# BIOPSYCHOSOCIAL EDUCATION FOR INDIVIDUALS WITH SUBACUTE AND CHRONIC PAIN IN THE HAND, WRIST, OR ELBOW: A PILOT STUDY

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## ABSTRACT

Despite best practices in the treatment of elbow, wrist, and hand injuries, some individuals continue to have pain beyond the expected time of recovery. Lingering pain can contribute to psychological, social, and economic burdens. The biopsychosocial pain neuroscience education (PNE) has been successful in treating individuals with lingering pain in musculoskeletal injuries, but literature involving the use of PNE for individuals with distal upper extremity pain is lacking. The purpose of this study is to investigate whether a PNE program will reduce pain and improve outcomes in individuals following elbow, wrist, and hand injuries using a rehabilitation counseling lens. A total of ten individuals aged 18 years and older ($M$= 46.6, $SD$ =13.83) from the United States with subacute or chronic pain in the distal upper extremities completed the four weekly telehealth sessions lasting between 30 to 60 minutes each. This PNE program was a pre-experimental design where all individuals received the intervention.

A one-way repeated measures multivariate analysis of variance (MANOVA) was first used to determine the effects of the pain neuroscience educational program on all biopsychosocial variables as a whole. Six dependent variables were studied: perceived pain using the Pain Numeric Rating Scale (NRS), pain catastrophizing using the Pain Catastrophizing Scale (PCS), kinesiophobia using the Tampa Scale for Kinesiophobia –11 (TSK-11), and function and social participation using the Quick Disabilities of the Arm, Shoulder, and Hand Outcome Measure (*Quick*DASH) and the Canadian Occupational Performance Measure (COPM). Participants improved from pretest to posttest in all variables in the primary analysis except for *Quick*DASH. The difference between the participants from pretest to posttest on the combined variables using the one-way repeated measures MANOVA could not be utilized as the data did not meet the required assumptions. Using a univariate analysis, three of the six variables were found statistically and clinically significant with large effect sizes. These variables include pain ($F$ (1,

9) = 13.048, $p$ = .006; $n_p^2$ = .592); kinesiophobia ($F$ (1, 9) = 14.188, $p$ = .004; $n_p^2$ = .612) as well as satisfaction with occupational performance ($F$ (1, 9) = 14.656, $p$ = .004; $n_p^2$= .620). Pain catastrophizing ($F$ (1, 9) = 1.858, $p$ = .206 $n_p^2$ = 0.171) and occupational performance ($F$ (1, 9) =4.279, $p$= .069, $n_p^2$= 0.322) achieved large effect sizes but were underpowered to achieve statistical significance at the 95% confidence interval. Function and social participation measured by the *Quick*DASH was neither statistically significant *nor* clinically significant ($F$ (1, 9) =.005, $p$ = .943, $n_p^2$= 0.001).

Exploratory analyses indicated positive outcomes. Participants achieved a statistically significant improvement in mood from pretest to posttest with a large effect size $F$(1,9) =5.335, $p$ =.046; $n_p^2 = .372$. A strong working alliance between the researcher and participants was achieved (goals, $M$= 18.5, 95% CI [17.14, 19.86], tasks, $M$= 17.2, 95% CI [15.45, 18.95], and bond, $M$= 18.7, 95% CI [17.69, 19.71]). Participants reported that the brief PNE program was at least moderately to extremely effective at reducing their pain, and they were at least moderately to extremely satisfied with the intervention. Participants also reported reduced usage of medication to treat pain from pretest to posttest.

This pilot study provided effect sizes for assessment tools to better study pain using PNE in the distal upper extremity population. These effect sizes can provide a better prediction for appropriate power in future randomized controlled trials**.**

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# CHAPTER 1: INTRODUCTION

Upper extremity injuries are ubiquitous. In 2016, the National Center for Health Statistics reported 42.3 million injury-related emergency department visits, of which 26% were upper extremity injuries (Gordon et al., 2021). Using the National Electronic Injury Surveillance System (NEISS), Gordon et al. examined the prevalence of hand and wrist injuries in the United States emergency departments from 2009 to 2018. They identified 649,131 hand and wrist injury cases, correlating to 25,666,596 patients nationally. Surgically managed hand and wrist injuries contribute significantly to the health care system burden (Robinson et al., 2021). The authors found that the median cost in Australia for non-compensable cases was $4,508 and $5,057 for compensable cases. In 2019-2020, injuries to the arm and shoulder had above-average costs for lost-time workers' compensation claims averaging $49,116 (https://injuryfacts.nsc.org/work/costs/workers-compensation-costs/). One example of these upper extremity injuries is a distal radius fracture (DRF). It is a common wrist injury affecting individuals across the lifespan, and the incidences of distal radius fractures are increasing worldwide (MacIntyre et al., 2016; Nellans et al., 2012). This type of injury can cause significant psychological, social, and economic consequences for these individuals (Grob et al., 2008; Grunert, et al., 1992; Gustafsson & Alstrom, 2004). The complexity of this injury's effects on an individual's life warrants a broader view of intervention techniques. The more we understand all aspects contributing to recovery, the better the outcomes for our rehabilitation clients. Rehabilitation professionals continually seek out new interventions to reduce pain, improve outcomes, and return these clients with hand, wrist, and elbow injuries to their prior levels of function. Interdisciplinary approaches are gaining momentum utilize the biopsychosocial approach, a theoretical lens consistent with medical, rehabilitation counseling, and occupational

therapy practices. Unfortunately, not all stakeholders (healthcare professionals, employers, and third-party payers) agree with this approach and continue to focus on outcomes from a biomechanical lens (Koestler, 2010). The biomedical approach to elbow, hand, and wrist injuries assesses the injury site for healing of the skin, ligaments, nerves, and bone; joint range of motion; edema; and pain. On the other hand, a biopsychosocial approach assesses these factors and a client's subjective functional ability, psychological factors, and quality of life.

This paper investigates whether a biopsychosocial pain educational program will improve outcomes and reduce pain in individuals following elbow, wrist, and hand injuries.

**Statement of Problem**

Therapists treat many types of elbow, wrist, and hand injuries in upper extremity rehabilitation. As stated above, one type of injury is the distal radius fracture. A distal radius fracture (DRF) is "a low-energy fracture occurring approximately 2 cm above the distal articular surface of the radius at the junction where the cortical bone becomes thinner and is reinforced by the trabecular bone network" (MacIntyre & Dewan, 2012, p. 136). These fractures can be treated operatively or non-operatively depending on injury and patient factors. Individuals who sustain this type of injury can achieve optimal strength, range of motion, and function within three to six months regardless of operative or non-operative management (MacDermid et al., 2007).

Despite the successful return of basic physical function post-surgery, functional and psychosocial outcomes may not be optimal. Approximately 16% of individuals experience continued pain and disability one-year post-fracture and experience complications such as ongoing hand stiffness, complex regional pain syndrome (CRPS), malunion, and delayed return to work (Mehta, et al., 2010; Moore & Leonardi-Bee, 2008). One of the most common complications following DRF is CRPS. CRPS is a chronic pain condition that often affects one

limb (arm, leg, hand, or foot), usually after an injury. Prolonged or excessive pain and changes in skin color, temperature, or swelling in the affected area characterize CRPS. Changes to the peripheral and central nervous systems may cause CRPS (NINDS, 2017). Literature reports CRPS incidence in individuals post DRF ranging from 8.3% (Beerthuizen et al., 2012) to 39% (Li et al., 2010).

Complications can develop with and without the onset of CRPS. Individuals who are more likely to experience complications and poorer outcomes include older adults, those who have high baseline pain, those injured at work, and individuals with lower levels of education (MacIntyre & Dewan, 2016). Older adults are more susceptible to functional decline following DRF (Amarosa, et al., 2011; Edwards, et al., 2010; Roh, Lee et al., 2014). In a retrospective chart review, American individuals aged 70 years and older who experienced a DRF showed significant associations between aging, decreased ability, and decreased quality of life (Amorosa et al., 2011). Sex/gender has mixed results. Earlier studies show no difference between males and females in pain and disability, but more recent studies found that women have higher residual pain and disability (MacIntyre & Dewan, 2016). Roh et al. (2014) found that individuals with higher scores on the Pain Catastrophizing Scale (PCS) and the Pain Anxiety Symptom Scale (PASS) preoperatively were associated with decreased grip strength, range of motion, and function in the acute phase of recovery. Individuals who have higher baseline pain after a DRF were more likely to have chronic pain one-year post-surgery (Mehta, 2015) and higher reported baseline pain and disability and prolonged work loss (MacDermid et al., 2007). Individuals receiving injury compensation had doubled the amount of pain and disability than those not receiving compensation (MacDermid et al., 2002) and were four times less likely to return to work (Fernandez et al., 1997). Third-party compensation claim, education level, and pre-

reduction radial shortening were significant predictors of pain and disability in individuals with DRF six months post-reduction (MacDermid et al., 2002). Education was a robust determinant of socioeconomic status influencing outcomes of individuals with DRF (Paksima, et al., 2014). In their study of 227 adults with DRF, Paksima et al. (2014) found that each increased level of education acquired doubled the rate of improvement over time in grip strength, wrist range of motion, pain, and function. Factors relevant to predicting/influencing functional outcomes following DRF pertain to not only biological (degree of radial shortening and age) but also psychological (patient-reported pain and anxiety) and social (disability, education level, and compensation). Given this information, biopsychosocial theories would apply to intervention strategies to improve outcomes. We can understand the environmental aspects affecting outcomes, but interventions would not typically involve changes to education level, and compensation and atypical interventions would be long-term. Current practice can provide interventions for other biopsychosocial aspects of care following distal radius fractures to prevent and treat chronic pain and disability in the short term.

***Pain as an Outcome***

One of the most salient factors in outcome measurement is pain. In 1979, the International Association for the Study of Pain (IASP) defined *pain* as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage" (Merskey et al., 1979). This definition recognizes pain as a subjective experience, links pain to both the sensory system's physiology and the neurobiology of emotions and specifies that pain is associated with a specific adequate stimulus (Treede, 2018). Due to the advancements in our understanding of pain, the IASP reevaluated and updated this definition of pain. In 2020, the IASP published a new definition of pain as "an unpleasant sensory and emotional experience

associated with, or resembling that associated with, actual or potential tissue damage" (Raja et al., 2020, p. 1977). The IASP Council unanimously accepted this definition and noted several concepts to explain pain further. One, pain is always personal and is affected by biological, psychological, and social factors. Two, pain and nociception are different phenomena. Three, individuals learn the concept of pain through lived experiences. Four, a person's experience of pain should be respected. Five, although pain usually serves an adaptive role, it may have adverse effects on function and social and psychological well-being. Six, verbal description is only one of several behaviors to express pain. The inability to communicate does not negate the possibility that a human or a nonhuman animal experiences pain (Raja et al., 2020). This new definition is consistent with the biopsychosocial theory as evidenced by the first concept above. Because of this, our interventions for pain remediation should also reflect the biopsychosocial theory.

Pain can be acute, subacute, or chronic. Chapman and Vierck (2017) described acute pain as an unpleasant, complex, dynamic physiological response to tissue trauma related to the acute inflammatory process, while pain that lasts beyond the inflammatory process is considered chronic. *Acute pain* lasts less than six weeks (American College of Rheumatology Clinical Guidelines, 1996). Acute pain left untreated in individuals can lead to discomfort, suffering, delayed healing, an increased risk of morbidity, prolonged hospital stays, and chronic persistent pain (Macrae, 2008). Subacute pain is pain that has been present for at least six weeks but not more than three months (van Tudler et al., 1997). *Chronic pain* persists longer than three months and often becomes the sole or predominant clinical problem in some patients (IASP, 2011). Chronic pain can lead to decreased participation in everyday activities, increased dependency on others, and loss of family or work roles (Rochman, 2014).

Chronic pain affects many people on many levels. An estimated 20% of people worldwide are affected by chronic pain (Goldberg & Summer, 2011). In the United States, approximately 51.6 million adults were affected by chronic pain in 2021 (Rikard et al., 2023), with national pain costs ranging from $560 to $635 billion annually (Gaskin & Richard, 2012). In 2019, Pitcher, Von Korff, Bushnell, and Porter proposed a new concept to understand the multidimensional nature of chronic pain called high impact chronic pain (HICP). HICP includes both disability and pain duration and identifies the more severely impacted portion of the chronic pain population. Using the 2011 National Health Interview Survey data, Pitcher et al. (2019) found that approximately 10.6 million individuals in the United States were affected by HICP, and chronic pain was strongly associated with an increased risk of disability after controlling for other chronic conditions. In 2021, those affected by HICP grew to 17.1 million (Rikard et al., 2023).

Individuals with HICP were more likely to report more severe pain, cognitive and mental health impairments, worsening health, decreased self-care, and greater health care use than those with chronic pain without disability. An interdisciplinary biopsychosocial approach to chronic pain has the most significant evidence for efficacy, cost-efficiency, and iatrogenic complications prevention (Schatman, 2012). Given that pain is pervasive, costly, and causes undue distress, it behooves us to utilize biopsychosocial intervention strategies to decrease pain along the pain continuum.

### *Types of Chronic Pain Professionals*

Many types of professionals work within a team to treat chronic pain. These teams are either multidisciplinary or interdisciplinary. Sometimes, professionals confuse *multidisciplinary* pain management interventions with *interdisciplinary* pain management interventions and use the terms interchangeably in the literature (Gatchel et al., 2014). *Interdisciplinary* team approaches

differ in that these same professionals integrate services under one roof, provide more frequent communication about client care, share the same rehabilitation philosophy, and actively involve the client in treatment decisions (Gatchel et al., 2014). The authors defined *multidisciplinary* team approaches as involving many different providers (e.g., psychologists, physicians, occupational therapists, physical therapists, and vocational rehabilitation specialists/ rehabilitation counselors) but providing limited integration of services, goals, and communication. Like Schatman (2012), Gatchel et al. (2014) argued that interdisciplinary pain programs provide the best clinical care for pain clients and cost-effective long-term treatment options. The first year of chronic pain management is the most costly; therefore, the authors recommend early referral to an interdisciplinary pain management program (Kronborg et al., 2009). Physicians, occupational therapists, and rehabilitation counselors are three professionals who work with individuals with chronic pain in multidisciplinary and interdisciplinary teams.

**Physicians.** Physicians are professionals who practice medicine. Prior to graduation from medical school, physicians will demonstrate "knowledge of the important non-biological determinants of poor health and of the economic, psychological, social, and cultural factors that contribute to the development and/or continuation of maladies" (The Medical School Objectives Writing Group, 1999, p.17). The Federation of State Medical Boards defines the practice of medicine as:

1. Advertising, holding out to the public, or representing in any manner that one is authorized to practice medicine in the jurisdiction;
2. Offering or undertaking to prescribe, order, give, or administer any drug or medicine for the use of any other person;
3. Offering or undertaking to prevent or to diagnose, correct, and/or treat in any

manner or by any means, methods, or devices any disease, illness, pain, wound, fracture, infirmity, defect, or abnormal physical or mental condition of any person, including the management of pregnancy and parturition;

4. Offering or undertaking to perform any surgical operation upon any person;

5. Rendering a written or otherwise documented medical opinion concerning the diagnosis or treatment of a patient or the actual rendering of treatment to a patient within a state by a physician located outside the state as a result of the transmission of individual patient data by electronic or other means from within a state to such physician or the physician's agent;

6. Rendering a determination of medical necessity or a decision affecting the diagnosis and/or treatment of a patient; and

7. Using the designation Doctor, Doctor of Medicine, Doctor of Osteopathic Medicine/Doctor of Osteopathy, Physician, Surgeon, Physician and Surgeon, Dr., M.D., D.O., or any combination thereof in the conduct of any occupation or profession pertaining to the prevention, diagnosis, or treatment of human disease or condition unless such a designation additionally contains the description of another branch of the healing arts for which one holds a valid license in the jurisdiction where the patient is located, (FSMB, 2018, p. 8).

