kwh224
33. Kannus P, Sievänen H, Palvanen M, Järvinen T, Parkkari J. Prevention of falls and consequent injuries in elderly people. *Lancet.* 2005;366(9500):1885-1893. doi:10.1016/S0140-6736(05)67604-0
34. Kates SL, Mears SC. A Guide to improving the care of patients with fragility fractures. *Geriatr Orthop Surg Rehabil.* 2011;2(1):5-37. doi:10.1177/2151458510397504
35. Crosby LA, Neviasser RJ. *Proximal humerus fractures.*; 2015. doi:10.1007/978-3-319-08951-5
36. Launonen A. Treatment of proximal humerus fracture. *Acta Orthop.* 2015; 86(3):280-285.
37. Lanting B, MacDermid J, Drosdoweck D, Faber KJ. Proximal humeral fractures: A systematic review of treatment modalities. *J Shoulder Elb Surg.* 2008;17(1):42-54. doi:10.1016/j.jse.2007.03.016
38. Neer C. Displaced proximal humerus fractures. *J Bone Jt Surg.* 1970;52-A(6):1077-1089.
39. Carofino BC, Leopold SS. Classifications in brief: The neer classification for proximal humerus fractures. *Clin Orthop Relat Res.* 2013;471(1):39-43. doi:10.1007/s11999-012-2454-9
40. Brorson S. Fractures of the proximal humerus. *Acta Orthop.* 2013;84(SUPPL. 351):1-32. doi:10.3109/17453674.2013.826083
41. Castoldi F, Blonna D, Assom M. *Book: Simple and Complex Fractures of the Humerus.*; 2015. doi:10.1007/978-88-470-5307-6
42. Lefevre-Colau MM, Babinet A, Fayad F, et al. Immediate mobilization compared with conventional immobilization for the impacted nonoperatively treated proximal humeral fracture: A randomized controlled trial. *J Bone Jt Surg - Ser A.*

- 2007;89 A(12):2582-2590. doi:10.2106/JBJS.F.01419
43. Jo MJ, Gardner MJ. Proximal humerus fractures. *Curr Rev Musculoskelet Med.* 2012;5(3):192-198. doi:10.1007/s12178-012-9130-2
  44. van de Water AT, Davidson M, Shields N, Evans MC, Taylor NF. The shoulder function index (SFInX): a clinician-observed outcome measure for people with a proximal humeral fracture. *BMC Musculoskelet Disord.* 2015;16(1):31. doi:10.1186/s12891-015-0481-x
  45. Jayakumar M, Overbeek CL, Lamb S, et al. What factors are associated with disability after upper extremity injuries? A systematic review. *Clin Orthop Relat Res.* 2018;476(11):2190-2215. doi:10.1097/CORR.0000000000000427
  46. Szyszkowitz R, Schippinger G. *Book: Fractures of the Proximal Humerus.* Vol 102.; 1999. doi:http://dx.doi.org/10.3109/17453674.2013.826083
  47. Pignolo R, Forcica MA. *Fractures in the Elderly.*; 1995. doi:10.1007/978-1-60327-507-1
  48. Fjalestad T, Strømsøe K, Blücher J, Tennoøe B. Fractures in the proximal humerus: Functional outcome and evaluation of 70 patients treated in hospital. *Arch Orthop Trauma Surg.* 2005;125(5):310-316. doi:10.1007/s00402-005-0803-9
  49. Brouwer ME, Reininga IHF, El Moumni M, Wendt KW. Outcomes of operative and nonoperative treatment of 3- and 4-part proximal humeral fractures in elderly: a 10-year retrospective cohort study. *Eur J Trauma Emerg Surg.* 2017;0(0):0. doi:10.1007/s00068-017-0890-7
  50. Muhm M, Bott J, Lahr C, Winkler H, Ruffing T. Outcome after operative treatment of proximal humeral fractures in elderly patients. *Z Gerontol Geriatr.* 2016;49(6):505-511. doi:10.1007/s00391-015-0954-4
  51. Van de Water ATM, Shields N, Taylor NF. Outcome measures in the management of proximal humeral fractures: A systematic review of their use and psychometric properties. *J Shoulder Elb Surg.* 2011;20(2):333-343. doi:10.1016/j.jse.2010.10.028
  52. Launonen AP, Lepola V, Flinkkilä T, Laitinen M, Paavola M, Malmivaara A. Treatment of proximal humerus fractures in the elderly. *Acta Orthop.* 2015;86(3):280-285. doi:10.3109/17453674.2014.999299
  53. Ring DC. Self-reported upper extremity health status correlates with depression. 2006:1983-1988.
  54. Roh YH, Lee BK, Noh JH, Oh JH, Gong HS, Baek GH. Effect of depressive symptoms on perceived disability in patients with chronic shoulder pain. *Arch Orthop Trauma Surg.* 2012;132(9):1251-1257. doi:10.1007/s00402-012-1545-0
  55. Nota SPFT, Spit SA, Oosterhoff TCH, Hageman MGJS, Ring DC, Vranceanu AM. Is social support associated with upper extremity disability? *Clin Orthop Relat Res.* 2016;474(8):1830-1836. doi:10.1007/s11999-016-4892-2
  56. Mahabier KC, Van Lieshout EMM, Bolhuis HW, et al. Humeral shaft fractures:

- measuring recovery after operative versus non-operative treatment (HUMMER): A multicenter comparative observational study. *BMC Musculoskelet Disord*. 2014;15(1):1-9. doi:10.1186/1471-2474-15-39
57. Torrens C, Corrales M, Vila G, Santana F. Functional and quality of life results of displaced and nondisplaced proximal humeral fractures treated conservatively. Pdf. 2011;25(10):581-587.
  58. Inauen C, Platz A, Meier C, et al. Quality of life after osteosynthesis of fractures of the proximal humerus. 2013;27(4):74-80.
  59. Handoll HGH, Ollivere BJ. Interventions for treating proximal humeral fractures in adults. *Cochrane Libr*. 2015;(11). doi:10.1002/14651858.CD000434.pub4.www.cochranelibrary.com
  60. Bruder A, Taylor NF, Dodd KJ, Shields N. Exercise reduces impairment and improves activity in people after some upper limb fractures: A systematic review. *J Physiother*. 57(2):71-82. doi:10.1016/S1836-9553(11)70017-0
  61. Par- PR, Vita DI, Foundation SL. A guide on how to develop an International Classification of Functioning, Disability and Health Core Set. 2012;48(3):1-12.
  62. Canham RB, Murthi AM, Union M, Hospital M. Upper extremity proximal humeral fractures. 2017;28(2):160-163.
  63. Iyengar JJ, Devic Z, Sproul RC, Feeley BT. Nonoperative treatment of proximal humerus fractures : A systematic review. 2011;94158:612-617.
  64. Leonard M, Mokotedi L, Alao U, Glynn A, Dolan M, Fleming P. The use of locking plates in proximal humeral fractures: Comparison of outcome by patient age and fracture pattern. *Int J Shoulder Surg*. 2009;3(4):85-89. doi:10.4103/0973-6042.63214
  65. De Kruijf M, Vroemen JPAM, De Leur K, Van Der Voort EAM, Vos DI, Van Der Laan L. Proximal fractures of the humerus in patients older than 75 years of age: Should we consider operative treatment? *J Orthop Traumatol*. 2014;15(2):111-115. doi:10.1007/s10195-013-0273-8
  66. Hageman MGJS, Jayakumar P, King JD, Guitton TG, Doornberg JN, Ring D. The factors influencing the decision making of operative treatment for proximal humeral fractures. *J Shoulder Elb Surg*. 2015;24(1):e21-e26. doi:10.1016/j.jse.2014.05.013
  67. Bahrs C, Rolaufts B, Dietz K, Eingartner C, Weise K. Clinical and radiological evaluation of minimally displaced proximal humeral fractures. *Arch Orthop Trauma Surg*. 2010;130(5):673-679. doi:10.1007/s00402-009-0975-9
  68. Südkamp NP, Audigé L, Lambert S, Hertel R, Konrad G. Path analysis of factors for functional outcome at one year in 463 proximal humeral fractures. *J Shoulder Elb Surg*. 2011;20(8):1207-1216. doi:10.1016/j.jse.2011.06.009
  69. Tamimi I, Montesa G, Collado F, et al. Displaced proximal humeral fractures: When is surgery necessary? *Injury*. 2015;46(10):1921-1929. doi:10.1016/j.injury.2015.05.049



70. Iacobellis C, Berizzi A, Biz C, Camporese A. Treatment of proximal humeral fractures with reverse shoulder arthroplasty in elderly patients. *Musculoskelet Surg.* 2015;99(1):39-44. doi:10.1007/s12306-014-0331-2
71. Calori GM, Colombo M, Bucci MS, et al. Complications in proximal humeral fractures. *Injury.* 2016;47:S54-S58. doi:10.1016/j.injury.2016.07.039
72. Boileau P, Krishnan SG, Tinsi L, Walch G, Coste JS, Molé D. Tuberosity malposition and migration: Reasons for poor outcomes after hemiarthroplasty for displaced fractures of the proximal humerus. *J Shoulder Elb Surg.* 2002;11(5):401-412. doi:10.1067/mse.2002.124527
73. Tejwani NC, Liporace F, Walsh M, France MA, Zuckerman JD, Egol KA. Functional outcome following one-part proximal humeral fractures: A prospective study. *J Shoulder Elb Surg.* 2008;17(2):216-219. doi:10.1016/j.jse.2007.07.016
74. Sirveaux F, Navez G, Roche O, Molé D, Williams MD. Reverse prosthesis for proximal humerus fracture, technique and results. *Tech Shoulder Elb Surg.* 2008;9(1):15-22. doi:10.1097/BTE.0b013e31815dca3c
75. Cabana F, Pagé C, Svtelis A, Langlois-Michaud S, Tousignant M. Is an in-home telerehabilitation program for people with proximal humerus fracture as effective as a conventional face-to face rehabilitation program? A study protocol for a noninferiority randomized clinical trial. *BMC Sports Sci Med Rehabil.* 2016;8(1):27. doi:10.1186/s13102-016-0051-z
76. Kostanjsek N. Use of the International Classification of Functioning, Disability and Health (ICF) as a conceptual framework and common language for disability statistics and health information systems. *BMC Public Health.* 2011;11(SUPPL. 4):S3. doi:10.1186/1471-2458-11-S4-S3
77. Bruder AM, Shields N, Dodd KJ, Taylor NF. Prescribed exercise programs may not be effective in reducing impairments and improving activity during upper limb fracture rehabilitation: a systematic review. *J Physiother.* 63(4):205-220. doi:10.1016/j.jphys.2017.08.009
78. Tousignant M, Giguère A-M, Morin M, Pelletier J, Sheehy A, Cabana F. In-home telerehabilitation for proximal humerus fractures: A pilot study. *Int J Telerehabilitation.* 2015;6(2):31-38. doi:10.5195/IJT.2014.6158
79. Kwan LL, Macintyre NJ, West S, West MS. Rehabilitation of proximal humerus fractures : An environmental scan of Canadian physiotherapy practice patterns rehabilitation of proximal humerus fractures : An environmental scan of Canadian physiotherapy practice patterns. 2017;(September).
80. Slobogean GP, Noonan VK, Famuyide A, O'Brien PJ. Does objective shoulder impairment explain patient-reported functional outcome? A study of proximal humerus fractures. *J Shoulder Elb Surg.* 2011;20(2):267-272. doi:10.1016/j.jse.2010.06.005
81. Roy JS, Macdermid JC, Woodhouse LJ. Measuring shoulder function: A systematic review of four questionnaires. *Arthritis Care Res.* 2009;61(5):623-632.

doi:10.1002/art.24396

82. Handoll HH, Keding A, Corbacho B, Brealey SD, Hewitt C, Rangan A. Five-year follow-up results of the PROFHER trial comparing operative and non-operative treatment of adults with a displaced fracture of the proximal humerus. *Bone Jt J.* 2017;99B(3):383-392. doi:10.1302/0301-620X.99B3.BJJ-2016-1028
83. Zirngibl B, Biber R, Bail HJ. Humeral head necrosis after proximal humeral nailing: what are the reasons for bad outcomes? *Injury.* 2016;47:S10-S13. doi:10.1016/S0020-1383(16)30847-6
84. Esen E, Dođramaci Y, Gültekin S, et al. Factors affecting results of patients with humeral proximal end fractures undergoing primary hemiarthroplasty: A retrospective study in 42 patients. *Injury.* 2009;40(12):1336-1341. doi:10.1016/j.injury.2009.06.019
85. Slobogean GP, Slobogean BL. Measuring shoulder injury function: Common scales and checklists. *Injury.* 2011;42(3):248-252. doi:10.1016/j.injury.2010.11.046
86. Kovalak E. Surgical management of 3 and 4-part proximal humerus fractures with locking plates in elderly. *J Clin Anal Med.* 2017;8(3):243-247. doi:10.4328/JCAM.4834
87. Olerud P, Ahrengart L, Söderqvist A, Saving J, Tidermark J. Quality of life and functional outcome after a 2-part proximal humeral fracture: A prospective cohort study on 50 patients treated with a locking plate. *J Shoulder Elb Surg.* 2010;19(6):814-822. doi:10.1016/j.jse.2009.11.046
88. Walton DM, Macdermid JC, Pulickal M, Rollack A, Veitch J. Development and initial validation of the satisfaction and recovery index ( SRI ) for measurement of recovery from musculoskeletal trauma. 2014:316-325.



## Chapter 2

### A systematic review of predicting factors in recovery after proximal humerus fracture in adults

#### Introduction

Proximal humerus fracture (PHF) is a common upper limb injury that may lead to ongoing disability and interfere with independent daily life <sup>1-4</sup>. The peak incidence of PHF has been reported in the 60-90 year-old group with a female to male ratio of 70:30 <sup>5</sup>. Women are more susceptible to PHF and it may be attributed to the higher frequency of osteoporosis in women <sup>6</sup>. In Ontario, at three community hospitals, 20% of visits to the outpatient fracture clinics filled for patients with PHF <sup>7</sup>. Individuals with PHF are at risk for falls and/or sustaining a hip fracture in the first year after PHF <sup>8-10</sup>. PHF and concomitant hip fracture can lead to poorer function, hospitalization, and likelihood of discharge to a facility not home <sup>3,11</sup>. Court-Brown et al <sup>4</sup> reported that PHF has the potential to significantly affect individuals' transition from an independent living to a degree of social dependency. The authors claimed that this injury often happens to the "fit elderly independent patient who is still a net contributor to society" indicating that they live at their own home, and perform their own shopping and housework (2001, p. 370).

Following PHF, evidence is conflicting in regard to recovery expectations <sup>12-14</sup>. A substantial proportion of patients may have persistent disability at one year and even 18 months <sup>15-20</sup>. Olsson et al <sup>21</sup> reported that impairments at the one-year assessment will

predict the long-term disability with 71% sensitivity for protracted pain and 88% sensitivity for persistent shoulder dysfunction. Yet, evidence also is available showing that patients will be expected to recover within six to 12 months after PHF<sup>4,22,23</sup>.

Conflicting evidence on what constitutes recovery and/or non-recovery, in part, is due to the different operationalized meanings. Also, there are numerous outcome measures to assess the extent of impairments, ongoing disability, or back to normal life after this injury. Identifying prognostic factors that are associated with future outcomes is of great value<sup>24-26</sup>. Prognosis research may simply help answer the question ‘what is the likelihood of this particular outcome in an individual with this condition’? In addition, it can help screen patients for worse outcome on early prognosis, and develop new treatment intervention strategies. To date, prognostic studies aiming at identifying important factors that affect outcome following PHF are significantly lacking<sup>1</sup>.

The purposes of this systematic review were to 1) identify the quality and content of studies addressing potential predictors of recovery and non-recovery following a PHF and, 2) to map the identified factors within the biopsychosocial health frame of the International Classification of Functioning, Disability and Health (ICF). As an extension to these purposes, modifiability of factors was also considered.

## Definitions

This study adopts the widely used biopsychosocial model of the ICF to evaluate “recovery” in the components of functioning and disability at three levels: body function and structure, activities and participation under the impact of PHF and in the personal and environmental context<sup>27</sup>. According to this holistic view, patients’ outcomes after an

injury go beyond the biological/physiological changes (at body function or structure) that reflect the health condition alone. Rather, it covers changes in the activity and participation. Tracking changes in all levels of functioning in accordance with the ICF may be useful to predict outcomes <sup>27</sup>.

A *prognostic factor* is any variable that, among people with a particular health condition, is associated with subsequent health outcome <sup>28,29</sup>. Prognostic factors are alternatively known as prognostic variables, prognostic indicators, prognostic determinants, and predictors. Prognosis research may *predict* why some factors (i.e., support, access to care) may improve future outcomes while other factors (i.e., age, co-morbidities) worsen future outcomes. In this review, any factor, denoting positive *functioning* and negative (*disability*) concepts as a result of interactions between health condition (PHF) and contextual factors is considered a potential predictor. Prognostic factors that are amenable to change are modifiable, and/or not amenable to change (non-modifiable).

## Methods

The protocol of this review was confirmed by all co-authors, and registered in the International Prospective Register of Systematic Reviews (PROSPERO) <sup>30</sup> under the registration number CRD42019116670. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed for reporting <sup>31</sup>.

## Eligibility criteria

In order to be included in the review, all studies (observational studies, follow-up and case-control studies, and experimental/clinical trials) involving individuals aged  $\geq 18$  experiencing PHF (of any severity) for which they received operative and/or non-

operative treatments were eligible. Outcomes were eligible if categorized into those assessing impairments, progress of functioning, and reduction of disability, return to daily life activities, and/or independent living, and health service use (nursing home). We decided to consider qualitative studies because drawing individuals' own values for the future outcomes adds fuel to the idea that prognostic information enhances the patient's likelihood of achieving desired future outcomes <sup>29</sup>. Studies reporting risk factors for the onset of PHF as opposed to predictors of future outcomes were excluded, as were studies presenting results of radiologic classification, specific treatments or surgical techniques with no prognostic evaluation of factors.

### Data sources and searches

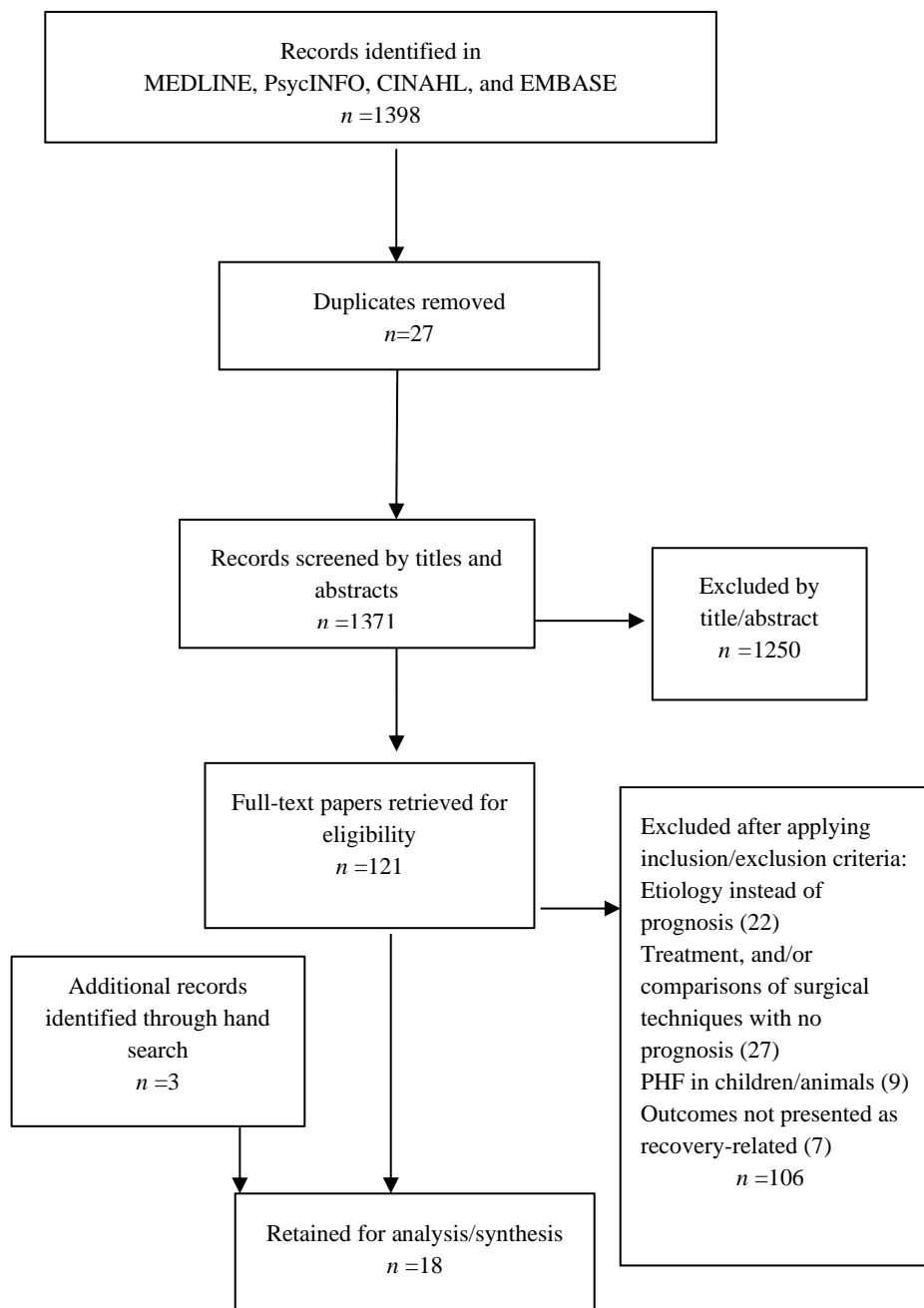
The first author (AV) and an experienced Liberian at the University of Western Ontario performed an extensive databases search in Medline and PsycINFO (via Ovid), CINAHL (via EBSCO) and EMBASE (via Elsevier) between 1980 to May 2018. The initial search strategy was performed in Medline, and adjusted to the specificities of the other databases. To identify additional studies that may have been missed in the database searches, a manual search of relevant journals and reference lists of included studies was performed.

### Study selection

A two-stage screening process was conducted by one author (AV) to assess the relevance of studies and was applied after the initial search. A total of 1398 citations were retrieved and exported into the online electronic systematic review software (Distiller SR, Ottawa, ON) for de-duplication and tracking the selection process. In the first stage, after

removing 27 duplicates, 1371 citations were screened by titles and abstracts, and 1250 references were excluded. The excluded references mainly were: radiologic classification, description or comparison of surgical techniques or treatment options with non-prognosis results, PHF in children and/or animals, reviews, protocols and commentaries. At stage two, full-text reading of potentially relevant studies for the retained 121 references was performed with regard to the pre-determined criteria (i.e., type of studies, participants, and outcomes). At this stage, 106 papers were removed on the basis of the inclusion criteria and 15 studies remained. Three papers were identified through hand-searching the reference list of included papers. As a result, a final set of 18 full-text articles were included for further analysis and synthesis (Figure 5).

Figure 5 PRISMA flow chart showing selection process of the included studies



## Data collection and synthesis

Data collected from eligible studies were: first author, publication year, details of setting, study design, sample size, gender, age, fracture type, treatment intervention, follow-up length, potential factors, outcome measurement tools, and a qualitative summary of main results. Themes relevant to patient perspectives on future recovery outcomes were collected from one qualitative study. Potential prognostic factors were categorized based on the ICF framework where recovery outcomes were associated with factors such as: health condition (primary and secondary conditions), body function and structure, activity and participation, environmental and personal, in accordance with the definitions adopted from the ICF model. Each domain was sub-categorized based on modifiability. Environmental factors were sub-classified as either facilitators or barriers based on how they were investigated in the specific study context. One independent reviewer (AV) extracted data and a second reviewer (MS) checked data for accuracy and consistency. Statistical pooling of data was not possible due to heterogeneity at many levels such as study designs, populations, outcome measurements, follow-up length, and study quality. Therefore, we opted for to conduct a narrative synthesis for reporting prognostic factors<sup>32</sup>.

## Quality assessment

The types of quality assessment tools considered in this review were mixed, because the types of studies included were mixed. The Quality in Prognosis Studies (QUIPS) tool as described by Hayden et al was used for the prospective and retrospective cohort studies<sup>33</sup>. QUIPS tool considers six domains of potential biases: participation, attrition, prognostic factor measurement, confounding measurement and handling, outcome

measurement, and statistical analysis and reporting. Each domain was assessed with modifying a list of prompting questions, scoring each question with “yes”, “no”, or “unclear” and a final evaluation for low, moderate and high risk of bias (RoB). We considered all responses to prompting questions and assessed the overall RoB in the studies. The Cochrane Collaboration’s RoB tool <sup>34</sup> was used for assessing the RCTs, comprising seven major sources of biases of randomization (sequence generation and allocation concealment), blinding (participants, health providers and outcome assessors), completeness of outcome data , selection of outcome reported. Other biases domain was used for assessing confounding variable adjusting age, gender and fracture type. The Critical Appraisal Skills Program (CASP) tool <sup>35</sup> was selected for the methodological appraisal of qualitative studies. Three researchers (AV, MS and JMD) first met for a calibration review and to clarify the meaning and interpretation of each quality appraisal tool. Two independent reviewers (AV and MS) assessed the quality of the included studies. Rating discrepancies in evaluation were discussed between AV and MS until they agreed on a consensus. All inter-rater disagreements were settled through consulting JMD.

### Levels of evidence

The strength of evidence for the potential prognostic factors was ranked using four levels of evidence based on Sackett et al <sup>36</sup> and Ariëns et al <sup>37</sup>: (i) *strong evidence*: consistent findings in at least two high quality studies, (ii) *moderate evidence*: one high quality study and consistent findings in one or multiple low quality studies (iii) *weak evidence*: findings of one cohort or consistent findings in one or more low quality studies, and (iv) *inconclusive evidence*: inconsistent findings irrespective of study quality.



## Results

### Selection of studies

The electronic searches resulted in an initial yield of 1398 hits from four databases. De-duplication and removal of irrelevant references through title and abstract screening resulted in 121 full-text papers that were assessed by the application of the inclusion criteria. At this stage, 106 papers were excluded: etiology instead of prognosis (n=22), treatment or comparison of surgical procedures with no prognostic evidence (n=27), PHF studies involving children and/or animals (n=9), and no recovery-related outcomes (n=7). As a result, the final pool of literature yielded 18 studies (including three studies through hand search) for further analysis. The PRISMA flow chart shows the process of study selection (Figure 5).

### Study characteristics

Table 1 presents a summary of characteristics from the 18 included studies<sup>3,11,16,21,24,38-50</sup>. The included studies were conducted in UK (5), Canada (3), USA (3), Germany (2), Turkey (2), Netherland (1), Switzerland (1) and Sweden (1) and published in peer-reviewed journals between 2003 and 2017. There were 10 prospective<sup>16,21,24,39,43,46-50</sup>, and six retrospective cohorts<sup>3,11,40-42,45</sup>. Of the 18 studies, one was a randomized controlled trial<sup>38</sup>, and one was a qualitative study<sup>44</sup>. A total number of 3787 patients participated in the included studies and 2486 patients (64%) completed follow-up analyses. The number of participants in quantitative studies ranged from 34<sup>47</sup> to 637<sup>3</sup>, with 9 studies enrolling more than 100 patients<sup>3,11,16,24,38,39,41,46,48</sup>. The qualitative study<sup>44</sup> enrolled 12 participants with a PHF. The average age of participants ranged from 55 to 86, of which, 76% aged 65 years or older, and 73% were female. In two studies,<sup>39,48</sup>

enrolled patients age varied from 23-94, with only 11% under 50 years of age. Fifty percent of fractures were displaced <sup>11,39-43,46,47,49</sup>, 22% nondisplaced or minimally displaced <sup>16,38,48,50</sup>, and 28% a combination of nondisplaced and displaced fractures <sup>3,21,24,44,45</sup>. A 1-year follow-up assessment was common amongst studies with the exception of a 6-month follow-up study <sup>44</sup> and a 13-year prospective follow-up study <sup>21</sup>.

Table 1 Characteristics of the included studies

Author (year) country	Study design	N Dropout Time to follow-up (Year)	Gender/ Age (SD)	Fracture type/ intervention	Potential predictors	Outcome measure	Qualitative summary of main results	RoB
Christiano (2017) <sup>46</sup> USA	Pros	172 Dropout: 25% 1 Y follow-up	65% W 61.5±13.5	Displaced/ Op	Demographics, fracture type, BMI, ROM, comorbidities, complications	DASH	Older age, lower educational level, comorbidities, post-operative complications statistically significant predictors of worse DASH BMI and fracture type not significantly associated with DASH	H
Fallatah (2008) <sup>49</sup> Canada	Retros	56 Dropout: 21% 2-4 Y follow-up	73% W 63± 11.8	Displaced/ Op	Demographics, previous shoulder surgery, residual pain levels, functional ability, ROM, strength, rotator cuff tear	ASES WORC	Previous ORIF associated with more pain and less function (ASES) Rotator cuff tear associated with more postoperative pain (WORC)	L

							Patients treated by surgeon expert trended toward a better ROM, less pain and higher WORC	
Inauen (2013) <sup>39</sup> Switzerland	Pros	269 Dropout: 37% 1 Y follow-up	77% W 72 (21-94) n=28<44 n=241(50-75+)	Displaced Op	Demographics, fracture type, QoL, recovery progress	SF-36 CS	Older age, female gender and fracture severity cumulatively predict worse results (SF-36 and CS) Older age predictor of longer period of time for recovery	H
Kovalak 2017 <sup>40</sup> Turkey	Retros	53 Dropout: 0% 1 Y follow-up	72% W 68.3±10.3	Displaced Op	Demographics, pre-operative hospitalization status, fracture type, bone healing time	CS VAS	Higher pain predicted by 4-part fracture (CS) forward elevation and abduction were inversely correlated with age and pre-operative hospitalization	M
Kozanek (2015) <sup>41</sup> USA	Retros	100 Dropout: 0% ---	77% W 68±16	Displaced Op	Demographics, public insurance, household income, length of hospitalisation, discharge disposition,	AOs	Preoperative blood transfusion more likely associated with AOs (infection etc.), less likely discharged home, and significantly longer	M

					comorbidity status		hospital stay	
LeBlanc 2015 <sup>42</sup> Canada	Retros	75 Dropout: 19% 2 Y follow-up	70.5% W 67±11.5	Displaced Op	Demographics, BMI, bone density, fracture type, hand dominance	DASH ASES SST ROM SF-12	Worse DASH, ASES, SST scores in patients with DOM– hand injuries. ROM showed higher correlations with self- reported and objective outcomes in DOM-hand PH group. Non-DOM group had average DASH and SF-12 scores near equivalent to age- matched population norms, but DOM group had approximately a 50% worse DASH and a 10% worse SF-12 score.	L
Muhm (2016) <sup>43</sup> Germany	Pros	62 Dropout: 24% 1 Y follow-up	83.9 % W 73.3± 7.6	Displaced Op	Demographics, marital status, comorbidities, fracture type, self-reliant	SF-12 BI NRS ROM	Pre-fracture higher values of SF-12 and BI are predictors of higher self-reported SF-12 and BI at 1 y	M

					exercise		Compliance to rehabilitation crucial for better outcome	
Canbora (2013) <sup>47</sup> Turkey	Pros	34 Dropout: 1 5% 1Y follow-up	72.4% W 78± 8.6	Displaced Non-op	Demographics, fracture type, dominant side PHF, comorbidities	Q-DASH CS VAS	Initial fracture comminution prognostic factor for CS at 1 y.	H
Neuhaus (2013) <sup>11</sup> USA	Retros	100 dropout: 0%	74% W 71 ± 17	Displaced Op/non-op	Demographics, fracture type, comorbidities, concomitant injuries	AOs	Older age (75+), concomitant fracture and co-morbidities significant predictors of AOs, and discharge to a facility not home	M
Olsson (2005) <sup>21</sup> Sweden	Pros	258/47 13 Y follow-up	80% W 78± 9	Displaced/ non-displaced Op/non-op	Demographics, Fracture type comorbidities	CS	Long term outcomes predicted at 1 y assessment. (i.e., existence of symptoms at 1 y assessment will probably remain)	H
Sudkamp (2011) <sup>24</sup> Germany	Pros	514 Dropout: 1 0% 1 Y follow-up	72% W 73 ± 12.3	Displaced/ non-displaced Op/non-op	Demographics, fracture type, concomitant injuries	CS	Age, female gender, treatment, surgery technique, intra/post op complications and varus deformity negative predictors of CS at 1 y.	L

Clement (2014) <sup>3</sup> UK	Retros	637 Dropout: 24% 1 Y follow-up	82.4% W 76.9 (65-98)	Displaced/ non-displaced Non-op	Demographics, fracture type, employment, shopping, dressing, recreation, living in own home	CS	Factors related to social independent function predict post- fracture CS at 1 y. No association between gender/ age and recovery of function	M
Poeze (2010) <sup>45</sup> The Netherland	Pros	101 Dropout: 40% 1.4-5.2 Y follow-up	74.5% W 70±10	Minimally displaced Non-op	Demographics, fracture type, # of fracture parts,	DASH CS ROM Strength	Angular deformity significant predictor of DASH & CS at a median 2.2 y of follow-up.	M
Gaebler (2003) <sup>50</sup> UK	Pros	507 Dropout: 26% 1 Y follow-up	72% W 66 (mean)	Minimally displaced Non-op	Demographics, time taken to recovery	Neer score	Age and pre-fracture functional ability are predictors of good or poor post-fracture results (i.e., time taken to return to activities and social roles (dressing, personal hygiene, driving, housework, employment and shopping) correlated with age	H
Court- Brown (2004) <sup>48</sup> UK	Pros	133 Dropout: 24% 1 Y	NS 68 (23-94) 89% >50	Minimally displaced Non-op	Demographics, return to routine activities,	Neer score	Decreased shoulder function associated with older age Faster return to daily	H

		follow-up					activities can be expected in younger patients	
Hanson (2009) <sup>16</sup> UK	Pros	160 Dropout: 22.5% 1 Y follow-up	73.8% W 63.3 ± 14.8	Minimally displaced Op/non-op	Demographics, profession, bone density, smoking, concomitant diseases and medication, fracture type	DASH	Smokers have a 2.5 for increased risk of impingement syndrome and 5.5 times for nonunion compared with non-smokers.  Employment is predictor of lower difference between DASH scores (pre and post injury) compared to part-time, unemployed status	L
Hodgson (2003) <sup>38</sup> UK	<b>RCT</b>	86 Dropout: 6% 4 M & 1 Y follow-up	81% W 70.±12.5	Minimally displaced Non-op	Demographics Fracture type, Dominant-side Injury, BMI	CS SF-36	Immediate rehabilitation showed less pain, less problems with work and other activities at 16 wk and 1 y assessment compared to delayed rehab post-fracture	L



Hara 2017 <sup>44</sup> Canada	<b>Qual.</b>	12 Dropout: 8% 6 M follow-up	64% W 68 (60-87)	Displaced/ Non-displaced Op/non-op	Demographics, fracture type, level of function, education level	Interview questions	Rehabilitation, support services, patient engagement access to information are likely to improve recovery (emerged themes)	M
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AOs= adverse outcomes; ASES= American Shoulder and Elbow Surgeons; BI= Barthel Index; CS= The Constant Score; DASH= Disabilities of the Arm, Shoulder and Hand; NRS= numeric rating scale; Non-op= non-operative; Op= operative; RoB= risk of bias; SST= the Simple Shoulder Test; VAS= Visual analogue Scale; WORC= Western Ontario Rotator Cuff Index; W=women

Table 2 Quality assessment using QUIPS tool (Cohort studies, n=16)

Study	Domains						
	Study participatio n	Study attrition	Prognostic factor	Outcome	Confounding factor	Statistical analysis	Overall RoB
Canbora 2013 <sup>47</sup>	L	L	M	M	H	H	H
Christiano 2017 <sup>46</sup>	H	H	M	M	M	M	H
Clement 2014 <sup>3</sup>	M	M	M	M	M	L	M
Court-Brown 2004 <sup>48</sup>	M	H	H	H	H	H	H
Fallatah 2008 <sup>49</sup>	L	L	M	L	M	L	L
Gaebler 2003 <sup>50</sup>	L	H	H	H	H	H	H
Hanson 2009 <sup>16</sup>	M	M	L	L	L	L	L
Inauen 2013 <sup>39</sup>	H	H	L	L	H	H	H
Kovalak 2017 <sup>40</sup>	L	L	M	M	M	M	M
Kozanek 2015 <sup>41</sup>	L	L	L	M	M	L	M
LeBlanc 2015 <sup>42</sup>	L	M	L	L	M	L	L
Muhm 2016 <sup>43</sup>	M	H	M	M	M	M	M
Neuhaus 2013 <sup>11</sup>	L	M	M	M	M	M	M
Olsson 2005 <sup>21</sup>	H	H	M	M	H	M	H
Poeze 2010 <sup>45</sup>	L	M	M	M	M	M	M
Sudkamp 2011 <sup>24</sup>	L	M	L	L	L	L	L

H= high; M=moderate; L=low; RoB=risk of bias

Table 3 Quality assessment of the included RCT using Cochrane Collaboration's tool

Hodgson et al<sup>38</sup>

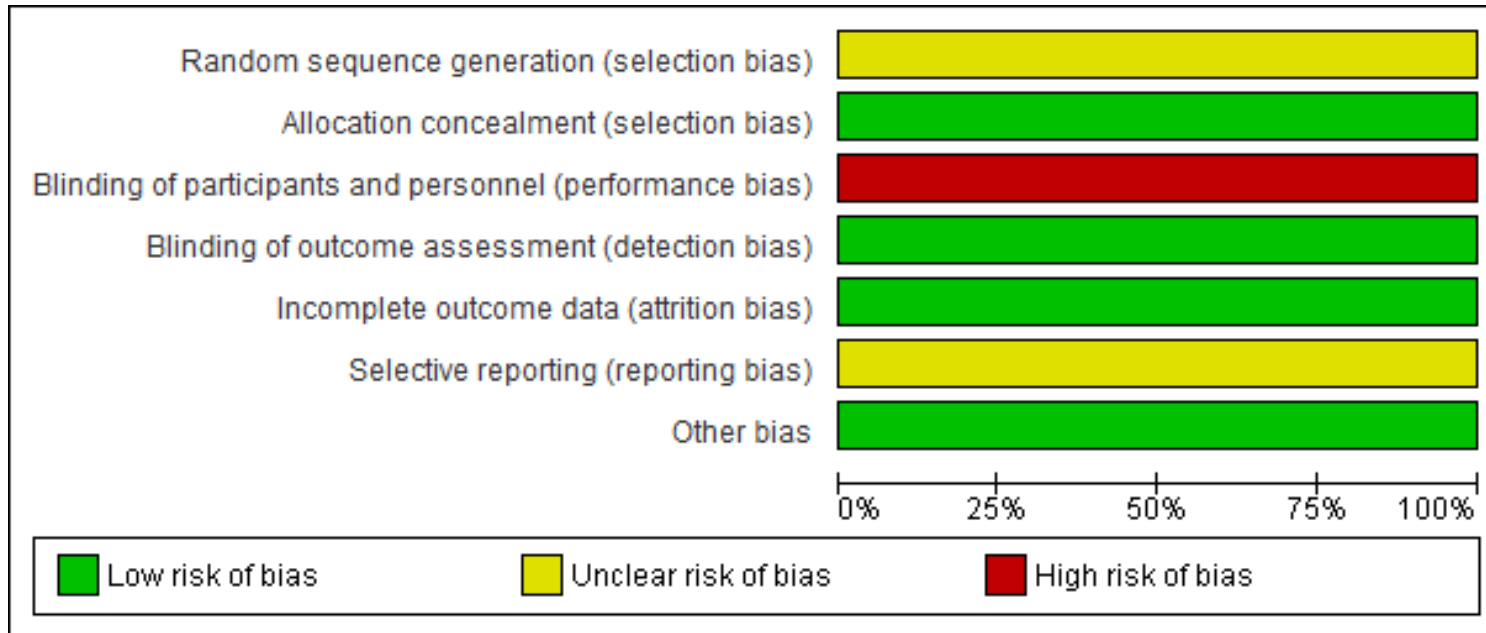


Table 4 Methodological assessment of the included qualitative study using CASP tool

Hara et al <sup>44</sup>

<ol style="list-style-type: none"> <li>1. Was there a clear statement of the aims of the research?</li> <li>2. Is a qualitative methodology appropriate?</li> <li>3. Was the research design appropriate to address the aims of research?</li> <li>4. Was the recruitment strategy appropriate to the aims of the research?</li> <li>5. Was the data collected in a way that addressed the research issue?</li> <li>6. Has the relationship between researcher and participants been adequately considered?</li> <li>7. Have ethical issues been taken into consideration?</li> <li>8. Was the data analysis sufficiently rigorous?</li> <li>9. Is there a clear statement of findings?</li> <li>10. How valuable is the research?</li> </ol>	<p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Partially</p> <p>Yes</p> <p>No</p> <p>Yes</p> <p>Partially</p> <p>Yes</p> <p>Valuable</p>
Overall quality	<b>Moderate</b>

## Outcomes

Fourteen validated outcome measures were identified in 18 studies (Table 1). The most commonly self-reported measurement was the Disability of the Arm, Shoulder and Hand (DASH)<sup>16,42,45-47</sup>, followed by the American Shoulder and Elbow Surgeons Shoulder Score (ASES)<sup>42,49</sup>, Western Ontario Rotator Cuff (WORC)<sup>49</sup>, Barthel Index (BI)<sup>43</sup>. Pain intensity was measured by a visual analogue scale (VAS)<sup>40,47</sup> and Numeric Rating Scale (NRS)<sup>43</sup>. A mix of both subjective and objective tools were Constant score (CS)<sup>3,21,24,38-40,45,47</sup>, and Neer rating<sup>48,50</sup>. Range of motion was measured in three studies<sup>42,43,45</sup>. Muscle strength was measured in one study<sup>45</sup>. The generic health status (quality of life) comprising subscales of physical functioning, role functioning, bodily pain, social functioning and mental functioning was assessed using Short-Form 36 (SF-36) and (SF-12) in four studies<sup>38,39,42,43</sup>. Each outcome measure had a different number of questions or items.

## Quality assessment

Sixteen longitudinal cohort studies<sup>3,11,16,21,24,39-43,45-50</sup> were assessed using QUIPS tool. Four studies<sup>16,24,42,49</sup> had overall low RoB, six studies<sup>3,11,40,41,43,45</sup> had moderate RoB, and six studies<sup>21,39,47,48,50</sup> had high RoB. The main reasons for RoB were attrition rate >20% in six studies (Christiano et al. 2017; Court-Brown and McQueen 2004; Inauen et al. 2013; Muhm et al. 2016; Olsson, Nordquist, and Petersson 2005; Gaebler, MM, and CM 2003), study confounding in five studies<sup>21,39,47,48,50</sup> and inappropriate statistical analysis for the study design or lack of reporting transparency in four studies<sup>39,47,48,50</sup>. A summary of quality assessment for 16 prospective and retrospective cohort studies is

displaced in Table 2. The RoB of the included RCT<sup>38</sup> was low using Cochrane Collaboration's tool (Table 3). The methodological appraisal of one qualitative study<sup>44</sup> was moderate using CASP tool (Table 4). Overall, five of the 18 studies (28%) had low RoB, seven studies (39%) were of moderate and six studies (33%) of high RoB. Reviewers (AV, MS, JMD) independently assessed the included papers and discussed discrepancies until consensus was reached for final decisions.

## Prognostic factors

A total of 23 factors, and 4 themes were identified as correlates of recovery after PHF.

We mapped potential factors into the biopsychosocial framework of the ICF (Table 5). A brief description of factors with the graded strength of evidence is presented in this section beginning with factors related to the health condition (including injury, diagnosis, and treatment-related factors), followed with factors linked to main components of functioning (body function and structure, activity, and participation), and the environment-person context. A summary of the themes related to recovery is also presented from the only included qualitative study.

## Health conditions

**Injury, diagnosis, and treatment-related factors.** Several studies examined the relationships between health-condition-related factors and recovery. Evidence was graded weak for previous fractures, concomitant fractures, comorbidities, number of medication intake, chronic alcoholism, rotator cuff tear, surgical treatment of PHF, and pre-operative blood transfusion. One low RoB study showed that previous fractures, and concomitant multiple fractures increase the likelihood for discharge to a facility not home <sup>11</sup>. Two studies (one moderate and one high RoB) <sup>11,46</sup> looked into the role of comorbidities and reported that co-existent morbidities such as diabetes mellitus, obesity, chronic pulmonary disease, chronic coronary heart disease, and congestive heart failure were predictors for discharge to a short or long-term facility not home in patients with PHF <sup>11</sup>. Diabetes was a significant predictor of worse DASH score, and was associated with

delayed fracture healing and poor shoulder function<sup>46</sup>. A significant correlation was observed between the number of medication intake and one-year follow-up assessment<sup>21,43</sup>. Chronic alcoholism was a factor of increasing adverse outcomes following PHF in one moderate RoB study<sup>11</sup>. Patients with a rotator cuff tear had lower scores on the WORC functional outcomes and more severe pain than those with no tear in a low RoB study<sup>49</sup>. One low RoB study<sup>24</sup> reported that the surgical treatment (vs. non-surgical treatment) of PHF was a prognostic factor associated with better outcome, particularly, in active, younger and healthier patients with PHF. Pre-operative blood transfusion was independently associated with increased odds for adverse outcomes including surgical site infection, pulmonary embolism, etc., and patients, who received blood transfusion before operation, had a significantly longer hospital stay and were less frequently discharged home in a moderate RoB study<sup>11,41</sup>. Evidence was moderate for the presence of intra/postoperative complications leading to the worse functional outcomes in two studies with low and moderate RoB<sup>24,46</sup>. Patients with intra/post-treatment complications had significantly lower mean CS values (-4.1 and -7) than those without<sup>24</sup>. Similarly, postoperative complications (i.e., screw penetration, avascular necrosis, infection and so on) were adverse outcomes among older adults undergoing surgery, and a significant predictor of worse DASH score independently where adjusted for factors comorbidities, age and education level<sup>46</sup>.

Evidence, however, was inconclusive for the type of fracture (as defined by Neer and AO classifications), and anatomical deformity (i.e., varus/valgus angulation). Nine studies<sup>3,16,24,39,43,46,47,49,50</sup> differently reported on the prognosis value of the fracture type on



recovery-related outcomes. Fracture displacements and/or number of fragments were statistically significant predictors of worse functional scores in five studies<sup>3,16,39,43,47</sup>. One low RoB study reported that patients with 3-, and 4-part fractures were 3.7 times more likely to experience an intraoperative complication compared to those with minimally displaced fracture<sup>24</sup>. However, the results of three studies<sup>46,49,50</sup> did not support the notion that the fracture type is a prognosis of poorer functional outcome after PHF. The risk of experiencing varus or valgus angulation of greater than 30° was an important predictor of the functional outcome as examined in three studies<sup>21,24,45</sup> but this anatomical malunion did not have any association with decreasing function in two studies<sup>47,48</sup>.

### Activity and participation

Evidence was graded limited for the pre-fracture social independence including living in own home, dressing, shopping, recreation, and being employed. A retrospective study with moderate RoB evaluated measures of social independence association with recovery, and reported that individuals' pre-fracture independence level significantly predicts CS mean at one year follow-up when controlling for age and gender, and the fracture severity<sup>3</sup>. Gaebler et al<sup>50</sup> found that the ability to undertake their own shopping (independently) following PHF was the only determinant of satisfactory recovery. One moderate RoB study<sup>43</sup> found that displaying pre-fracture physical health and scoring between 50-100 on the Barthel index was an independent predictor of returning to usual activities and roles at one-year assessment following PHF. Work status was also a predictor of outcome showing that employed patients had less functional limitations at

one-year follow-up assessment compared to unemployed and part-time employed individuals with PHF. This study showed the smaller differences in pre and post fracture DASH ratings for >75% of employed PHF patients compared to part-time or unemployed patients.<sup>16</sup> The influence of healthy worker index on achieving solid healing, sufficient function and strength to return to work post-fracture was claimed in this low RoB study.

### Environmental factors

Three environmental factors (facilitators) were identified, including rehabilitation, surgeon's expertise and surgical procedures. Evidence was graded moderate for the role of immediate rehabilitation on predicting the recovery-related outcomes in two high and moderate RoB studies<sup>38,50</sup>. Participants who started immediate physiotherapy within one week following PHF had less pain, and experienced less problems with work and other activities at 16 weeks and one-year assessment compared to controls that began rehabilitation after three weeks in a study with low RoB<sup>38</sup>. The length of rehabilitation was positively correlated with the Neer score at one year assessment when the results was adjusted for age in a study with high RoB<sup>50</sup>. A comparison of WORC scores showed that patients who were treated by shoulder specialists trended toward a better ROM, less pain and higher shoulder function compared to those who treated by non-specialists<sup>49</sup>. One study with low Rob showed that surgical procedures, for example, the locking proximal humeral plate (LPHP) fixation led to significantly less shoulder function compared with proximal humerus nail (PHN)<sup>24</sup>.

## Personal factors

Six personal factors were investigated: the post-fracture compliance to exercise, lower educational level, handedness, and smoking with weak evidence; and age and gender with inconclusive evidence. Compliant participants (61%) to rehabilitation exercises within the first three months after PHF significantly showed higher range of motion, and coped with daily activities at one-year follow-up assessment in a moderate RoB study<sup>43</sup>. One high RoB study observed the association of lower educational level and poorer recovery<sup>46</sup>. One low RoB study<sup>42</sup> reported that patients with PHF had 50% less DASH scores on the dominant hand in comparison to the non-dominant hand injury. Being a smoker showed 5.5 times likelihood of delayed bone healing and bone nonunion compared with non-smokers in a study with low RoB<sup>16</sup>. Age was examined in nine studies<sup>3,11,24,39,40,46-50</sup> with conflicting results. Six studies<sup>11,24,40,46,48,50</sup> showed that the older the patient at the time of PHF, the worse the outcome.

Age was the main predictor of the time taken to return to daily activities<sup>50</sup>, slower rate of functional progress<sup>24,39,40</sup>, and the increased likelihood for nursing home care in patients older than 75<sup>11</sup>. Other studies, however, observed no association between age and recovery-related outcomes<sup>3,47,49</sup>. In regard to gender, two studies<sup>24,39</sup> reported that men had higher CS (by 8 and 4.9 points, respectively) compared with those assessed for women but gender did not show any negative association with outcome in other studies<sup>11,38</sup>.

## Themes

Rehabilitation, emerged as the first most important theme within one-month and at six-month post-fracture for participants in a qualitative study <sup>44</sup>. Other themes were support services from family and healthcare system, and health literacy in this study with moderate methodological quality. Health literacy about the course of recovery (aligns with the patient engagement ) emerged as a theme encompassing knowledge of the injury, treatment and recovery leading to improved clinical and patient outcomes <sup>44</sup>. The less frequent theme in this study was access to information about the injury and treatment.

## Discussion

Following an injury, valid and reliable evidence about the expected course and outcome (desirable and undesirable) are important because patients want to know about the likely course of the condition and, healthcare professionals want to discover and evaluate new approaches to patient management <sup>29</sup>. This systematic review was an attempt to identify what will occur in the course of recovery after PHF. We found from the 17 quantitative and one qualitative studies (n=3787) a diverse range of 23 potential factors, and four themes, that were associated with recovery outcomes. Using the biopsychosocial framework of the ICF, recovery outcomes were influenced by prognostic factors in all ICF domains. The most common factors associated with negative outcome were tapped into the health condition covering pre-fracture health history, current diagnoses and post-fracture treatment-related factors. Of the 23 prognostic factors that have been examined, two factors with moderate evidence were rehabilitation, and intra/post-operative

complications associated with positive and negative outcomes respectively. Evidence was graded weak for the majority of factors (n=17, 74%) including presence of previous fractures, concomitant fracture(s), co-morbidities, number of medication intake, chronic alcoholism, rotator cuff tear, surgical treatment of PHF, pre-operative blood transfusion; pre-fracture social independence, pre-fracture physical health, being employed; post-fracture compliance to exercise, education level, handedness, and smoking; surgeons' expertise, and surgical procedures. The type (severity) of PHF, varus/valgus malunion, age and gender (n=4, 17%), were the most common examined factors but with conflicting evidence. The discrepancies of evidence for these factors were, in part, due to the considerable underlying heterogeneity of the individuals, outcome measures, and the study design of the included studies (Table 5).

Identifying prognostic factors based on their modifiability is of utmost importance because this acknowledges that early identification of modifiable factors could respond to new interventions in the recovery course following an injury. Of the 23 prognostic factors, 15 were non-modifiable in progressing slower recovery and/or non-recovery process. Although, the role of non-modifiable factors, cannot be underestimated to accurately evaluate at-risk individuals, and can be seen as more exhaustive monitoring of them, the predictive capacity of modifiable factors needs to be also highlighted more rigorously because the role of these factors are usually not direct. Due to the weak and/or conflicting evidence, it remained difficult for us to determine a clear set of factors across the injury, diagnosis and treatment with the magnitude and direction of negative association with recovery outcomes. However, our findings are consistent with previous

research reporting relationships between multiple health conditions and undesirable outcomes following a fracture. There is also research data that mediating factors can positively change potential future outcomes depending on the severity of health conditions.

As it relates to activities and participation domains, our research data showed that the pre-fracture social independence was more influential upon outcome regardless of fracture severity, age and gender <sup>3</sup>. This factor is seen in a positive light when patients with PHF are considered for participating in clinical trials or surgical interventions. Other investigators showed that pre-fracture low level of independence was a predictor of negative outcome in a group of elderly with hip fracture <sup>51</sup>. As living independently at home is one salient recovery wish for older people <sup>3,48</sup>, more subjective assessments of functional limitations and participation restrictions are needed when planning for better outcomes in patients with PHF. Interestingly, being employed was markedly a predictor of less limitations at one-year assessment where employed patients showed a higher likelihood of achieving bone healing, functional ability and strength to return to work in shorter time compared to non-employed or part-time employees <sup>16</sup>. Prompt assessment of the patients' social roles is an important point in regard to future outcome, and may assist health professionals in directing interventions for improving outcomes in general. A relatively old study showed a positive relationship between independence in activities and return to work in patients with hand injuries <sup>52</sup>.

Table 5 Strength and direction of evidence of potential factors associated with recovery

Prognostic factor	No. of studies	Association (Yes/No)	Direction of association	Level of evidence
<b>Health condition</b>				
<b>Injury, diagnosis, and treatment</b>				
Previous fracture(s)	(1) <sup>11</sup>	Y	↓	Weak
Concomitant fracture(s)	(1) <sup>11</sup>	Y	↓	Weak
Comorbidities	(2) <sup>11,46</sup>	Y	↓	Weak
No. of medication intake	(2) <sup>21,43</sup>	Y	↓	Weak
Chronic alcoholism	(1) <sup>11</sup>	Y	↓	Weak
Rotator cuff tear	(1) <sup>49</sup>	Y	↓	Weak
Surgical treatment of PHF	(1) <sup>24</sup>	Y	↓	Weak
Pre-operative blood transfusion	(2) <sup>11,41</sup>	Y	↓	Weak
Intra/post-operative complications	(2) <sup>24,46</sup>	Y	↓	<b>Moderate</b>
Type of fracture (PHF)	(5) <sup>3,16,24,40,44,48</sup> (3) <sup>46,49,50</sup>	Y N	↓ 0	Inconclusive
Malunion (varus/valgus)	(3) <sup>21,24,45</sup> (2) <sup>47,48</sup>	Y N	↓ 0	Inconclusive
<b>Activity and participation</b>				
Pre-fracture social independence	(2) <sup>3,50</sup>	Y	↑	Weak
Pre-fracture physical health	(1) <sup>43</sup>	Y	↑	Weak
Being employed	(1) <sup>16</sup>	Y	↑	Weak
<b>Personal</b>				
Post-fracture compliance to exercise	(1) <sup>43</sup>	Y	↑	Weak
Lower educational level	(1) <sup>46</sup>	Y	↓	Weak
Handedness	(1) <sup>42</sup>	Y	↓	Weak
Smoking	(1) <sup>16</sup>	Y	↓	Weak
Age	(6) <sup>11,24,40,46,48,50</sup>	Y	↓	Inconclusive
	(3) <sup>3,47,49</sup>	N	0	
Gender	(2) <sup>24,39</sup> (2) <sup>11,38</sup>	Y N	↓ 0	Inconclusive
<b>Environmental</b>				
Immediate rehabilitation	(2) <sup>38,50</sup>	Y	↑	<b>Moderate</b>
Surgeon experience	(1) <sup>49</sup>	Y	↑	Weak
Surgical procedures (techniques)	(1) <sup>24</sup>	Y	↑	Weak
<b>Themes</b>				
Rehabilitation	(1) <sup>44</sup>	Y	↑	
Support services	(1) <sup>44</sup>	Y	↑	
Health literacy (patient engagement)	(1) <sup>44</sup>	Y	↑	
Access to information	(1) <sup>44</sup>	Y	↑	

NOTE: 0= no association provided; ↑= predictive of a positive outcome; ↓=predictive of a negative outcome

Table 6 Classified prognostic factors (including themes) by their modifiability

	<b>Non-modifiable</b>	<b>Modifiable/potential modifiable</b>
Health condition	Previous fracture(s) Concomitant fracture(s) Comorbidities Chronic alcoholism Rotator cuff tear Type of fracture Malunion (varus/valgus)	Pre-operative blood transfusion Intra/post-surgical complications Surgical treatment of PHF # of medication intake
Body function and structure		
Activity and participation	Pre-fracture social independence Pre-fracture physical health Being employed	
Personal factors	Age Gender Educational level Handedness Smoking	Post-fracture compliance to exercise
Environmental factors		Immediate rehabilitation Surgeon' expertise Surgical procedures (technology)
		<b><u>Themes</u></b> Rehabilitation Support services Health literary (patient engagement) Access to information



We identified, amongst other factors pertinent to the course of recovery, a number of personal and environmental factors. Personal and environmental factors, are said to act as facilitators or barriers across the ICF components<sup>53,54</sup>. The contextual factors may account for some of the unexplained variance in prognostic studies<sup>55</sup>. According to the ICF, variables allocated to the individuals' personal factors comprised features that are either inherent (age, gender) or acquired (education level, compliance to exercise, and smoking). Although these factors are not part of a health condition that all or any of which can partly (but not completely) mediate a health condition, and a person's functioning. Personal factors are not currently classified in the ICF due to the large social and cultural variance between individuals<sup>27</sup>. However, they have considerable role in functioning and disability at any level in creating a filter which interacts with an individual's personal perception of their own health condition. A key finding that has come to light as a result of this review, was the positive effect on the outcome at one-year for those who self-reliantly exercised within the first three months after their PHF<sup>43</sup>. There is evidence to support the role of post-fracture exercise in reducing impairments and improving upper limb function following upper limb fractures<sup>56</sup>. However, it seems that exercise is more likely to reduce impairments, especially range of movement, than improvements in activity limitations, as stated by Bruder et al<sup>56</sup>. However, compliance to exercise is a complex, continuous and dynamic process that is frequently compromised by other factors. In the Adherence Model, developed by the World Health Organization<sup>57</sup>, improving compliance is said to depend on the social and economic factors, the health care system, the characteristics of a health condition, and other patient-related

factors. Early discussion about the recovery expectations may be a strong determinant for compliance to exercise after PHF. Among nonmodifiable personal factors associated with poor outcome were age and female gender. None of these two factors were considered as definitive and direct predictors of poor or non-recovery. As such, we could not come to any firm conclusions regarding these two factors. Overall, we believe that in considering age and gender issues, a broader range of other personal experiences need to be considered to enable us to gain a more complete understanding of the impact of these factors on recovery outcomes. Future research can further improve our understanding of the impact of gender on the complex and dynamic PHF recovery course.