In chronic pain management, the physician has a specific role. Gatchel et al. (2014) describe the physician in an interdisciplinary chronic pain management team as the medical director for the team and assumes medical management for the client by coordinating treatment with other health professionals, providing constant and effective communication among team members, attending

interdisciplinary team meetings, and evaluating/monitoring treatment outcomes.

**Occupational therapists.** Occupational therapists are professionals that work within the interdisciplinary chronic pain management team providing physical rehabilitation. Occupational therapy is

> the therapeutic use of everyday life occupations with persons, groups, or populations (i.e., the client) for the purpose of enhancing or enabling participation. Occupational therapy services are provided for habilitation, rehabilitation, and promotion of health and wellness for clients with disability- and non-disability-related needs. These services include acquisition and preservation of occupational identity for clients who have or are at risk for developing an illness, injury, disease, disorder, condition, impairment, disability, activity limitation, or participation restriction (AOTA Occupational Therapy Practice Framework: Domain and Process, 4th Ed., p.1). Occupational therapy is consistent with the biopsychosocial model in that the practitioners "recognize the importance and impact of the mind-body-spirit connection on engagement and participation in daily life" (AOTA, 2020b, pp.6-7).

Occupational therapists can voluntarily seek additional credentialing for upper extremity rehabilitation. For over 35 years, the Hand Therapy Certification Commission (HTCC) has been certifying occupational therapists (OTs) and physical therapists (PTs) in this advanced clinical specialty (Keller et al., 2021). The Certified Hand Therapist (CHT) credential identifies excellence in hand therapy and awards to OTs and PTs after completing at least three years of clinical experience, of which 4,000 hours or more are accrued in direct hand therapy practice, and who have passed the comprehensive Hand Therapy Certification Examination (HTCE). To maintain the CHT credential, these individuals must either pass reexamination or accrue hours in hand therapy practice and participate in upper extremity professional development every five

years (Keller et al., 2021). These specialists evaluate clients' psychosocial, functional, developmental, vocational, avocational, and ergonomic factors to create a care plan in collaboration with the client. These clinicians typically work closely with hand surgeons and frequently communicate to provide time-sensitive treatment to facilitate the best outcomes. There are over 6,700 CHTs in the United States, of which 86% are occupational therapists, 13% are physical therapists, and one percent maintain both occupational and physical therapy credentials (https://www.htcc.org/consumer-information/the-cht-credential/who-is-a-cht).

In the context of pain management, occupational therapists utilize interventions including, but not limited to, education, functional goal setting, pain control, ergonomic training, neuromuscular re-education, progressive muscle relaxation, communication skills, proactive problem solving, pacing, and home exercise/activity programs (Rochman, 2014). Referrals to other professionals are indicated when chronic pain is accompanied by psychological, cognitive, and emotional problems. Koestler (2010) suggested that occupational/hand therapists spend a considerable amount of time with clients and can provide insight into when a referral for a more comprehensive psychological evaluation may be warranted. She suggested that occupational therapists observe clients who demonstrate non-compliance; resistance to assuming self-care responsibilities; avoidance behaviors; catastrophizing; emotional displays; exaggerated pain behaviors or guarding; and expressions of anger, blame, helplessness, and hopelessness. Depending on how these behaviors affect the progression of outcomes, a referral to a mental health provider may be warranted. Koestler reported that a referral for a psychological consult is mandatory when clients express suicidal ideation, have a history of disabling depression or suicidal gestures, are experiencing psychotic symptoms or irrational thinking, or are suspected of substance abuse.

**Rehabilitation Counselors.** Rehabilitation counselors are professionals who work in the interdisciplinary chronic pain management team. A rehabilitation counselor "assists persons with physical, mental, developmental, cognitive, and emotional disabilities to achieve their personal, career, and independent living goals in the most integrated setting possible through the application of the counseling process. The counseling process involves communication, goal setting, and beneficial growth or change through self-advocacy, psychological, vocational, social, and behavioral interventions" (CRCC Code of Ethics, 2017, p. 1). Rehabilitation counselors also work within the frameworks of the biopsychosocial model incorporating physical, psychological, emotional, and environmental attributes to facilitate quality of life. Rehabilitation counselors have managed chronic pain to regain productive lifestyles and employment (Beck & Lustig, 1990). They identify the physical, psychosocial, and environmental factors affecting chronic pain and provide intervention strategies to reduce impairment and modify pain behavior (Reagles, 1984). As multidisciplinary team members, rehabilitation counselors have valid and vital roles, especially in return to work (Tuck, 1983).

As described above, biological, psychological, and social factors influence recovery following upper extremity injuries to the elbow, wrist, and hand. Unfortunately, many individuals develop chronic pain following these injuries. Current treatment of upper extremity injuries includes physicians and occupational therapy providers. For example, physicians treat distal radius fractures by stabilizing the fracture site using surgical or immobilizing techniques such as casting, prescribing medications to facilitate healing, and monitoring healing through imaging tools such as x-rays or CT scans. Once the fracture is reduced, physicians refer these clients to occupational therapists. Occupational therapists evaluate and treat these individuals with acute and subacute distal radius fractures in the outpatient setting by fabricating orthoses, educating

clients in pacing, energy conservation, adaptive ADL techniques, and utilizing range of motion exercises, and functional activities, activity analysis, soft tissue mobilization, and physical agent modalities. Rehabilitation counselors do not typically provide interventions to individuals with distal radius fractures and other elbow, wrist, and hand injuries early in the rehabilitation process, but they possess unique counseling skills that can assist individuals experiencing disfunction in the subacute and chronic phases of recovery. No literature was identified specifically investigating chronic pain prevention in individuals with distal upper extremity injuries or the use of rehabilitation counseling in the subacute phases of elbow, wrist, and hand rehabilitation.

**Significance of the Study**

Individuals with elbow, wrist, and hand injuries can have complications. For example, even though fractures heal appropriately, range of motion increases, and grip strength improves, the individuals can continue to experience pain and dysfunction one- and two years post-injury. Given the high cost of chronic pain to the individual and society, it behooves us to identify individuals struggling in the subacute phase of injury of rehabilitation and beyond to provide interventions to alleviate their physical, psychological, and social distress from professionals competent in providing appropriate care.

The results of this study may contribute to evidence-based research for individuals with elbow, wrist, and hand injuries by validating an educational intervention delivered through a rehabilitation counseling lens. Finally, if validated, the biopsychosocial intervention will provide practitioners with another asset to improve outcomes and return individuals with injuries to their elbows, wrists, and hands to their prior levels of function.

## Purpose of Study

Chronic pain causes distress and is costly to clients, their families, and society. Considering the benefits from early intervention, it is prudent to study interventions to prevent and remediate chronic pain. Including rehabilitation counselors in the interdisciplinary team to address unmet biopsychosocial factors influencing pain beyond the acute phase may improve outcomes following injuries to the elbows, wrist, and hands. This study investigates the efficacy of a biopsychosocial pain curriculum delivered using a rehabilitation counseling lens to prevent and remediate chronic pain in individuals with elbow, wrist, and hand injuries.

## Research Questions and Hypotheses

1. Will the biopsychosocial pain neuroscience educational program significantly reduce pain?

    1a) It is hypothesized that participants will score significantly lower on the Pain Numeric Rating Scale following the pain neuroscience educational program.

2. Will the biopsychosocial pain neuroscience educational program significantly reduce psychological variables of pain catastrophizing and kinesiophobia?

    2a) It is hypothesized that participants will score significantly lower in the Pain Catastrophizing Scale following the pain neuroscience educational program;

    2b) It is hypothesized that participants will score significantly lower on the Tampa Scale of Kinesiophobia -11 following the pain neuroscience educational program.

3. Will the biopsychosocial pain neuroscience educational program significantly improve variables of social and functional participation?

    3a) It is hypothesized that participants will score significantly lower on the *Quick*DASH following the biopsychosocial pain neuroscience educational program.

    3b) It is hypothesized that participants will score significantly higher in performance on the

Canadian Occupational Performance Measure following the biopsychosocial pain neuroscience educational program.

3c) It is hypothesized that participants will score significantly higher in satisfaction on the Canadian Occupational Performance Measure following the biopsychosocial pain neuroscience educational program.

# CHAPTER 2: LITERATURE REVIEW

There are many types of professionals who work within a team to assist clients with chronic pain. As a team, these professionals work from a theoretical framework. The following section will discuss the theoretical framework, professional roles as they apply to ethical standards and scopes of practice, and evidence to support the use of interventions to treat and prevent chronic pain. This information will be the basis for creating an intervention to reduce pain in individuals with elbow, wrist, and hand injuries during the subacute and chronic rehabilitation phase.

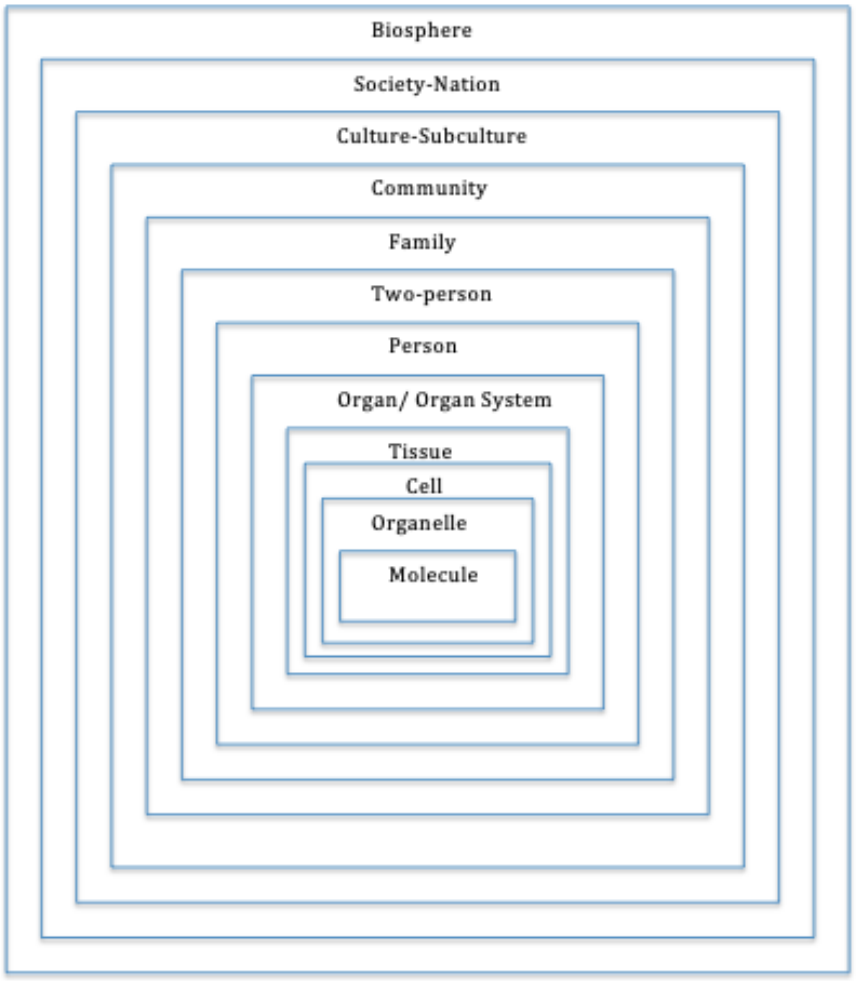
## Biopsychosocial Model

The theoretical models we use to organize care can affect client outcomes. A long-standing theoretical model used by the medical community is called the biomedical model. This model's origins date back to four centuries when physicians were allowed to study a body without dealing with an individual's soul, morals, mind, or behavior (Engel, 1978). The biopsychosocial model was introduced as an alternative to the prevailing biomedical model. A physician named George Engel, MD, first described the biopsychosocial model in the late 1970s. Engel (1978) contended that to understand an individual's illness perspective truly, one must consider not only the disease but all levels of the natural systems, including subatomic particles, cells, tissues, organs, organ systems, the person, the family, the community, the culture, and ultimately the biosphere (Figure 1). In the biomedical model, patients were reduced to the dysfunctional portions of the body, separate from the person. This idea was called *dualism*, where the mind was separate from the body. The biomedical model used a reductionist conceptual framework suggesting that nature involves discrete interactions in a linear causal fashion (Engle, 1978). The biopsychosocial model was not dualistic or reductionist and did not concentrate on linear cause-

and-effect. Instead, the biopsychosocial model was a reciprocal causal model (Engle, 1978), where systems can simultaneously produce causal effects on each other. The biopsychosocial model suggested that health, disease, and disability were each a system interacting with the other systems. Engel (1980) explained that each system was, at the same time, a component of higher systems (Figure 1).

**Figure 1**

*The Continuum of Natural Systems.*




*Note:* Adapted from *The Clinical Application of the Biopsychosocial Model (1980).*

This system approach was based on the work of two biologists, Paul Weiss and Ludwig von Bertalanffy. Engel described that two individuals could undergo the same changes in their social or molecular structures, but they will have different outcomes based on their history. A change in one individual can have little or no change, but in another individual, that exact change can have profound disruptions in the system. These changes affect the individual and those in relationship with the individual, such as family and community members (Engel, 1978).

Power differentials and personal agency differed in the two models. In the biomedical model, the physician identifies the disease and the treatment. The ancillary healthcare professionals oversaw the individual's care (Engel, 1978). The biomedical model is diseased-focused, not individual-focused. If test results were negative, the individual was not considered ill, no matter their complaints or concerns. Given this rationale, the individual has no responsibility in the healing process. The physician must identify and "fix" the problem. The individual is acted upon. In the biopsychosocial model, the individual is the central focus. A physician will recognize that to serve the individual best is to investigate the higher levels of the system and the lower levels of the system hierarchy (Engle, 1980). For example, a physician will identify the stabilizing and destabilizing effects of events in the individual's social environment that can feed back and cause stabilizing or destabilizing influence on the individual's illness (Engle, 1980). In other words, the physician will assist the client in recognizing that environmental or social factors contribute to the disease presentation. The physician gathers this information by interviewing the individual to understand their strengths, supports, and barriers contributing to illness or state of well-being. The individual is in a relationship with the physician and is considered a team member.

Engel (1978) argued that physicians in the late 1970s were more interested in physical

measures using increasingly elegant and sensitive instruments consistent with the biomedical model than patients' actual concerns. Patients' concerns focused on how one felt, how one functioned, how one related, and the ability to love, work, struggle, seek options and make choices (Engel, 1978). The biopsychosocial and biomedical perspectives in client care were at odds. Under the biomedical model, physicians diagnosed and created treatment plans, whereas other health professionals addressed the more personal aspects of patient care by using their "common sense" (Engel, 1978). Engel argued that physicians and ancillary health workers were no more trained in behavioral or psychosocial issues than a layperson and believed that "Anyone can do it." Engel (1978) suggested that the psychosocial and behavioral issues requiring interventions, previously classified as "common sense," actually required specialized knowledge and were better addressed by mental health professionals.

Under the biopsychosocial model, physicians and ancillary health professionals recognize the need to understand the patient from all levels, including psychosocial and behavioral factors. Professionals should have a working knowledge of each discipline's principles, language, and basic facts but are not expected to be an expert (Engel, 1980). Understanding one's competency to deliver an intervention is vital and consistent with health professionals' codes of ethical conduct. The American Medical Association (AMA) Code of Medical Ethics (2016) states that "a physician shall be dedicated to providing competent medical care, with compassion and respect for human dignity and rights" (p.1). The American Occupational Therapy Association (AOTA) states that occupational therapists shall "provide occupational therapy services, including education and training, that are within each practitioner's level of competence and scope of practice" and "maintain competency by ongoing participation in education relevant to one's practice area," (2015, p.3). Rehabilitation counseling interventions would be consistent

with the tenets of the biopsychosocial model. Rehabilitation counselors can provide interventions affecting the psychological areas not previously addressed in traditional care of elbow, wrist, and hand injuries. The Commission on Rehabilitation Counselor Certification (CRCC) code of ethics states that in the areas of knowledge and competency, "rehabilitation counselors are knowledgeable about systems and laws, as well as organizational policies, and how they affect access to employment, education, transportation, housing, civil rights, financial benefits, medical services, and mental health services for individuals with disabilities. They keep current with changes in these areas to advocate effectively for clients and/or to facilitate self-advocacy of clients in these areas" (2017, p.12-13). The physician and occupational therapist understand the need to address biopsychosocial factors and are ethically bound to provide competent care. If they do not possess the competency or ability to provide interventions for the psychological factors, they are bound to refer clients to professionals who can.