The environmental factor with the positive capacity of predicting recovery outcomes was rehabilitation with moderate evidence. Early rehabilitation in conjunction with educating patients about the benefits of early mobilization, led to restore normal shoulder function, reducing pain and coping with daily activities at six-month follow-up in the RCT <sup>38</sup>. The positive role of early mobilization within the first week of PH injury confirmed reducing pain and improving shoulder activity compared with delayed mobilization in a recent systematic review <sup>58</sup>. However, rehabilitation and its positive prognostic role still need more clarification because the relationships between the ICF components of contextual factors are dynamic and complex. For instance, patients with various health conditions might not be ready to start rehabilitation exercise immediately after the injury. Or, looking into the real-life situations, access to rehabilitation for all populations is not equal in order to predict comparable results. An additional example is the availability of an experienced surgeon that positively influences the final outcome following PHF. But

the treating surgeon ultimate decision is based on the patient's factors such as quality of bone, age, finances and so on. Hence, the expertise of the surgeon does not have the same influence under different personal factors. This suggests that even though a factor may be modifiable in theory, it may not always represent an amenable target in practice. Personal and environmental factors and how they predict positive and negative outcome may turn out to be a crucial aspect of further research.

Despite growing evidence regarding the impact of psychological traits (the ability to see the positives in stressful situations like an injury), we did not find any evidence for the prognostic importance of psychosocial factors in the reviewed studies. The role of psychological factors, however, has well-documented in other research. Regardless of anatomical site, evidence suggests that the musculoskeletal conditions often share a similar clinical course on average, and similar prognostic factors may predict outcome <sup>59</sup>.

As noted earlier, this review planned to include findings from quantitative and qualitative studies to present a comprehensive context and evidence on recovery (but not evidence of effectiveness) through a biopsychosocial window. Evidence from qualitative studies can play an important role in adding value to systematic reviews for policy, practice and patient centered care decision-making <sup>60</sup>. In spite of evidence from effectiveness, individuals' experiences and views shed some lights on the factors that may predict recovery outcomes. Understanding factors that put patients into the risk of non-recovery is a vital step into planning and organizing their treatment plan and therefore, patients should be assessed based on their individual circumstances, taking into account their

opinions as potential facilitators or barriers in their recovery. In the reviewed qualitative study, when asked about what could improve recovery, Individuals' answers emerged as four important themes: rehabilitation, support services, health literacy (aligns with patient's engagement), and access to information. Rehabilitation, in this study, was an important short-term and long-term theme in the recovery course as stated by patients with PHF<sup>44</sup>. Participants either treated surgically or non-surgically perceived the role of rehabilitation in achieving their future outcome as a positive factor. The focus on rehabilitation is a reflective of patients' preferences, and needs and their desire to know how this injury affects them in the future. Support services, and education were also themes emerged from this semi-structured interview with positive impact on the recovery from PHF. Educating patients to take an active role in their health care increasing the anticipated desirable outcomes as perceived by participants<sup>61</sup>. Other investigators reported that this factor provides opportunities to them to take active role in their recovery and reinforces active coping strategies for daily challenging after a hip fracture<sup>62</sup>. The level of engagement in activities performed within the context of everyday life (i.e., participation as defined by the ICF), particularly work, family and leisure activities, are seen as an important predictor. Patient engagement may have an overlapped implication with participation domain. Participation is a complex construct and is strongly influenced by environmental factors. Engagement opportunities in the recovery process was a theme implying the positive impact on recovery as expressed by the patients with PHF<sup>44</sup>. The level of engagement in activities performed within the context of everyday life (i.e., participation as defined by the ICF), particularly work, family and

leisure activities, are seen as an important predictor. Although limited, this finding reflects functioning from the perspective of the individuals and provides a useful construct to support the process of patient engagement within the ICF model <sup>27</sup>.

### Strengths and limitations

Use of the biopsychosocial frame of the ICF enabled us to identify various combinations of factors that are positively or negatively associated with recovery after PHF. This review highlighted a number of key modifiable factors that can inform interventions targeting recovery outcomes. Including a quantitative study was based on an idea that information about probabilities must be ultimately about shared decision with the patients. Our review also has limitations. Admittedly, including studies with different designs and appraisals was challenging; this made synthesizing difficult. As such, the results of this review should be interpreted with caution. Including participants with any type of PH fracture who received surgical and non-surgical treatments, was a limitation because it made the estimation of prognosis across different subgroups of individuals difficult. The risk of selection bias may have also been considered since the initial screening of titles and abstracts was performed by one reviewer instead of two.

### Implications

A number of different groups including researchers, health professionals and individuals with PHF could leverage the findings of this review. Identifying more modifiable factors, that have yet to be uncovered, are important predictors and likely help inform better recovery process. Evaluating the strength of associations between modifiable factors and recovery will generate new knowledge by the researchers. This, in turn, is a step toward

translational pathway for developing new interventions. Also, there is no doubt that the treatment-related factors can assist health professionals with providing more accurate prognoses. The risk of adverse outcomes, hospital stay, and discharge to a facility not home raise the question whether specific characteristics of individuals can explain new ways of management and whether this might lead to new intervention targets. Post-fracture compliance to rehabilitation exercise, support services, and providing health education to patients are promising factors in engagement of patients during the transition period from an injury to recovery, which their prognostic value, as of yet, is unclear.

### Conclusion

This review showed that prognostic factors of recovery and/or non-recovery are multifactorial and not associated with the injury alone. Identification of different factors associated with recovery makes it possible to monitor at-risk patients with PHF for additional care, and to develop interventions targeted at more modifiable factors, as their roles is yet unclear. This review reinforces using the inclusive ICF framework to disentangle the complex factors predicting recovery following PHF.

## References

1. Slobogean GP, Johal H, Lefavre KA, et al. A scoping review of the proximal humerus fracture literature Orthopedics and biomechanics. *BMC Musculoskeletal Disord.* 2015;16(1):1-10. doi:10.1186/s12891-015-0564-8
2. Launonen AP, Lepola V, Flinkkilä T, Laitinen M, Paavola M, Malmivaara A. Treatment of proximal humerus fractures in the elderly. *Acta Orthop.* 2015;86(3):280-285. doi:10.3109/17453674.2014.999299
3. Clement ND, Duckworth AD, McQueen MM, Court-Brown CM. The outcome of proximal humeral fractures in the elderly: predictors of mortality and function. *Bone Joint J.* 2014;96-B(7):970-977. doi:10.1302/0301-620X.96B7.32894
4. Court-Brown CM, Garg A, McQueen MM. The epidemiology of proximal humeral fractures. *Acta Orthop.* 2001;72(4):365-371. doi:10.1080/000164701753542023
5. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. *Injury.* 2006;37(8):691-697. doi:10.1016/j.injury.2006.04.130
6. Launon AP, Lepola V, Saranko A, Flinkkilä T, Laitinen M, Mattila VM. Epidemiology of proximal humerus fractures. *Arch Osteoporos.* 2015;10:209. doi:10.1007/s11657-015-0209-4
7. Hajcsar EE, Hawker G, Bogoch ER. Investigation and treatment of osteoporosis in patients with fragility fractures. *Cmaj.* 2000;163(7):819-822.
8. Clinton J, Franta A, Polissar NL, et al. Proximal humeral fracture as a risk factor for subsequent hip fractures. *J Bone Jt Surgery-American Vol.* 2009;91(3):503-511. doi:10.2106/JBJS.G.01529
9. Lauritzen, J. Schqarz, P. NcNair, B. Transbol I. Radial and Humeral Fractures as Predictors of Subsequent Hip, Radial or Humeral Fractures in Women, and their Seasonal Variation. *Osteoporos Int.* 1993:133-134.
10. Maravic M, Briot K, Roux C. Burden of proximal humerus fractures in the French National Hospital Database. *Orthop Traumatol Surg Res.* 2014;100(8):931-934. doi:10.1016/j.otsr.2014.09.017
11. Neuhaus V, Swellengrebel CHJ, Bossen JKJ, Ring D. What are the factors influencing outcome among patients admitted to a hospital with a proximal humeral fracture? *Clin Orthop Relat Res.* 2013;471(5):1698-1706. doi:10.1007/s11999-013-2876-z

12. Twiss T. Proximal Humerus Fractures. 2015;23-42. doi:10.1007/978-3-319-08951-5
13. Iacobellis C, Berizzi A, Biz C, Camporese A. Treatment of proximal humeral fractures with reverse shoulder arthroplasty in elderly patients. *Musculoskelet Surg.* 2015;99(1):39-44. doi:10.1007/s12306-014-0331-2
14. Innocenti M, Carulli C, Civinini R, Matassi F, Tani M, Muncibì F. Displaced fragility fractures of proximal humerus in elderly patients affected by severe comorbidities: Percutaneous fixation and conservative treatment. *Aging Clin Exp Res.* 2013;25(4):447-452. doi:10.1007/s40520-013-0063-4
15. Lübbecke A, Stern R, Grab B, Herrmann F, Michel JP, Hoffmeyer P. Upper extremity fractures in the elderly: Consequences on utilization of rehabilitation care. *Aging Clin Exp Res.* 2005;17(4):276-280. doi:10.1007/BF03324610
16. Hanson B, Neidenbach P, de Boer P, Stengel D. Functional outcomes after nonoperative management of fractures of the proximal humerus. *J Shoulder Elb Surg.* 2009;18(4):612-621. doi:10.1016/j.jse.2009.03.024
17. Price MC, Horn PL, Latshaw JC. Proximal humerus fractures. *Orthop Nurs.* 2013;32(5):251-258. doi:10.1097/NOR.0b013e3182a39b20
18. Schumaier A, Grawe B. Proximal humerus fractures: Evaluation and management in the elderly patient. *Geriatr Orthop Surg Rehabil.* 2018;9:1-11. doi:10.1177/2151458517750516
19. Abimanyi-Ochom J, Watts JJ, Borgström F, et al. Changes in quality of life associated with fragility fractures: Australian arm of the International Cost and Utility Related to Osteoporotic Fractures Study (AusICUROS). *Osteoporos Int.* 2015;26(6):1781-1790. doi:10.1007/s00198-015-3088-z
20. Holloway KL, Bucki-Smith G, Morse AG, et al. Humeral Fractures in South-Eastern Australia: Epidemiology and Risk Factors. *Calcif Tissue Int.* 2015;97(5):453-465. doi:10.1007/s00223-015-0039-9
21. Olsson C, Nordquist A, Petersson CJ. Long-term outcome of a proximal humerus fracture predicted after 1 year: A 13-year prospective population-based follow-up study of 47 patients. *Acta Orthop.* 2005;76(3):397-402. doi:10.1080/17453670510041295
22. Neer C. Displaced proximal humerus fractures. *J Bone Jt Surg.* 1970;52-A(6):1077-1089.
23. Kruithof RN, Formijne Jonkers HA, van der Ven DJC, van Olden GDJ, Timmers TK. Functional and quality of life outcome after non-operatively managed



- proximal humeral fractures. *J Orthop Traumatol*. 2017;18(4):423-430. doi:10.1007/s10195-017-0468-5
24. Südkamp NP, Audigé L, Lambert S, Hertel R, Konrad G. Path analysis of factors for functional outcome at one year in 463 proximal humeral fractures. *J Shoulder Elb Surg*. 2011;20(8):1207-1216. doi:10.1016/j.jse.2011.06.009
  25. Sheehan KJ, Williamson L, Alexander J, et al. Prognostic factors of functional outcome after hip fracture surgery: A systematic review. *Age Ageing*. 2018;47(5):661-670. doi:10.1093/ageing/afy057
  26. Bekkering GE, Oostendorp RAB, Hendriks EJM. Prognostic factors of whiplash-associated disorders : a systematic review of prospective cohort studies. 2003;104:303-322. doi:10.1016/S0304-3959(03)00050-2
  27. World Health Organization. How to use the ICF: A practical manual for using the International Classification of Functioning, Disability and Health (ICF). *World Heal Organ*. 2013;(October):100. doi:10.1016/j.dhjo.2015.03.002
  28. Riley RD, Moons KGM, Snell KIE, et al. A guide to systematic review and meta-analysis of prognostic factor studies. *BMJ*. 2019;364. doi:10.1136/bmj.k4597
  29. Hemingway H, Croft P, Abrams K, et al. Prognosis research strategy ( PROGRESS ) 1 : A. 2013;5595(February):1-11. doi:10.1136/bmj.e5595
  30. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *J Chinese Integr Med*. 2009;7(9):889-896. doi:10.1016/j.jclinepi.2009.06.005
  31. Moher D, Liberati A, Tetzlaff J, Altman DG. Statement. 2009;89(9):873-880.
  32. Slavin RE. Best evidence synthesis: An intelligent alternative to meta-analysis. *J Clin Epidemiol*. 1995;48(1):9-18. doi:10.1016/0895-4356(94)00097-A
  33. Hayden JA, Windt DA Van Der, Cartwright JL, Co P. Research and Reporting Methods Annals of Internal Medicine Assessing Bias in Studies of Prognostic Factors. *Ann Intern Med*. 2013;158:280-286. doi:10.7326/0003-4819-158-4-201302190-00009
  34. Higgins JPT, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD. The Cochrane Collaboration ' s tool for assessing risk of bias in randomised trials. 2011:1-9. doi:10.1136/bmj.d5928
  35. Critical Appraisal Skills Programme. Critical Appraisal Skills Programme (2018a). CASP Cohort Study Checklist. [online] Available at: URL. Accessed: Date Accessed. 1994;(2018). <https://casp-uk.net/casp-tools-checklists/>.

36. Sackett DL, Straus SE, Richardson WS et al. Evidence-Based Medicine: How to Practice and Teach EBM. 2nd ed. Edinburgh, Scotland: Churchill Livingstone Inc; 2000: 95-105. 2000:2000.
37. Ariëns GAM, Van Mechelen W, Bongers PM, Bouter LM, Van Der Wal G. Physical risk factors for neck pain. *Scand J Work Environ Heal.* 2000;26(1):7-19. doi:10.5271/sjweh.504
38. Hodgson SA, Mawson SJ, Stanley D. Rehabilitation after two-part fractures of the neck of the humerus. *J Bone Jt Surg.* 2003;85(3):419-422.
39. Inauen C, Platz A, Meier C, et al. Quality of Life After Osteosynthesis of Fractures of the Proximal Humerus. 2013;27(4):74-80.
40. Kovalak E. Surgical Management of 3 and 4-Part Proximal Humerus Fractures with Locking Plates in Elderly. *J Clin Anal Med.* 2017;8(3):243-247. doi:10.4328/JCAM.4834
41. Kozanek M, Menendez ME, Ring D. Association of perioperative blood transfusion and adverse events after operative treatment of proximal humerus fractures. *Injury.* 2015;46(2):270-274. doi:10.1016/j.injury.2014.11.032
42. Leblanc JEM, Macdermid JC, Faber KJ, Drosdowech DS, Athwal GS. Outcomes after hemiarthroplasty for proximal humerus fracture are significantly affected by hand dominance. *J Orthop Trauma.* 2015;29(8):379-383. doi:10.1097/BOT.0000000000000294
43. Muhm M, Bott J, Lahr C, Winkler H, Ruffing T. Outcome after operative treatment of proximal humeral fractures in elderly patients. *Z Gerontol Geriatr.* 2016;49(6):505-511. doi:10.1007/s00391-015-0954-4
44. O'Hara NN, Garibaldi A, Sprague S, et al. Rehabilitation, not injury or treatment details, dominate proximal humeral fracture patient concerns: a thematic analysis. *Eur J Pers Centered Healthc.* 2017;5(3):351-356. doi:10.5750/ejpc.v5i3.1328
45. Poeze M, Lensen AF, Van Empel JM, Verbruggen JP. Conservative management of proximal humeral fractures: Can poor functional outcome be related to standard transscapular radiographic evaluation? *J Shoulder Elb Surg.* 2010;19(2):273-281. doi:10.1016/j.jse.2009.07.066
46. Christiano A, Christian P, Sanjit K, Kenneth E. Functional outcome after PHF fixation: Risk factors. 2017;83(212):1-7.
47. Canbora MK, Kose O, Polat A, Konukoglu L, Gorgec M. Relationship between the functional outcomes and radiological results of conservatively treated displaced proximal humerus fractures in the elderly : A prospective study.

- 2013;7(3):105-109.
48. Court-Brown CM, McQueen MM. The impacted varus (A2.2) proximal humeral fracture: Prediction of outcome and results of nonoperative treatment in 99 patients. *Acta Orthop Scand*. 2004;75(6):736-740.  
doi:10.1080/00016470410004111
  49. Fallatah S, Dervin GF, Brunet J a, Conway AF, Hrushowy H. Functional outcome after proximal humeral fractures treated with hemiarthroplasty. *Can J Surg*. 2008;51(5):361-365.
  50. Gaebler C, MM M, CM C-B. Minimally displaced proximal humeral fractures. *Acta Orthop Scand*. 2003;74(5):580-585.  
<http://search.ebscohost.com/login.aspx?direct=true&db=rzh&AN=106080265&site=ehost-live>.
  51. Hulsbæk S, Larsen RF, Troelsen A. Predictors of not regaining basic mobility after hip fracture surgery. *Disabil Rehabil*. 2015;37(19):1739-1744.  
doi:10.3109/09638288.2014.974836
  52. Bickers DS. Factors affecting return to work after job-related injuries. *J Med Assoc Ga*. 1992;81(12):673-677.
  53. Ueda S, Okawa Y. The subjective dimension of functioning and disability: What is it and what is it for? *Disabil Rehabil*. 2003;25(11-12):596-601.  
doi:10.1080/0963828031000137108
  54. Wasiak J, McMahon M, Danilla S, Spinks A, Cleland H, Gabbe B. Measuring common outcome measures and their concepts using the International Classification of Functioning, Disability and Health (ICF) in adults with burn injury: A systematic review. *Burns*. 2011;37(6):913-924.  
doi:10.1016/j.burns.2011.02.012
  55. Jayakumar M, Overbeek CL, Lamb S, et al. What Factors Are Associated With Disability After Upper Extremity Injuries? A Systematic Review. *Clin Orthop Relat Res*. 2018;476(11):2190-2215. doi:10.1097/CORR.0000000000000427
  56. Bruder A, Taylor NF, Dodd KJ, Shields N. Exercise reduces impairment and improves activity in people after some upper limb fractures: A systematic review. *J Physiother*. 2011;57(2):71-82. doi:10.1016/S1836-9553(11)70017-0
  57. Organization WH. Adherence to long-term therapies: Evidence for action. *World Heal Organ*. 2003;(Geneva):1-209. doi:10.4028/www.scientific.net/AMM.321-324.1779
  58. Bruder AM, Shields N, Dodd KJ, Taylor NF. Prescribed exercise programs may

not be effective in reducing impairments and improving activity during upper limb fracture rehabilitation: a systematic review. *J Physiother.* 2017;63(4):205-220. doi:10.1016/j.jphys.2017.08.009

59. Artus M, Campbell P, Mallen CD, Dunn KM, Van Der Windt DAW. Generic prognostic factors for musculoskeletal pain in primary care: A systematic review. *BMJ Open.* 2017;7(1):1-10. doi:10.1136/bmjopen-2016-012901
60. Noyes J, Hannes K, Booth A, et al. Qualitative Research and Cochrane Reviews. *Cochrane Handb Syst Rev Interv Version 530.* 2015:1-26. [https://methods.cochrane.org/sites/methods.cochrane.org.qi/files/public/uploads/Handbook52\\_QQ\\_Qualitative\\_web%0Aupdate%0AOct](https://methods.cochrane.org/sites/methods.cochrane.org.qi/files/public/uploads/Handbook52_QQ_Qualitative_web%0Aupdate%0AOct).
61. Tsui K, Fleig L, Langford DP, Guy P, MacDonald V, Ashe MC. Exploring older adults' perceptions of a patient-centered education manual for hip fracture recovery: "Everything in one place." *Patient Prefer Adherence.* 2015;9:1637-1645. doi:10.2147/PPA.S86148
62. Griffiths F, Mason V, Boardman F, et al. Evaluating recovery following hip fracture: A qualitative interview study of what is important to patients. *BMJ Open.* 2015;5(1):1-10. doi:10.1136/bmjopen-2014-005406

## Chapter 3

### A Descriptive Analysis of Recovery Perceptions in the First Year after Proximal Humerus Fracture in Adults

#### Introduction

A proximal humerus fracture (PHF) often occurs in the fit elderly independent patient who is still a *net contributor to society* (Court-Brown, 2001, p.370)<sup>1</sup>. Previous work shows that around 80% of patients live independently at their own home with the ability to perform household tasks, shop independently and perform recreational activities before fracture<sup>2-4</sup>. However, this injury can result in severe and prolonged disability and social dependency postfracture<sup>5</sup>. Individuals with PHF reported significantly more severe difficulties with self-care<sup>6</sup> reflecting the importance of shoulder function in the personal care. PHF can be a major cause of functional disability and result in a reduction in subjective patient- perceived health<sup>7-9</sup>. The intensity of pain, and discomfort experienced by patients may have psychological impact<sup>10</sup>. De Potter et al.<sup>11</sup> showed that the presence of proximal upper extremity injuries considerably reduces quality of life mainly due to limitations on the health domains self-care, usual activities and complaints of pain and discomfort. Physical and mental limitations in daily activities might reduce independence and potentially influence level of social roles<sup>3,12,13</sup> while it imposes substantial use of health services<sup>14</sup>.

The results of a recent systematic review of 41 studies involving fractures in various regions of the hand/wrist and arm showed that psychological and social factors were more consistently associated with disability than factors related to upper extremity impairment<sup>10</sup>. In that systematic review, disability after upper extremity injuries (including two studies of shoulder and humerus fracture) was most consistently associated with symptoms of depression, pain catastrophizing, anxiety and negative cognitive behavior<sup>10</sup>. In another study, Ring et al<sup>16</sup> reported the correlation between depression and DASH score for patients with a variety of arm problems. In that study, the authors claimed that self-assessed disability is related as much or more to illness behavior than to pathophysiology.

Following PHF, rehabilitation exercises are vital parts of surgical and non-surgical treatments regardless of the severity of the PHF, yet there is controversy on the most effective treatment<sup>17</sup>. Exercise after PHF aims at restoring range of motion, normal shoulder strength and ultimately return to normal functional activities<sup>18</sup>. In a large study of risk factors for PHFs, low level of physical activity and poor balance were related to the increased incidence of PHF in elderly<sup>19</sup>. This suggests that physical activity and exercise decrease the risk of falling by slowing bone loss and reducing the risk of falls. PHFs in adults are often as a result of a simple fall. In specific, winter months, mostly December and January are the peak risk of PHF incidence due to slip and fall on snow and ice<sup>20-22</sup>. The role of specific exercises in reducing impairments and improving upper

limb function after PHF was supported in a systematic review (2011)<sup>23</sup>. Nonetheless, the updated systematic review in 2017, generating data on 22 trials and 1299 participants<sup>24</sup>, the investigators concluded that the current exercise programs after PHF are poorly described in terms of duration, intensity and progression and are not sufficient to clearly show the effectiveness of exercise in making changes in moving the arm in everyday activities.

Considering that hands are fundamental for performing basic and instrumental daily activities, PHF may broadly impact daily life experiences by individuals. To describe day-to-day functional difficulties, the International Classification of Functioning, Health and Disability (ICF) adopted by the World Health Organization (WHO) provides a comprehensive framework<sup>25</sup>. Within this framework, the individuals' experience of functioning is not as the consequence of health condition (injuries, diseases), but the result of the dynamic interaction between health condition and both personal and environmental factors (i.e., contextual factors)<sup>26</sup>. Using the ICF model as a reference, our recent systematic review of prognostic factors of recovery following a PHF demonstrated that the subjective dimension of functioning are less clear although our evidence showed that objective (clinical) outcomes are well-defined in the literature. The rationale for incorporating recovery concepts into the ICFs is that this health model covers comprehensively the spectrum of functioning problems as experienced by patients with musculoskeletal injuries<sup>27,28</sup>. To date, there is no study addressing what areas of functioning are most important for individuals after PHF. Also, it is not clear how individuals perceive facilitators and barriers to exercise after PHF. The purpose of this

investigation was to describe recovery as experienced/perceived by individuals with PHF, and to identify facilitators, barriers and preferences to exercise, using standardized ICF functioning terminology.

## Methods

The Office of Human Research Ethics (OHRE) of the University of Western Ontario approved the protocol of this study prior to commencement (Reference No.: 111265).

The study was structured and written in accordance with the Checklist for Reporting Results of Internet E-Surveys (CHERRIES)<sup>29</sup>.

## Setting

This survey study was conducted at the Roth-McFarlane Hand and Upper Limb Centre (HULC), the largest upper extremity surgical unit in Canada providing care for the patients with upper extremity injuries.

## Participants

Participants with PHF treated by three board certified orthopedic surgeons at HULC were recruited from June 15, 2018 until April 30, 2019. The eligibility criteria were 1) age of 45 years or older, 2) a PHF occurred in a year prior to survey, and 3) understanding the purpose of study and signing the consent form). Individuals were excluded from the study if they did not speak English, had cognitive impairments, were institutionalized, and lived in a nursing home. All eligible patients gave their written consent to participate in this study. The anonymity of the participants in this study was protected by assigning them unique numeric IDs (i.e., P1, P2, P3...) for the purpose of data analysis.



## Survey administration

The survey was paper-administered and online. REDCap (Research Electronic Data Capture) a secure web-application (<http://redcap.lawsonresearch.ca>) was the platform for building and administering online survey. Three validated questionnaires to answer research questions in this study: the short form of the Disabilities of the Arm, Shoulder and Hand (QuickDASH), the Patient Specific Functional Scale (PSFS), and the Personalized Exercise Questionnaire (PEQ). In addition, we measured socio-demographic data including age, gender, education, living/work status, health conditions, dominant side PHF, and mechanism of PHF along with recovery goals, and perceived facilitators/barriers to recovery via three open-ended questions. A pilot testing was performed for the demographics questionnaire with receiving feedback from one co-author (JMD). This questionnaire (online form) was piloted with five senior adults from the community to evaluate wording of the items, and time to complete.

## Questionnaires

The QuickDASH is a patient reported outcome measure (PROM) that measures disability in relation to the upper limb<sup>30,31</sup>. The QuickDASH has been shown to have a Cronbach's alpha in the range 0.88-0.89 with the same level of reliability as the full-length DASH<sup>32</sup>. The language of the concepts (i.e., open, turn, push, wash, carry and so on) used in this region-specific tool is very close to the content of the ICF classification<sup>33</sup>.

The PSFS is a patient-specific PROM that measures function<sup>34</sup>. The PSFS allows patients to report their functional limitations in three to five important activities that are unable to do or have difficulty with due to their injury from 0 being "unable to perform

activity” to 10 for being “able to do perform activity at same level as before injury or problem”<sup>35</sup>. The content validity, concurrent validity, sensitivity to change, internal consistency and the outcome distribution of the PSFS in PHF for functional limitations has been established<sup>36</sup>. Other studies demonstrated that functional limitations in the PSFS could be linked to the ICF taxonomy<sup>37-40</sup>.

The PEQ is a PROM that measures the facilitators/barriers and preferences to exercise. The PEQ is a new mixed-method approach survey consists of 6 domains containing 35 categorical questions and 3 open-ended items relating to individuals’ exercise goals, facilitators and barriers to exercise. Open-ended questions prompt the individuals to identify facilitators and barriers that may not have been captured through closed-ended questions. The PEQ showed high content validity of individual items (0.50 to 1.00), and moderate to high content validity of the overall questionnaire (0.91)<sup>41-2</sup>.

### Data collection

The research staff approached potentially eligible participants (n=106) with PHF during outpatient visits at HULC between 2 weeks and 12 months postfracture. Sixty-seven individuals gave consent to participate in the study. Twenty-four patients declined to participate in the study, and reasons for refusal included lack of interest, being overwhelmed with pain, or stress either about the X-ray results or visiting a hand surgeon for the first time and too frail to participate in the study. We excluded 12 patients for not meeting the inclusion criteria, if they were hospitalized or lived in a nursing home (n=8), transferred from a mental hospital with behavioral issues and or limited cognitive

function (n=4). The survey required 30-45 minutes to complete. A family member of patients or AV gave assistance to participants if they were not able to write.

## Data analyses

The Statistical Package for the Social Sciences (SPSS) version 25.0 (Chicago, IL, USA) was used for all collected data. Frequency and percentages were reported for categorical data. Responses to the open-ended questions were analyzed thematically with emergent coding. The overall score ranges from 0 to 100 with higher score (1-5) reflecting greater disability. However, we did not use the aggregate mean score. Rather, mean score was calculated for each item. The 11 items of QuickDASH were mapped into the activity and participation and body function components of the ICF. Important activities in the PSFS were also coded according to the ICF coding rules. Mean score calculated in the PSFS for the three highest frequent ICF chapters was calculated individually and not as a total score. Responses to the open-ended questions in the demographics and PEQ were coded thematically considering the contextual factors in the ICF model. We dichotomized responses to questions 19-24 and 32-34 of the PEQ that contained multiple response options (check all that apply) as one and two highest response options vs. other response options.