In the above example, Engle (1980) provided, the physician determined that the social environment may destabilize the client's wellness. The physician could refer the client to a rehabilitation counselor to assist the client in developing solutions to their situation. Rehabilitation counselors could assist in improving client agency. De Jong and Berg (2013) explained that clients could feel ashamed and disappointed that they need assistance. They would rather believe their condition is biological and thus "out of their control." Having personal or family problems means that they bear some responsibility in the situation. Using a client-centered approach, rehabilitation counselors can support the client in developing strategies to improve their situation. By reminding the client that the solutions will require hard work, the rehabilitation counselor places the responsibility for change and solutions on the client. As a result, the rehabilitation counselor assisted the client in improving their self-efficacy and

wellness.

## Psychological Factors Influencing Pain

Several psychological factors can influence pain. Research has shown that pain-related fear, including fear of movement or reinjury, catastrophizing, and depression contribute to predictions of pain-related outcomes (Wideman & Sullivan, 2011; Sullivan et al., 1995). The following section describes prominent factors pain: kinesiophobia, threat assessment, pain catastrophizing, and depression.

### *Kinesiophobia*

In the acute stages after injury, some individuals are frightened to move or use their bodies secondary to pain. If these individuals do not move their bodies, they can limit neuroplastic changes. Lack of movement can result in poorer functional outcomes, such as chronic pain. Fear of movement is called *kinesiophobia*. Kori et al. (1990) described this fear as "an excessive, irrational, and debilitating fear of physical movement and activity resulting from a feeling of vulnerability to painful injury or reinjury" (p.36). The shortened version of the Tampa Scale of Kinesiophobia (TSK-11) was developed to assess pain-related fear in patients with chronic low back pain (Woby et al., 2005). The authors found it to be a reliable and valid measure of fear of motion/(re)injury for individuals with chronic pain (Tkachuk & Harris, 2012). Swinkels-Meewisse, et al. (2003) studied kinesiophobia in the acute back pain population and summarized that

1. in the chronic back pain population, pain-related fear is associated with impaired physical performance and self-reported disability,
2. pain-related fear predicts future disability and health status in the open population,
3. in individuals with acute low back pain, pain-related fear predicts future occupational

disability,

4. educational interventions focused on reducing negative beliefs and attitudes, mediating avoidant-behavior, reducing work absenteeism in patients with low back pain, and
5. reduction of pain-related fear as a result of cognitive-behavioral interventions is associated with increased functional abilities and increased activity tolerance.

MacDermid et al. (2018) performed a scoping review of psychological factors on upper extremity disability. The author's data indicated that the TSK-11 is not commonly used as an outcome measure in distal upper extremity literature to identify kinesiophobia (MacDermid et al., 2018). However, interest in this tool for this population is gaining. In 2009, Appleby and colleagues compared outcome measures in assessing change post-carpal tunnel surgery and advocated for further study of the TSK-11 to add to further understanding of the relationship between pain and outcomes. The TSK-11 outcome measure is common in the literature investigating psychological interventions in chronic pain populations. In 2021, Doerrer et al. compared individuals with DRF only and DRF with shoulder pathology and found increased kinesiophobia when the individual did not have surgery to address the DRF, had increased pain, and had decreased function. Both groups had decreased kinesiophobia when compensatory mechanisms increased. Addressing kinesiophobia in the subacute and chronic phases of distal upper extremity injuries may reduce pain, work absenteeism, and disability.

### *Threat Assessment*

Threat assessment and emotions can influence our perception of pain. Emotions relevant to pain assessment are fear and anxiety. Emotions are functional in that when people can improve their ability to identify the emotion they experience, they can make informed choices about whether the emotion will be helpful in the situation (Lench & Carpenter, 2018). Emotions

respond directly toward a specific object, event, condition, or environment (Lench & Carpenter, 2018). Parsafar and Davis (2018) explained that fear and anxiety are emotions generated by the initial perception of threat when the certainty of harm is unknown. The authors distinguished fear from anxiety in that fear is a response to an actual, specific, identifiable, proximate stressor and the perception of immediate, predictable substantial harm. Anxiety is a response to appraising an unpredictable or potential threat with a low probability of actual harm. In other words, fear has a high probability of actual harm, and anxiety has a low probability of actual harm. During fear responses to stimuli, individuals are more likely to demonstrate a startle, freeze, or flee response. In contrast, in an anxiety response to stimuli, individuals are more likely to demonstrate an avoidance response (Parsafar & Davis, 2018).

Neuroscience identified evidence supporting pain generation using a top-down or cognitive process, not a bottom-up approach that focuses on nociceptors and other sensory/peripheral neurons. In one study, Lim et al. (2020) studied threat prediction from schemas as bias in pain perception using functional MRI data. Schemas are higher-level knowledge structures allowing humans to quickly extract meaning from sensory inputs. Sometimes these schemas can influence our perceptions of pain and have lingering effects. Lim et al. (2020) suggested that pain perception consists of predicted threats and sensory inputs. Their study found evidence that threat predictions generated from schemas continued to influence pain perception despite increased prediction errors arising from the sensory evidence. Although the perceptual bias was reduced with increased prediction errors, the bias could not be erased. Thus, pain is more heavily reliant on pain prediction based on past learning than sensory inputs of the present. Lim et al. also found that individuals who presented with higher levels of pain catastrophizing and lower levels of mindfulness were significantly more reliant on these schemas than sensory inputs.

### *Pain Catastrophizing*

Individuals with chronic pain tend to ruminate on their pain experience, exaggerate the threat of pain and adopt a negative appraisal of their own ability to deal with pain (Sullivan et al., 1995; Sullivan et al., 2001). In chronic pain, catastrophizing is a cognitive process characterized by a lack of confidence, a lack of control, and an expectation of negative outcomes (Keefe et al., 1989). Authors found that after controlling for demographic variables and pain severity, initial pain-related pain catastrophizing scores (PCS) were positively related to functional disability and depression six months later (Keefe et al., 1989). In a systematic review and meta-analysis involving 29 studies investigating the association between preoperative anxiety or pain catastrophizing and chronic postsurgical pain (CPSP), Theunissen et al. (2012) reported a statistically significant association in 67% of the musculoskeletal surgery studies compared with 36% from other surgery studies. The authors recommended that these anxiety variables be considered in future studies investigating the transition from acute to chronic pain. Lee et al. (2008) found that, even after controlling for age, gender, time since injury, and pain intensity, life stress and catastrophizing were significantly related to depression. Of the five life stress domains examined, Lee et al. (2008) found personal and social domains to have the highest correlation with depression.

Psychosocial and pain-related variables contribute to the quality of life of persons with chronic pain (Lee et al., 2008), and psychological factors at admission were important variables in predicting employment outcomes (Dozois et al., 1995). However, work and financial stress had the most significant predictors of depression. The PCS is not typically used in populations with subacute and chronic injuries to the elbows, wrists, and hands. It is a common outcome measure for other populations with chronic pain.

### *Depression*

Depression symptoms in the acute phase can predict chronic pain and disability. Young et al. (2008) evaluated a model including cognitive, affective, and trauma factors on the progression of acute neck and back pain to chronic pain and disability in 84 individuals. Their path model of chronic pain predicted 26% of the total variance in three-month pain reports. Young Casey et al. (2008) found that higher trauma exposure and more depressive symptoms at initial evaluation independently and significantly predicted greater pain at three months. In their path model for chronic disability, their variables accounted for 58% of the variance in three-month pain-related disability. At three months, initial depression, pain permanence beliefs, and chronic pain intensity were independent and significant predictors of disability. Pain permanence beliefs and chronic pain intensity explained the greatest amount of variance in disability. Depressive symptoms had the strongest positive, independent predictor of chronic pain and disability. The authors suggest that depression screening in individuals with acute pain may be essential to prevent chronic pain and disability. Yeoh et al. (2016) investigated the effects of depression on upper extremity function, general health, complications, and symptoms consistent with CRPS following a distal radius fracture in adults aged 55 years and older. Researchers found that depression was the most important predictor of upper extremity functional outcome after controlling for gender, age, treatment, comorbidity, and complications. Depression is commonly screened for in the primary care physicians' and hand surgeons' offices during the acute phase.

Early screening for risk factors may facilitate improved outcomes. Lee and researchers (2008) recommend that health professionals routinely screen chronic pain patients for life stress and cognitive vulnerability risk factors that elevate the pain experience and depression. Young Casey et al. (2008) and Yeoh (2016) echoed this recommendation. By screening clients earlier in

the rehabilitation process to identify psychological risk factors, health professionals can offer resources or refer them to other professionals to address these factors. Addressing psychological factors may decrease clients' stress burdens and facilitate meaningful life experiences.

Tang and Crane (2006) reported that individuals with chronic pain were twice as likely to die by suicide. This hypothesis was confirmed by the Fishbain et al. (2014) narrative review and Calati et al. (2015) meta-analysis. In individuals with mental disorders, chronic pain conditions significantly increase their risk of suicide ideation and attempts (Ratcliffe et al., 2008). Sommers-Flanagan and Shaw (2017) reported that risk factors are poor predictors of suicide, but they should be understood and used in a comprehensive suicide assessment. For example, they can be used to inform clients and normalize their suicidal ideation. This normalizing frame of reference can reduce patient self-criticism and catastrophizing (Nystul, 1994).

Given individuals in chronic pain may be more susceptible to suicidal ideation and suicidal attempts, emotional well-being should be tracked. Single-item measures are quicker and less laborious to complete and confer a higher degree of transparency than factor scales (Brown and Astell, 2012). There are many evidence-based and clinically informed strategies used to address suicide ideation (Sommers-Flanagan & Shaw, 2017). Effective approaches to suicide assessment begin with establishing a collaborative working relationship between the mental health provider and the individual (Sommers-Flanagan, 2016).

**Evidence on Psychological Interventions in Pain Populations**

Psychosocial interventions to treat chronic pain were first introduced into practice by Fordyce et al. (1968). Over these past 50 years, psychosocial interventions have grown in scope and are now standard practice for treating pain, distress, and disability in chronic pain populations such as arthritis, low back pain, neck pain, fibromyalgia, and musculoskeletal pain conditions. The

terms psychological and psycho-educational have also been used in the pain literature. Unfortunately, these three terms have been used interchangeably throughout the pain literature without explanations of how or why the intervention was classified. For example, cognitive behavioral therapy was referred to as *psychological* in some literature (Applebaum et al., 1988; Bradley et al., 1987; Calfas et al., 1992; Carnes et al., 2012; Freeman, 2002; Gay et al., 2002; Glombiewski et al., 2010), *psychosocial* in other literature (Dixon et al., 2007; Evers et al., 2002; Fordyce et al.,1968; Hollon & Beck, 2013) and psycho-education in another (Barlow et al., 2000) Given the literature did not provided definitions of these classification, definitions outside the pain literature was sought. In 2011, the National Collaborating Centre for Mental Health published an explanation of *psychological* interventions suggesting they can be classified as behavioral, cognitive, systemic, psychodynamic, humanistic, motivational, disease, social and environmental. No definitions or explanations of psychosocial interventions were provided. Given that this was the only definition identified and includes social and behavioral aspects, for practical purposes, the interventions will be classified as psychological. The following section will discuss recent results on the effectiveness of these interventions and the appropriate time to intervene to prevent chronic pain.

In a meta-analysis testing the effectiveness of psychological interventions for arthritis pain management, Dixon et al. (2007) analyzed 27 randomized controlled trials (RCTs). To be included in the analysis, each study must include adults over the age of 18 years, individuals with osteoarthritis and rheumatoid arthritis, pain as an outcome, and at least one psychological intervention (cognitive-behavioral therapy (CBT) for pain management/ pain coping skills training, stress management, emotional disclosure, hypnosis, biofeedback, or psychodynamic therapy). The final analysis included 3,409 participants, mean age 58.9 years (n=23 studies),

69.5% female (n=25 studies), and 81% Caucasian (*n*=9.33%). The most frequent intervention was CBT for pain management/pain coping skills (*n*=23), followed by stress management (*n*=5), psychodynamic intervention (*n*=2), biofeedback (*n*=1), and hypnosis (*n*=1). Dixon et al. (2007) found an overall effect size of 0.177 (95% CI = .256-.094) indicating participants in the psychological interventions had significant reduction in pain (primary outcome) compared with control groups. Although the effect size is small, the authors argued it is consistent with other meta-analyses studying a variety of pain populations. The meta-analysis also supported efficacy of interventions on other psychological, social, and biological outcomes. Dixon et al. described the conclusions as tentative given outcome measures varied across studies. The authors found that psychological interventions had large effects on measures of coping (ES =.72), small to medium effects on joint swelling (ES =.35) and measures of anxiety (ES =.28), and small effects on depression (ES= .21), disability (ES =.15), and pain self-efficacy (ES =.18). In other words, the participants may have only seen a small reduction in pain, depression, disability, but they were much better able to cope with the pain, had considerably less anxiety, and move better given the reduction in swelling.

Session duration also varied across studies. The average number of sessions was 8.5 (4-20), and the average session length was 86 minutes (15-120 minutes). Dixon et al. (2007) advocated for promptly making psychological treatment available for many patients to prevent unnecessary pain and educating physicians and other allied professionals on the benefits of psychological interventions.

Researchers used psychological interventions with individuals diagnosed with fibromyalgia. In 2010, Bernardy et al. found 14 RCTs comparing cognitive-behavioral therapies (CBT) with control groups on participants of any age diagnosed with fibromyalgia in North and

Middle Europe (n=9) and North America (*n*=5). Participants' mean age was 47 years, the median percentage of women was 100%, and the median percentage of Caucasians was 91%. Interventions included face-to-face cognitive (*n*=3), operant behavioral (*n*=2), or cognitive-behavioral therapies (*n*=10) with defined psychotherapeutic content as active treatment. The primary outcomes of interest were pain, sleep, fatigue, and multidimensional function (quality of life). Secondary outcomes studied were depressed mood, pain self-efficacy, and healthcare-seeking behavior. Authors used standardized mean difference (SMD) using means and standard deviations to calculate the effect size. SMD is also known as Hedges (adjusted) g. Authors used Cohen's categories to evaluate the effect size (small > 0.2-0.5; medium > 0.5-0.8 and large > 0.8). In their systematic review and meta-analysis, Bernardy, et al. (2010) found CBT had a small effect for reducing depressed mood (SMD .24, 95% CI [-.40, -.08]; $p$ =.004) and a large effect on improved self-efficacy pain (SMD .85, 95% CI [.25, 1.46]; $p$ = .006) compared to controls at post-treatment. No significant effect was found for fatigue, sleep, or quality of life. The median intervention was nine weeks (5-15weeks), and the median total treatment time was 27 hours (6-75 hours). At follow-up, CBT improved self-efficacy pain (SMD .90, 95% CI [.14, 1.66], $p$ =.02) and operant behavioral therapy reduced the number of physician visits (SMD -1.57, 95% CI [-2.00, -1.14]; $p$ < .001) compared with controls. At follow-up, no significant effects were found on pain, fatigue, sleep, and depressed mood. Authors found comparing studies was difficult due to the variety of outcome measures used and advocated for a core set of outcome measures, including response rates, to improve the internal validity of meta-analysis.