## Results

Between June 2018 and April 2019, a total of 59 individuals (out of 67) with PHF completed questionnaires leading to a completion rate of 81% across the demographics, QuickDASH and PSFS. Participants had missing data on the PEQ, resulting in an overall participation rate of 65%. Participants completed paper administered questionnaires at

the clinic (n=36, 61%), by mail (n=18, 30.5%) and online survey (n=5, 8.5%). Eight people did not mail the questionnaires back although they had consented to the study.

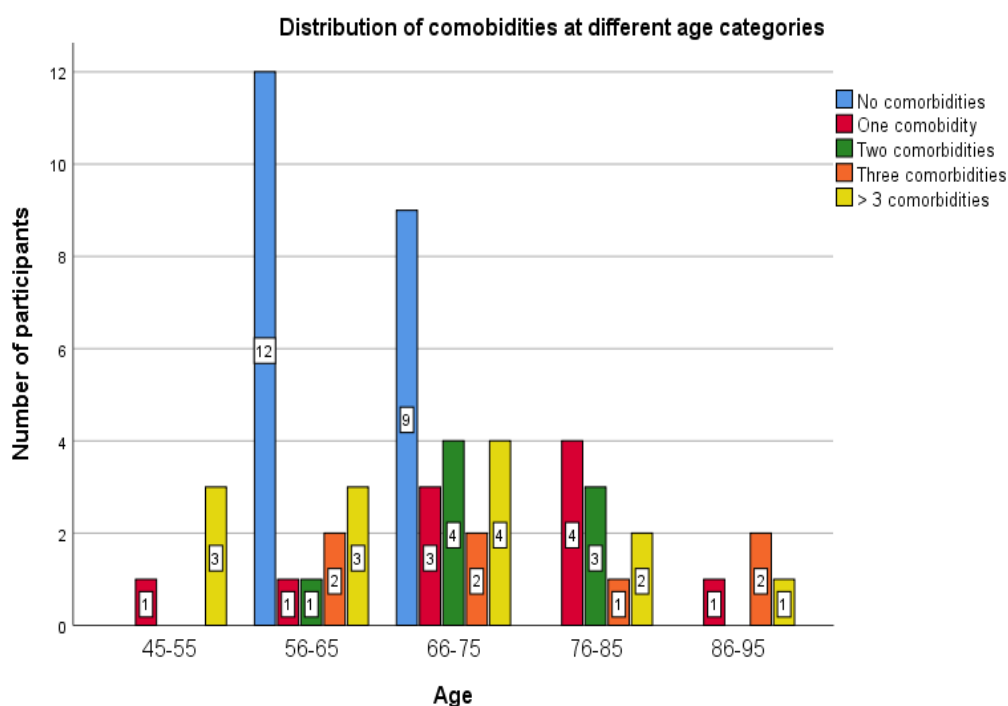
## Demographics

Table 4 represents the demographic information provided by the 59 participants. Forty-seven of participants (80%) were women. The majority of our participants (72.9%) were between 66-75 age range (40.7%) and 55-65 (32.2%). Twenty-nine participants (59.3%) were living with a family member (spouse mostly: n=29, others: n=6) and 24 (40.7%) alone. In total, 67.6% of participants (n= 40) had education at college level (n=23), undergraduate (n=12), graduate level (n=4), and 32.4% had high school (n=13) or less than high school (n=6) education. Participants were retired (64.4%), employed and semi-employed (25.4%), and disabled and not able to work due to injuries other than PHF (8.5%). One participant reported on an unemployment status. PHF was reported in dominant hand by 33 (60%) of participants. From a health status perspective, the most prevalent chronic conditions were osteoporosis (25%) diabetes (18.6%) depression (16.7%) and osteoarthritis (16%) reported by individuals.

Table 7 Participants demographics (percentage)

<b>Parameters</b>	<b>n</b>	<b>%</b>
<b>Gender</b>		
Woman	47	80
Man	12	20
<b>Age (ranges)</b>		
45-55	2	3.4
56-65	19	32.2
66-75	24	40.7
76-85	10	17
86-95	4	6.7
<b>Education</b>		
< high school	6	10.1
High school diploma	13	22.3
Some college without degree	10	17
College with degree	14	23.6
Undergraduate degree	12	20.3
Graduate degree	4	6.7
<b>Living status</b>		
Living with partner/spouse	29	49.2
Living with a relative	6	10.1
Alone	24	40.7
<b>Employment</b>		
Retired	38	64.4
Full-time	10	16.9
Part-time	5	8.5
Disability pension due to injuries other than PHF	5	8.5
Unemployed	1	1.7
<b>Dominant hand fracture</b>		
Yes		55.9
No		44.1
<b>Number of falls</b>		
Once	30	50.8
≥ twice	29	49.2

Figure 9 represents the distribution of comorbidities amongst participants. Overall, the co-morbidities were osteoporosis, osteoarthritis, diabetes, and blood pressure. Fourteen participants (23.7%) reported on other comorbidities such as high cholesterol (n=4) blood pressure (n=3) hypothyroid (n=2) dizziness (n=1) hypoglycemia (n=1) chronic obstructive pulmonary disease (n=1) seizure (n=1) and bladder cancer (n=1) (Figure 9).

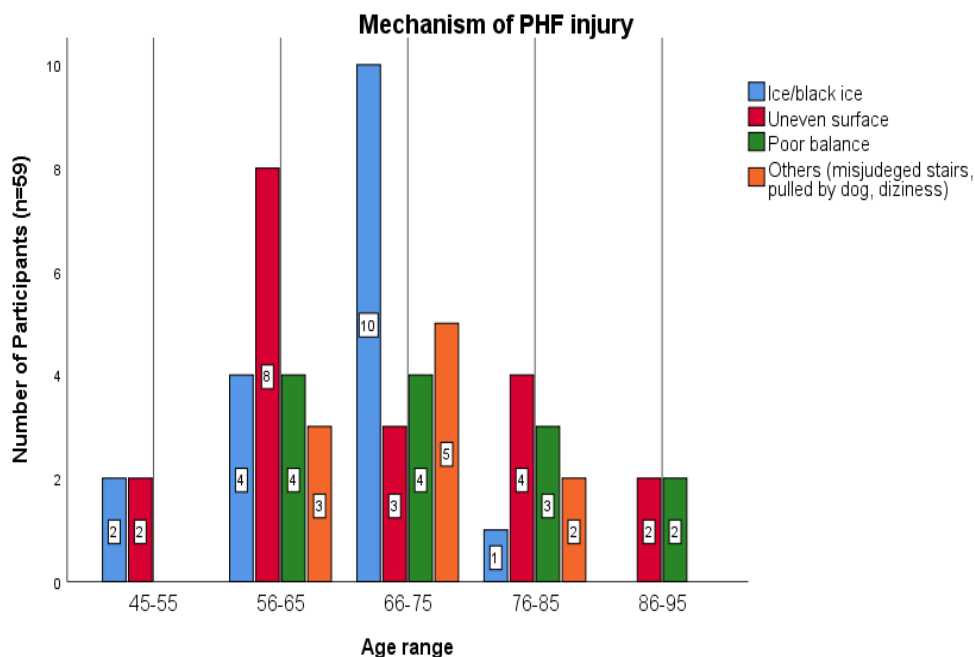


**Figure 5 Age and No. of comorbidities**

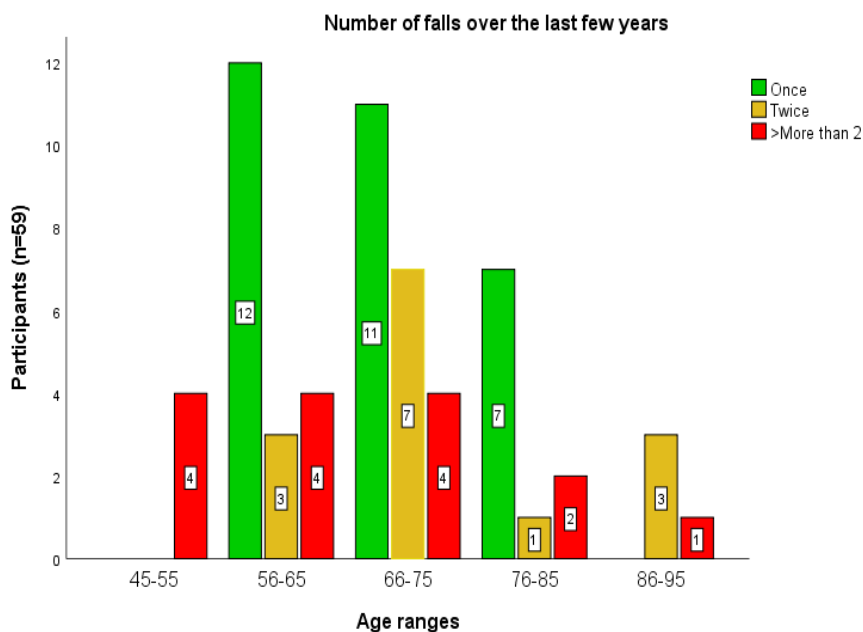
The most common reasons for PHF were uneven surfaces (at home and outside, n=19), slipping on the ice/ black ice (n=17), poor balance (n=13). Other reasons for falling were: misjudged stairs (n=5) pulled by dog (n=3) dizziness due to medication (n=1) and numbness in legs (n=1) (Figure 10). Participants reported on the number of falls over the

last few years: once (n=30, 50.8%), twice (n=14, 23.7%) and >twice (n=15, 25.4%).

Forty-one participants (69.5%) were in the 0-3 months of sustaining PHF, followed by 6 (10.2%) in 4-6 months, 4 (6.8%), 7-9 months and 8 (13.6%) in 10-12 months (Figures 11).



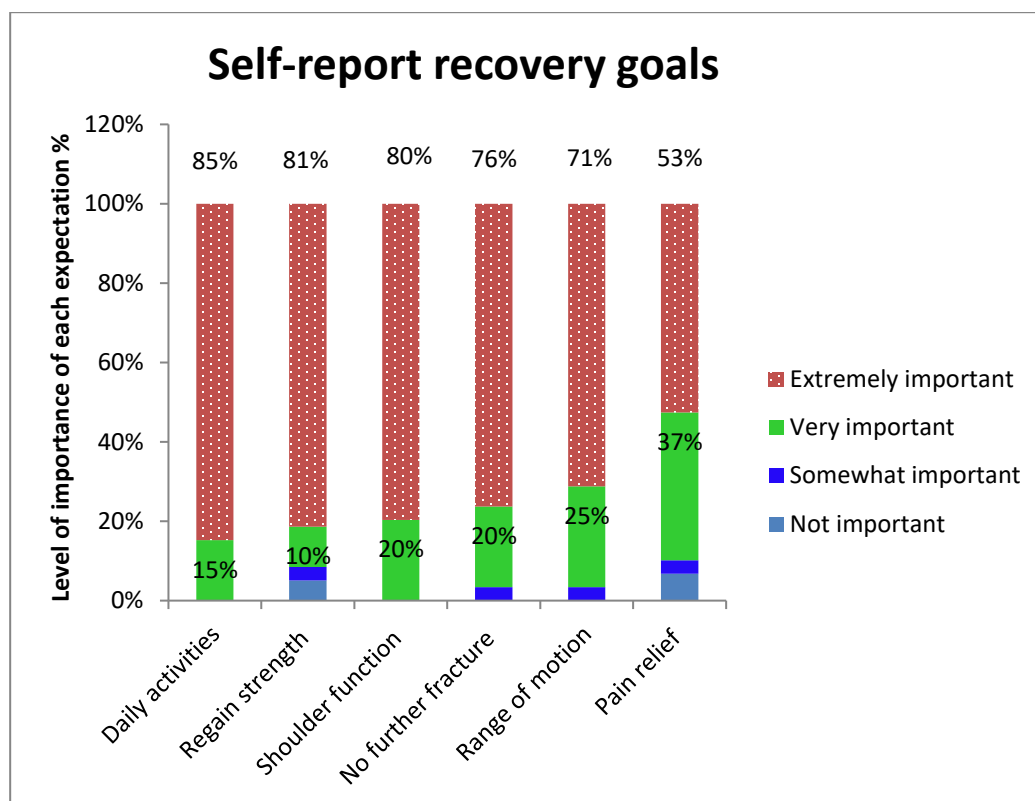
**Figure 6 Mechanism of fall according to age range**



**Figure 7 Number of falls in different age groups**

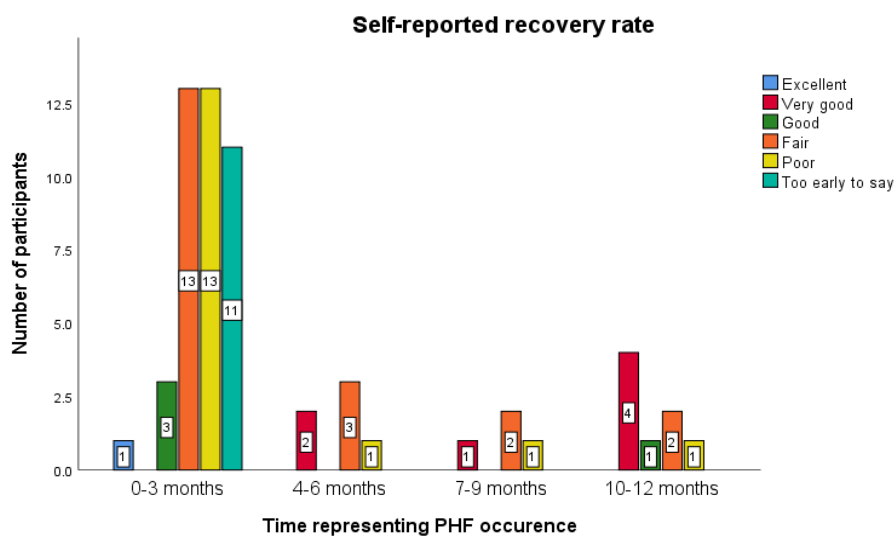
The level of importance of six recovery goals (shoulder function, regain strength, daily activities, pain relief, range of motion, and prevent further fracture) based on a 4-point Likert Scale labeled: 1, extremely important; 2, very important; 3, somewhat important; and 4, not important was reported by participants. Figure 12 illustrates the rank order of goals as rated by the participants (n=59). As shown in this figure, 85% of participants selected “performing daily activities” as an ‘extremely important’ recovery goal after PHF.





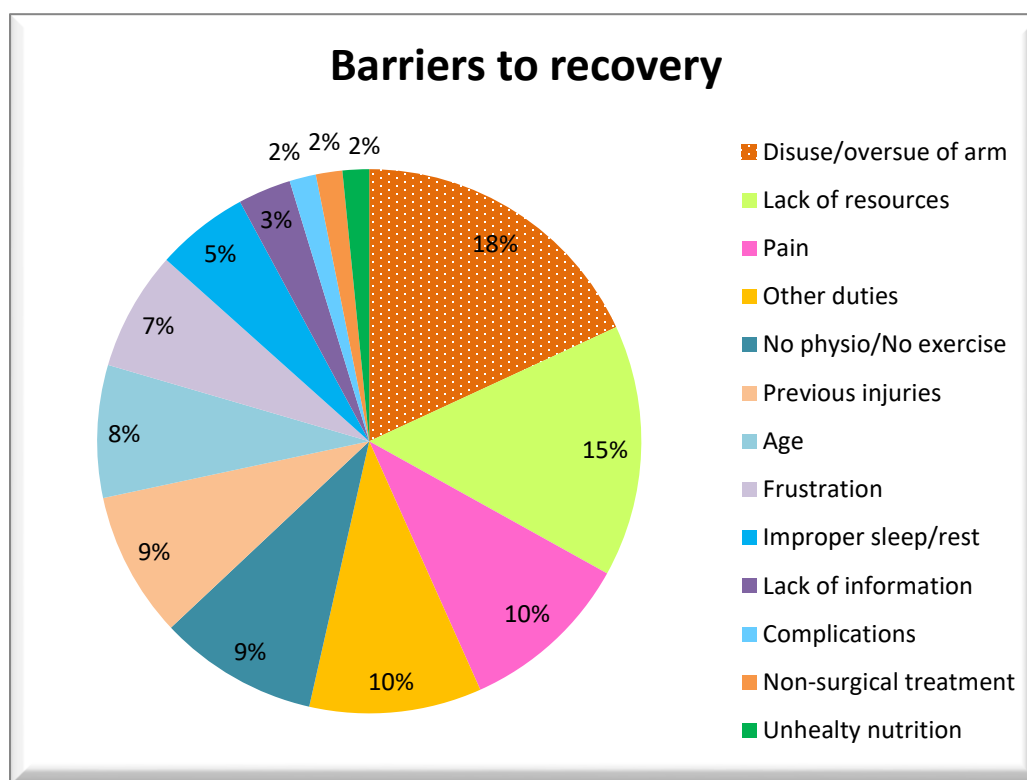
**Figure 8 Recovery goals (Rank order of goals)**

Individuals perceived recovery rate was excellent (n=1), very good (n=7), good (n=4), fair (n=20), poor (n=16) and too early to say (n=11) based on the time PHF occurred. Figure 13 represents perceived recovery rate by participants (n=59) at different stage after PHF occurrence. Since the majority of participants were within the first 3 months after PHF, recovery rate is highly reported as fair, poor or too early to say (Figure 13).



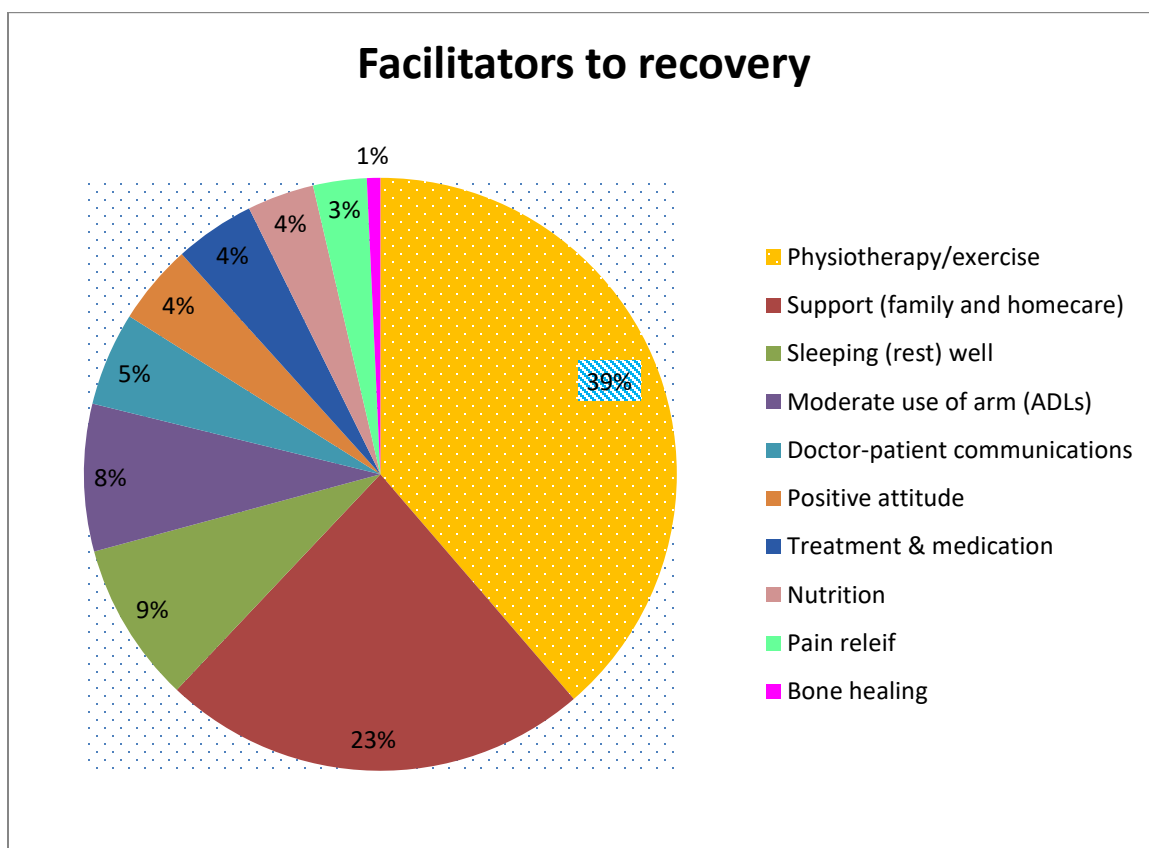
**Figure 9 Perceived recovery rate**

Barriers to recovery were grouped and ranked by percentage according to the number of times each barrier was stated by participants into 13 themes including disuse/overuse of arm (18%), lack of access to resources (15%), pain (10%), other duties (10%), lack of physio exercise (9%), previous injuries (9%), age (8%), frustration (7%), improper sleep/rest (5%), lack of information (3%), complications (2%), non-surgical treatment (2%), and unhealthy nutrition (2%). Figure 14 illustrates the ranked perceived barriers from most to least as stated by participants (n=59).



**Figure 10 Barriers to recovery**

Figure 15 shows major facilitator themes of recovery from PHF. Responses were summarized into 10 themes and ranked by percentage according to the number of times each facilitator was stated by participants (n=59). Facilitators were: physiotherapy/exercise (39%), support from family and healthcare (23%), sleeping well (9%), moderate use of arm in ADLs (8%), doctor-patient communication (5%), positive attitude (4%), treatment and medication (4%), nutrition (4%), pain relief (3%), and bone healing (1%).



**Figure 11 Facilitators to recovery**

### QuickDASH

The overall mean QuickDASH score was 63.2 (SD 20.8) for the whole sample (n=59).

The mean QuickDASH score for 11 items is presented in Table 5 and Figure 16. The breakdown of the questions refers to 2 questions on the severity of symptoms such as pain and tingling, 6 questions related to the level of difficulty (inability) in performing physical activities and 3 questions on the impact of the health condition on social and work activities and sleep. The 11-QuickDASH items were linked to 8 chapters of the

ICF: 3 items belonged to the ICF *body functions* component (b) and 8 items to the *activity* and *participation* component (d).

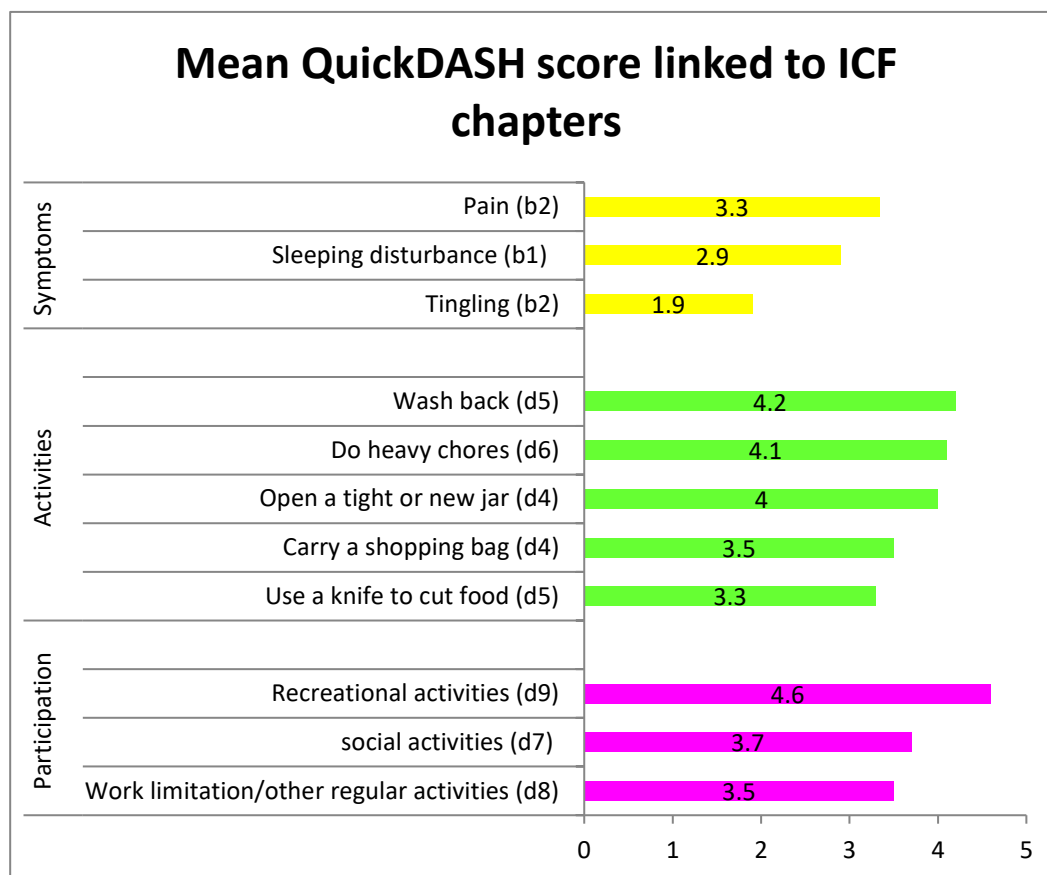
**Table 8 Linking between the QuickDASH and ICF categories**

Symptoms	Unable	Mean	ICF Code/ Category
Arm, shoulder or hand pain at all.	11 (18.6%)	3.3	b28014 Pain in upper limb
During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder, or hand?	8 (13.6%)	2.9	b134 Sleep function
Tingling (pins and needles) in your arm, shoulder, or hand.	3 (5.1%)	1.9	b265 Touch function
<b>Activities</b>			
Wash your back	37 (62.7%)	4.2	d5100 Washing body parts
Do heavy household jobs (e.g. wash walls, floor)	31 (52.5%)	4.1	d640 Doing housework
Open a tight or new jar	30 (50.8%)	4.0	d4453 Turning or twist the hands or arms
Carry a shopping bag or briefcase	20 (33.9%)	3.5	d4301 Carrying in the hands
Use a knife to cut food	19 (32.2%)	3.3	d550 Eating
<b>Participation</b>			
Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g. golf, hammering, tennis etc.	47 (80%)	4.6	d920 Recreation and leisure
During the past week, <i>to what extend</i> has your arm, shoulder, or hand problem interfered with your normal social activities with family, friends, neighbors or groups?	19 (32)	3.7	d9205 Socializing
During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder, or hand problem?	12 (20%)	3.5	d840-d859 work and employment

**Note.** This table shows the number, percentage of participants and each item mean score in the QuickDASH labelled as “*unable*” (the last option) rated 5. These items were linked to 3 level of the ICF functioning.

In the *body function* component, sleep function was the item linked to mental functions in chapter 1. Pain and tingling were linked to pain sensation and sensory function in

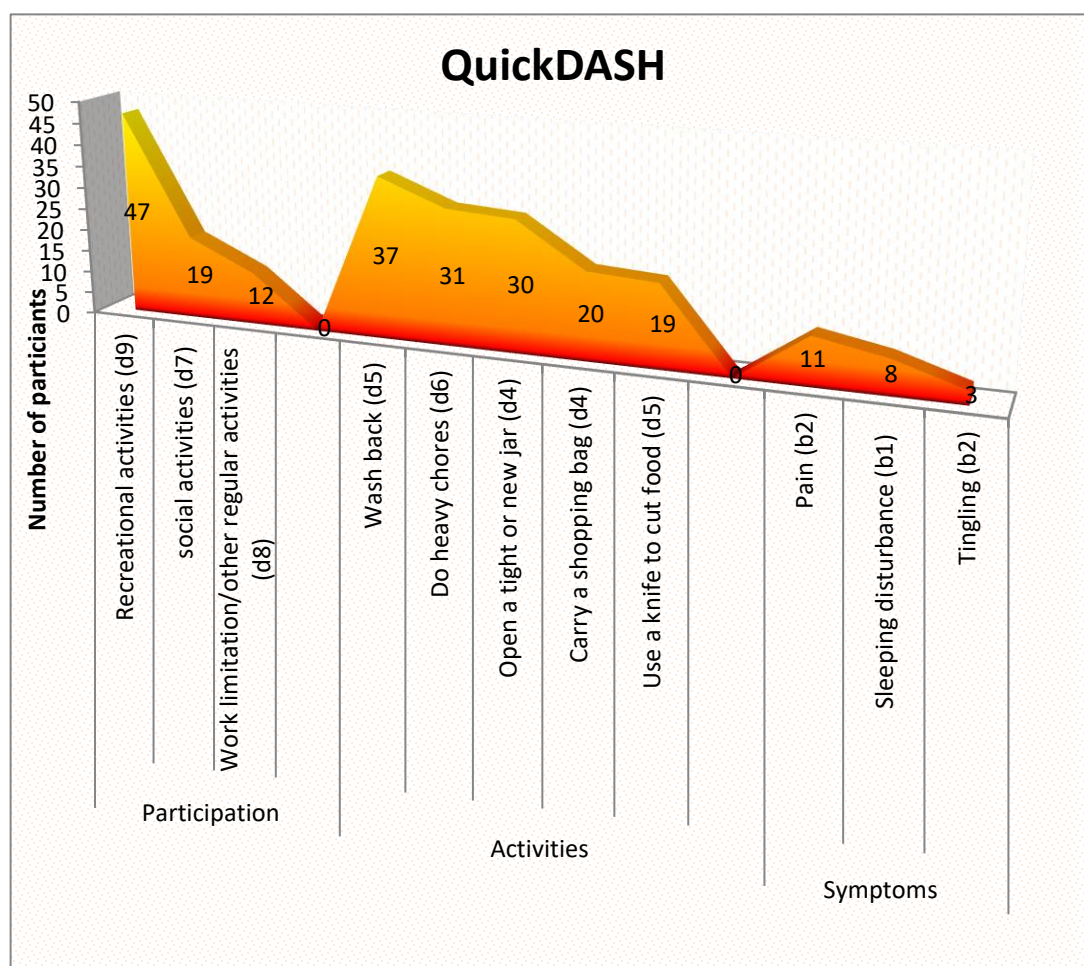
chapter 2. In the *activity* and *participation* component, two items (open a tight or new jar, and carry a shopping bag) were linked to chapter 4: ‘turning or twisting the hands or arm’, and ‘carrying in the hands’. In chapter 5 links were made for two items (wash back and use a knife to cut food) to the categories ‘personal care’ and ‘eating’. In chapter 6, a link was made for one item (do heavy chores, wash walls, floor) to the category ‘doing household’. In chapter 7, one item was linked to interpersonal relationships and interactions. In chapter 8 only one category was linked to ‘performance of tasks and actions necessary for participating in activities regarding work, job’. In chapter 9, recreation and leisure activity was linked to actions and tasks necessary for participating in a social life. The QuickDASH item that received the highest mean (4.6) was recreational activities linked to chapter 9 (Figure 16).



**Figure 12 Mean QuickDASH score**

This chart shows linking between the 11 QuickDASH items and 8 chapters of the ICF functioning: 3 items belonged to the ICF *body functions* component (b) and 8 items to the *activity* and *participation* component (d). Each item on the QuickDASH is scored from 0 to 5 with higher scores indicating greater disability. The QuickDASH item that received the highest mean (4.6) score was recreational activities linked to chapter 9.

The number of participants (n=59) who rated themselves 'unable'=score 5 on a scale from 1-5 for each 11 item as displaced in Figure 17.



**Figure 13 Linking between QuickDASH and ICF**

Functional problems in 3 level of the ICF functioning on the QuickDASH scale by the number of participants (n=59). The horizontal axis presents the items classified as symptoms, activities and participation, and the vertical axis shows the number of participants. The number of participants at each functioning level has fluctuated representing the highest number of participants with 100% inability to perform recreational activities (n=47) rated their ability 5 on a 0-5 Likert scale. For example, 47 participants scored themselves 5 showing their disability to perform recreation activities. Only three participants scored tingling sensation 5 indicating 'extreme'.



## PSFS

In total, the content of PSFS yielded 168 functional activities reported by 59 participants.

Using the ICF classification, meaningful concepts were linked to nine chapters of the ICF from the two domains of the ICF framework: activity and participation (d) and body function (b) (Table 6).

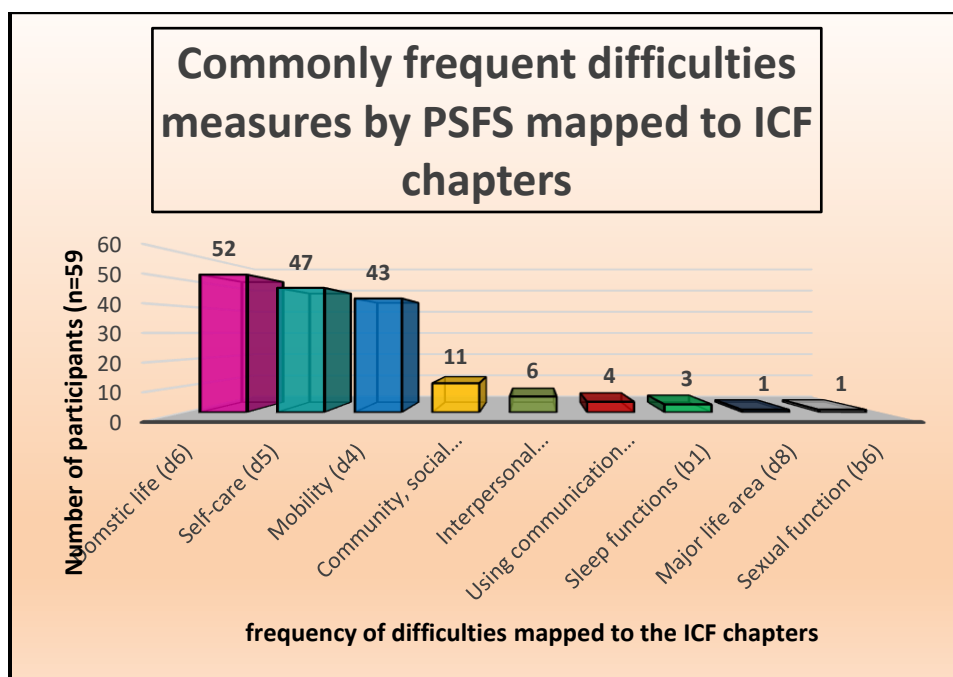
**Table 9 Linking between functional activities (PSFS) and ICF**

	N	ICF Code/Chapters/Category title
<b><u>d ACTIVITY AND PARTICIPATION</u></b>		
		<b>d6 DOMESTIC LIFE</b>
Grocery shopping	5	d6200 Shopping
<b>Cooking/preparing meals/baking</b>	16*	d630 Preparing meals
Housework /ADLs, ironing, vacuuming, laundry, changing sheets, chores	22*	d640 Household tasks
Cleaning oven, washing dishes	2	d6401 Cleaning cooking area and utensils
Mopping floor	1	d6402 Cleaning living area
Sewing, mending	2	d6500 Making and repairing clothes
Gardening	4	D6505 Taking care of plants, indoors and outdoors
<b><u>d5 SELF-CARE</u></b>		
Bathing, showering	18*	d510 Washing oneself
Personal grooming	1	d520 Caring for body parts
Drying/ styling hair, combing	2	d5202 Caring for hair
Fining toenail	1	d5204 caring for toenail
Bathroom	1	d530 Toileting
Dressing, pulling clothes up, tie shoes	23*	d540 Dressing
Eating with right hand	1	d550 Eating
<b><u>d4 MOBILITY</u></b>		
Lifting, yard work, shoveling	8	d430 Lifting and carrying objects
Pushing walker	1	d4451 Pushing
Reaching up, reaching back	3	d4452 Reaching
Opening medicine bottle	2	d4453 Turning or twisting the hands or arms
Driving car	29*	d4751 Driving
<b><u>d9 COMMUNITY , SOCIAL AND CIVIC LIFE</u></b>		
Doing exercise (strength training, golf, yoga, swimming, cardio fitness, hiking, biking)	9	d920 Recreation and leisure
Knitting/ crocheting , craft carpentry	2	d9203 Crafts
<b><u>d7 INTERPERSONAL INTERACTIONS AND RELATIONSHIPS</u></b>		
Going out as before, restaurant/ clubs	3	d750 Informal social relationships

Caring grandkids, mother/husband	3	d608 Family relationships, other specified
<b>d3 COMMUNICATION</b>		
Computer use, typing	4	d360 Using communication devices and techniques
<b>d8 MAJOR LIFE AREAS</b>		
Work	1	d840-D859 Work and employment
<b>b BODY FUNCTIONS</b>		
<b>b1Mental functions</b>		
Sleeping in bed	3	b134 Sleep function
<b>b6 Reproductive functions</b>		
Sex	1	b640 Sexual function

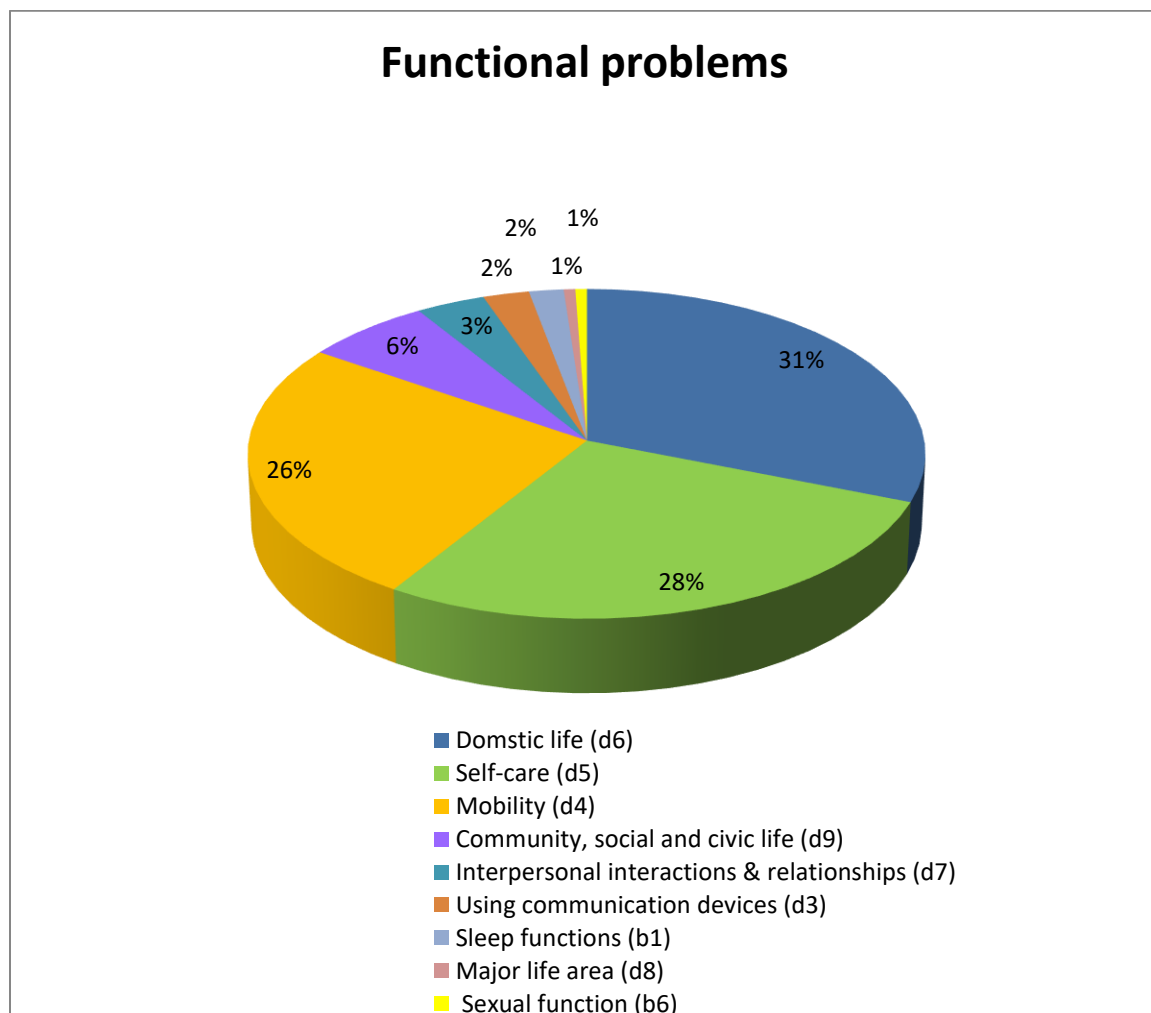
The first column of this table represents functional activities as stated by participants (n=59). The second column shows the frequency of activities (n=168) with the highest frequent activities shown with an asterisks (n=168). Functional activities were coded in the ICF frame, belonged to the 7 Chapters of the ICF *activities* and *participation* component under 25 categories, and 2 chapters of the ICF *body functions* component under 2 categories.

Fifteen categories from the content analysis were linked to seven activities and participation domains and two body functions domains (Figure 18). These included: domestic life (d6), self-care (d5), mobility (d4), community, social and civic life (d9), communication (d3), general tasks and demands (d2), mental functions (b1), major life areas (d8), and sexual function (b6) ranked from most frequent to least. The most commonly frequent problems reported by participants were: domestic life (d6), self-care (d5) and mobility (d4) were the most commonly frequent activities. As Figure 18 shows, the activities are demonstrated in terms of their frequency distribution, and mean of frequencies (i.e., percentage).



**Figure 14 Functional limitation identified by SPFS**

This bar chart identifies functional limitations by participants with PHF that were linked to the ICF using the specific chapters provided by the ICF framework. There are 9 chapters from the 2 domains: activity and participations (d) and body functions (b).

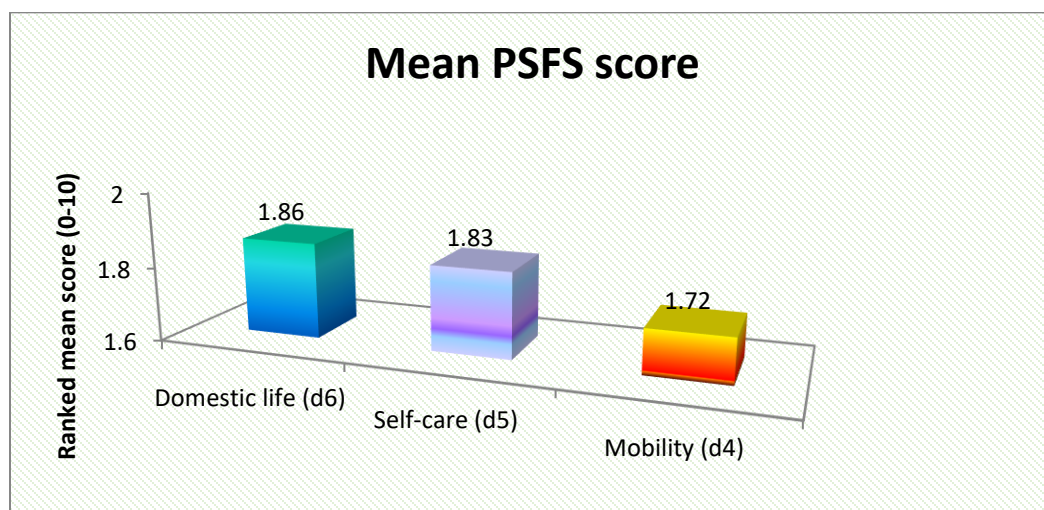


**Figure 15 Functional problems (percentage of participants)**

The number of participants and percentage of reported functional problems on PSFS- Functional problems were identified in 9 chapters of the ICF and 2 components of activity and participation (d) and body function (b).

In Figure 19, since each individual had three choices, all the responses for activities in the same ICF chapter were added up and sorted in decreasing order. Of which, domestic

life (d6), self-care (d5), and mobility (d4) were the most frequent ones reported. As the total number of frequencies for the first figure was triple of the whole data, (3 choices), the mean of the three numbers in activity 1, activity 2 and activity 3 was the preferred option in order to show the mean frequency of activities which again the most frequent activities were sorted as d6, d5, and d4. The scores were ranked between 0-10, indicating “0” unable to perform the activity and “10” able to perform the activity. The average mean scores for d6, d5 and d4 were 1.86, 1.83 and 1.72 respectively (Figure 20).



**Figure 16 Frequency of functional problems (mean score)**

This graph shows the mean frequency of activities which again the most frequent were as before: d6, d5, and d4. The scores were ranked between 1-10, indicating that 1 the most severe and 10 the least one. The average scores for d6, d5 and d4 were 1.86, 1.83 and 1.72 respectively.

## PEQ

### Community support network

Questions in this section measured participants’ perceptions about exercise under supervision, and the attitude of individuals in their network (health professionals, family

and friends) as support toward exercise. Forty-nine participants (83%) answered the questions and 10 did not. Thirty-nine participants (80%) preferred someone to supervise them with an exercise, and nine (18.3%) were not sure. Exercise under supervision was not applicable to one person. Of those who wanted to be supervised (n=39), the majority preferred to exercise under supervision of a healthcare professional (n=31, 79.5%), or a personal trainer (n=7, 19.3%). One participant preferred to exercise with her husband. Responses to two questions with 'Yes/No' answers in this section measured how individuals perceive the attitude of others toward exercise. The positive attitude of healthcare professionals was a facilitator that encourages individuals to be physically active (n= 33, 84.7 %). Also, the positive attitude of family and friends was perceived as a motivator toward exercise by 31 individuals (79.5%).

### Access to exercise

Questions were about exercise facility distance, transportation, safety and the type of environment in this section. Forty-seven participants (80%) answered the questions and 12 did not. Thirty-four (72.3%) exercised at home, or in a place not farther than 3 miles (25.5%). One participant had access to an exercise facility in a place <3-6 miles. Participants used their own vehicle (n=7), walked (n=5) or took public transportation (n=1) if they did not exercise at home. Nearly all participants (91%) had a safe place to exercise. Four participants were not sure if their exercise site was safe. Thirty-four (72.3%) had an encouraging place to exercise, 8 (17.2%) did not, and 5 (10.5%) were not sure. Of those who exercised at a facility (n=13), only 6 people (46%) had access to a free of charge membership.

## Exercise goals

The third section of PEQ measured exercise goals and preferences. Participants were asked about seven exercise goals, using a four-point Likert scale ('not important', 'somewhat important', 'very important', and 'not applicable'). Responses (n=54) were compiled and organized in a stacked bar chart (Figure 21) representing the option 'very important' for increase muscle strength (88.8%), be more flexible (85.2%), feel less tired (79.6%), have better balance (74.1%), have less pain (74.1%), be able to walk longer (68.5%) and fall less often (68.5%) respectively.

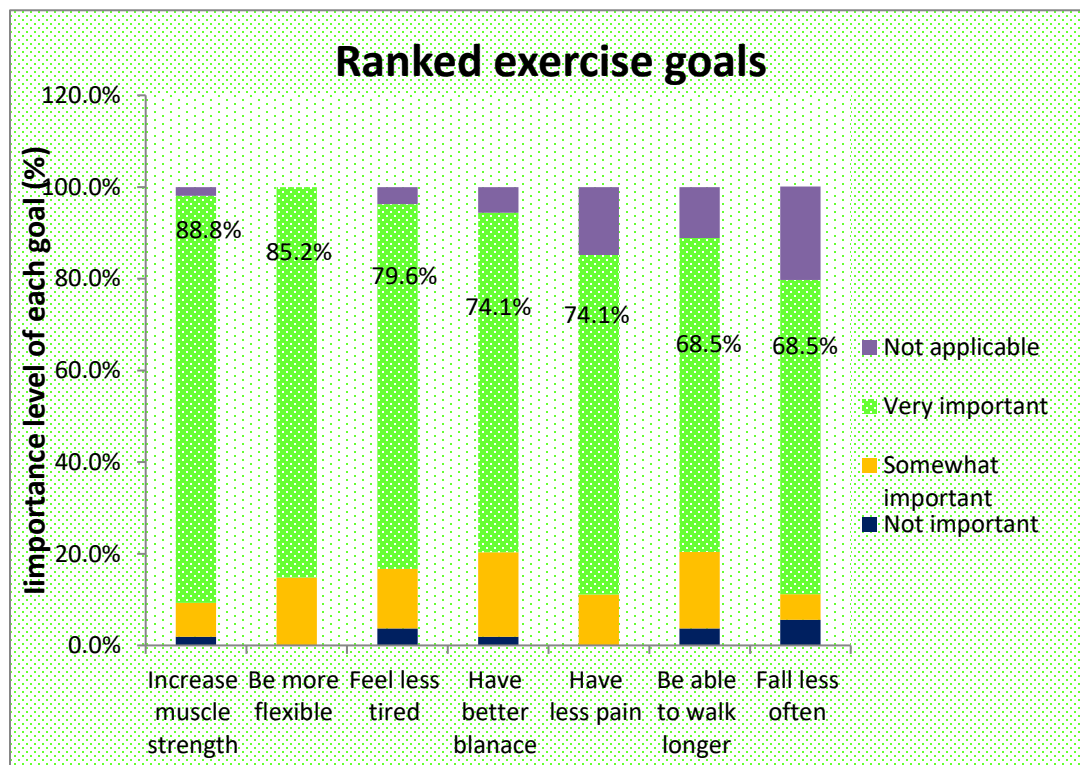


Figure 17 Ranked exercise goals

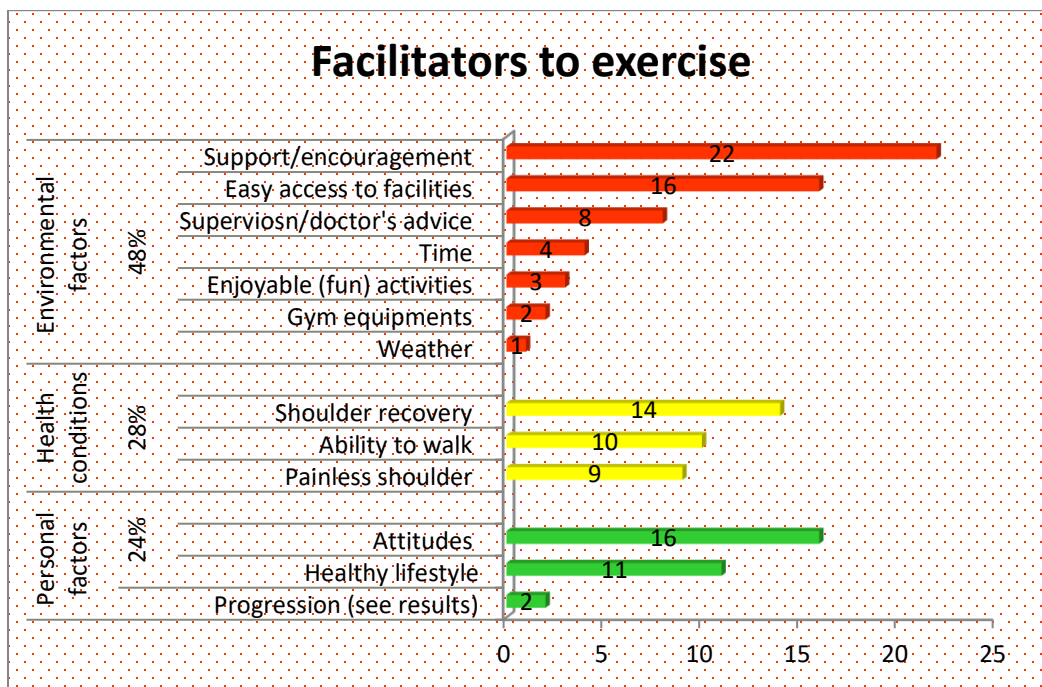
This stacked bar chart shows the frequency distribution of 7 exercise goals representing the green part as 'very important'.

Thirty seven (62.7%) answered one open-ended question “what is your MOST important exercise goal?” in this section. The responses yielded the following results: recovery, back to normal/ restore shoulder function (54%), balance and walk better (19%), more flexible (16.2%), be in a better shape and lose weight (8.1%), and no goal (2.7%).

### Exercise facilitators

This section contained one open-ended and six multiple-choice questions related to the exercise facilitators. Of the 42 respondents who answered the open-ended question (list up to 3 facilitators), 118 items were coded into 13 themes indicating 7 environmental facilitators: support/ encouragement (from spouse, kids, doctors and gym buddies); easy access to a facility (transportation, location of exercise, positive environment, small class size); supervision and advice from doctors; time; enjoyable (fun) activities; access to equipment at home; and weather, and 3 personal facilitators: attitudes (motivation, determination, desire to recovery, goal setting); healthy lifestyle (diet, nutrition, be physically active); and fitness results (i.e., be trimmer, be in shape). Three facilitators were grouped under health conditions: shoulder recovery (healing, feel recovered, return to pre-fracture strength, regain arm strength); ability to walk (with no sling, outdoor walking independently); and painless shoulder (Figure 22). Two participants endorsed that nothing facilitates exercise.





**Figure 18 Facilitators to exercise**

This graph shows how often a list up to 3 facilitators to exercise was stated by participants (n=45). In total, the number of times a facilitator stated was 118 times. Perceived facilitators to exercise were coded into 13 themes: 7 environmental factors, 3 personal factors, and 3 health-related facilitators. The horizontal axis shows the number of times a facilitator was nominated by participants and the vertical axis shows frequency distribution of facilitators: environmental factors (n=56, 48%), health conditions (n=33, 28%), and personal factors (n=29, 24%)

Thirty-seven participants answered 6 questions with multiple choice options in this section, and their responses were summarized as follows: nearly all participants preferred to exercise at home or outdoors (n=36). The best time for exercise was in the morning, i.e., between 6:00 am to 12:00 pm (n=34). In regard to preferred exercise schedule, 24 participants preferred exercise on their own time and 13 chose fixed time, or multiple drop-in times. Participants preferred small group classes <10 people (n=20), and other options were large group class >10 people, and no preference for the class size. All participants (n=37) preferred to learn proper exercise techniques by a healthcare

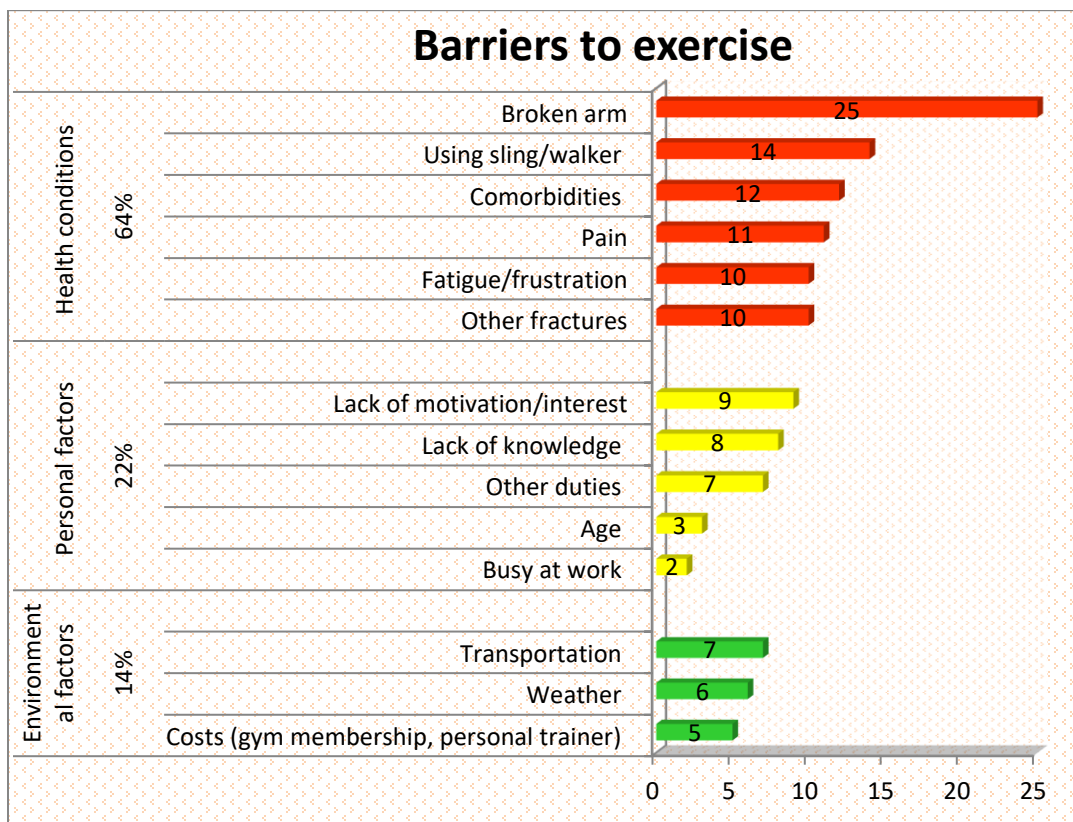
professional, or a personal trainer (n=19). Twenty participants chose other options: print handout (n=7), by video (n=6), have a friend or another person (n=3), website (n=2), and using an app (n=2). Participants felt comfortable with exercise easy to remember (n=33), easy to perform (n=31), challenging (n=15) or fast paced (n=5).

### Feedback and tracking

The question in regard to receiving feedback in exercise was answered by 35 respondents as 'yes'. Participants wanted to know about their progression, proper exercise techniques either by monthly or weekly feedback. However, only 9 participants were willing to give feedback about their exercise to health professionals. Fifty participants did not answer to this question.

### Barriers to exercise

Thirty-four (57.6%) participants answered 'yes' to the question "*do you have things that stop you from exercising?*" Derived from responses to the open-ended question related to three exercise barriers, participants (n=45) answers generated 129 statements. These barriers were coded into 14 themes (Figure 23).



**Figure 19 Barriers to exercise**

This graph shows how often a list up to 3 barriers to exercise was stated by participants (n=45). In total, the number of times a barrier stated was 129 times. Perceived barriers to exercise were coded into 14 themes: 6 health-related barriers, 5 personal factors, and 3 environmental factors. The horizontal axis shows the number of times a barrier was nominated by participants and the vertical axis shows frequency distribution of barriers: health conditions (n=82, 64%), personal (n=29, 22%) and environmental factors (n=18, 14%).

The most commonly reported barriers belonged to their current/previous health conditions: broken arm(s), shoulder weakness, injured both arms; using sling and walker; comorbidities (diabetes, fibromyalgia, foot issues, left hip bursitis, sciatica pain, surgery due to bladder cancer, and general weakness); pain; fatigue/frustration; and other fractures (hip, ribs, knee). Personal factors were lack of motivation/interest (bored with exercise), lack of exercise knowledge (unestablished exercise program); other duties (unexpected things to do, friends drop-in, doctor's appointment, dog responsibility,

caring for spouse, travelling a lot, husband and grandkids responsibility), age, and busy at work. Perceived environmental barriers were transportation, weather, and costs of exercise (gym membership, personal trainer). Other barriers were: fear of falling or injury such as breaking a bone or bruising, lack of willpower, limited mobility, and difficulty with understanding exercise or doing exercise properly. Participants (n=20) reported that they would spend more time exercising if they had fewer barriers, 12 were 'unsure', and 2 stated 'no'. Fifty-three participants answered the last question of the PEQ in regard to using mobility devices. In total, four used a cane, two a walker, and one a wheelchair and walker.

## Discussion

This cross-sectional descriptive study aimed to identify a broad array of perceived recovery together with the facilitators and barriers toward exercise while individuals are in the recovery pathway from PHF. To this end, we identified that the highest frequency distribution of difficulties (85%) was in the domestic life, self-care and mobility. Participants (80%) reported inability to perform recreational activities. Using closed and open-ended questions in surveying allowed us to answer the research questions via a comprehensive list of concepts that participants with PHF provided. The present study categorized, quantified and coded the concepts extracted from outcome measures within the ICF model. The course of recovery after PHF is variable depending on the interplay among several main areas of functional disability, and important activities for persons. Moreover, there are multiple elements such as the person, the fracture pattern, and the environment that can impact engagement in exercise.