Researchers also used psychological interventions with individuals with chronic musculoskeletal pain. Carnes et al. (2012) performed a systematic review of delivery styles and content for self-management of chronic musculoskeletal pain. The authors argued that the

contents and characteristics of self-management interventions for chronic pain vary considerably and identifying the most optimal means of course delivery is beneficial. Carnes et al. (2012) sought RCTs performed from January 1994 to April 2009, identifying chronic musculoskeletal pain as the primary condition in adults 18 or older. The researchers excluded studies examining rheumatoid arthritis conditions exclusively as it has a different course of treatment. Carnes et al. identified 46 RCTs that met their selection criteria and the following definitions. *Chronic pain* was defined as pain lasting longer than three months. *Self-management* was defined as a structured, taught, or self-taught course with distinct components aimed at patients to improve the participants' health status or quality of life by teaching them skills to apply to everyday life. Carnes et al. defined the three follow-up intervals as short-term (less than four months), medium – (between four and eight months), and long-term (greater than eight months). The program of interest had to contain at least two components of the following five groups: psychological (cognitive or behavioral therapy), mind-body therapies (relaxation, meditation, or guided imagery), physical activity (any form of exercise), lifestyle (dietary and sleep management), and pain education (understanding their condition and medication management). The researchers were interested in the following outcome measures with published evidence of validity and reliability: pain intensity, physical function, general mental health, depression, anxiety, social function, healthcare utilization, global health measures, self-efficacy, and quality of life Authors calculated a pooled "effect size" for outcomes across studies using standardized mean differences (SMD)/ Hedges' (adjusted) g and assessed meaningful size using Cohen's *d* (< 0.2 minor, 0.2 to 0.5 small, 0.5 to 0.8 moderate, and 0.8 large).

Of the 46 RCTs identified, most studies were from Europe (*n*=22) and North America (*n*=18), with a few studies from Asia (*n*=3), the Middle East (*n*=2), and South America (*n*=1). Most of

the studies focused on either osteoarthritis in the lower extremities (28%) or low back pain (26%), followed by fibromyalgia (11%). The remaining 35% were for mixed chronic pain conditions. The mean age for those studies reporting age was 55 years, with 72% female participants and a total of 8539 participants. Effect sizes for delivery mode identified the group format (*n*=27) had statistically significant yet small beneficial effects for pain intensity across all time points: short-term SMD = .24, medium-term SMD = .25, long-term = .20. Similar results were identified for self-efficacy in groups with significant, yet small effects in the short-term (SMD = .37), medium- (SMD = .29), and long-term (SMD = .23). Group formats produced significant small effects in global health in the short-term (SMD = .45) and medium terms (SMD = .54) but were nonsignificant in the long term. Sessions delivered by healthcare professionals had significant small effects on pain intensity in the short-term (SMD = .27) but only significant minor effects in the medium- and long term. When measuring self-efficacy, content that healthcare professionals delivered produced significant small effects across all time points (short-term SMD = .38, medium-term SMD = .37, and long-term SMD = .25). Most interventions (82%) contained a psychological component (cognitive or behavioral). Psychological interventions had small significant effects on pain intensity in the short-term (SMD = .28) and medium-term (SMD = .28) but only minor significant changes in the long-term. Most studies utilized a pain education component (76%). Results indicate that self-management was favored in most outcomes irrespective of pain education in the short term, but in the medium term, there was more evidence to include it. Most courses lasted eight weeks or less (74%). More evidence supported the benefits of courses of less than eight weeks compared with longer courses.

In a Cochran systematic review, Williams et al. (2012) investigated psychological therapies

for managing chronic pain (excluding headaches). The authors identified RCTs in the chronic pain population by comparing credible psychological treatment with a placebo, other active treatment, treatment as usual, or waitlist control. Forty-two studies met the criteria, and 35 studies (4788 participants) provided data. The outcome measures of interest were pain, disability, mood, and catastrophizing. The intervention was deemed credible if delivered by or supervised by a healthcare professional qualified in psychology and was based on a psychological framework or model. Inclusion criteria for the studies were: available for full publication of an RCT; psychological treatment as active treatment of primary interest; had a definable psychotherapeutic content; published in a peer-reviewed science journal and had 20 or more participants in each treatment arm at the end of the assessment. The population of interest included adults 18 years or older who reported pain lasting at least three months in any body site. Studies were excluded if the study populations were only headaches or associated with life-threatening malignant disease. The search criteria range in the Cochran Central Registered of Controlled Trials, MEDLINE, EMBASE, and Psychlit from their inception to September 2011.

The results from this systematic review are less encouraging than the other systematic reviews on the effectiveness of CBT and behavioral interventions. Williams et al. (2012) concluded that there was no evidence that behavioral therapies were effective for any outcomes except for mood when compared to an active control immediately after treatment ($Z = 1.94$, $p = .05$; SMD -.46, 95% [CI – 0.94 to 0]). CBT had small positive effects on pain immediately following post-treatment but only when compared with treatment as usual/wait list condition ($Z = 2.59$, $p < .05$; SMD -0.21, 95% CI [ -.37 to -.05]). There was no effect on pain when compared with an active control or at follow-up in the treatment as usual/waitlist conditions. When measuring disability, CBT had small effects at post-treatment ($Z = 2.66$, $p < .01$; SMD -.19, 95% CI [-.33 to -.05]),

and at follow-up (Z = 2.28, $p < .05$; SMD -.15, 95% CI [-.28 to -.02]) when compared with an active control and only at post-treatment when compared with the treatment as usual/wait list conditions (Z = 2.35, $p < .05$; SMD -.26, 95% CI [-.47 to -.04]). When measuring mood, CBT had no effect immediately post-treatment or at follow-up compared with active control. When compared with the treatment as usual/wait list conditions, CBT had a moderate effect on mood post-treatment (Z = 3.84, $p < 0.01$; SMD -.38, 95% CI [-.57 to -.18]) and a small effect at follow up (Z = 1.99, $p = 0.05$; SMD -.26, 95% CI [-.51 to 0]). For catastrophizing outcomes, CBT had a small effect compared to an active control immediately post-treatment (Z = 1.92, $p = .05$; SMD -.18, 95% CI [-.36 to 0]) but no effect at follow up. In comparison to treatment as usual/wait list, CBT a had moderate effect on catastrophizing immediately post-treatment (Z = 4.58, $p < .01$; SMD -.53, 95% [CI -.76 to -.31]) but not at follow up.

This Cochran systematic review with stricter inclusion criteria and identification of control types produced mixed results. How one defines inclusion criteria, populations, interventions, and controls can produce different results. Williams et al. (2012) found that CBT is effective if it is delivered by experienced staff and those trained and supervised in the trial protocol and advise that "these results cannot be extrapolated to CBT delivered by untrained staff" (p. 16). Even with the most detailed protocol, treatment will differ in the hands of different therapists with greater or lesser skills at relating the material to the clients' experiences rather than in general terms. Given this view, we must identify which professionals have the competency to deliver interventions.

In 2020, Garza published a systematic review of unconventional pain management techniques for people with systemic lupus erythematosus. She defined *unconventional pain management* as "a wide-ranging set of methods that involve various strategies opposite to those treating pain

with pharmacological agents" (p.4). Types of interventions included CBT (most common), physical exercise, education, meditation, yoga, and breathing. CBT strategies most used were restructuring or challenging thoughts, relaxation techniques, coping strategies, progressive muscle relaxation, stress management training, and approaches to controlling pain. Some of these interventions are like interventions described above as *psychological therapies.* None of these studies presented in this review described pain neuroscience education. Garza identified seven articles that met her criteria. Most participants were females, with five studies exclusively female, one with 87% female and the other with 94% female. In this review, pain was measured using the Visual Analog Scale (VAS), the McGill Pain Scale (MPS), or the Brief Pain Inventory (BPI). Fear of pain was measured using the Tampa Scale for Kinesiophobia (TSK). Physical activity was measured with the International Physical Activity Questionnaire (IPAQ) and the Physical Function Scale (SF-36). Garza found mixed outcomes regarding pain reduction. Three studies using CBT indicated a statistically significant reduction in pain; one internet-based CBT intervention and an aerobic exercise intervention did not have statistically significant changes in pain. The author did not consistently indicate the number of sessions or frequency of interventions in the studies for comparison for this article.

**Evidence on Biopsychosocial Interventions in Pain Populations**

A biopsychosocial pain education curriculum has demonstrated improved pain treatment outcomes. Mosely and Butler (2015) described the difference between cognitive-behavioral pain management programs and the *Explain Pain* curriculum. Cognitive-behavioral approaches in pain management address maladaptive thought patterns and coping strategies (Smith & Williams, 2013). Through this process, changing these maladaptive thoughts can assist clients in coping with pain. Mosely and Butler argue that "somewhere along the way, CBT approaches

utilized the concept that pain is unavoidable, but suffering can be alleviated" (2015, p. 808). When integrating the above systematic reviews and meta-analyses, CBT approaches decrease pain significantly, although the effect sizes are small. Dixon et al. (2007) found that learning about pain can reduce pain. In fact, Mosely and Butler used Dixon et al. (2007) to support their biopsychosocial *Explain Pain* program. Mosely's and Butler's educational interventions intend to change one's understanding of what pain actually is, what function pain serves, and what biological processes are thought to support it (2015). Essentially, the *Explain Pain* program is similar to a cognitive behavioral approach in that it changes maladaptive views about pain and sees it as less threatening. The main differences appear to be that traditional CBT attempts to manage chronic pain and *Explain Pain* attempts to treat the pain (Moseley & Butler, 2015). *Explain pain* does this by using a "conceptual change theory" where learning is based on challenging existing knowledge and knowledge structures instead of just providing new information. This learning process is emergent, not linear which is consistent with Engel's biopsychosocial theory. Other researchers using these basic concepts use several names, e.g., neuroscience education, pain neuroscience education, and pain neurophysiology education. For ease of understanding, the general name *pain neuroscience education (PNE)* will be used to identify the intervention. The following research supports the use of these concepts in the pain population.

Several systematic reviews reported on the effect of pain neuroscience education (PNE) on pain (Clarke et al, 2011; Louw et al., 2011; Louw et al., 2016; Siddall et al., 2022, Traeger et al., 2015; Watson et al., 2019; Wood & Hendrick, 2018). PNE is described as an education session(s) describing the neurobiology and neurophysiology of pain and pain processing by the nervous system (Louw et al., 2011). This type of education addresses how the nervous system

(peripheral and central) interprets information from tissues, and neural activation can modulate the pain experience. It also includes psychological aspects that help determine their pain experience and that pain is not a true indication of tissue pathology. Depending on the timing, PNE may be used as a preventative measure in acute pain situations and as a treatment intervention in chronic pain populations (Louw et al., 2011). PNE is not to be performed in isolation but delivered as part of a wider intervention (Clarke et al., 2011) for example, occupational therapy or medical care provided by a physician.

Clarke et al. (2011) performed a systematic review and meta-analysis to examine the benefits of PNE on chronic low-back pain (CLBP). The authors identified two RCT involving adults over age 18 years in which at least 50% of the participants had non-specific CLBP (with or without associated leg pain). Individuals with possible serious spinal pathology were excluded. The authors reported PNE compared to control groups was statistically significant for pain reduction in the short term with a mean difference (95% CI) between groups of 5mm (0, 10.0) on the 100 mm Visual Analog Scale and the benefits continued for up to 12 months. There is insufficient data to show a benefit on physical function for PNE in comparison of these two RCT Psychological improvements were statistically significant in terms of attitudes towards pain and catastrophizing. Social function was assessed by work status. The PNE group was four times more likely to have a greater improvement in work status at six months post intervention than the control group and twice as likely to have a greater improvement in work status at 12 months post intervention. Clarke et al. (2011) found the results of this meta-analysis as very low-quality evidence based on the Cochrane Back Review Group Limitations of this study include the small number of studies (two RCT), low quality evidence, and the author of the Explain Pain/PNE intervention was also author to both RCT studied.

Louw et al. (2011) performed a systematic review of eight studies including RCT (*n*=6), nonrandomized experimental trials (n=1), and comparative study (n=1) investigating the effects of PNE on pain disability, anxiety, and fear/stress for chronic musculoskeletal pain. The authors included studies with adult patients aged 18 years and older, published in English language within years 1999-2010. The systematic review included 401 participants, of whom 63% were women (*n*=252) with a mean age of 38.2 years. PNE was performed by physical therapists. Interventions varied lasting anywhere from 30 min to three hours and one to four sessions. Meta-analysis could not be performed given heterogeneity of outcome measures. The authors found evidence that PNE positively affects pain ratings, physical performance, perceived disability, and catastrophizing in patients with chronic musculoskeletal pain. One-on-one interventions were used most often and produced superior outcomes compared with group interventions. The low number of studies (*n*=8), heterogeneity of outcome measures, and quality of evidence limited this study.

Traeger et al. (2015) performed a meta-analysis of randomized and nonrandomized clinical trials on the efficacy of PNE on reassurance in acute or subacute low back pain (LBP) in primary care. The authors defined reassurance as the removal of fears or concerns about illness. Studies were included based on the following criteria, randomized or non-randomized clinical trials, participants were adults with acute (less than six weeks duration) or subacute (6-12 weeks duration) LBP, interventions took place in primary care settings, at least one intervention was performed by a primary care practitioner (physician, nurse, or physiotherapist), and measured reassurance as an outcome. Reassurance was operationalized to include any measure of fear, illness concern, worry, anxiety, catastrophizing, distress, or healthcare utilization. Studies were excluded if there were group interventions, did not involve face-to-face interventions, provided

multidisciplinary interventions, and more than 30% of participants had chronic LBP. The authors reviewed results of subacute and acute low back pain of 14 studies that met their qualifications. Educational interventions in the experimental conditions utilized the "biopsychosocial" approach to pain and lasted anywhere from five minutes to 2.5 hours. Traeger et al. (2015) found moderate quality level of evidence (12 studies) supporting reassurance patient education (PNE) improved reassurance more than the control education groups in the short term (SMD -.21, 95% CI [-.36 to -.07]), and high-quality evidence (8 studies) that reassurance patient education (PNE) increased reassurance greater than the control group in the long-term (SMD -.15, 95% CI [-.27 to -.03]). There was moderate quality evidence that PNE decreased LBP-related primary care visits compared to control education groups. These effects were seen for up to 12 months (SMD -.14, 95% CI [-.28 to 0]) at a 12-month follow up). Interventions delivered by physicians were significantly more reassuring than when delivered by a nurse or physiotherapist. The limitations of these studies were that there was not one direct measure of reassurance.

Louw et al. (2016) performed a systematic review to update and explore the effects of PNE on individuals' distress from musculoskeletal pain, specifically low back pain, chronic fatigue syndrome, fibromyalgia, lumbar radiculopathy awaiting lumbar surgery, and chronic neck pain. Studies were included based on the criteria listed in Louw et al. (2011) except for longer date ranges (2002 to 2015) and acceptance of RCT only. Studies must investigate either pain or disability to be considered "relevant" and at least 75% of the trials that analyzed the PNE must have the same result (positive, neutral, or negative) to be considered "generally consistent." Thirteen RCT met the above requirements including 734 participants of which 398 received the PNE (70% female), mean age 41.7 years. Verbal one-on-one delivery of PNE between the participant and provider was the primary delivery method ($n$=10), two studies used group

delivery, and one study only provided information from a book. Pedagogy tools included prepared pictures, PowerPoint presentations, drawings, examples, metaphors, and books. Intervention frequency and duration varied from receiving a book and asked to complete sections to seven one-hour interventions. Studies including PNE with movement therapy appeared more successful than education -only interventions especially for pain reduction and no PNE intervention was worse than the control. Louw et al. found supporting evidence that PNE improves pain ratings, disability, pain knowledge, pain catastrophizing, fear-avoidance, physical movement, unhealthy attitudes and behaviors regarding pain, and healthcare utilization.

Wood and Hendrick (2018) performed a systematic review and meta-analysis as a follow up to Clark et al. (2011) investigating the effects of PNE on individuals with chronic low back pain. Wood and Hendrick (2018) were primarily investigating the effects of PNE on pain and disability, with kinesiophobia and pain catastrophizing as secondary outcomes. The researchers included published RCTs between 2011 and 2017 involving adults 18 years and older who reported chronic low back pain with or without leg pain of at least three months duration. The researchers excluded trials including specific pathologies, e.g., spinal stenosis, pregnancy-related low back pain, spinal tumors. Using the CINAHL, MEDLINE, Cochrane, and Web of Science databases, the researchers found 6761 papers in their initial search and identified eight RCTs (n=615) meeting their inclusion and exclusion criteria, one of which was used in Clark et al. (2011). Using the table of trial characteristics, sample sizes ranged from 12 to 216, mean ages ranged from 36 years to 60.1 years, and percent female ranged from 55.3% to 67%. There was no mention of race or ethnicity characteristics of the population. Types of PNE delivered included a five-minute explanation of PNE; a three session PNE including one group webinar, and individual session; four weekly one-on-one sessions of PNE; one three-hour PNE one-on-

one session; two RCT cited two sessions of PNE; PNE one to two times per week for eight weeks; and four 30-minute PNE sessions.