The content of the QuickDASH, and PSFS were linked well within the ICF model and covered multiple chapters in the *activities* and *participation* component and the *body functions* component. Self-report assessment of recovery-related outcomes indicates that individuals with PHF present a larger number of limitations with daily activities and participation and fewer limitations with body functions. Consistent with our results, a previous systematic review displayed that the most frequently addressed aspects of functioning in shoulder pain included more than twice as many concepts of activities and participations than concepts of body functions and structure<sup>43</sup>. The separate entities of the QuickDASH items showed that PHF covers several of the prominent concepts in the participation and activities component, and also some concepts of body functions. The QuickDASH item that received the highest mean score (4.6) was recreational activities linked to the ICF chapter 9. As shown, a high percentage of participants (80%) rated themselves 'unable' in the recreational activities. This poor level of functioning has a significant clinical impact suggesting that inability to recreational activities is not only related to the level of disability due to the PHF injury, but to the influence of personal and environmental factors. Calculating the mean score for QuickDASH items as separate entities emphasizes the importance of measuring activity limitations and participation restrictions as experience by patients when clinicians evaluate the shoulder function following PHF. It also prevents obscure patients' important outcomes on the basis of the total score.

Since, certain domains and categories from the ICF are not covered by the QuickDASH, using PSFS in this paper helped to address a list of the most important activities as

perceived by individuals. Results from the PSFS, identified 52 activities tapped into the ICF *activity* and *participation* component, with only two activities under the component of body functions. Three chapters of *domestic life* (d6), *self-care* (d5) and *mobility* (d4) encompassed the most common activities in the PSFS supporting the usefulness of this scale as a patient specific measure of activities. This finding is similar to the results of a large scale study with a total of 2, 911 PSFS activities from 1,050 files for patients with musculoskeletal disorders linking the 100% of activities to the ICF *activity* and *participation* component <sup>37</sup>. In another study <sup>40</sup>, examining the validity and reliability of the PSFS, over 90% of the activities stated in PSFS by persons with PHF were well-suited in the ICF *activity* and *participation* component. We deliberately chose to report important functional activities by participants using the specific chapters in the ICF framework because this linkage helps health professionals monitor the major factors of interest of their patients with regard to disability and functional progress during rehabilitation. To date, none of the currently used outcome measures in people with PHF measure the single construct of activity limitations. The Shoulder Function Index (SFInx), however, is one unidimensional clinician-measured performance measure developed specifically for PHF that focuses on the use of the affected arm to perform daily tasks such as placing objects into high cupboards, washing their back <sup>43</sup>. Upon validation of this scale, van de Water et al. argued that if ongoing disability after a PHF is experienced as limitations in performing specific activities, these activities should be measured and monitored as single construct. The use of the SFInx is recommended in a

recent systematic review of available evidence for 11 clinician-measured shoulder outcomes <sup>45</sup>.

The exercise questionnaire (PEQ) demonstrated the novel information about perceived facilitators, barriers and preferences to exercise and provided a holistic list of concepts attained across the contextual factors of ICF. The most prominent facilitators and barriers to exercise brought forth by PEQ fit well within the contextual factors of the ICF framework. Understanding contextual factors related to exercise is important because individuals' expectations, attitudes, and beliefs together with the environment in which they live, can affect their perceptions about exercise. Personal factors can play key roles in shaping different recovery trajectories in related to exercise. Similarly, environmental factors may provide insight into facilitating or hindering a condition. The following section addresses these factors within the ICF environmental and personal factors from participants' perspectives.

### Environmental factors

Participants provided a number of factors in regard to facilitators, barriers and their exercise goals following PHF: the most frequent facilitators were support and encouragement (health professionals, family members and friends), easy access to exercise, and supervision. Support following injury has a positive role on how injured individuals manage the impacts of various injuries <sup>46-49</sup>. Support from health professionals is one central environmental factor acting both a facilitator and barrier. Randström et al. <sup>47</sup> discussed that health professionals have a key role to motivate older persons with fractures to perform their exercise and make progress in their rehabilitation.

Access to an exercise facility was another prominent facilitator/barrier noted in responses of the participants suggesting that accessibility, transportation, costs, weather and convenience of an exercise location are important for older adults with musculoskeletal injuries. The easiness or challenges individuals face with respect to access to a convenient and safe place to exercise can impact their engagement in exercise. In line with our data, the geographic distance between the home and exercise facilities was one matter of concern, as noted in a scoping review of rehabilitation after PHF<sup>50</sup>. One plausible explanation for this concern is individuals' inability to drive after PHF. Using public transportation, and the weather conditions, (in specific, in Canada) and or paying for taxi are other issues that should be considered. Having exercise equipment at home and flexible time to exercise were other preferences of participants. Considering that the majority of individuals with PHF are elderly, it is important to modify post-fracture exercise programs based on their conditions. One solution might be arranging e-health. To date, only one pilot study investigated the feasibility of an in-home telerehabilitation program for PHF patients as an alternative delivery of the health services<sup>50</sup>. The feasibility of tele-rehabilitation was confirmed in this study and the results obtained on the DASH questionnaire demonstrated that upper limb function was more than twice as good after the program than prior to it<sup>50</sup>. In that study, seventeen patients with PHF received an 8-week period videoconferencing system and the global score for user satisfaction with the health services was 82%. As a clinical implication, it is important to bear in mind the costs pertaining to exercise (such as membership fees, hiring a personal trainer) together with other related expenses in modifying rehabilitation exercise



programs for individuals with PHF. Figure 22 shows several other factors served as facilitators to exercise after PHF. This implies that less active individuals, the more environmental barriers they perceive. Hence, the less likely they involve in exercise.

### Personal factors

The preferences reported by participants highlight the impact of the persons (i.e., behavioral characteristics, attitudes, and beliefs), their existing health condition due to PHF, and other comorbid conditions in the process of recovery and exercise engagement. Identifying perceived barriers and facilitators at personal level suggests that there is no one-fit-all definition to the recovery because conditions vary from one person to another. To this end, it was not also surprising that perceived facilitators, barriers and preferences to exercise is different, as reflected by the diversity of responses. Given the diversity of physical function, psychological and motivational factors underlines a clinical implication since understanding these factors may result in modifying the treatment plan and tailoring exercise based on individual's needs. The interrelated nature of many of the facilitators and barriers suggests that some of the perceived facilitators are direct reflections of perceived barriers or vice versa. For example, strategies to improve facilitators could directly remedy barriers, in recovery and exercise engagement. At personal level, positive attitude was noted in the PEQ. Positive attitude toward exercise has been supported in other studies<sup>51-53</sup>. Participants also endorsed the importance of a healthy lifestyle, good nutrition, and seeing the results of exercising as facilitators. Considering the small sample size in this study, these results can be more reliable in further studies with large sample size.

The results of this study bring forward important information about the influence of the broken arm, using sling, other health conditions, pain, and negative emotions.

Understanding factors affecting physical activity or inactivity may help develop targeted interventions that can optimize compliance to exercise after injury. It is also important for healthcare providers to know their patients' facilitators, barriers and preferences before prescribing specific exercise programs. Exercise barriers were prominently related to the health conditions of participants both as a facilitator or barrier to recovery and exercise compliance. These results are in agreement with other studies that also indicate that health has a key role in recovery and activity level after an injury. In summary, the interaction between the environmental and personal factors can be carried out by the health promoters, and health professionals for the purpose of optimizing exercise amongst this population. In specific, the results of PEQ support the theoretical model of the ICF contextual factors for accommodating the exercise needs of older adults (either active or inactive) throughout rehabilitation programs after PHF.

### Strengths and limitations

Strengths of this study are the reliance on and analysis of the individuals' perspectives. The use of open-ended questions in surveying allowed for participants' unique responses and feedback in their own words without being limited by multiple choices or a 'yes' or 'no' option. Also, linking data to the ICF comprehensive functioning model highlighted the multidimensionality of functional recovery, particularly for the application of the ICF in the context of recovery and exercise after PHF. There are, however, limitations to consider when interpreting the findings. Initially, we planned to collect data from

participants who were within the first year of sustaining PHF. However, the majority of the recruited participants were within the first three months of the recovery process. This poses a limitation on the study results because recovery perceptions and expectations may change over the time as individuals go through the process. Length of PEQ also led to collect unequal responses in this questionnaire since participants did not respond to all questions due to pain, frustration, time and/ or other personal reasons. Hence, the results of PEQ may not be generalizable. Finally, the thematically analysis of open-ended questions was subject to the author's interpretation. This might lead to missing some aspects of individuals' perceptions.

### Implications

PHF is more prevalent among older adults. They need additional care and support in their journey to be recovered. Educating patients through e-health/telerehabilitation may be one new step for developing cost-effective exercise programs. In specific, it is a way of supporting those who are in need of extra care if they are housebound due to their injury and not being able to drive a car. Moreover, peer support programs, as an extension to current rehabilitation programs can be a venue for sharing their experiences, educating and encouraging them to exercise after PHF.

### Conclusions

Through surveying, individuals with PHF were encouraged to put their perceptions into words about recovery and exercise while recovering from this injury. The use of biopsychosocial model of the ICF demonstrated a set of prominent factors of functional difficulties and participation restrictions after PHF. Results highlighted the fact the

engaging in exercise after PHF is multi-layered indicating several facilitators, barriers and preferences at personal and environmental levels. Identifying a number of important facts in this study help clinicians have a broader picture of recovery through the eyes of their patients. The subjective dimensions of recovery and rehabilitation exercise while recovering from PHF may enhance the interpretation of objective data, change clinicians' strategies for considering a wide range of treatment, and alleviate some of the barriers individuals face after PHF. In particular, evaluating the effect of contextual factors is important in further investigations.

## References

1. Court-Brown CM, Garg A, McQueen MM. The epidemiology of proximal humeral fractures. *Acta Orthop*. 2001;72(4):365-371. doi:10.1080/000164701753542023
2. Fjalestad T, Strømsøe K, Blücher J, Tennoøe B. Fractures in the proximal humerus: Functional outcome and evaluation of 70 patients treated in hospital. *Arch Orthop Trauma Surg*. 2005;125(5):310-316. doi:10.1007/s00402-005-0803-9
3. Clement ND, Duckworth AD, McQueen MM, Court-Brown CM. The outcome of proximal humeral fractures in the elderly: predictors of mortality and function. *Bone Joint J*. 2014;96-B(7):970-977. doi:10.1302/0301-620X.96B7.32894
4. Brouwer ME, Reininga IHF, El Moumni M, Wendt KW. Outcomes of operative and nonoperative treatment of 3- and 4-part proximal humeral fractures in elderly: a 10-year retrospective cohort study. *Eur J Trauma Emerg Surg*. 2017;0(0):0. doi:10.1007/s00068-017-0890-7
5. Pignolo R, Forcica MA. *Fractures in the Elderly*.; 1995. doi:10.1007/978-1-60327-507-1
6. Calvo E, Morcillo D, Foruria AM, Redondo-Santamaría E, Osorio-Picorne F, Caeiro JR. Nondisplaced proximal humeral fractures: High incidence among outpatient-treated osteoporotic fractures and severe impact on upper extremity function and patient subjective health perception. *J Shoulder Elb Surg*. 2011;20(5):795-801. doi:10.1016/j.jse.2010.09.008
7. Jo MJ, Gardner MJ. Proximal humerus fractures. *Curr Rev Musculoskelet Med*. 2012;5(3):192-198. doi:10.1007/s12178-012-9130-2
8. Price MC, Horn PL, Latshaw JC. Proximal humerus fractures. *Orthop Nurs*. 2013;32(5):251-258. doi:10.1097/NOR.0b013e3182a39b20
9. Twiss T. Proximal Humerus Fractures. 2015:23-42. doi:10.1007/978-3-319-08951-5
10. Jayakumar P, Overbeek CL, Lamb S, et al. What factors are associated with disability after upper extremity injuries? A systematic review. *Clin Orthop Relat Rest*. 2018; 476 (11):2190-2215. doi:10.1097/CORR 0000000000427
11. De Putter CE, Selles RW, Haagsma JA, et al. Health-related quality of life after upper extremity injuries and predictors for suboptimal outcome. *Injury*. 2014; 45 (11): 1752-1758. Doi:10.1016/j.injury.2014.07.016

12. Calvo E, Morcillo D, Foruria AM, Redondo-Santamaría E, Osorio-Picorne F, Caeiro JR. Nondisplaced proximal humeral fractures: High incidence among outpatient-treated osteoporotic fractures and severe impact on upper extremity function and patient subjective health perception. *J Shoulder Elb Surg.* 2011;20(5):795-801. doi:10.1016/j.jse.2010.09.008
13. Van de Water ATM, Shields N, Taylor NF. Outcome measures in the management of proximal humeral fractures: A systematic review of their use and psychometric properties. *J Shoulder Elb Surg.* 2011;20(2):333-343. doi:10.1016/j.jse.2010.10.028
14. Launonen AP, Lepola V, Flinkkilä T, Laitinen M, Paavola M, Malmivaara A. Treatment of proximal humerus fractures in the elderly. *Acta Orthop.* 2015;86(3):280-285. doi:10.3109/17453674.2014.999299
15. Lübbeke A, Stern R, Grab B, Herrmann F, Michel JP, Hoffmeyer P. Upper extremity fractures in the elderly: Consequences on utilization of rehabilitation care. *Aging Clin Exp Res.* 2005;17(4):276-280. doi:10.1007/BF03324610
16. Kwan LL, Macintyre NJ, West S, West MS. Rehabilitation of proximal humerus fractures : An environmental scan of Canadian physiotherapy practice patterns  
Rehabilitation of proximal humerus fractures : An environmental scan of Canadian physiotherapy practice patterns. 2017;(September).
17. Handoll HGH, Ollivere BJ. Interventions for treating proximal humeral fractures in adults. *Cochrane Libr.* 2015;(11). doi:10.1002/14651858.CD000434.pub4.www.cochranelibrary.com
18. Rtitle CRA, Pt VL, Bureau NJ, Pt FD, Pt JR, Rouleau DM. Acute proximal humeral fractures in adults. 2017;30:158-166.
19. Lee SH, Dargent-Molina P, Bréart G. Risk Factors for Fractures of the Proximal Humerus: Results From the EPIDOS Prospective Study. *J Bone Miner Res.* 2002;17(5):817-825. doi:10.1359/jbmr.2002.17.5.817
20. Lind T, Kroner K, Jensen J. The Epidemiology of Fractures of the Proximal Humerus. *Arch Orthop Trauma Surg.* 1989;108:285-287. doi:10.1007/BF00932316
21. Launon AP, Lepola V, Saranko A, Flinkkilä T, Laitinen M, Mattila VM. Epidemiology of proximal humerus fractures. *Arch Osteoporos.* 2015;10:209. doi:10.1007/s11657-015-0209-4
22. Passaretti D, Candela V, Sessa P, Gumina S. Epidemiology of proximal humeral

- fractures: a detailed survey of 711 patients in a metropolitan area. *J Shoulder Elb Surg.* 2017;26(12):2117-2124. doi:10.1016/j.jse.2017.05.029
23. Bruder A, Taylor NF, Dodd KJ, Shields N. Exercise reduces impairment and improves activity in people after some upper limb fractures: A systematic review. *J Physiother.* 57(2):71-82. doi:10.1016/S1836-9553(11)70017-0
  24. Bruder AM, Shields N, Dodd KJ, Taylor NF. Prescribed exercise programs may not be effective in reducing impairments and improving activity during upper limb fracture rehabilitation: a systematic review. *J Physiother.* 63(4):205-220. doi:10.1016/j.jphys.2017.08.009
  25. World Health Organization. How to use the ICF: A practical manual for using the International Classification of Functioning, Disability and Health (ICF). *World Heal Organ.* 2013;(October):100. doi:10.1016/j.dhjo.2015.03.002
  26. Ueda S, Okawa Y. The subjective dimension of functioning and disability: What is it and what is it for? *Disabil Rehabil.* 2003;25(11-12):596-601. doi:10.1080/0963828031000137108
  27. Kostanjsek N, Rubinelli S, Escorpizo R, et al. Assessing the impact of health conditions using the ICF. 2011;8288. doi:10.3109/09638288.2010.527032
  28. Cieza A, Geyh S, Chatterji S, Kostanjsek N, Üstün B, Stucki G. ICF linking rules: An update based on lessons learned. *J Rehabil Med.* 2005;37(4):212-218. doi:10.1080/16501970510040263
  29. Eysenbach G. Improving the quality of web surveys: The checklist for reporting results of internet E-Surveys (CHERRIES). *J Med Internet Res.* 2004;6(3):1-6. doi:10.2196/jmir.6.3.e34
  30. Smith M V, Calfee RP, Baumgarten KM, et al. Upper extremity-specific measures of disability and outcomes in orthopaedic surgery upper extremity-specific measures of disability and outcomes in orthopaedic surgery. Current concepts review. *J bone Jt surgery Inc.* 2012;94:277-285. doi:http://dx.doi.org/10.2106/JBJS.J.01744
  31. Slobogean GP, Noonan VK, O'Brien PJ. The reliability and validity of the Disabilities of Arm, Shoulder, and Hand, EuroQol-5D, Health Utilities Index, and Short Form-6D outcome instruments in patients with proximal humeral fractures. *J Shoulder Elb Surg.* 2010;19(3):342-348. doi:10.1016/j.jse.2009.10.021
  32. Beaton DE, Wright JG, Katz JN, et al. Development of the QuickDASH: Comparison of three item-reduction approaches. *J Bone Jt Surg - Ser A.*

2005;87(5):1038-1046. doi:10.2106/JBJS.D.02060

33. Drummond AS, Sampaio RF, Mancini MC, Kirkwood RN, Stamm TA. Linking the Disabilities of Arm, Shoulder, and Hand to the International Classification of Functioning, Disability, and Health. *J Hand Ther.* 2007;20(4):336-344. doi:10.1197/j.jht.2007.07.008
34. Stratford P, Gill C, Wetaway M, Binkley J. Assessing disability and change on individual patients: A report of a patient specific measure. *Physiother Canada.* 1995;47(4):258-263.
35. Hefford C, Abbott JH, Arnold R, Baxter GD. The Patient-Specific Functional Scale: Validity, Reliability, and Responsiveness in Patients With Upper Extremity Musculoskeletal Problems. *J Orthop Sport Phys Ther.* 2012;42(2):56-65. doi:10.2519/jospt.2012.3953
36. Uhl TL, Westgate PM, Smith-Forbes E V., Moore-Reed SD, Kibler W Ben. Descriptive Analysis of Common Functional Limitations Identified by Patients with Shoulder Pain. *J Sport Rehabil.* 2015;24(2):179-188. doi:10.1123/jsr.2013-0147
37. Andelic N, Johansen JB, Bautz-Holter E, Mengshoel AM, Bakke E, Roe C. Linking self-determined functional problems of patients with neck pain to the International Classification of Functioning, Disability, and Health (ICF). *Patient Prefer Adherence.* 2012;6:749-755. doi:10.2147/PPA.S36165
38. Fairbairn K, May K, Yang Y, Balasundar S, Hefford C, Abbott JH. Mapping Patient-Specific Functional Scale (PSFS) items to the International Classification of Functioning, Disability and Health (ICF). *Phys Ther.* 2012;92(2):310-317. doi:10.2522/ptj.20090382
39. Smith-Forbes E V, Moore-Reed SD, Westgate PM, Kibler W Ben, Uhl TL. Descriptive analysis of common functional limitations identified by patients with shoulder pain. *J Sport Rehabil.* 2015;24(2):179-188. doi:10-1123/jsr.2013-0147
40. Mannberg Bäckman S, Stråt S, Ahlström S, Brodin N. Validity and sensitivity to change of the Patient Specific Functional Scale used during rehabilitation following proximal humeral fracture. *Disabil Rehabil.* 2016;38(5):487-492. doi:10.3109/09638288.2015.1044623
41. Rodrigues IB, Adachi JD, Beattie KA, MacDermid JC. Development and validation of a new tool to measure the facilitators, barriers and preferences to exercise in people with osteoporosis. *BMC Musculoskelet Disord.* 2017;18(1):1-9. doi:10.1186/s12891-017-1914-5



42. Rodrigues IB, Adachi JD, Beattie KA, Lau A, MacDermid, JC. Determining known-group validity and test-retest reliability in the PEQ (personalized exercise questionnaire). *BMC Musculoskelet Disord*. 2019; 20 (373).
43. Roe Y, Soberg HL, Bautz-Holter E, Ostensjo S. A systematic review of measures of shoulder pain and functioning using the International classification of functioning, disability and health (ICF). *BMC Musculoskelet Disord*. 2013;14. doi:10.1186/1471-2474-14-73
44. van de Water AT, Davidson M, Shields N, Evans MC, Taylor NF. The Shoulder Function Index (SFInX): a clinician-observed outcome measure for people with a proximal humeral fracture. *BMC Musculoskelet Disord*. 2015;16(1):31. doi:10.1186/s12891-015-0481-x
45. Nowak LL, Davis AM, Mamdani M, Beaton DE, Kennedy C, Schemitsch EH. A systematic review and standardized comparison of available evidence for outcome measures used to evaluate proximal humerus fracture patients. *J Orthop Traum*. 2019;In press(C). doi:10.1097/BOT.0000000000001462
46. Bellamy CD, H. Flanagan E, Costa M, et al. Barriers and Facilitators of Healthcare for People with Mental Illness: Why Integrated Patient Centered Healthcare Is Necessary. *Issues Ment Health Nurs*. 2016;37(6):421-428. doi:10.3109/01612840.2016.1162882
47. Randström KB, Asplund K, Svedlund M. Impact of environmental factors in home rehabilitation - A qualitative study from the perspective of older persons using the International Classification of Functioning, Disability and Health to describe facilitators and barriers. *Disabil Rehabil*. 2012;34(9):779-787. doi:10.3109/09638288.2011.619621
48. Tsui K, Fleig L, Langford DP, Guy P, MacDonald V, Ashe MC. Exploring older adults' perceptions of a patient-centered education manual for hip fracture recovery: "Everything in one place." *Patient Prefer Adherence*. 2015;9:1637-1645. doi:10.2147/PPA.S86148
49. Wiseman T, Foster K, Curtis K. The experience of emotional wellbeing for patients with physical injury: A qualitative follow-up study. *Injury*. 2016;47(9):1983-1989. doi:10.1016/j.injury.2016.03.021
50. Macintyre NJ, Kwan LL, Johal H, et al. Rehabilitation of Proximal humerus fracture- A scoping review. *SM J of Trauma Care & Treatment*. 2017; 1 (1):1-12.
51. Tousignant M, Giguère A-M, Morin M, Pelletier J, Sheehy A, Cabana F. In-home telerehabilitation for proximal humerus fractures: A Pilot Study. *Int J*

*Telerehabilitation*. 2015;6(2):31-38. doi:10.5195/IJT.2014.6158

52. Boutevillain L, Dupeyron A, Rouch C, Richard E, Coudeyre E. Facilitators and barriers to physical activity in people with chronic low back pain: A qualitative study. *PLoS One*. 2017;12(7):1-16. doi:10.1371/journal.pone.0179826
53. Pol M, Peek S, van Nes F, van Hartingsveldt M, Buurman B, Kröse B. Everyday life after a hip fracture: what community-living older adults perceive as most beneficial for their recovery. *Age Ageing*. 2019:1-8. doi:10.1093/ageing/afz012
54. Ashe M, Tsui K, Fleig L, Langford D, Guy P, MacDonald V. Exploring older adults' perceptions of a patient-centered education manual for hip fracture recovery: "everything in one place"; *Patient Prefer Adherence*. 2015;9:1637. doi:10.2147/PPA.S86148

## Chapter 4

### An Interpretive Description of Individuals' Experiences with and Perceptions of Recovery after Proximal Humerus Fracture

#### Introduction

Proximal humerus fractures (PHFs) are increasing in incidence, particularly in older adults<sup>1-4</sup> and are the third most common osteoporotic fracture after the distal radius and vertebra<sup>3</sup>. Following PHF, individuals report considerable disability<sup>4,5</sup>, due to the high functional demands on the shoulder during everyday activities. Up to 80% of the PHF are non-displaced and amenable to conservative treatment<sup>6-9</sup>. However, individuals often undergo a lengthy course of recovery and may not fully be recovered at one year and even up to 18 months<sup>3,10-14</sup>. The risk of PHF was nearly five times greater for women ages 60-64 and 21 greater for women ages 80-84<sup>15</sup>. The susceptibility of women to PHF is likely related to osteoporosis<sup>7,8,12,16</sup>.

A scoping review of 1051 studies, summarized the nature of the literature on PHF, which consists primarily of studies of surgical treatment (67%), biomechanics and basic science studies (10%). This scoping review indicates that little attention has been directed towards patient priorities and perspectives outcomes<sup>17</sup>. A recent systematic review investigated the trends of outcome measures and the conceptualization of disability in patients' upper extremity injuries (including PHF)<sup>18</sup> and highlighted the impacts on psychological aspects of illness and pain (such as emotional distress and coping strategies) and defined factors associated with recovery. To date, there is scant qualitative research on PHF in comparison to hip fracture<sup>19-26</sup>, wrist fracture<sup>27</sup>, distal radius fracture<sup>28</sup>, and other injuries<sup>29-34</sup>. The use of qualitative research methods has recently been proposed as a key component in the further development of trauma outcome research<sup>34</sup>. Thus far, one qualitative study has been published exploring patients desire in regard to information they need while recovering from PHF<sup>35</sup>. The results of this study revealed

that individuals are more concerned about rehabilitation and support services available to them after PHF but not the biomedical information and the nature of the injury. However, the authors did not investigate patients' perceptions and beliefs of living with PHF. The objective of this study is to describe individuals' experiences, priorities and, facilitators/barriers to recovery after PHF from the individuals' perspectives.

## Methods

This study was approved by the Research Ethics Board (REB) of the University of Western Ontario (Project ID: 111265) on June 15, 2018. The methods and finding of this study are reported in line with Consolidated Criteria for Reporting Qualitative Studies (COREQ) guidelines to ensure transparency <sup>36</sup>.

## Design

Interpretive description of semistructured interviews guided this qualitative study <sup>37,38</sup>. This methodology enables health researchers to analyze multiple realities in clinical problems within the context of health care system <sup>37</sup>. Interpretive description is an applied, and inductive analytic approach that is increasingly used to extend knowledge in the patient-centered care, provide an in-depth understanding of human health and illness experiences, and improve clinical practice <sup>38,39</sup>.

## Participants

Through purposive sampling, we recruited individuals with a diverse background including age, gender, education, and pre-fracture medical history. Research staff identified a subset of participants with a PHF from a previous survey who had expressed their interest in participating in this interview study. The inclusion criteria were 1) age of 45 or older 2) in the first year of recovery after PHF 3) mentally able to understand the purpose of this study and 4) signing the informed consent to participate in the study. All patients were in the first year of recovery at the time of interview except one who was admitted at our clinic as a new patient whose referral letter did not show the injury date. This individual had sustained PHF 12 years earlier and was able to provide us with rich descriptions of his lifelong recovery process. A protocol deviation was reported to the

REB we were permitted to include this subject in our study because there was no potential for negative impact on the health and safety of this participant and his descriptions of the long-term consequences of injury added more meaning to our study. All participants gave written informed consent to participate in the study. The sample size was determined based on thematic saturation <sup>37</sup>.

## Procedure

The interviews were semi-structured and carried out between January and May 2019 by AV (a PhD student, woman). Topics were developed and piloted in a focus group meeting with the supervisor (JMD) and PhD fellows. The following questions were open-ended to allow for emerging themes throughout the interview process. Prompt questions such as “tell me more about it” and “can you please give me an example” were used to encourage participants in further elaboration.

### Interview questions guide

1. Tell me about your shoulder fracture.
2. What things bother you the most?
3. How do you cope with your new life?
4. What facilitates and or prevents recovery?
5. What are your expectations?
6. What would be your advice for someone like you?

Each interview lasted approximately 30-40 minutes; it was digitally recorded, and then transcribed. We removed all identifiers, names and specific information and assigned a number to each participant to ensure confidentiality. During the interviews, AV made reflective field notes on particular body language (s) or obvious mode changes which assisted interpretation of the interview data. There were 6 face-to-face interviews that took place in a private room at our research lab at the Roth McFarlane Hand and Upper Limb Centre (HULC) at St. Joseph’s Health Care Centre in London, Ontario and 8 phone

interviews depending on the individuals' preferences. Saturation of themes and experiences was reached with the 14 participants.

### Theoretical perspectives

As with other qualitative methods, the researcher's theoretical perspective guides data collection, analysis and interpretation. Interpretive description provided a good fit for the structure and objectives of this study. This methodology was developed by Sally Thorne, in response to a need for an alternative method to answer complex questions pertaining to health and clinical problems<sup>40</sup>. Interpretive description seeks access to an important kind of knowledge about patients' experiences when they encounter certain challenges or transitions following an injury. This methodology enables researchers to locate variations within the subjectivity of experiences shared by those in the same health condition but having multiple realities. As stated by Thorne<sup>40</sup>, a researcher, in an interpretive description, unlike some qualitative methods, does not need to bracket his/her preconceptions, because in interpretive description, there will be always some background knowledge, or clinical pattern observation within which studies of human health and injuries are generated. As such, the researcher is the insider and the co-creator of the generated knowledge. The generation of an interpretive description product is discoveries within complexity and explorations of meanings that allow for clinical application. Thus, patterns and themes within the data are ordered into a story, or a professional narrative, in order that we might make sense of the most important ideas to be conveyed and access meaning in a new manner.