Some positive effects were identified from the meta-analysis. Pain was measured using the pain NRS tool in five of the six RCTs analyzed, while the sixth studied used the visual analog scale (VAS). VAS was converted to the NRS scale to pool effects. Researchers identified 428 participants who reported data on the short-term pain outcomes (within the first six weeks). Meta-analysis of results indicated a weighted mean difference (WMD) of .73, 95% CI [ -.14, 1.61] on a 10-point scale of PNE in comparison to the control group and found no statistically significant difference ($p$ =0.10). There was also considerable heterogeneity ($I^2$ = 95%, $X^2$ = 109.57) and low-quality evidence that PNE in isolation/combination with another treatment compared to control group improved pain in the short term (Wood & Hendrick, 2018). The authors removed the largest study (Werner et al. 2016, $n$=216) and performed a subgroup analysis using the remaining 212 participants. In this analysis, the researchers identified a statistically significant difference ($p$ < .001) in short term pain comparing PNE to control with a WMD of 1.32 (95% CI, 1.08, 1.56) with low heterogeneity ($I^2$ =0 %, $X^2$ = 3.55). This resulted in moderate quality evidence supporting the addition of PNE to physiotherapy intervention. The authors performed a meta-analysis on the long-term effects of PNE on pain and found no statistical significance ($p$ = .056) with a WMD of .44, 95% CI [-1.03, 1.91] with considerable heterogeneity ($I^2$ = 99%, $X^2$ = 80.40).

Disability was the second primary outcome investigated in Wood and Hendrick (2018). They performed a meta-analysis on five studies all of which use Roland Morris Disability Questionnaire (RMDQ) which included 362 participants. Results indicated a clinically and statistically significant mean difference (2.28, 95% CI [.20, 4.25]) between PNE as a stand-alone

or in combination with physiotherapy compared with control groups. There was considerable heterogeneity between groups ($I^2$ = 98%, $X^2$ = 215.51). The authors performed another subgroup analysis removing Werner et al. (2016), resulting in 88 participants examining the effects of PNE on disability compared with controls. Results to this subgroup analysis indicated a higher WMD of 3.94 (95%, CI [3.37, 4.52]) with both clinical significance (2 points or 8% to 12%) and statistical significance ($p$ < .01), and lower heterogeneity ($I^2$ =0 %, $X^2$ = 0.86). This indicated moderate quality of evidence that adding PNE to physiotherapy improves disability as measured on the RMDQ. Wood and Hendrick (2018) performed a subgroup analysis on two studies measuring disability at 12 months. Long term effects of PNE on RMDQ for disability did not demonstrate statistical significance ($p$ = .13) with WMD of 2.18 (95%, CI [-.67, 5.02]) compared with control groups, but it did meet clinical significance. There was also considerable heterogeneity ($I^2$ = 95%, $X^2$= 21.80). The authors were uncertain as to the effectiveness of PNE in the long term due to low quality of evidence.

Wood and Hendrick (2018) identified some studies measuring psychological outcomes as a secondary analysis comparing PNE against a control. Three studies ($n$=194) utilized the TSK assessing kinesiophobia. The meta-analysis indicated a statistically significant ($p$ < .001) with a WMD of 4.72 (95% CI [2.32, 7.13]). Clinical significance was not achieved, and considerable heterogeneity was present ($I^2$ = 95%, $X^2$ = 41.36). Two studies measured pain catastrophizing using the PCS. Results indicated a statistically significant difference between the PNE group and the control group ($p$ < .001) and a WMD of 2.54 (95% CI [-4.23, 9.31]). These results were not clinically significant and had considerable heterogeneity ($I^2$=99%, $X^2$=195.85).

Wood and Hendrick (2018) noted the considerable levels of heterogeneity affected analysis. Heterogeneity was addressed by subgrouping trials into the intervention of PNE. Werner et al.

(2016) had variations in the delivery method of PNE and authors identified that the PNE condition and the control condition may have been more similar than intended. Removal of this study from some of the analyses reduced the amount of heterogeneity and positively affected the results in favor of PNE over control.

Watson et al. (2019) conducted a mixed-method systematic review and meta-analysis. The purpose of this research was to determine the effectiveness of PNE as an intervention for chronic musculoskeletal pain in adults 18 years or older and identify their perceptions of PNE as it relates to their experiences, its effectiveness, and their understanding of pain. The study included quantitative RCT comparing PNE with no treatment or usual care, concomitant studies where PNE was delivered in addition to another treatment that was received by both groups, and studies that compared PNE with another active treatment strategy. The methodology was guided by the Joanna Briggs Institute Reviewers Manual 2017. These studies must include pain and disability as the primary outcomes. Secondary outcomes could include validated measures investigating physical or psychological well-being. Qualitative studies were included if they explored the experiences and perceptions of adults with chronic musculoskeletal pain who received PNE. For quantitative studies, the authors initially searched MEDLINE and CINHL to identify key terms for articles published between 2002 to 2018. They followed up the search using the identified keywords and expanded the databases to include The Cochrane Library, AMED, PsychINFO, PEDro, Scopus, EMBASE, ERIC, Web of Science, clinicaltrials.gov, ProQuest, and EThOS. The research pair reviewed the reference lists to identify additional studies, eliminated duplicates, and must agree that inclusion criteria were met. Disagreements were discussed and a third researcher was involved to resolve disputes. Qualitative studies were critically appraised by pairs of researchers for quality using the Cochran tool for assessing the

risk of bias and the Qualitative Assessment and Review instrument by the Joanna Briggs Institute. Disagreements were resolved by discussion or involving an additional researcher was included to resolve disputes. This review utilized a parallel results convergent design, where the quantitative and qualitative results were presented separately (segregated design) and then was configured where the complementary findings were juxtaposed and organized to a line of argument.

The researchers performing the systematic review identified 12 RCTs (n=755) and four qualitative studies (n=50) that met their criteria. All quantitative studies included more women than men and mean ages ranged from 37 to 70 years. Participants lived in the United States, Europe, and Australia. There was no mention of the participants' race or ethnicity. PNE was delivered in one-on-one instruction and group sessions lasting anywhere from 30 minutes to three hours. Four studies provided the instruction in one visit, while eight studies provided the PNE in multiple sessions. In the qualitative studies, the researchers provided little demographic information on the participants. Three of the four studies were performed in the United Kingdom in the same pain clinic, and one was performed in the Netherlands primarily in the participants' homes. The participants' mean age ranged from 46.0 years to 48.5 years. Three of the four studies included participants with mixed musculoskeletal pain and one study indicated participants had chronic low back pain.

The effects of PNE on the chronic musculoskeletal pain population were positive for some variables in the quantitative studies. The meta-analysis was divided into three time points, short term (>3 months), medium term (≥3-6 months), and long term (>12 months). Pain outcome scores were converted to the Visual Analogue Scale (VAS, no pain 0-100mm maximum pain). In the short term, random effects pooled results across nine studies indicated PNE reduced pain

5.91mm greater than the control group ($p$=.139, 95% CI [-13.75, 1.93], $I^2$ =8 5.22, tau = ±10.36). In the medium term, random effects pooled across seven studies indicated PNE reduced pain by 6.27mm greater than the control group ($p$=.334, 95% CI [-18.97, 6.44], $I^2$ = 92.81, tau ± 16.07). Both the short term and medium term had low-quality evidence and considerable heterogeneity. The authors reported plausible causes of heterogeneity could be publication bias, study quality, age, percent male, baseline pain, duration of pain, PNE alone or PNE plus an intervention, and duration of education. Only two studies collected pain outcomes for the long term and results were not pooled. Both studies indicated a much larger decrease in pain over control than seen in the short and medium term, 53mm and 22mm on the VAS. The researchers used a 10% improvement in outcomes to indicate a clinically important difference as proposed by the National Institute for Health and Clinical Excellence (NICE). Although the results were favorable for PNE over control for the reduction in pain, the difference lacks clinical significance.

The other primary outcome was disability. Disability was measured in eleven studies by several different functional outcome measures. Outcome measures were converted to a 100-point scale, with a higher scale indicating greater disability. In the short term, ten studies were included. The PNE interventions had a greater mean reduction of disability of 4.09 out of 100 greater than the control group ($p$ = .028, 95% CI [-7.72, -.45], $I^2$ = 86.17, tau ± 4.65). In the medium term, disability was reduced by 8.14 points greater than the control group ($p$ = .032, 95% CI [-15.60, -.68], $I^2$ = 95.53, tau ± 9.25). Both short term and medium term demonstrated a moderate level of evidence for the reduction in disability and considerable heterogeneity. Only two studies conducted long term measurements of disability and could not be pooled. Both studies indicated a greater reduction of disability over the control group, 19 and 23 points at 12

months. Although there was a greater improvement in the PNE condition over the control group, the pooled effect sizes in the short- and medium-term disability did not produce a clinically significant difference.

Kinesiophobia was a secondary outcome measure of interest. Seven RCTs measured kinesiophobia and all seven studies used some version of the TSK. The data was converted to allow for pooling. In the short term, pooled effects indicated a 13.55% reduction in kinesiophobia over the control group ($p$ = .03, 95% CI [-25.89, -1.21], $I^2$ = 97.25, tau ± 16.19). In the medium term, four studies measured kinesiophobia and the effects could not be pooled. Half of the studies showed statistical significance in favor of the PNE group. No studies investigated kinesiophobia in the long term. A clinically significant difference was found in kinesiophobia for the PNE intervention compared with the control in the short term.

Pain catastrophizing was a secondary measure as well. Ten studies investigated pain catastrophizing using the PCS, therefore no conversion was necessary. There are 52 points possible in the PCS with higher points indicating greater pain catastrophizing. In the short term, pooled effects for nine studies indicated a mean reduction of 3.33 points greater reduction in pain catastrophizing over the control group ($p$ = .015, 95% CI [-6.01, -.65], $I^2$ = 97.62, tau ± 3.79). In the medium term, pooled effects for six studies measured pain catastrophizing indicated a greater mean reduction of 5.26 points in the PNE condition over the control group ($p$=.053, 95% CI [-10.59, .08], $I^2$ =9 9.03, tau ± 6.53). Both the short- and medium-term investigations produced moderate quality of evidence in favor of PNE, but considerable heterogeneity was present. One study reported on pain catastrophizing in the long run but no data on statistical significance was provided. A clinically significant difference in pain catastrophizing was found in the medium term, but not the short term.

Qualitative synthesis resulted in two major findings. One, participants should be allowed to tell their own story in attempts to be heard. Two, participants should receive PNE by health care professionals skilled in the delivery of PNE to facilitate pain reconceptualization and provide ongoing monitoring to ensure the PNE concepts are made relevant to the participants' lives. This recommendation is consistent with ethical and legal standards of practice. Only those individuals who have demonstrated competency should provide the PNE intervention.

Siddall et al. (2022) performed a systematic review and meta-analysis to determine the effects of adding PNE with exercise compared to exercise alone in individuals 18 years and older with chronic musculoskeletal pain. The study accepted articles from inception to November 2020 using MEDLINE, PubMed, CINHL, and the Cochrane Central Register of Controlled Trials (CENTRAL) databases. Other search sources included clinical trial registries, gray literature, and hand searches of relevant articles. The researchers found five RCTs published between 2015 to 2020 met their criteria. This meta-analysis used more recent RCTs than previous systematic reviews and limited the types of control interventions. The population consisted of 460 participants (73% female) with musculoskeletal injuries to the spine, e.g., low back, nonspecific, or cervical. Mean ages for the RCTs ranged from 20.7 years to 53.0 for the PNE conditions and 21.3 years to 51.0 for the control conditions. All studies provided PNE based on *Explain Pain* content, but content delivery varied. PNE sessions lasted anywhere from five to 120 minutes, occurred before, during, or after the exercise intervention, and were either group or individual delivery. Exercises varied in content. The length of the RCTs ranged from four to 12 weeks. All studies used pain, disability, and kinesiophobia outcome measures, and four of the five studies measured pain catastrophizing. Pain outcomes included the visual analog scale or the pain numeric rating scale. Disability outcome measures included five different tools. Kinesiophobia

was measured using three different versions of the Tampa Scale for Kinesiophobia (TSK). Pain catastrophizing was measured with the Pain Catastrophizing Scale (PCS).

Results indicated positive effects of using PNE in the exercise treatment plan. Short-term effects (less than 12 weeks) were calculated with all five RCTs, but only two of the five RCT provided long-term effects (greater than 12 weeks) and could not be included in the meta-analysis. PNE plus exercises significantly reduced pain scores in the short-term (WMD, -2.09; 95% CI [-3.38, -.80]; $I^2$ = 86%, low certainty). The mean difference of 2.09 is close to the median estimate of 2.3 and the mean estimate for the difference in pain score lies within the published interquartile range for MCID for chronic pain which is 1.2 to 3.9. Siddall et al. (2022) reported that PNE with exercise was statistically significant on short-term disability compared to exercise alone (SMD, -0.68; 95% CI [-1.17, -0.20]; $I^2$ = 81%, low certainty). PNE with exercise was statistically significant on short-term kinesiophobia scores compared with exercise alone (SMD, -1.20; 95% CI [-1.84, -0.57]; $I^2$ = 88%, moderate certainty). Of the four studies using the PCS, PNE with exercise significantly reduced pain catastrophizing scores compared with exercise alone (WMD, -7.72; 95% CI [-12.26, -3.18]; $I^2$ = 83%, very low certainty). Analyses detected considerable heterogeneity in all four variables among the RCTs.

**Biopsychosocial Study Designs**

Werner et al. (2016) performed a RCT investigating the differences between four PNE and control/ business as usual groups for subacute or chronic LBP. Each of the four sessions lasted 30 minutes. The PNE conditions included topics of past experiences influencing pain perceptions and beliefs about back pain (session one), pain physiology (session two), how the continuation of pain after apparent recovery could be caused by the patient's total symptom burden (session three) and drawing conclusions from the education received and implementing it into his/her

own health behaviors (session four). Six general practitioners and nine physical therapists were randomly assigned to deliver the PNE interventions to 110 participants, and six general practitioners and ten physical therapists were randomly assigned to provide the control condition to 106 participants. Results indicated that both groups improved significantly from baseline but no differences between groups were found. The authors suggested that both groups benefitted from additional attention from healthcare providers.

A similar result was found in Traeger et al. (2019). Researchers performed an RCT investigating the efficacy of initiating the PNE curriculum compared with a placebo condition in individuals aged 18 to 75 years with acute low back pain (fewer than six weeks duration). Traeger et al. (2019) was to identify if intensive patient education added to basic primary care in individuals with acute low back pain improved clinical outcomes. Of the 202 participants, the mean (SD) age was 45 (14.5) years and 51% were females. Participants were excluded if they had chronic back pain, pain rated less than 3/10 on the pain intensity scale, low risk of pain chronicity, clinical features of serious spinal pathology, poor command of the English language, previous spinal surgery, and serious mental health conditions. Pain education included two one-hour sessions of PNE and information on self-management techniques such as pacing and maintaining activity. The placebo group received two one-hour sessions of active listening without advice.

Results were mixed. Results indicate that PNE was not more effective than placebo/active listening at reducing pain. What the authors did not report was that participants in both the experimental and placebo conditions experienced a clinically significant decrease in pain. Farrar, Young et al. (2001) found a reduction of two points, or 30%, in the pain NRS scale to be clinically important. Each group had a mean difference of approximately four points from

baseline to 3 months. There was a small effect of treatment group on disability. The PNE group had a lower disability score than the placebo group at week 1 (mean difference, -1.6 points on a 24-point scale; 95% CI [-3.1, -.1]; $p = 0.03$) and at 3 months (mean difference; 95% CI [ -3.2, -0.2]; $p = 0.03$). No between group differences were seen at 6- or 12-month follow up. Although these results were statistically significant, they did not meet the standards for clinical significance. Other significant between-group differences found were participants in the PNE group had lower odds of recurrent back pain at 12 months (odds ratio, .44; 95% CI [0.24-0.82]) and the odds of seeking healthcare at 3-months were also lower (odds ratio, .43; 95% CI [0.19, -0.93]). The authors also reported that the PNE group had reduced catastrophizing and unhelpful beliefs, but causal mediation found no evidence that these psychological mechanisms reduced pain.

Traeger et al. (2019) viewed the results as negative as they were not more effective than the placebo and suggested that the intervention was time-consuming and complex. There were some significant findings between groups. If a client has less pain, less catastrophizing, less disability, uses less health care services, and had less chance of long-term back pain due to the PNE intervention, it may warrant study to identify the initial costs of the intervention compared with time off work, medication use, and health care use. Participants may report that reduction in pain, disability, and catastrophizing are priceless, or valuable to their quality of life. Another consideration could be the timing of innervation in that pain in the acute phase is normal. Perhaps preventative innervations should begin closer to three months when pain is classified as chronic.

Based on the above discussion, identifying the appropriate time to intervene as well as length of intervention could be important to prevent undue distress and better manage resources. The

following research addresses these concerns and informs study design.

In their study of catastrophizing and pain-anxiety on DRF outcomes, Roh et al. (2014) suggested that addressing psychological factors and coping strategies up to 12 weeks post injury has the potential to decrease pain intensity and disability. Some meta-analyses found the average psychological intervention length was about 9 weeks (Dixon et al., 2007; Bernardy et al., 2010) and was performed in groups. The more recent meta-analyses found that group interventions lasting less than eight weeks were more effective (Carnes et al., 2012). If these CBT groups were utilized, participants should be identified at least three weeks post injury during the early stages of healing. During this stage, pain is anticipated and considered in the normal process of healing. Many clients would be enrolled in the CBT group, and this could lead to an overuse of resources. In the PNE conditions, treatment intervals ranged from as little as one visit lasting 30 minutes (Louw et al., 2014; Meeus et al., 2010) to one time per week for four weeks lasting one hour per session (Moseley 2002; Moseley, 2003) and was most frequently performed one educator-to-one client. Providing fewer interventions with improved outcomes would reduce overall costs of providing treatment. PNE has been shown to decrease pain (Clarke et al. 2011; Lee et al., 2016; Louw et al., 2011; Louw et al., 2016; Siddall et al., 2022; Watson et al., 2019; Wood & Hendrick, 2018); increase motion (Louw et al., 2011; Louw et al., 2016); improve psychological factors (Louw et al., 2011; Louw et al., 2016; Siddall et al., 2022; Traeger et al., 2014; Watson et al., 2019); improve function/decreased disability (Clarke et al., 2011; Lee et al. 2016; Louw et al. 2011; Louw et al., 2016; Siddall et al., 2022; Watson et al., 2019); and decrease healthcare utilization (Louw et al., 2016; Traeger et al., 2014). Using PNE prior to 12 weeks with individuals with distal upper extremity injuries who are demonstrating abnormal progression/ healing has the possibility of treating current pain and preventing chronic pain and

disability. PNE may also decrease pain and disability in individuals with chronic distal upper extremity injuries.

**Conclusion**

Mosley et al. (2012) propose that the assessment of the information received is affected by superficial and deep learning. Superficial learning is based on heuristics, which require little thought or contemplation and sometimes include avoidant behavior (Moseley et al., 2012). This type of superficial involvement may lead to lack of participation in treatment. Deep learning involves higher engagement in the treatment and acceptance that "not all pain equals danger." It is with this deep learning that the client is willing to change their conception of pain. Education on how pain is conceived is a critical component of diffusing the pain feedback loop.

Education has been shown to have a positive influence on pain reduction in chronic and acute conditions. Differences in length and duration of interventions were noted. Given recent evidence that brief interventions have positive outcomes for reducing pain and disability and improving catastrophizing and kinesiophobia, further examination of brief PNE is warranted in other pain populations. Although studies indicate that psychological factors are linked to poorer outcomes in hand injuries (Koestler, 2010; Ladds et al., 2017; Turkington et al., 2018), no interventions were identified in the literature to address these factors and improve outcomes with elbow, wrist, and hand injuries. This is a fertile area of rehabilitation research. If chronic pain is identified at three months post injury/surgery, then it behooves rehabilitation professionals to provide services to individuals in distress in the subacute period of recovery following elbow, wrist, and hand injuries as well. Given rehabilitation counselors are uniquely qualified to address these psychological factors, they should be included in the interdisciplinary rehabilitation team working with clients with distal upper extremity injuries who are experiencing distress during the

subacute and chronic phases of rehabilitation.

# CHAPTER 3: METHOD

The purpose of this chapter was to describe the investigation on whether using a biopsychosocial pain neuroscience educational program (PNE) with a rehabilitation counseling lens will improve outcomes for individuals with pain following injuries to their elbows, wrists, and/or hands. The following sections outlined the research design, modification resulting from the pandemic, research questions and hypotheses, participants, procedures, measures, data management, and analysis.

## Research Design

This was a pre-experimental, one-group pretest-posttest design such that all participants received pretest evaluations, an intervention, and posttest evaluations (Creswell, 2014). This study used quantitative data to measure PNE's effects on pain, psychological variables, and social and functional variables. Exploratory quantitative analysis was used to collect data on mood, participant satisfaction, and therapeutic alliance. Exploratory qualitative analysis was used to identify participants' recommendations for intervention improvements.

## Modifications

### *Coronavirus Disease (COVID-19) Pandemic*

On December 31, 2019, the World Health Organization Country Office in the People's Republic of China received information from the Wuhan Municipal Health Commission website on the presence of "viral pneumonia" in Wuhan, People's Republic of China. After weeks of investigation, this viral pneumonia was named COVID-19 on February 11, 2020. COVID-19 was classified as a pandemic and Michigan State University (MSU) suspended face-to-face classes on March 11, 2020. On March 13, 2020, a National State of Emergency was issued. In

response, the MSU Human Research Protection Program (HRPP) restricted in-person research and suggested modification to existing studies to reduce the risk of transmission to participants and research teams. The existing protocol for this research study was modified to meet the MSU HRPP guidelines. This research study was modified from a face-to-face intervention into a telehealth intervention. This modification resulted in a reduction of operating costs by approximately $2,400 by eliminating travel and copy expenses. The face-to-face interventions were replaced with video conferencing.

### *Incentive*

The incentive was changed to improve recruitment. Initially, the incentive was a $50 gift card. The incentive was later increased to $100. The increased incentive appeared to have little to no effect on increasing participation rates.

### *Sample Characteristics*

The population characteristics were expanded several times to improve recruitment.

**Geographical Area.** Geographical area was one characteristic which changed. Participants were initially recruited from the West Michigan area, but the study was later expanded to include the State of Michigan, then the Midwest of the United States, to finally, the whole United States to achieve a sufficiently powered study.

**Diagnosis.** Diagnosis was another characteristic that evolved. Initially, surgeons and therapists were to identify individuals who experienced subacute distal radius fractures. Due to recruitment difficulty, the population of study expanded to include any wrist injury, then any hand or wrist injury, to finally any individuals receiving occupational therapy for injury to the elbow, wrist, or hand.

**Time from Injury.** Time frame of pain was also changed. Initially, the study included

individuals that had pain six to eight weeks post injury, and then six to nine weeks post injury. The population was finally expanded to include individuals with chronic pain.

This characteristic change had the most impact on recruitment and comprised 90% of the final sample.

### *Dependent Variables*

Initially, dependent variables were selected to represent the biopsychosocial theory from among those variables most commonly studied with PNE. Biological variables were not included in the final revision. The first biological variable omitted was dynamometry for grip strength measurement as it would violate the "no human contact" order from the university during the initial COVID-19 research restrictions. With the expansion of the injuries included in the study to improve the recruitment, the number of joints measured greatly increased requiring a larger sample size to maintain power. Range of motion could be measured in the video conference using goniometry on a screen capture, but because of the difficulty of recruiting participants, it was decided that all range of motion variables should be removed from the analysis to maintain power.

## Research Questions and Hypotheses

The specific research questions and hypotheses are as follows:

1. Will the biopsychosocial pain neuroscience educational program significantly reduce pain?

    1a) It is hypothesized that participants will score significantly lower on the Pain Numeric Rating Scale following the pain neuroscience educational program.

2. Will the biopsychosocial pain neuroscience educational program significantly reduce psychological variables of pain catastrophizing and kinesiophobia?

    2a) It is hypothesized that participants will score significantly lower in the Pain

Catastrophizing Scale following the pain neuroscience educational program;

2b) It is hypothesized that participants will score significantly lower on the Tampa Scale of Kinesiophobia -11 following the pain neuroscience educational program.

3. Will the biopsychosocial pain neuroscience educational program significantly improve variables of social and functional participation?

3a) It is hypothesized that participants will score significantly lower on the *Quick*DASH following the biopsychosocial pain neuroscience educational program.

3b) It is hypothesized that participants will score significantly higher in performance on the Canadian Occupational Performance Measure following the biopsychosocial pain neuroscience educational program.

3c) It is hypothesized that participants will score significantly higher in satisfaction on the Canadian Occupational Performance Measure following the biopsychosocial pain neuroscience educational program.

**Participants**

***Demographics***

The following section describes characteristics reported by the participants (see Table 3.1). Of the ten participants who completed the intervention, five participants identified themselves as female (50%), and five participants identified as male (50%). The age range of participants was 26-63 years ($M$=46.6 years old, $SD$ = 13.83 years). Most participants identified themselves as Caucasian (80%), one participant identified as African American (10 %), and one participant identified as "other" (10 %). All individuals had at least some post-secondary education. Most of the participants identified as employed (80%), and two participants identified as unemployed (20%). Participants lived in different areas of the United States - four resided in California; three

resided in Michigan; one resided in Washington; one resided in Wisconsin; one participant resided in Florida.

**Table 3.1**

*Demographic Variables of Participants (N=10)*

| Variable | | n (%) |
|---|---|---|
| Gender | | |
| | Female | 5 (50%) |
| | Male | 5 (50%) |
| Race/Ethnicity | | |
| | Caucasian | 8 (80%) |
| | African American | 1(10%) |
| | Other | 1(10%) |
| Age | | |
| | 18-27 | 1(10%) |
| | 28-37 | 3 (30%) |
| | 38-47 | 0 (0%) |
| | 48-57 | 3 (30%) |
| | 58-67 | 3 (30%) |
| State | | |
| | California | 4 (40%) |
| | Michigan | 3 (30%) |
| | Florida | 1 (10%) |
| | Washington | 1 (10%) |
| | Wisconsin | 1 (10%) |
| | No | 4 (40%) |
| Education | | |
| | Some college | 1 (10%) |
| | Associate's degree | 1 (10%) |
| | Bachelor's degree | 4 (40%) |
| | Master's degree | 2 (20%) |
| | Doctorate | 2 (20%) |
| Employment | | |
| | Employed | 8 (80%) |
| | Unemployed | 2 (20%) |
| Injured at Work | | |
| | Yes | 3 (30%) |
| | No | 7 (70%) |

**Table 3.1 (Cont'd)**

| | | |
|---|---|---|
| Medical insurance | | |
| | Private | 8 (80%) |
| | Federal/Medicare | 1 (10%) |
| | State/Medicaid | 1 (10%) |
| | Auto | 0 (0%) |

***Diagnoses and Duration of Pain***

Injuries occurred from multiple factors; some participants had more than one diagnosis, while most had chronic pain. One participant was diagnosed with bilateral (B) hand pain. One participant received surgery to excise a ganglion cyst which later developed into Complex Regional Pain Syndrome (CRPS). One participant had CRPS in B feet which spread to the hand. One participant had medial and lateral epicondylitis with cubital tunnel. One participant had a wrist sprain (grade II) with B lateral epicondylitis and osteoarthritis in digits. One individual had a wrist sprain (grade III) with a history of multiple wrist sprains of various degrees and a scaphoid fracture. One participant had a wrist sprain involving multiple ligaments of various grades and tendonitis. One individual had a distal radius fracture and developed CRPS. One individual had distal radius and ulnar fractures with radial and ulnar nerve injuries at the elbow. One individual had an amputation proximal to the distal interphalangeal joint. One participant had subacute pain lasting ten weeks. Nine participants had chronic pain: one participant had pain for five months, one had pain for nine months, one had pain for ten months, three had pain for one year, one had pain for three years, one had pain for four years, and one had pain for over 24 years.

Other factors relevant to injuries are worth noting. Seven participants identified as right-hand dominant (70%), one participant identified as left-hand dominant (10%), and two participants identified as ambidextrous (20%). Of the eight participants identifying handedness, six participants injured their dominant hand (60%). The two participants who identified as

ambidextrous injured their right hands (20%). Three of the ten participants reported they were off work due to injury (30%). Three of the participants reported they were injured at work (30%). No participants reported that the injury was caused by an auto accident. Most of the participants had private health insurance (80%). No participant identified as currently receiving worker compensation, although two individuals reported receiving the benefit previously under capped compensation. The participants explained that workers' compensation in their state has yearly caps, and they achieved their yearly cap. No participants reported they were under litigation for their injuries.

**Procedure**

A total of ten participants were included in the study using a snowball sampling technique. Multiple modifications occurred in this study expanding the population and reducing the numbers of variables studied due to issues with recruitment. A power analysis using G*Power 3.1 was performed predicting ten participants would achieve 80% power with 95% confidence interval. The *f* statistic used in the calculation was converted from the pain effect size reported in Moseley (2003c).

The following section describes the recruitment strategies. After receiving approval from the MSU Institutional Review Board (see Appendix A), occupational therapists and physicians specializing in upper extremity injuries, and working in the United States were contacted individually about the study by email, phone, and/or mail. These professionals were educated about the research project, provided with information on how to contact the MSU Institutional Review Board with questions, and provided with a recruitment flyer (see Appendix B). These professionals were identified by their published membership information on the American Society of Hand Therapist (ASHT) website, and the Hand Therapy Certification Commission

(HTCC) website, as well as internet published company profiles. Facebook advertisements were posted in the following state and national occupational therapy groups: Grand Valley State University Occupational Therapy Alumni, Michigan Occupational Therapy Association, Hands4OT, Pain4OT, PainOT. The study was also advertised on the LinkedIn platform on the researcher's professional page. All ten participants were referred by members of either the Michigan Occupational Therapy Association (MIOTA) or the American Society of Hand Therapists (ASHT). Recruitment occurred from June 2020 to March 2022 and stopped after a sample size of ten was achieved. A total of 16 individuals were screened for eligibility. Two individuals were excluded due to inclusion criteria, and three individuals who initially expressed interest did not initiate the pre-intervention survey. Of the 11 individuals who signed the informed consent, ten participants completed the initial survey, intervention, and the post-intervention survey. The individual who signed the consent and did not complete the initial survey was given three reminders to complete the survey. Data reported is based on the ten individuals who completed the intervention and surveys.

Physicians and occupational therapists identified individuals on their caseload who had an injury to their elbows, wrists, and/or hands; were experiencing pain at least six weeks post-injury; were at least 18 years old; and spoke, read, and wrote English, and provided them with the research study flyer. Willing participants contacted the researcher who then emailed a copy of the informed consent (see Appendix C). Once the participant expressed interest in participating in the research, the participant was emailed the consent for their review, and they were provided a link to the pre-intervention survey created in Qualtrics (https://qualtrics.com). The pre-intervention survey included the electronic consent form to sign, demographics, past medical history, exclusion criteria (see Appendix D), the Pain Catastrophizing Scale, the Tampa

Scale for Kinesiophobia – 11, and the QuickDASH. After the pre-intervention survey was completed, the researcher reviewed the exclusion criteria. The exclusion criteria were any surgery three months prior to the date of the upper extremity injury; a current diagnosis of cancer; a psychiatric condition not including depression or anxiety; and a neurological condition such as multiple sclerosis, Parkinson's disease, dementia, spinal cord injury, or stroke. No participants reported any of the exclusion criteria. Data was coded with the participant number only to de-identify data for analysis.