### Data analysis

AV transcribed the audio-recordings of interviews and uploaded them into Nvivo version 12 (QSR, International, 2019). Filed notes were added to each file in Nvivo. Guided by interpretive description, transcripts were read several times to ensure understanding of the patterns and meanings among the pieces<sup>37</sup>. Initial code generating was used to sort data into common patterns. At this stage, some data tapped into several different codes, if it was not clear where to fit the units of meaning. The Nvivo<sup>TM</sup> was used to merge these

initial codes together to view the whole picture and the inter-relationships of codes at a glance<sup>42</sup>. Developing subthemes and themes was an iterative process and it required re-reading the quotes attached to each code and looking at the data as a whole in relation to the research question. Subthemes were developed and placed under two overarching themes. The final stage of the thematic analysis was writing up the interpretation to describe the whole story of findings. In an attempt to avoid misinterpretation of participants' statements in the interviews, the supervisor (JMD) separately reviewed data to provide confidence in the trustworthiness of themes. Themes and subthemes were accepted by the entire research team.

## Results

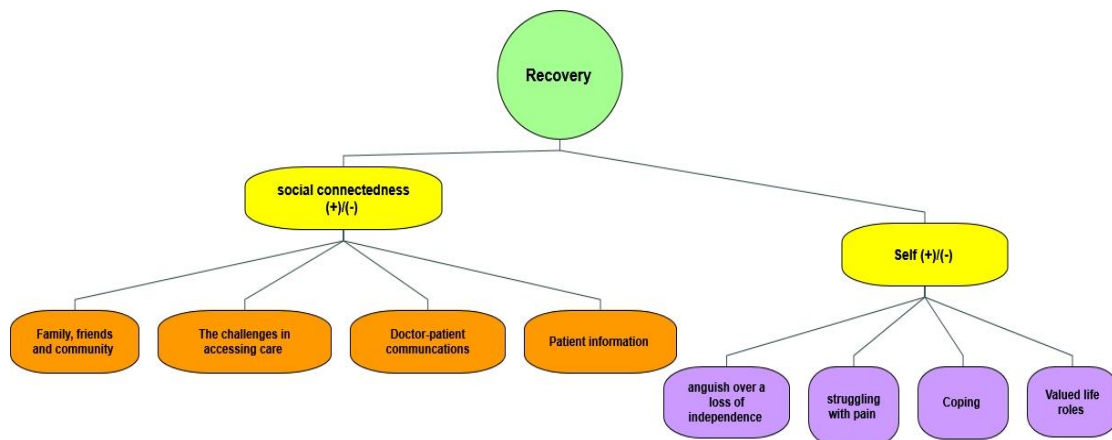
The data were drawn from 14 in-depth semistructured interviews with women (n=9, 64%) and men (n=5, 36%) with PHF. Interviewees varied in age, education level, living and employment status and their health conditions. The participants' age ranged from 45-95, two youngest participants were in the range of 45-55 ages and went on disability benefits plan due to other injuries, one of which was living in a rooming house. Participants lived with their spouse (n=4), and lived alone (n=7). Three participants lived with a family member, one with her daughter, one with the grandson and one who was caring her 96 years of age blind mother. The chronic conditions included depression (6), osteoporosis (4), osteoarthritis (3), diabetes (3), bladder cancer (1) and thyroid dysfunction (1). The oldest participant was 94 years old and was living on her own before the PHF and currently with her grandson. The level of education was at university graduate degree (1), undergraduate (4), college with degree or some college without degree (6), and high school (3). The majority of participants (10) were within the first three-month of recovery post-fracture, 10-12 months (3), and one person was in the twelfth year of a lifelong recovery. Four individuals were employed, eight were retired and two were on disability benefits plan. Participants had between one and three falls except one who had almost 10 fragility fractures (Table 7).

**Table 10 Participants characteristics**

Participants	Living /employment status	Age range	Gender	dominant hand fracture	Time since injury	Pre-fracture comorbidities
P1	Living with spouse, retired	66-75	W	Y	>3	0
P2	Alone, retired	66-75	W	N	>3	2
P3	Alone, goes to a retirement facility soon, retired	76-85	M	Y	>3	2
P4	Living with a 96 years old blind mom , semi-retired	56-65	W	N	>3	0
P5	Alone, on disability plan	45-55	M	Y	>3	5
P6	Living with spouse, self-employed	56-65	W	Y	10-12	0
P7	living with daughter, retired	76-85	W	Y	>3	1
P8	Alone, retired	66-75	M	N	>3	0
P9	Alone, on disability plan	45-55	W	Y	>3	2
P10	Alone, self-employed	65-75	M	Y	>3	1
P11	Living with grandson, retired, goes to nursing home soon	85-95	W	Y	>3	2
P12	Alone, retired	66-75	W	N	10-12	1
P13	Living with spouse, employed	56-65	W	Y	10-12	0
P14	Living with spouse, self-employed	66-75	M	Y	12 Y	2

A total of 115 key direct meaning units were identified from the content of the interviews/transcripts and subsequently mapped onto 35 initial codes, and 6 subthemes (general thoughts, emotional challenges, coping, expectations, family and healthcare system). Two overarching concepts emerged: “self” and “social connectedness”. A visual representation of developing subthemes under each main theme is shown in Figure 24. As shown in this figure, each subtheme acts either as a facilitator (+) or barrier (-).





**Figure 20 Concept map**

Thematic mind map showing links between concepts and themes

### Concept 1: Self Struggling with pain

Pain and sleep discomfort (inability to sleep in a comfort position) were common experiences in the early stages of the injury recalled by all patients. One individual vividly recalled her pain below:

*It really was very unbearable for the first while [crying] like a waterfall pulling down my arm. Now I try and go without having opiates for a longer time but sometimes I don't let it go too long when I go to a pain crisis or I can't really cope ...*

Pain had an impact on individuals' sleeping and was mentioned by all patients. But it seemed that patients were able to manage it gradually. Two individuals described their experience and how they gradually identified the position that was less painful and make sleeping possible.

*Pain was bad, extremely bad; it pulled on here [pointing] on my arm when I was flat but in weeks you find a position that is with less pain. You have certain position to sleep but you can't lie on your side until you find something that works...I tried putting some pillows under my arm and now I sleep better.*

## Anguish over loss of independence

Experiences of doing simple tasks and seeking help from others were emotion-provoking throughout the interviews. The descriptions of how the fracture disrupted their day to day activities were laden with emotion. The oldest participant (94 years old) described losing her transition from living independently before fracture to a life that is totally different because she needs help for *everything*. When asked to describe what everything meant to her, she emphasized that ‘*everything is everything*’ and continued:

*Like going to washroom, and getting dressed by my grandson. I can't brush my teeth after fracture. I moved out from my place and living with my grandson now but soon....living in a nursing home because I can't manage myself after this [fracture].*

When asked about bothering things the most, one woman recalled her life before the injury. She was full of emotions, cried and laughed several times while talking about her life experiences before and after fracture:

*This has really been a depressing time in my life. I was always on the go, but I am not able to do things but I like to keep going, I don't want to give up and the biggest thing I have is a nightmare to get help from others like people stepping up to the plate and get things done for me.*

Yet another woman explained her frustration due to her loss of autonomy and not being able to do everything for herself. When asked to explain it in more details, she continued, “I can't put my hair in a ponytail and having this hair flopping around my face really bothers me. But the big thing is just not having my independence, not being able to when I see something that I want to do and not being able to go ahead and do it.....[pausing] and for whatever reason, I feel clumsier these days and more things seem to drop or fall off of my hand...”.

## Coping

Coping abilities emerged as an important subtheme in our analysis. The influence of positive and negative attitudes was visible when participants described how they coped and moved on from various setbacks after PHF. Coping seems to be a product of the individuals' interaction with the injury that leads to developing a strategy. Patients'

coping strategies in response to limitations and restrictions imposed by a disability are based on their needs and/or personal attitudes. Participants described their experiences in regard to finding a way to adapt to their new situations in a number of different ways. It was noticeable that those who lived alone were more creative to find their way of managing post-fracture life. One man revealed his struggle to lead his life as normally as possible because nobody was there to do things for him.

*I grin and bear it. Put it in that way, as a sucker for punishment, I guess [Chuckling].*

When asked what he meant with this statement, he explained how some activities that were previously taken-for-granted now imposed restrictions on him:

*..Oh Jesus! It was hard for me to do that because I couldn't reach down to where I wanted to pull on my socks and I couldn't get my socks away until I bought a thing that you put your socks on that [socks slider] and stuff like that...*

Then he continued:

*When you get down the road you realize where the curves are in the road. You find out where the roadblocks are and you just go around. So that's you know that's what you do.*

Coping included compensatory movements that patients used after their fracture such as kneeling down instead of leaning over to pick up a thing from the floor, wearing pants with elastic waists, cutting foods on a higher stand. Compensation with the upper limb was also reported, even when the dominant side was injured. A man with a dominant hand injury was surprised by his ability to brush his teeth with his left hand after PHF. He explained that he was halfway to being skilled with non-dominant left hand, but felt that with more practice he might be able to switch over to the left hand completely. A mid-aged woman who was eating mainly canned food for financial reasons, reported on learning how to secure a can with her foot on the can and open it with the non-injured hand.

Not all people with loss of function were able to compensate, or were motivated to remain independent. One of these cases is acceptance as a coping strategy. A man in his

mid-70s was an example of having no desire/motivation to manage his life on his own, and expressed his readiness to experience a new nursing home life. He said:

*I can't think of anything because I'm 76 years old and I am not prepared for any change. So, as I get older, there will be other things that I can't do. That happens when you get older, and so just have to cope with the situation at the moment whatever.*

Engagement in rehabilitation and recovery was variable, with some having a more passive approach and others assuming personal responsibility. The following examples highlight the level of self-engagement when participants were asked about what might facilitate the recovery. The youngest woman in the study, who was on disability plan, suffering from depression and multiple chronic conditions (multiple fractures, fibromyalgia, osteoporosis, and hearing loss), could not think of anything that she might do with her recovery.

*...I don't know. This is not my job. They [doctors] should tell me. Maybe physio, I don't know. But I guess that's physio. That would probably be the only thing. I don't know....[pausing].*

In contrast to this low sense of engagement, others interviews perceived rehabilitation exercises, following clinician advice and maintaining motivation during the recovery process as necessary to attaining a better recovery. One woman found that doing rehabilitation exercises at home several times per day has helped her to a faster recovery. Another woman discussed the importance of being care-giver to motivate their engagement in recovery. This woman recounted:

*I'm taking care of my 96 year old blind mother. So maybe that was good too. Maybe it forced me to keep active. I listened to my doctor and do my exercises lots and lots per day [smiling satisfactorily].*

Similarly, a woman reflected on her compliance *to do what she was told to do* by her physiotherapist. She recalled a previous injury stating “I ruptured my biceps tendon on this arm [left arm] a couple of years ago, and the physio was just amazing and my recovery was fast so that is why I am diligent about exercise”. For another woman, the recovery process was associated with regular engagement with treatment plan recommended by her care providers:

*I know it [recovery] is a progressive process of bit by bit, regaining the full motion and the full strength in my right arm and hand and is doing whatever the expert say I need to do. That's what I will be doing and if it takes 6 months or it takes 9 months so that's what it takes, I am prepared to do whatever is necessary to get it back to where or close to where it was before.*

Having social support allowed others to accept their limited abilities: “Well, my husband now does lot of things, I am not gardening at all, no laundry, and no groceries [laughing] I am just happy with doing smaller load of things”.

Despite having faced challenges in a lifelong (12 years) recovery process, a man described coping as accepting the conditions realistically:

*I certainly don't do those things that I can't do. So, I don't think I've recovered in twelve years but I'm pretty strong willed.... where I find that I'm not able.. I step back and I look at it and say what do I have to do to accomplish? What I want to do? And there are very few things that I absolutely cannot accomplish. Like I can't reach overhead and screw a screw. So, if I need a ladder to get higher, I bring a ladder in and I climb the ladder. If I need to have more tools with me when I'm up on the ladder I put them attached to my body before I get on the ladder. Instead of going up and down up and down up and down I just stop and I look and I say what do I have to do to accomplish this, and I do it. Period.*

This man understands and accepts his limitations and values his strengths and capacity to perform most daily tasks.

Acceptance is not always a positive coping strategy as it may result in less engagement in rehabilitation, recovery or life roles. The youngest man who broke his shoulder for the second time, was living with arthritic arms and diabetes, and defines himself as someone who gets bored and depressed easily. Just getting through the days for quite a long time even before re-fracturing, he tries to get rest, and not to think about his life. He says that “diabetes hampers me a lot, just in everyday life even before I fell and is going to hamper my recovery with the shoulder as well”. When asked what might help him to recovery, he said:

*I can't think of anything that would really help me, but I suppose EMS is the best bet to strengthen my arms muscles if I can afford buying it. This is one of the Dr. Ho's machines (Electrical muscle Simulation) and I want to have one at home but I can't buy this machine.*

To this participant, more negative feelings about his current and past situations were associated with his sense of recovery. However, he still feels recovered if he is able to buy this EMS machine.

### Valued life roles

Valued life roles before fracture seemed to influence what individuals expect in terms of recovery in their future life. Many of the participants, who had previously been physically active, hoped to completely regain their functional independence; while others simply expected to function at a reasonable degree depending on what was important for them. For some of the participants, images of a favorite activity in the past were a reminder of what they want to achieve again. In answering what would be a fully-recovered version of you, a woman said:

*I would be able to do all things I normally do [laughing], I would be able to drive, and in couple of months, we'll be looking at spring and getting out into the garden and outside and that's my passion to be outside in the dirt and what I love to....get out my flower beds and start to see the beginning of spring. That's where I would hope to be in that period of time. I hope to achieve that goal because there's a lot to do in our garden and I don't know who's going to tend it if I don't, and we are going to be spreading a lot of grass seeds and do away some of them.*

Thinking about future life was also linked to different emotions including fear, uncertainty and if they would not be able to pursue a normal life as before.

*... I am searching on humerus fracture a lot and it seems that people never get back to fully range of motion after this fracture. So, this scares me about the future but I don't give up...*

A man with a negative outlook seemed to expect the worst with no hopeful view of the future.

*....there's nothing really that helps that anybody is concretely able to do beyond what's happening now.....[pausing] pills won't do anything.... injections won't do anything. I don't think there are things that maybe a doctor might be able to suggest certain actions or motions that would help me in the future and...that's about it I think.*

Being viewed as normal was a perception for a man who felt hopeless and unable to recover from his PHF because of other chronic conditions. His biggest dream is to drive a car, and in specific, 'to shift'. When asked why driving a car is the most important

dream, he said: “If you drive a car, I suppose you feel nobody really knows there’s anything wrong with you. You feel more normal as you were I guess”.

## Concept 2: Social connectedness Family, friends and community

This theme voiced by several participants and they generally reflected positively on how the support they received during this challenging period helped them with the transition to recovery. A woman with multiple chronic conditions and fractures who lives with her daughter and her family says:

*My daughter, my son-in-law even you know, like I mean, he doesn't help you get dressed or anything but, he's around, and my grandchildren...everybody helps and I am so blessed!*

Further, this woman points to her daughter who is with her at interview and says:

*She [pointing to her daughter] is my biggest help, but she can't do it all the time. She works full-time and she's got her own family, I don't expect her to do it. I don't want her to do it really.*

While she was highly encouraged by her daughter’s help, she expressed her great concerns about being a burden on her daughter and that she does not want to put more pressure on her life.

Two participants appreciated what neighbors and community members did for them during their recovery.

*...the neighbors are absolutely wonderful like they're in and out checking on you all the time. Can I do something? So, that has been very beneficial. I do have family in town and if they're not checking in, they're calling me to see if they can pick up something at the grocery store for me. ....I'm very lucky. I have family and neighbors and friends that I can rely heavily on.*

One participant reported that prayers from his church community lifted his spirit throughout the recovery process. Nevertheless, two interviewees expressed their disappointments for not receiving help from family:

*Well, I have to tell you that the good thing is that I have my husband, because I have two daughters and I have a granddaughter and they live within two blocks from our home and surprise, surprise that I have not seen none of them since this [fracture] happened. This has been a real eye opener to me you know because both of these daughters have had health issues and mom has always been there and now mom needs a little help and nobody is there so that it has been a real eye opener and it has been very emotional [crying but trying to stop her tears coming down]. It is just disappointment. It is a big disappointment to me.*

And the woman with countless previous fracture (10 maybe as she stated), whose divorce will be final soon, was living on disability benefits expressed the impact of lack of social support:

*I've been living in a rooming house with a bunch of men, very strange men all that. So there is absolutely nobody that's been helping me... but maybe... if I need a jar open, and they're around or whatever. But, lifting things, washing dishes, stuff like that, there's really nobody that helps me at all.*

### The challenges in accessing care

Along with family support, almost all participants clearly described their concerns about accessing care (rehabilitation) that facilitated their recovery process. Lack of access to physiotherapy, massage therapy and personal trainers were expressed as barriers to recovery. A self-employed woman highlights the importance of physiotherapy after fracture:

*I go to physio and massage therapy once a week. I do yoga, I am not sure what else. I am doing it since I injured myself. It helped me to strengthen the muscle around and it helped me with the management of the pain as well.*

Although others stressed the importance of insurance coverage (costs). One participant described the lack of a continuum care:

*Well, most of my treatment has been outside of the healthcare system. My private insurance helped a lot. I don't really think this is available under health care. They would say I am fine, so I guess if you want more, you have to pay by yourself. My doctor says that I am fine.*

Another participant also emphasized on the vital importance of physiotherapy as a facilitator in her own recovery process and described “physiotherapy is helping a lot if it continues but I don't have insurance and I have to pay, it's lots of money and I can't afford it.”



In addition, access to the Personal Support Worker (PSW) discussed by those participants who live alone with no family member to support them at home after injury. One participant was happy with having a PSW because she was able to live at her home without hurting her arm. However, the woman (on disability benefits plan) was so disappointed that she did not receive the care that she needed. She stated:

*.. they [care system] should make sure you're not going home alone and trying to survive on your own and trying to do things. I didn't shower for three weeks because I couldn't get this thing [pointing to sling] off, I couldn't.*

She then continues “OK, I'm exaggerating a little, it was less than three weeks but I couldn't shower for a long time because it hurt. I had nobody to help me. The other woman also added:

*...at the beginning, bathing was my worst part. I couldn't take my shirt off. I wasn't allowed to remove the sling. So, I couldn't change. I had someone help me change after three weeks. It was very difficult... so washing yourself when you are sweaty and get your shirt gets off is probably the most challenging thing in the first few weeks if you have nobody around.*

## Doctor-patient communications

With respect to communication with specialist, physiotherapists and nurses, most participants had a positive feedback and communications were perceived as good and satisfactory as it could be. One of the participants was so pleased with her treatment at our clinic and her doctor's incredible attention:

*He[orthopedic surgeon] is very patient and his fellow who first met with me in the clinic with Dr... stayed after closing hours, arranged for me to go have a CT immediately and waited for me to come back even though he was done for the day to read my results to me. I was most impressed with that. I came on the wrong day to see my doctor a week early. He still took me so I've been most impressed with the doctors' attention and ability to explain everything.*

The other patient expressed:

*I have many experiences with hospitals but there is something special about St. Joseph that I want to say, there is always more compassion aspect, there is something different here at St. Joseph. It's not the building; it's about people that you don't get it at other hospitals. It's unique care at St. Joseph that you don't get it in other places.*

However, a few expressed their concerns about waiting so long and difficulty in having an appointment, and knowing if they need a surgery or not. One participant was disappointed with the attitude of his doctor, although he believed that his doctor was very knowledgeable, talented, and knew his job very well. When asked what he wants from doctors, he said: “I want them to look at my eyes and tell me what is going on with my shoulder”. Giving more details, he continued:

*When we walked in, he sat down and spoke to the resident as if I wasn't even in the damn room he walked in. But guess what? They're there because of me! I'm like the center of this whole thing. Some doctors think they are the center of the whole thing. Big difference! Huge difference!*

In terms of doctor-patient relationship, one woman recalled:

*Dr...calling women 'girls' makes me think he does not see us as competent adults, which reduces my trust. How can he be so ignorant in 2019? What else does he not understand, that might affect his judgement? His resident has my sympathy.*

Likewise, the other patient with multiple health problems said: “I wish they could be ...[pausing] better doctors. When asked to describe what she meant by “better doctors”, she explained that I mean “take more of an interest in patient, some look very impersonal”.

## Patient information

Repeatedly, participants expressed a need for information about their recovery, what do and not do before the first doctor’s visit after fracture and pre/post-operative care. Participants want to know what is happening in the healing process in simple and nontechnical language. One woman said “sometimes I think they tend to think that you were the patient already know what you should be doing but you just are a lay person and if you never had that experience before... you don’t know what you have to do.

*I need more information about what else is injured apart from the fracture. Why does it hurt when I move it in certain ways? Why has my arm been so weak since the bone was fractured? My last appointment with the doctor (I only saw the resident, not doctor) was rushed. She didn't offer explanations and I didn't think to ask. Not her fault but I wish I had more info now so I could take more responsibility for my healing. I hope the PT will answer my questions.*

When asked what form of information they prefer, one woman said:

*...it [information] would be to have a little handout with a picture of the shoulder just a sketch of the shoulder for a lay person because they're using a lot of terminology, the proper terms for each body part or bone. So it'd be nice to have a diagram, a hand diagram not a photo with a list of each of the each of those parts of the shoulder and what their function is.*

Another patient said “well, I think I get inundated with information. Information is sketchy.... maybe more pictures, more videos, films or whatever to get a better understanding of what they call”.

*.. but to me the language on the printout does not help me a lot. Like sometimes it says to rest your arm, sometimes it doesn't say, sometimes it says to sit other times it says to stand. I don't know by the drawings what they're trying to tell me and so when I was at physio the last time I asked them about one of the exercises and he said you're doing it wrong. So, he told me again but then by the time I got home, I forgot, like my brain doesn't work hundred percent [laughing]. I think I just need everything clearer.*

Also, some of the participants were afraid of doing something wrong, so that they decided to do nothing (i.e., home exercise). One of the interviewees who had a surgery after PHF expressed his confusion about bruising on his arm a few days post-surgery:

*.....there was a lot of bruising around the shoulder, deep purple bruises and yellow and after a little while it went into my hand. I wondered that oh like is something going wrong here. Do I have to call the hospital? But when I went back, for the first visit with my doctor, the lady doctor said “bruising travels because of gravity. And so the upset I had like I didn't know what was going on, so it would have been nice to know if somebody had said, in a couple of days your arm is going to be showing this bruising or discoloration, but don't worry about it. All that it's just because it's going to travel down on your shoulder where the incision was and it's just gravity and you'll be okay. This is what will happen, don't worry about it. That would have been nice because it's just what you expect.*

### Peer advice and recovery

All participants were eager to share their experiences and offer advice to other people who may sustain the same fracture. Some of the key advice for their peers were: 1) trust your doctors and do whatever they say to do, 2) be positive, complaining cannot change anything 3) prepare a list of important questions because you forget most of them when you see the doctor and finally 4) be cautious and don't break you shoulder, if you do not have anyone to take care of you or money.

## Discussion

The aim of this study was to describe the experiences of individuals while recovering from PHF. Through an interpretive lens, the recovery was described by exploring a broad range of experiences and perceptions individuals encountered during their transition from the injury to a normal life. Participants also shed some light on the barriers and facilitators to the recovery course based on their own experiences. The findings from this study highlight how the same injury impacts the physical, psychological (emotional) and social life of individuals. Overarching themes from this study show that recovery after PHF is beyond pain and discomfort. In fact, recovery is a complex process interacting within the individuals' complexity and environment (i.e. access to care and so on) that facilitates or hinders the recovery process.

Our participants represented a wide range of real experiences as a manifestation of their own specific personal behaviors. In particular, coping and compensatory mechanisms showed a distinct difference between those who are more capable of adapting and managing their new situation and those who are not due to suffering from depression or other related health conditions. Also, strategies for maintaining functional independence entailed that individuals with positive attitudes try to make the best of handling the situation whereas those having a negative attitude may expect the worst to happen. The theme 'self' identified fit with the results from previous qualitative studies demonstrated that individuals recognized the need for them to go through a process of readjusting expectations of themselves and become more responsible following wrist fracture <sup>43</sup>. Young and Resnick also highlighted the importance of the patient positive and "never give-up" attitudes can bring about desired changes within the context of hip fracture recovery <sup>21</sup>. The echoing of various perceptions and behavioral aspects of people's way of life implies that health behaviors and psychological orientations are associated with socioeconomic inequalities <sup>44</sup> suggesting a need to for more qualitative research.

In addition to the 'self' theme, social connectedness, feeling cared for, and perceiving that others (family, friends, and community) are available to help was discussed by our participants. The majority of participants reflected on the invaluable support they received from family and friends or neighbors. Alternatively, the perception of isolation was apparent in one of the interviews where the interviewee was totally overwhelmed as a result of divorce, financial issues and living in a rooming house. As found in prior research, access to care and emotional support are associated with less disability suggesting that having someone available to provide help is important for patients with musculoskeletal injuries, during the period of adjustment to the specific condition <sup>45</sup>.

All of the individuals reflected on support from healthcare system. As quoted repeatedly, insurance coverage, the cost of treatment and financial pressures might have influenced patients' decisions on their likelihood of getting care, and as a result, this may be a barrier to their recovery. In our study, the interpersonal style of the therapist and positive relationship with a therapist were valued by individuals. Consistently, others have found that individuals need to perceive that their therapist listens and cares about their challenges after upper extremity injuries <sup>46</sup>. Also, many interviewees conveyed a willingness to know what a reasonable expectation is about returning to normal and regaining full function. This feedback from the patients indicates their desire to be involved in their treatment as a team member. Likewise evidence suggests that interventions promoting health education improves patient engagement, resulting in positive health outcomes as measured by health behavior and reduces the use of health services <sup>47</sup> whereas poor health information is associated with worse health outcomes <sup>19</sup>.

In this study, participants shared a wide range of divergent perceptions and experiences while recovering from PHF. Some adjusted their expectations, and developed coping (compensatory) strategies and remained positive for the next step in their life. Some accept the conditions and presented their disengagement from current circumstances. More specifically, the diversity of perceptions were from our oldest participant (94 years old) who was still striving for independence (self) while the youngest ones, a woman and

man in their late 40s were desperately seeking social support. The bottom line is the need for exploring and understanding the consequences of PHF, and if extra support from healthcare can make a change in the quality of recovery for those who perceive negative outcomes and have limited access to a social support network.

### Practice implications

This study affirms the necessity for health providers to recognize the significant impact of barriers and facilitators on individuals' physical, emotional and social life following PHF. Based on present findings, a multidisciplinary treatment plan might be desirable where sources (people with PHF and healthcare professionals) are collaborating toward a whole. Building a multidisciplinary health team including health providers, peer support, case management may remove some barriers and facilitate the transition from this state for individuals. The multidisciplinary system may provide extra help for those who have a slower pace of recovery, and are amotivated due to their life context. Identifying what kind of support individuals need at different stages of their post-fracture course may facilitate the process. Interventions on self-management education and coping skills may be considered early in the recovery process.

### Strengths and limitations

The majority of participants in this research study were within the first 3 months of recovery in spite of our effort to recruit patients in different range of recovery within a year after injury. It would have added more breath to the results of this study if we had recruited participants at different time frames after their injury; however it was not possible due to time constraints and seasonal changes. This may be considered a weakness of this study.

### Conclusion

Recovery after PHF is a complex phenomenon that is beyond pain and physical discomfort. The findings suggest that perceptions offer a portrait of complex interaction between individual (self) and social connectedness. The individuals' divergent

experiential evidence in relation to their recovery, and the presence or absence of social connectedness during this course may facilitate or hinders the process.