After completion of the pre-intervention survey, the researcher emailed a Zoom link with a password to the participant. The password prevented unauthorized access to video conferencing known as "Zoom bombings." After each of the four sessions, the researcher emailed the participant a summary of the intervention topics discussed and homework for the week. Prior to the next scheduled intervention, the researcher emailed a new Zoom link with password. After the fourth session, the participant was emailed a link to the post-intervention survey. Once the fourth session was completed, the participants were sent a link to the post-treatment Qualtrics survey. The post-treatment survey included questions on treatment history (see Appendix D), PCS, TSK-11, QuickDASH, a post-intervention survey on participant experience, and the Working Alliance Inventory – Short Revised (WAI-SR) survey data. Once the post-treatment survey was completed, the participant was emailed a $100 Amazon gift card.

### *Intervention*

**Pain Neuroscience Education.** This study required curriculum for four sessions of biopsychosocial pain neuroscience education lasting 30 minutes to one hour each. This delivery method was used in Werner, et al. (2016) and was the only study located that explicitly discussed an educational protocol. The biopsychosocial education will include topics of past experiences

influencing pain perceptions and beliefs about pain (session one), pain physiology (session two), how the continuation of pain after apparent recovery could be affected by the patient's total symptom burden (session three) and drawing subjective information from the education and implementing it into their life (session four). This format was selected from the previous studies as it most closely aligned with Moseley and Butler's biopsychosocial education model described in *Explain Pain: Supercharged* (2017). Participants were shown PowerPoint presentations based on material from the handouts and followed the same sequence. Other factors were used in the creation of the sessions in addition to the education material presented in the PowerPoint.

**Data Collection.** Data were collected at the beginning of each session. At the beginning of each session, a brief description of each session of the study was provided; the participants were given the opportunity to ask questions about the study and share their stories; they rated their pain using the Pain NRS; and rate their mood using the Mood Scaling with a Suicide Floor (see Appendix E).

**Session One.** In the beginning of the first session, the COPM was administered, and data was collected. After the sessions, participants were provided homework. After session one, homework consisted of watching the L. Mosely YouTube video (https://www.youtube.com/watch?v=Yv37I4_tPBA), and a Dangers in Me and Safety in Me (DIMS/SIMS) worksheet (see Appendix F) to identify stressors and assets in their life. The participants were also provided with a handout reviewing the first session's concepts.

**Session Two.** The video and the information from the DIMS/SIMS worksheet were reviewed at the beginning of the second session, along with a teach-back session where the participants reported what they learned. If misconceptions occur, additional instruction was provided. At the end of the second session, participants were provided with instructions on how to manage their

pain symptoms based on the information provided in the DIMS/SIMS worksheet. Participants were to incorporate as many SIMS as possible and eliminate any DIMS. The homework included watching the L. Mosely YouTube video on the hand pain neurotag (https://www.youtube.com/watch?v=Yv37I4_tPBA). Participants were also provided a version of Steve de Shazer and Insoo Kim Berg's Solutions Focused *Miracle Question*: *"Suppose tonight, while you slept, a miracle occurred. When you awake tomorrow, what would be some of the things you would notice that would tell you life had suddenly gotten better?"* (https://www.psychologytoday.com/us/blog/in-therapy/201001/cool-intervention-10-the-miracle-question). Participants were asked to reflect on the question and visualize what the ideal lived experience would be.

**Session Three.** At the beginning of the third session, participants are asked to teach-back what they learned from the second, and misconceptions were discussed. The participants were then asked to share how their ideal life looks using the Miracle Question. Strategies for behavior change were discussed to attain an ideal lived experience. At the end of the third session, participants were asked to review the wellness websites provided. Websites included pertain to meditation/mindfulness, healthy sleep hygiene, diet, and exercise. Homework included reviewing wellness websites.

**Session Four.** At the beginning of the fourth session, participants were asked to teach-back information from the previous sessions, and misconceptions were discussed. Participants were asked to identify the behavior changes they made considering the presented information. COPM was then readministered, and the data was collected.

**Education Content.** The educational content of the intervention developed by Moseley and Butler (2017) was based on ten target concepts. One, pain is normal, personal and always real.

Two, there are danger sensors, not pain sensors. Three, pain and tissue damage rarely relate. Four, pain depends on the balance of danger and safety. Five, pain involves distributed brain activity. Six, pain relies on context. Seven, pain is one of many protective outputs. Eight, people are bioplastic. Nine, learning about pain can help the individual and society. Ten, active treatment strategies promote recovery.

Steps were taken to assure participant understanding of theoretical concepts. The curriculum was reviewed by a middle school science educator who graduated from Michigan State University's College of Education doctoral program. Language and content were consistent with the suggestion made in the National Research Council's *A Framework for K-12 Science Education Practices, Crosscutting Concepts, and Core Ideas (2012)* as well as a Model Systems Knowledge Translation Center's *Writing Factsheets That Patients Can Read and Use (n.d.)* https://msktc.org/lib/docs/KT_Toolkit/MSTKC_WritingGuidelines_508.pdf . The content was also reviewed by many rehabilitation professionals prior to administration. The committee members were professionals and educators of rehabilitation counseling and supervision, kinesiology, and neuroscience. Additional reviews and comments were solicited from national and international professionals familiar with pain management including pain psychologists, counselors, physicians, and physical therapists. Supervision was also provided throughout the intervention by Dr. Gloria K. Lee, Ph.D., CRC, dissertation committee chair.

**Concurrent treatment.** Participants received treatment from other professionals. Participants were under the care of a physician who identified how the upper extremity was treated and possibly prescribed medication. As individuals age, it is more likely they will possess comorbid conditions with associated prescriptions from other physicians as well. Given most upper extremity specialists called CHTs are occupational therapists (https://www.htcc.org/consumer-

information/the-cht-credential/who-is-a-cht) and pain neuroscience education is well documented in the physical therapy literature and not in the occupational therapy literature, this study focused on individuals receiving occupational therapy. Occupational therapists provided care in the form of orthoses, home exercise programs, activities of daily living, pacing, etc. The exact nature of "usual care" is unknown. Physicians decide on their own protocols and occupational therapists treat within the protocols provided. Protocols are general guidelines on time intervals to begin interventions, e.g., active range of motion, passive range of motion, light activities of daily living, strengthening. Within these general timelines, occupational therapists could have provided more specific interventions based on evidence and training. Three participants also received care from mental health providers outside of this study. Given the complexity of usual care, identification of treatments received is warranted to further describe the population studied.

**Measures**

This study included one independent variable and six dependent variables. The independent variable is the biopsychosocial PNE intervention. The dependent variables include perceived pain on the Numeric Rating System (NRS); psychological outcome measures of the Pain Catastrophizing Scale (PCS) and the Tampa Scale for Kinesiophobia-11 (TSK-11); and social and functional outcome measures of the *Quick* Disabilities of the Arm, Shoulder, and Hand Questionnaire (*Quick* DASH) and the Canadian Occupational Performance Measure (COPM). Exploratory variables include Mood Scaling with a Suicide Floor, the Working Alliance Inventory – SR (WAI-SR), Satisfaction Survey, and an open-ended question for perceptions on the intervention. The following paragraphs provide descriptions of measures and rationale for use in this study.

### *Perceived Pain*

Pain intensity was measured using the Numeric Rating System (NRS). The NRS (Melzack, 1975) is described as the most frequently used patient-reported outcome in clinical practice globally (Williamson & Hoggart, 2005). The NRS has been shown to be sensitive to treatments impacting neuropathic pain or pain that occurs from damage to the nervous system and not a result of ongoing tissue damage (Galer & Jensen, 1997). This measure asks clients to rate their pain using a 0 to 10 rating scale. A zero indicates no pain and ten indicates the "worst thing you have ever personally experienced," (Walton et al., 2018). This pain measure has also been used across all pain populations, cultures, and languages (Flaherty, 1996; Gagliese et al., 2005) and is equally valid in young and old populations (Gagliese et al., 2005; Herr et al., 2004).

### *Psychological Outcome Measures*

**Pain Catastrophizing.** The Pain Catastrophizing Scale (PCS) measures pain catastrophizing (Sullivan, 2009). Catastrophizing is defined as "an exaggerated negative mental set brought to bear during actual or anticipated painful experience" (Sullivan et al., 2001). The PCS consists of 13 items measuring rumination, helplessness, and magnification and is measured on a scale of zero to 52 with lower scores indicating lower levels of pain catastrophizing. On each of the items, the participants indicate the degree to which they felt or thought about pain. Using a five-point scale, a zero indicates not at all and four indicates "all the time." A score of 30 and above represents a clinically relevant level of catastrophizing (Sullivan, 2009). The PCS has good internal consistency (coefficient alpha: PCS = .87, rumination = .87, magnification = .66, and helplessness = .78; Sullivan et al., 1995). Roh et al. (2014) found that individuals with higher scores on the Pain Catastrophizing Scale (PCS) and the Pain Anxiety Symptom Scale (PASS) preoperatively for distal radius fractures were associated with decreased grip strength, range of

motion, and function in the acute phase of recovery.

**Kinesiophobia.** The Tampa Scale for Kinesiophobia -11 (TSK-11, Woby et al., 2005) measures participants' fear of movement. The Tampa Scale for Kinesiophobia (TSK) is frequently used to measure fear of movement or (re)injury (Roelofs et al. (2011). The TSK is a 17-item measure where individuals rate each item on a 4-point Likert scale where a score of one indicates strongly disagree and a score of four indicates strongly agree. Items 4, 8, 12, and 16 are scored inversely. The total scores range from 17 to 68, with higher scores reflecting greater fear of movement or (re)injury (Woby et al., 2005). Researchers found the TSK-11 to be similar in psychometric properties to the original TSK and offered the advantage of brevity (Woby et al., 2005). They reported both measures demonstrated good internal consistency (TSK: = .76; TSK-11: = .79), test–retest reliability (TSK: Interclass Correlation Coefficient (ICC) = .82, and standard error measurement (SEM) = 3.16; TSK-11: ICC = .81, SEM = 2.54). The Tampa Scale for Kinesiophobia – 11 (TSK-11) has possible scores ranging between 11and 44 points with lower scores indicating lower levels of kinesiophobia. Chimenti et al. (2021) reported the kinesiophobia severity subgroups for TSK-11 are low (≤ 22), mild (23-28), moderate (29-35), and high (≥ 36). The domains measured by the TSK-11 include fear of pain, fear of motion, and somatic focus. While investigating normative properties of the TSK, Roelofs et al. (2011) found that for diagnoses, chronic low back pain displayed the highest scores for fear of movement, followed by upper extremity disorder, fibromyalgia, and osteoarthritis. The authors also found that gender was predictive of higher scores in the TSK somatic focus, where males scored higher than females, and age was predictive of TSK activity avoidance focus, where older participants scored higher than younger participants.

***Social Outcome Measures***

**Upper Extremity Function.** Upper extremity function was assessed using the *Quick* Disabilities of the Arm, Shoulder, and Hand Questionnaire (*Quick* DASH, Beaton et al., 2005). DASH is a region-specific measure of disability and symptoms in individuals with musculoskeletal disorders of the upper extremities (Hudak et al., 1996). Wong et al. (2007) described the tool as a patient-reported outcome that includes items on work and self-care activities as well as psychological factors. The tool contains 30 items on a five-point scale. Responses are calculated with a final score of 0 (no disability) to 100 (most severe disability). The DASH has two optional four-item scales identifying symptoms and function in athletes, musicians, and other workers who require a high degree of physical performance. The DASH is offered free of charge and has been published in more than 50 languages (www.dash.iwh.on.ca). From the DASH, a shortened version using 11 items was developed called the *Quick*DASH. The domains measured include daily activities, symptoms, social and work function, sleep, and confidence (Beaton et al., 2005). The *Quick*DASH (*Q*DASH) is measured on a scale of zero to 100, with lower scores indicating higher levels of functioning. Recommendations for cross-cultural adaptations to the *Quick*DASH were published as well (Beaton et al., 2007). Research indicated that the *Quick*DASH could be used instead of the DASH with similar precision (reliability and validity) in upper extremity disorders (Gummesson et al., 2006). Caution should be used when changing from the DASH to the *Quick*DASH in the context of distal radius fractures as the *Quick*DASH has a systematic bias of higher scores. However, Tsang et al. (2017) concluded that the *Quick*DASH still demonstrated good concurrent validity and responsiveness.

**Client-Centered Function.** The Canadian Occupational Performance Measure (COPM, Law et al., 2019) is another functional tool that identifies client occupational performance problems

and satisfaction. The COPM is a semi-structured interview tool that assists the client in identifying what they need to, want to, or are expected to do and prioritizes activities that are most important in their life (Law et al., 2019). The Canadian Measure of Occupational Performance (COPM) has two independent scores. The COPM performance section is measured on a scale of zero to ten, with higher numbers indicating higher function. For this study, this score will be identified as COPM-P. Individuals select tasks on self-care including personal care, functional mobility, and community management; productivity including paid/unpaid work, household management, and play/school; and leisure including quiet leisure, active leisure, and socialization. Clients prioritized the most important activities and selected up to five tasks. Afterward, the clients are asked to rate how well they believe they perform the tasks, with a score of one indicating "not well at all" to a score of ten indicating "extremely well." Then, clients are asked how satisfied they are with their performance. For this study, COPM–S indicates the participants' satisfaction with their performance. The COPM-S is measured on a scale of zero to ten, with higher numbers indicating higher satisfaction with occupational performance. On each task, a score of one indicated "not satisfied at all" to a score of ten indicated "very satisfied." Given it is a semi-structured interview, the COPM's inter-rater reliability is not expected to be high (Law et al., 2019). Essen et al. (2005) identified the lowest test-retest interclass correlation of .67-.69, while other studies found the test-retest to be much higher (Cup et al., 2003; Kjeken et al., 2005; Pan et al., 2003; Sewell & Singh, 2001). The COPM was identified as the gold standard for testing the concurrent validity of the DASH -DLV finding 81% of the problems were similar (Veehof et al., 2002). Essen et al. (2011) found significant correlations of the COPM with the Sickness Impact Profile, the Disability Impact Profile, and the Impact on Participation and Autonomy. A change score of two or more points

between initial screening and subsequent screening is considered clinically significant (Carswell et al., 2004). The COPM has an established history of use in chronic pain populations (Carpenter et al., 2001; Persson et al., 2013; Simon & Collins, 2017; Stanos, 2012), distal radius fractures (Nielsen & Dekkers, 2013; Ydreborg et al., 2015), as well as telehealth (Burton & O'Connell, 2018; Kronberg et al., 2021; Zahoransky & Lape, 2020).

### *Exploratory Variables*

**Mood.** Given individuals with chronic pain are at higher risk for depression and suicide, it was important to monitor the participants for declines in emotional wellbeing. Mood was monitored using a semi-structured clinical interview assessment. This style of assessment was favored over other suicide assessment scales and instruments because it is essential to developing and maintaining a therapeutic relationship (Sommers-Flanagan & Shaw, 2017). The Mood Rating with a Suicide Floor is such an assessment and is consistent with the biopsychosocial theory and solution-focused brief therapy used in the intervention as it works towards a collaborative orientation for problem-solving. Brown and Astell (2012) identified that "moods are subjective states of mind that are typically described and quantified using self-report measures" (p. 1197). Participants were asked to rate their current mood at the beginning of each session using a scaling technique from zero to ten. A score of zero indicates "the worst possible mood" and a score of ten indicates "the best mood possible." (Sommers-Flanagan & Shaw, 2017). This single-item mood assessment was used to identify emotional well-being. Given the nature of this assessment, specific information in the literature on reliability and validity is lacking.