## References

1. Handoll HH, Keding A, Corbacho B, Brealey SD, Hewitt C, Rangan A. Five-year follow-up results of the PROFHER trial comparing operative and non-operative treatment of adults with a displaced fracture of the proximal humerus. *Bone Jt J.* 2017;99B(3):383-392. doi:10.1302/0301-620X.99B3.BJJ-2016-1028
2. Kruithof RN, Formijne Jonkers HA, van der Ven DJC, van Olden GDJ, Timmers TK. Functional and quality of life outcome after non-operatively managed proximal humeral fractures. *J Orthop Traumatol.* 2017;18(4):423-430. doi:10.1007/s10195-017-0468-5
3. Schumaier A, Grawe B. Proximal Humerus Fractures: Evaluation and Management in the Elderly Patient. *Geriatr Orthop Surg Rehabil.* 2018;9:215145851775051. doi:10.1177/2151458517750516
4. Calvo E, Morcillo D, Foruria AM, Redondo-Santamaría E, Osorio-Picorne F, Caeiro JR. Nondisplaced proximal humeral fractures: High incidence among outpatient-treated osteoporotic fractures and severe impact on upper extremity function and patient subjective health perception. *J Shoulder Elb Surg.* 2011;20(5):795-801. doi:10.1016/j.jse.2010.09.008
5. Poeze M, Lenssen AF, Van Empel JM, Verbruggen JP. Conservative management of proximal humeral fractures: Can poor functional outcome be related to standard transscapular radiographic evaluation? *J Shoulder Elb Surg.* 2010;19(2):273-281. doi:10.1016/j.jse.2009.07.066
6. Vachtsevanos L. Management of proximal humerus fractures in adults. *World J Orthop.* 2014;5(5):685. doi:10.5312/wjo.v5.i5.685
7. Twiss T. Proximal Humerus Fractures. 2015:23-42. doi:10.1007/978-3-319-08951-5
8. Launonen AP, Lepola V, Flinkkilä T, Laitinen M, Paavola M, Malmivaara A. Treatment of proximal humerus fractures in the elderly. *Acta Orthop.* 2015;86(3):280-285. doi:10.3109/17453674.2014.999299
9. Clement ND, Duckworth AD, McQueen MM, Court-Brown CM. The outcome of proximal humeral fractures in the elderly: predictors of mortality and function. *Bone Joint J.* 2014;96-B(7):970-977. doi:10.1302/0301-620X.96B7.32894
10. Hodgson S. Proximal Humerus Fracture Rehabilitation. *Clin Orthop Relat Res.*



- 2006;(442):131-138. doi:10.1097/01.blo.0000194677.02506.45
11. Hanson B, Neidenbach P, de Boer P, Stengel D. Functional outcomes after nonoperative management of fractures of the proximal humerus. *J Shoulder Elb Surg.* 2009;18(4):612-621. doi:10.1016/j.jse.2009.03.024
  12. Price MC, Horn PL, Latshaw JC. Proximal humerus fractures. *Orthop Nurs.* 2013;32(5):251-258. doi:10.1097/NOR.0b013e3182a39b20
  13. Abimanyi-Ochom J, Watts JJ, Borgström F, et al. Changes in quality of life associated with fragility fractures: Australian arm of the International Cost and Utility Related to Osteoporotic Fractures Study (AusICUROS). *Osteoporos Int.* 2015;26(6):1781-1790. doi:10.1007/s00198-015-3088-z
  14. Holloway KL, Bucki-Smith G, Morse AG, et al. Humeral Fractures in South-Eastern Australia: Epidemiology and Risk Factors. *Calcif Tissue Int.* 2015;97(5):453-465. doi:10.1007/s00223-015-0039-9
  15. Kim SH, Szabo RM, Marder RA. Epidemiology of humerus fractures in the United States: Nationwide emergency department sample, 2008. *Arthritis Care Res.* 2012;64(3):407-414. doi:10.1002/acr.21563
  16. Han RJ, Sing DC, Feeley BT, Ma CB, Zhang AL. Proximal humerus fragility fractures: Recent trends in nonoperative and operative treatment in the Medicare population. *J Shoulder Elb Surg.* 2016;25(2):256-261. doi:10.1016/j.jse.2015.07.015
  17. Slobogean GP, Johal H, Lefavre KA, et al. A scoping review of the proximal humerus fracture literature Orthopedics and biomechanics. *BMC Musculoskelet Disord.* 2015;16(1):1-10. doi:10.1186/s12891-015-0564-8
  18. Jayakumar P, Overbeek CL, Lamb S, et al. What Factors Are Associated With Disability After Upper Extremity Injuries? A Systematic Review. *Clin Orthop Relat Res.* 2018;476(11):2190-2215. doi:10.1097/CORR.0000000000000427
  19. Tsui K, Fleig L, Langford DP, Guy P, MacDonald V, Ashe MC. Exploring older adults' perceptions of a patient-centered education manual for hip fracture recovery: "Everything in one place." *Patient Prefer Adherence.* 2015;9:1637-1645. doi:10.2147/PPA.S86148
  20. Ashe M, Schiller C, Franke T, Belle J, Sims-Gould J, Sale J. Words of wisdom &ndash; patient perspectives to guide recovery for older adults after hip fracture: a&nbsp;qualitative study. *Patient Prefer Adherence.* 2015:57. doi:10.2147/ppa.s75657
  21. Words KEY. Don ' t Worry , Be Positive : Improving Functional Recovery 1 Year



- After Hip Fracture. 2007.
22. Griffiths F, Mason V, Boardman F, et al. Evaluating recovery following hip fracture: A qualitative interview study of what is important to patients. *BMJ Open*. 2015;5(1):1-10. doi:10.1136/bmjopen-2014-005406
  23. Langford D, Edwards N, Gray SM, Fleig L, Ashe MC. "Life Goes On." Everyday Tasks, Coping Self-Efficacy, and Independence: Exploring Older Adults' Recovery From Hip Fracture. *Qual Health Res*. 2018;104973231875567. doi:10.1177/1049732318755675
  24. Bruun-olsen V, Bergland A, Heiberg KE. " I struggle to count my blessings " : recovery after hip fracture from the patients ' perspective. 2018:1-9. doi:10.1186/s12877-018-0716-4
  25. Franzblau L. A Qualitative Study of the Adult Patient ' s Experience after Complete Avulsion Traumatic Brachial Plexus Injury : Subjective Outcomes and Implications for Patient Educations. 2013.
  26. Nguyen K. EliScholar – A Digital Platform for Scholarly Publishing at Yale Exploring Patient Perspective At End Of Life : Qualitative Interviews With Terminally Ill Patients. 2012;(January).
  27. Bialocerkowski AE. Difficulties associated with wrist disorders--a qualitative study. *Clin Rehabil*. 2002;16(4):429-440. doi:10.1191/0269215502cr516oa
  28. Macdermid JC, Roth JH, Richards RS. Pain and disability reported in the year following a distal radius fracture : A cohort study. 2003;13:1-13.
  29. Samsson KS, Bernhardsson S, Larsson ME. "Take me seriously and do something!" - A qualitative study exploring patients' perceptions and expectations of an upcoming orthopaedic consultation. *BMC Musculoskelet Disord*. 2017;18(1):1-10. doi:10.1186/s12891-017-1719-6
  30. Tighe M, Molassiotis A, Morris J, Richardson J. Coping, meaning and symptom experience: A narrative approach to the overwhelming impacts of breast cancer in the first year following diagnosis. *Eur J Oncol Nurs*. 2011;15(3):226-232. doi:10.1016/j.ejon.2011.03.004
  31. Hewlett SA. Patients and Clinicians Have Different Perspectives on Outcomes in Arthritis. 2003;30(4).
  32. Slevin ML, Plant H, Lynch D, Drinkwater J, Gregory WM. Who should measure quality of life , the doctor or the patient ? 1988;(November 1987):109-112.
  33. Rozmovits L, Ziebland S. What do patients with prostate or breast cancer want

- from an Internet site? A qualitative study of information needs. *Patient Educ Couns*. 2004;53(1):57-64. doi:10.1016/S0738-3991(03)00116-2
34. Trickett RW, Mudge E, Price P, Pallister I. A qualitative approach to recovery after open tibial fracture: The road to a novel, patient-derived recovery scale. *Injury*. 2012;43(7):1071-1078. doi:10.1016/j.injury.2012.01.027
  35. O'Hara NN, Garibaldi A, Sprague S, et al. Rehabilitation, not injury or treatment details, dominate proximal humeral fracture patient concerns: a thematic analysis. *Eur J Pers Centered Healthc*. 2017;5(3):351-356. doi:10.5750/ejpc.v5i3.1328
  36. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research: A 32-item checklist for interviews and focus groups. *Int J Qual Heal Care*. 2018;19(6):349-357.
  37. Thorne S. *Interpretive Description, Second Edition*.
  38. Thorne S, Kirkham SR, Macdonald-emes J. Focus on Qualitative Methods Interpretive Description : A Noncategorical Qualitative Alternative for Developing Nursing Knowledge. 1997:169-177.
  39. Olsen NR, Bradley P, Nortvedt MW. Evidence based practice in clinical physiotherapy education : a qualitative interpretive description. *BMC Med Educ*. 2017;13(52):1-18.
  40. Thorne S, Kirkham SR, O'Flynn-Magee K. The Analytic Challenge in Interpretive Description. *Int J Qual Methods*. 2004;3(1):1-11. doi:10.1177/160940690400300101
  41. Rn CE, Rn MS. The good, the bad and the relative, part two: Goodness and the criterion problem in qualitative research. *Int J Nurs Pract*. 2003;5(1):2-7. doi:10.1046/j.1440-172x.1999.00139.x
  42. Welsh E. Dealing with Data: Using NVivo in the Qualitative Data Analysis Process | Welsh | Forum Qualitative Sozialforschung / Forum: Qualitative Social Rese... *Analysis*. 2002;3(2).
  43. Bamford R, Walker DM. A qualitative investigation into the rehabilitation experience of patients following wrist fracture. *Hand Ther*. 2010;15(3):54-61. doi:10.1258/ht.2010.010013
  44. Lynch JW. 1-s2.0-S0277953696001918-main.pdf. 1997;44(6):809-819. doi:10.1016/S0277-9536(96)00191-8
  45. Nota SPFT, Spit SA, Oosterhoff TCH, Hageman MGJS, Ring DC, Vranceanu AM. Is Social Support Associated With Upper Extremity Disability? *Clin Orthop*

*Relat Res.* 2016;474(8):1830-1836. doi:10.1007/s11999-016-4892-2

46. Smith-Forbes E V., Howell DM, Willoughby J, Armstrong H, Pitts DG, Uhl TL. Adherence of Individuals in Upper Extremity Rehabilitation: A Qualitative Study. *Arch Phys Med Rehabil.* 2016;97(8):1262-1268.e1. doi:10.1016/j.apmr.2015.11.008
47. Coulter A, Ellins J. Effectiveness of strategies for informing, educating, and involving patients. *Bmj.* 2007;335(7609):24-27. doi:10.1136/bmj.39246.581169.80

## Chapter 5

### Discussion and conclusions

#### Overview

PHF is a highly prevalent injury in adults. Despite the widely available studies on pure functional and clinical outcomes, recovery from PHF is underrepresented as perceived by individuals. This thesis focused on understanding the course of recovery after PHF in adults. Chapter one included a concise summary of the current knowledge on this topic and gave an overview related to my own research. One glaring gap was the need to move beyond biomedical aspects of PHF and clinical outcomes. The approach taken in this thesis work represents a '*shift of vision*' from what is available in the literature *to* build a framework in this study. The overarching aim of the thesis was approached in three main manuscripts (Chapters 2-4). As an advocate for the superiority of the biopsychosocial over biomedical model, I chose the World Health Organization's ICF framework in this research study. In a condition like PHF, the biopsychosocial nature of the ICF framework helps to explore the interconnected and dynamic interactions among biological, medical, and psychological aspects of recovery within the person-environment context. This chapter centers on my overall interpretation of the findings of the three manuscripts. The major results presented in Chapters 2-4 suggest a direction of future research as I believe that a number of interesting additional studies can be generated for further understanding of the underlying layers of the recovery course, in specific, the hidden layers in the person-environment context. This chapter concludes with a brief discussion of the study strengths and limitations and a take home message.

#### An interpretation description of the findings

This research study aimed to answer an overarching multifaceted question. To acquire an enriched understanding, and generate insight into the quantitative and qualitative sub-questions, a mixed methods approach fits well. The numbers (surveys) and stories of

individuals (semi-structured interviews) enabled me to have a broader understanding of a phenomenon recovery after PHF. Further, the biopsychosocial framework of the ICF enriched this study for reinforcing that complex health issues should be studied holistically. To meet this goal, I conducted three studies, each contributed uniquely towards the overarching research question.

The first study reviewed factors predicting recovery following PHF. Through the ICF framework, an imbalanced distribution of factors across domains of the functioning was identified. Further, placing factors on the basis of modifiability indicated that 65% of identified factors were non-modifiable. The findings of the systematic review suggested that basing prognostic factors solely on health conditions undermines other potential factors that might be modifiable. To my understating, modifiable prognostic factors enhance the usefulness of diagnosis in a practical way for reducing the burden of PHF in the entire course of recovery.

The second study was a descriptive analysis of recovery and exercise facilitators/barriers as perceived by individuals in the first year after PHF. In a combination of closed and open-ended questions, individuals were encouraged to put their perceptions into words about recovery and exercise after PHF. Participants brought up a broad range of real-life functional difficulties in the domains of activities and participation. Results from the PEQ, opened my eyes to realities that why people do not engage actively in rehabilitation exercises after an injury. Approaching exercise through the biopsychosocial health model of the ICF, disentangles barriers at the individuals' capacity and variance of conditions individuals live in. This may change a typical view from a *general-prescriptive-guide* to exercise to a more *individualized-guide* to exercise. Approaches to overcome barriers (lack of exercise knowledge, enjoyment, and access to free facilities), and promote facilitators (support, encouragement and education), are factors that are generally ignored in those general-prescriptive guidance to exercise as an essential part of care after injury.

The exploration of recovery in the third study highlighted a missing depth of understanding of the individuals' real experiences with, and perspectives of recovering

from PHF. I had the privilege to interview 14 patients with PHF at HULC and hear their voice about their stories, experiences and challenges they face after the injury. Two main themes that emerged from interviewing were ‘self’ and ‘social connectedness’; both matters in the recovery course, showing a broad variation in our own experiential self-relationship to a health phenomenon, and the manner in which, the presence or absence of connectedness, as a two-way road can change the recovery pathway. During interviewing, transcribing, coding and analyzing data, I was constantly asking myself: what I want to find beyond these words? How can I connect ideas together? Why that person said this and not that? During the interpretation of transcripts, I used to recall the interview date, the emotions of participants, if they were with a family member, and so on. The filed notes helped me to find meanings behind words and sentences, why they said so and why it mattered to them. This final step of my work within *interpretive description* of transcripts was the hallmark of my thesis. One big personal lesson was how we human beings are different, although I knew it before, but I touched it deeply. With listening to patients, I was thinking that recovery is actually a *discovery* of a new life, a new being and a new start beyond what we were, how we did. I think there is no return to what we were, it is just an adjustment to what we are and keep moving on. This discovery, in deed, needs more awareness of one’s own abilities (self) and more education, extra care and guidance (others). Understanding how recovery can be a unique experience based on our own realities is a key point in moving faster or reaching faster to new goals and expectations.

### Future directions

The overall findings of this study support the use of the biopsychosocial nature of the ICF model in answering multifaceted questions in the health field. The data presented in this entire work reflect the underlying premise of the ICF model that how individuals perceive their health outcomes depends on their personal attitudes and the environment in which they live. According to the ICF, contextual factors may determine how recovery and exercise can be perceived. Focusing on contextual factors of recovery could add to the findings in this study. The results of this study supported the notion in the literature

that the person is an important part of the recovery course. Another area that could benefit from a better understanding of recovery is to educate individuals. With regard to facilitators and barriers of exercise, this study provided some evidence to support that education is what people need. The results of this study imply that lack of knowledge in the process of recovery exist among people with a poor recovery. There is very little evidence in the literature that directly addresses the education needed by participants as to how be engaged in the process.

### Limitations and strengths

Limitations of this study should be acknowledged. First, it was the time constraints to finish this PhD project. This influenced the sample size. Next, it was the inclusion criteria to include individuals who are within the first year of the injury. This restriction was a source of limitation which could have affected the results. This study was conducted in one hand clinic and might lack diversity of participants and poses a limitation on the results. Notwithstanding the relatively limited sample, this study offers valuable insights into recovery from the perspectives of individuals. The majority of findings in this dissertation are based on the experiences, opinions and perceptions of individuals with PHF. The use of mixed methods in data collection and interpretation of subjective results increased the chance of exploring our research question in a quantitative and qualitative context. The conceptual model of ICF provided a coherent view of biological, individual and social factors. Looking at recovery through these two lenses were the strengths of this work.

### Take home message

This study provides a snapshot of the recovery course following PHF. Recovery after PHF is multifaceted and can be understood based on the interplay between multiple layers of hidden and unhidden factors. This understanding may not be as evident as it should be through a high-advanced x-ray and ultrasound devices. At personal level, individuals capacities are different and how they face barriers at many levels. From a

societal standpoint, support from the healthcare system, family and community, and health education may contribute to transform some of the barriers to facilitators.



## Appendices



**Date:** 15 June 2018

**To:** Dr. Joy MacDermid

**Project ID:** 111265

**Study Title:** Functional Recovery Following a Proximal Humerus Fracture (PHF): A Mixed Methods Study

**Application Type:** HSREB Initial Application

**Review Type:** Delegated

**Meeting Date / Full Board Reporting Date:** 03/Jul/2018

**Date Approval Issued:** 15/Jun/2018

**REB Approval Expiry Date:** 15/Jun/2019

Dear Dr. Joy MacDermid

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above mentioned study as described in the WREM application form, as of the HSREB Initial Approval Date noted above. This research study is to be conducted by the investigator noted above. All other required institutional approvals must also be obtained prior to the conduct of the study.

**Documents Approved:**

Document Name	Document Type	Document Date	Document Version
Interview guide-3	Interview Guide	23/May/2018	3
Letter of Information-interview	Written Consent/Assent	06/Jun/2018	3
Letter of Information-Questionnaires	Written Consent/Assent	06/Jun/2018	4
PatientDemographics	Paper Survey	06/Jun/2018	1
PatientDemographics.WEB	Online Survey	06/Jun/2018	
PatientFunctionalSpecificScale-WEB	Online Survey	06/Jun/2018	
PersonalizedExerciseQuestionnaire	Paper Survey	06/Jun/2018	1
PersonalizedExerciseQuestionnaire-WEB	Online Survey	06/Jun/2018	
QuickDASH	Paper Survey	06/Jun/2018	1
QuickDASH-WEB	Online Survey	06/Jun/2018	
Study Plan	Protocol	23/May/2018	1
ThePatientFunctionalSpecificScale	Paper Survey	06/Jun/2018	1

**Documents Acknowledged:**

Document Name	Document Type	Document Date	Document Version
Flow Diagram	Flow Diagram	23/May/2018	1
References-Literature Review	References	23/May/2018	1

No deviations from, or changes to, the protocol or WREM application should be initiated without prior written approval of an appropriate amendment from Western HSREB, except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriCouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations and the provisions of the

Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Please do not hesitate to contact us if you have any questions.

Sincerely,

Patricia Sargeant, Ethics Officer on behalf of Dr. Joseph Gilbert, HSREB Chair

*Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).*

## Appendix 1 Ethics approval letter



**Research Title:** Functional Recovery Following a Proximal Humerus Fracture (PHF): A Mixed Methods Study

**Principal Investigator:** Joy C. MacDermid, Co-director Clinical Research Lab  
Roth| McFarlane Hand and Upper Limb Centre , St. Joseph's Health Centre, Professor, Physical Therapy, University of Western Ontario, CIHR Chair in Gender, Work and Health,  
[REDACTED]

**Co-investigators:**

Dr. [REDACTED] MD

Dr. [REDACTED] MD

Azar Varahrami Vigeh, PhD Student

**Letter of Information**

**Introduction**

You are invited to participate in this study about "functional recovery after a shoulder fracture" because we feel that your experience can help us better understand the process of recovery in individuals with this type of injury.

This letter gives you the basic idea of what the research is about and what your role would be in the process. In order to decide whether or not you would like to participate in this study, it is important that you understand what the research involves. Please take the time to read this letter carefully and ask questions if anything is unclear.

**Purpose of this Study**

Recovery from a shoulder fracture is complex and challenging. The main purpose of this study is to hear from you about challenges you have faced as a result of your shoulder fracture. In particular, we want to know about your home, work or sport activities during recovery. This information helps healthcare providers optimize your treatment plans based on your needs and preferences.

For this study, we will need a total of 100 individuals who have been admitted for a proximal humerus fracture at Hand and Upper Limb Center (HULC), St. Joseph's Hospital. You are eligible to participate if you are 45 years or older, in the first year of recovery, and speak English.



### Study Procedure

If you agree to participate, you will be completing four questionnaires which will take between 30 to 40 minutes. The questionnaires include multiple choice and open-ended questions about your daily experiences while recovering from your shoulder fracture. You have the choice to participate in the paper survey or the online survey. In both cases, you will receive instructions how to complete surveys.

### Possible Risks and Harms

There are no anticipated risks or harms associated with participating in this study except for the possibility of fatigue or discomfort while completing questionnaires. You do not have to answer any questions that make you feel uncomfortable and you can leave the study at any time. There is also a risk of a breach of privacy, and we will take all preventive measures to help prevent such a breach from occurring. All data collected including your personal information and surveys responses will remain confidential and accessible only to the research team of this study.

### Possible Benefits

You may not directly benefit from participating in this study but information gathered may provide benefits to society as well as improving the healthcare services available to you.

### Voluntary Participation

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your future care. You do not waive any legal right by consenting to this study.

### Confidentiality

All data collected including your full name, telephone number, email, age, gender and surveys responses will remain confidential and accessible only to the research team of this study. Representatives of the University of Western Ontario Health Sciences Research Ethics Board and the Lawson Quality Assurance and Education Program may contact you or require access to your study-related records to monitor the conduct of the research. While we will do our best to protect your information there is no guarantee that we will be able to do so. All data collected will be stored on a secure hospital network on a password protected computer. In accordance with the Lawson policies, data will be kept for 15 years. If the results are published, your name will not be used. If you choose to withdraw from this study, your data will be removed and destroyed from our database. A list linking your identifier code with your name will be kept by the researcher in a secure place, separate from your study file.



### Compensation

You will not be compensated for participation in this research.



### Contact for Further Information

If you require any further information regarding this research study or your participation in the study you may contact PhD student, Azar Varahrami Vigeh, at [REDACTED] or [REDACTED] or research assistant, Katrina Munro at [REDACTED]

If you have any questions about your rights as a research participant or the conduct of this study, please contact: St. Joseph's Health Care London Patient Relations Consultant at [REDACTED]

**This letter is yours to keep for future reference.**

23-05-2018

VR 3 Clean

Page 3 of 8



**Consent Form**



**Study Title:** Functional Recovery Following a Proximal Humerus Fracture (PHF): A Mixed Methods Study

I have read the Letter of Information, have had the nature of the study explained to me, and all my questions have been answered to my satisfaction.  YES  NO

I agree to participate in this study.  YES  NO

**CONTACT FOR A FUTURE STUDY**

I agree to be contacted for a future study.  YES  NO

\_\_\_\_\_  
Participant's Name  
(Please print)

\_\_\_\_\_  
Participant's Signature

\_\_\_\_\_  
Date

Persons Obtaining Informed Consent (please print): \_\_\_\_\_

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

23-05-2018

VR 3 Clean

Page 4 of 8



**Research Title:** Functional Recovery Following a Proximal Humerus Fracture (PHF): A Mixed Methods Study

**Principal Investigator:** Joy C. MacDermid, Co-director Clinical Research Lab  
Roth|McFarlane Hand and Upper Limb Centre, St. Joseph's Health Centre, Professor, Physical Therapy, University of Western Ontario, CIHR Chair in Gender, Work and Health,

**Co-investigators:**  
Dr. Athwal, MD  
Dr. Faber, MD  
Azar Varahrami Vigeh, PhD Student

### Letter of Information

#### **Introduction**

You are invited to participate in a semi-structured interview about functional recovery after a shoulder fracture. This letter gives you the basic idea of what a semi-structured interview is about and what your role will be in the process. It is important that you agree to being interviewed and understand how the information contained in the interview will be used. Please take the time to read this letter carefully and ask questions if anything is unclear. This consent form is necessary for us to ensure that you understand the purpose of your involvement and that you agree to the conditions of your participation.

#### **Purpose of this Study**

Recovery from a shoulder fracture is complex and depends largely on several patient and injury factors. This qualitative study follows a semi-structured guide for in-person interviews to see things the way you see them. The semi-structured interview in this study is more like a conversation with the main focus on your experience, opinions and what you think or feel about recovery process. For the purpose of this study, the researcher will ask open-ended questions, allowing you to talk about your recovery from a shoulder fracture and how it affected your day-to-day life.

This interview is not expected to cause distress. If you feel uncomfortable by describing an experience, you have the right to stop the interview, skip the question(s) or withdraw from the research at any time.

23-05-2018

VR 3 Clean

Page 5 of 8



**Consent Form**



**Study Title:** Functional Recovery Following a Proximal Humerus Fracture (PHF): A Mixed Methods Study

I have read the Letter of Information, have had the nature of the study explained to me, and all my questions have been answered to my satisfaction.  YES  NO

I agree to participate.  YES  NO

I agree to be audio-taped in this study.  YES  NO

I consent to the use of unidentified quotes obtained during the interview in the publication of this research.  YES  NO

\_\_\_\_\_  
Participant's Name  
(Please print)

\_\_\_\_\_  
Participant's Signature

\_\_\_\_\_  
Date

Persons Obtaining Informed Consent (Please print):

My signature means that I have explained the study to the participant named above. I have answered all questions.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

23-05-2018

VR 3 Clean

Page 8 of 8





### Confidentiality

All data collected including your full name, telephone number, email, age, gender and your responses to interview questions (audio-recordings and notes) will remain confidential and accessible only to the research team of this study. Representatives of the University of Western Ontario Health Sciences Research Ethics Board and the Lawson Quality Assurance and Education Program may contact you or require access to your study-related records to monitor the conduct of the research. While we will do our best to protect your information, however, there is no guarantee that we will be able to do so. All recordings and notes collected during the interview will be stored in a locked filing cabinet in the HULC research lab. Recordings will be confidentially destroyed as soon as possible. In accordance with the Lawson policies, paper data will be kept for 15 years. If the results are published, your name will not be used. If you choose to withdraw from this study, your data will be removed and destroyed from our database. A list linking your identifier code with your name will be kept by the researcher in a secure place, separate from your study file.



### Compensation

If you decide to participate in this interview, we will pay for your parking fees.

### Contact for Further Information

If you require any further information regarding the interview process or your participation in the study you may contact Azar Varahrami Vigeh, at [REDACTED] or Research Assistant, Katrina Munro at [REDACTED]. If you have any questions about your rights as a research participant or the conduct of this study, you may contact St. Joseph's Health Care London Patient Relations Consultant at [REDACTED].

**This letter is yours to keep for future reference.**

23-05-2018

VR 3 Clean

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#### Study Procedure

We need a total of 20 individuals to assist us with this qualitative study. This informal meeting will take place in a private room at the Hand and Upper Limb Center and will last between 45-60 minutes. If you agree to participate, your voice will be audiotaped. Audio recordings will be transcribed verbatim for analysis by PhD student, Azar Varahrami Vigh. If you request not to be audiotaped, Azar will take written notes during the interview. You will be sent the transcript via email and given the opportunity to correct any factual errors. You are kindly asked to return any comments or feedback on your transcript within two weeks. All changes made to the interview transcript will be documented. We do not use your name on direct quotations from the interview. We do not use your name for publication purposes. Care will be taken to ensure that no information in the interview can reveal your identity. The access to the interview transcripts will be limited to Azar and the research team in this study.

#### Possible Risks and Harms

There are no known or anticipated risks or discomforts associated with this study except for the possibility of fatigue or discomfort while talking about an experience. To minimize emotional upset, fatigue, or distress during the interview, you can stop at any point, withdraw the study or simply skip the question(s) that cause discomfort. There is also a risk of a breach of privacy, and we will take all preventive measures to help prevent a breach from occurring. All data collected including your personal information and interview content will remain confidential and accessible only to the research team of this study. The tapes will be destroyed following completion of the research as soon as possible.

#### Possible Benefits

You may not directly benefit from participating in this study but information gathered may provide benefits to you and other community members who go through this experience as well as improving the healthcare services available to you.

#### Voluntary Participation

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your future care. You do not waive any legal rights by signing the consent form to participate in this research study.

## Appendix 2 Consent forms (survey and interview studies)

### Semi-structured Interview Questions Guide

Length: 30-45 minutes

Questions:

#### 1. General thoughts

Tell me about your broken shoulder please.

[PROBES: if they just say “it hurts”, ask how it hurts? Can you please tell me more?]

#### 2. Things bothering

[PROBES: What things are bothering you about your broken shoulder?]

#### 3. Difficulties (coping strategies) patient specific coping methods

[PROBES: How do you manage your daily activities? How do you cope? Give me an example please.]. If they say my husband helps me with washing dishes, ask them about other difficulties and they cope with.

#### 4. Management (facilitators and barriers)

[PROBES: How well do you exercise? Tell me about your goals? What are things that motivate you exercising more? What are barriers to exercise/what be things that stop you from exercising more often, for example, pain, fear of falling, etc.? What are your expectations/needs?]

#### 5. Expectations)

[PROBES: Have you been satisfied with your recovery so far? What things would you have liked to see differently regarding your recovery? What helpful information or support did you receive after your shoulder fracture? What might speed up/slow down recovery from shoulder fracture? What would you say to help someone else going through this recovery experience? If you could provide one or two words of wisdom, or a phrase, to help someone else through the recovery period, what would it be? What do you wish you knew then, that you know now?]

## Appendix 3 Interview questions guide

## Curriculum Vitae

**Name:** Azar Varahrami Vigeh  
**Post-secondary Education and Degrees:** Azad University  
**Tehran, Iran**  
 1996-1998 M.A. Universal Linguistics

The University of Western Ontario  
 London, Ontario, Canada  
 2013-2019 Ph.D.

**Related Work Experience:** Teaching Assistant  
 The University of Western Ontario  
 2013-2017

### Certifications & Training

- Seniors' Fitness Instructor, Canadian Center for Aging and Activity (CCAA)
- Strength Coach, Poliquin International Certification Program, Level 1 & 2
- Mature Fitness Training Specialist: Certified for working with seniors, the American Academy of Health and Fitness
- Certified Personal Trainer, CPTN
- Emergency First Aid w CPR Level A, Canadian Red Cross

### Publications:

- Varahra, Rodrigues, MacDermid, Bryant and Birmingham. "Exercise to Improve Functional Outcomes in Persons with Osteoporosis: A Systematic Review and Meta-Analysis", *Osteoporosis International* (2018), 29(2), pp 265-286.  
<https://www.ncbi.nlm.nih.gov/pubmed/29306984>
- Varahra, MacDermid, Birmingham, Szekeres. "Prognostic Factors in Recovery Following a Proximal Humerus Fractures in Adults: A Systematic Review".

Under review in the *Disability and Rehabilitation Journal*

### Abstracts Posters and Presentations

- *What are the functional patient experiences during recovery from a proximal humerus fracture*, Paper presented at the Faculty of Health Sciences Research Day, University of Western, May 15, 2018

- *Improving MSK Health through Clinical, Community & Health Services Research* , Poster session presented at 2018 Bone and Joint Conference, University of Western, May 10-12, 2018
- *Exercise to Improve Functional outcomes in Persons with osteoporosis*, Poster session presented at the World Congress on Osteoporosis, Osteoarthritis and Musculoskeletal Diseases, Krakow, Poland, April 2018
- *Functional Recovery Following a Proximal Humerus Fracture in Adults*. Poster presentation in London Health Research Day, April 30, 2019

Elite Personal Trainer  
 Unique Rehab & Physiotherapy, Toronto  
 GoodLife Fitness, Toronto & London Ontario

June 2008-August2013  
 Feb 2007 -Aug 2013

#### **Appendix 4 Curriculum Vitae**