**Working Alliance.** The Working Alliance Inventory – Short Revised (WAI-SR, Hatcher & Gillaspy, 2006) was used to measure working alliances. Bordin (1979) defined working alliance

as the agreement between the client and therapist on what goals should be made, collaboration on therapeutic tasks, and a positive emotional bond. The Working Alliance Inventory-Short Revised (WAI-SR) is a 12-question survey assessing three characteristics of therapeutic alliance: goals, tasks, and bond. For each characteristic, a possible score ranges between 4-20. Individuals are asked to rate their experiences with their therapist or therapy. The assessment uses a five-point scale where a one indicates "seldom" and a five indicates "always." In 2011, Horvath et al. analyzed over 190 studies to examine the relationship between working alliance and therapeutic outcomes. They found that the working alliance had a moderate effect ($r$ = .28; $d$ = 0.57) on the counseling outcome. The reliability and convergent validity were good (total score correlations > 0.74) with the Helping Alliance Questionnaire and the California Psychotherapy Alliance score (Munder et al., 2010).

**Participant Satisfaction and Suggestions for Improvement.** After completion of the intervention, participants were asked about their perceptions of the intervention in the exit survey. First, they were asked *"How helpful were the education sessions at reducing your pain?"* Five possible options were provided: 1) not helpful at all, 2) slightly helpful, 3) moderately helpful, 4) very helpful, and 5) extremely helpful. Second, participants were asked *"How satisfied are you with your pain reduction?"* Five possible options were provided: 1) not satisfied at all, 2) slightly satisfied, 3) moderately satisfied, 4) very satisfied, and 5) extremely satisfied. Third, participants were asked *"If you could change aspects of the program, what would they be and why?"* Yessis et al. (2012) reported that research participants' perceptions regarding their experiences during protocols provide outcome-based insights to improve research. Involving the participants in the research process is also consistent with the biopsychosocial theory as the participants are included in the research team to improve

intervention effectiveness.

**Data Management**

Data was collected throughout the intervention and after the intervention. The data was entered into a computer with password protection and will be housed at MSU for three years after the project closes under the supervision of Dr. Gloria Lee, Ph.D., and MSU's Human Research Protection Program. Participants' information collected as part of the research had all identifiers removed and may be used for future research studies. At the beginning of each session, data was collected and entered into a SPSS spreadsheet that was password protected after recruitment was completed. Field notes for each session were scanned and uploaded into a computer that was password protected.

**Data Analysis**

Analysis of the described outcome measures above required several statistical analyses. After the participant's survey submission, the researcher reviewed the participant's completed survey to check for missing data. When data was missing, the participant was contacted to review the missed questions. Two participant's missed questions and provided answers to complete the survey. No data was missing upon analysis. After completion of data collection, quantitative and qualitative responses were downloaded into a spreadsheet in the IBM Statistical Package for Social Science (SPSS) version 27.0. Scores for the separate assessments were calculated within the software for additional analyses. First, descriptive statistics were performed to generate mean values with standard deviations for pre- and post-intervention surveys. Second, assumption testing procedures for one-way repeated measure multivariate analysis of variance (MANOVA) were performed.

The MANOVA identified if there were differences in the multiple dependent variables over

time. The seven assumptions for the one-way repeated measures MANOVA that must be met (https://www.statistics.laerd.com). First, the study must have two or more dependent variables. This study has six dependent variables (DV). Second, the independent variable (IV) should have two or more groups. The study has two groups, pretest and posttest. Third, the study must have adequate size as identified by having more participants in each group than the number of DV. Given this study has six DV, each group must have more than six participants. This study had ten participants and an *a priori* power analysis confirmed sufficient power (80%) at the 95% confidence interval. Fourth, there may be no univariate or multivariate outliers. Fifth, there should be multivariate normality. Sixth, there should be a linear relationship between each pair of DV for each related group of IV. Lastly, there should be no multicollinearity. Chen et al. (2018) reported on the importance of performing pairwise comparisons following the omnibus testing. It is commonly believed that if an omnibus test is significant, there must be at least two groups that are significantly different. A phenomenon with omnibus testing can occur where results will indicate significance in the presence of non-significant *post hoc* testing between groups and vice versa. Given this rationale, univariate *post hoc* analyses were performed. Univariate analyses of variances (ANOVAs) were calculated for the six DV and a Bonferroni correction was used to reduce the chance of a type I error in the multiple statistical tests. Exploratory variables were tested depending on the nature of the data. Mood was analyzed using a one-way repeated measures ANOVA. The working alliance was tested post-intervention only because there is no working alliance anticipated prior to the intervention. The working alliance was analyzed by calculating the means and the confidence intervals. Demographic variables and answers to satisfaction and open-ended questions were provided for review.

# CHAPTER 4: RESULTS

Results of the current study were represented in four parts. First, since multiple variables were collected to measure the potential change of outcomes because of the intervention, the assumptions, and results of the repeated-measure MANOVA were reported first. Second, univariate analyses were performed to investigate the potential differences in the primary variable of interest: pain (a biopsychosocial construct), as well as secondary variables of interest: pain catastrophizing and kinesiophobia (psychological constructs), and occupational performance and satisfaction (social and functional role constructs). Third, while the above focuses on the primary and secondary outcomes, we also measured exploratory outcomes that may not have ample literature to support the benefits of pain neuroscience education in mood, therapeutic alliance, and patient satisfaction. Fourth, some informal, qualitative data would be reported to reflect on any of the relevant outcomes discussed above.

The study aimed to determine the efficacy of a pain neuroscience educational program with a rehabilitation counseling lens using a biopsychosocial model among individuals with elbow, wrist, or hand injuries in the subacute or chronic phase of rehabilitation. The hypotheses under investigation include:

1. Will the biopsychosocial pain neuroscience educational program significantly reduce pain?

    1a) It is hypothesized that participants will score significantly lower on the Pain Numeric Rating Scale following the pain neuroscience educational program.

2. Will the biopsychosocial pain neuroscience educational program significantly reduce psychological variables of pain catastrophizing and kinesiophobia?

    2a) It is hypothesized that participants will score significantly lower in the Pain Catastrophizing

Scale following the pain neuroscience educational program.

2b) It is hypothesized that participants will score significantly lower on the Tampa Scale of Kinesiophobia -11 following the pain neuroscience educational program.

3. Will the biopsychosocial pain neuroscience educational program significantly improve social and functional participation?

3a) It is hypothesized that participants will score significantly lower on the *Quick*DASH following the biopsychosocial pain neuroscience educational program.

3b) It is hypothesized that participants will score significantly higher in performance on the Canadian Occupational Performance Measure following the biopsychosocial pain neuroscience educational program.

3c) It is hypothesized that participants will score significantly higher in satisfaction on the Canadian Occupational Performance Measure following the biopsychosocial pain neuroscience educational program.

**Descriptive Statistics**

All dependent variables improved scores from the pretest to the posttest, except for the *Quick*DASH (see Table 4.1). On average, pain measured prior to the intervention on NRS was 3.9 and was reduced to 2.0 at the last session. PCS was on average 17.8 prior to the intervention and reduced to 15.9 after the intervention. The TSK-11 was on average 23.7 prior to the intervention and was reduced to 19.9 after the intervention. The COPM-P was on average 4.1 at the first session and improved to 5.6 on the last session. The COPM-S was on average 3.6 at the first interview and improved to 5.8 at the last interview. The *Quick*DASH scores on average increased from 38.6 prior to 38.9 after the intervention. The Mood variable was on average a 6.0 at the first session and the mean average increased to 7.9 at the fourth session.

**Table 4.1**

*Descriptive Statistics (N = 10)*

| | *M* | *SD* | CI Lower Bound | CI Upper Bound |
|---|---|---|---|---|
| Pain Pre | 3.90 | 2.38 | 2.20 | 5.60 |
| Pain Post | 2.00 | 2.58 | 0.15 | 3.85 |
| PCS Pre | 17.80 | 11.81 | 9.35 | 26.25 |
| PCS Post | 15.90 | 11.92 | 7.37 | 24.43 |
| TSK-11 Pre | 23.70 | 6.17 | 19.29 | 28.11 |
| TSK-11 Post | 19.90 | 5.00 | 16.32 | 23.48 |
| *Q*DASH Pre | 38.61 | 27.60 | 18.87 | 58.36 |
| *Q*DASH Post | 38.93 | 26.64 | 19.87 | 57.98 |
| COPM-P Pre | 4.07 | 1.30 | 3.13 | 5.00 |
| COPM-P Post | 5.64 | 1.94 | 4.25 | 7.03 |
| COPM-S Pre | 3.62 | 1.67 | 2.42 | 4.81 |
| COPM-S Post | 5.80 | 2.11 | 4.29 | 7.30 |
| Mood Pre | 6.00 | 2.31 | 2.00 | 10.00 |
| Mood Post | 7.90 | 1.52 | 5.00 | 10.00 |

Due to the heterogeneity of the sample, presentation of the studied variables was done with graphs and description of the nature of the injuries to best interpret the information. The data show there are smaller distributions of scores around the means for TSK-11 and large distributions of scores around the means of the *Quick*DASH (see Figure 4.1, Figure 4.2, and Table 4.2). Some participants with complications during the intervention had a decrease in function at posttest as seen in the *Quick*DASH.

**Figure 4.2**

*Data Distributions for PCS, TSK-11, and QuickDASH*

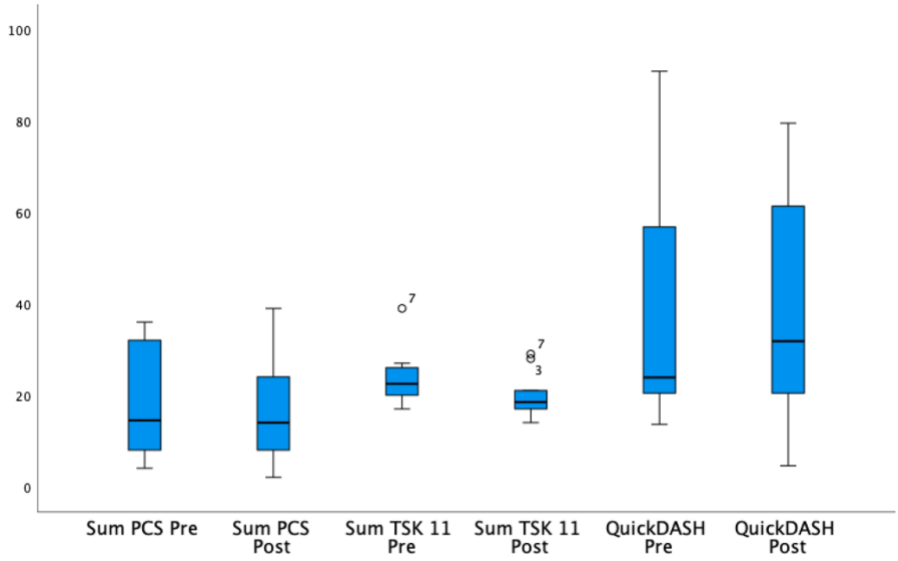



**Figure 4.3**

*Data Distributions for Pain NRS, COPM-P, COPM-S, and Mood*

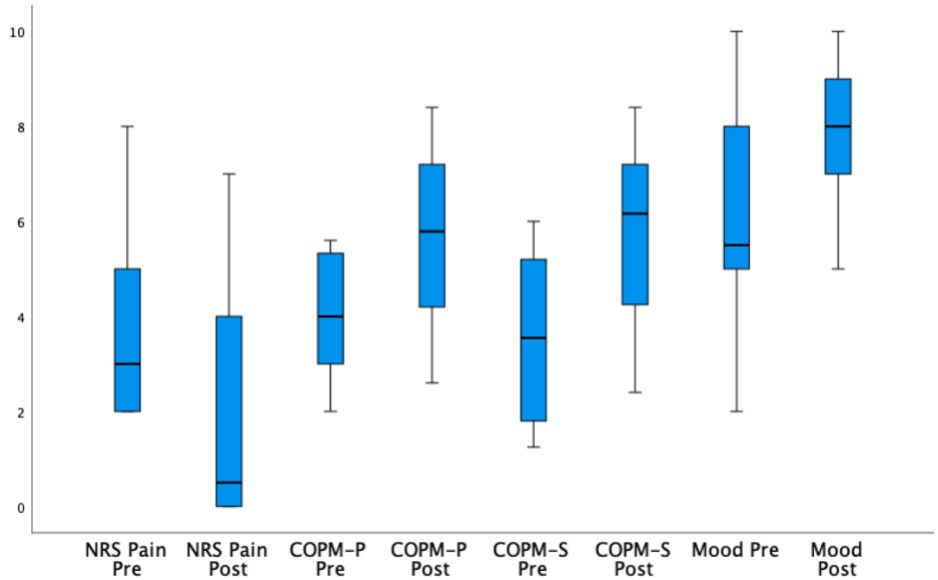


**Table 4.2**

*Profile on Individual Participants, Relevant Pain-related Variables and Studied Variables*

| Injury | Pain (pre, post) | PCS (pre, post) | TSK-11 (pre, post) | QDASH (pre, post) | COPM-P (pre, post) | COPM-S (pre, post) | Mood (pre, post) |
|---|---|---|---|---|---|---|---|
| Hand pain | 3, 0 | 10, 2 | 20, 15 | 22.50, 7.5 | 5.20, 7.60 | 3.40, 7.20 | 4, 9 |
| CRPS with ganglion cyst | 8, 7 | 33, 24 | 27, 20 | 90.91, 79.54 | 3.00, 4.20 | 1.60, 2.40 | 5, 8 |
| Epicondylitis and cubital tunnel | 4, 4 | 36, 39 | 26, 28 | 56.81, 54.54 | 5.33, 6.33 | 6.00, 6.33 | 2, 7 |
| Torn carpal ligament * | 3, 1 | 8, 8 | 19, 17 | 13.63, 27.27 | 4.60, 2.60 | 5.20, 7.20 | 8, 8 |
| CRPS with distal radius fracture* | 2, 3 | 7, 11 | 23, 19 | 22.73, 20.45 | 2.75, 5.25 | 1.25, 4.25 | 8, 5 |
| CRPS with fingernail injury * | 2, 0 | 16, 14 | 21, 18 | 43.18, 61.36 | 3.40, 3.20 | 1.80, 2.80 | 5, 7 |
| Finger amputation * | 8, 5 | 32, 30 | 39, 29 | 77.27, 72.72 | 3.40, 7.20 | 3.60, 8.40 | 6, 10 |
| Torn carpal ligament, lateral epicondylitis * | 2, 0 | 13, 15 | 23, 21 | 13.63, 36.36 | 5.60, 4.80 | 5.40, 5.20 | 7, 7 |
| Radius and ulna fractures with radial and ulnar nerve injuries | 2, 0 | 19, 14 | 22, 18 | 25.00, 25.00 | 5.40, 6.80 | 4.40, 6.00 | 5, 8 |
| Torn carpal ligaments | 5, 0 | 4, 2 | 17, 14 | 20.45, 4.54 | 2.00, 8.40 | 3.50, 8.20 | 10, 10 |

*Note:* * indicates complications occurring during intervention.

## Multivariate Analysis

### *Assumptions*

A one-way repeated measures MANOVA (also known as a profile analysis) was performed to test the constructs of the biopsychosocial theory, identify relationships among dependent variables, and reduce the chances of performing a type I errors (false positives). Data should meet seven assumptions to produce a valid result (www.statistics.laerd.com). An *a priori* power analysis was performed using G*Power 3.1 and the pain effect size (*f)* for calculation. The *a priori* power analysis confirmed a sample size of 10 participants would produce sufficient power for the main variable of interest, pain. The last four assumptions for one-way repeated measures

MANOVA assumptions were assessed after data collection. The sample could not meet the assumptions for multivariate normality, linearity between each pair of DV, and multicollinearity. Given all the assumptions were not met, the one-way repeated measures MANOVA could not be use.

**Univariate Analyses**

Univariate analyses were performed to assess efficacy and to determine effect sizes for future research as they are needed to calculate sample size more accurately with sufficient power. Univariate analyses can be subject to false positives (type I errors) therefore a Bonferroni correction was performed resulting in an adjusted $\alpha = .008$. Univariate analyses identified three clinically and statistically significant variables with the original and adjusted α levels: pain, kinesiophobia, and occupational satisfaction (see Table 4.3). The specific research hypotheses were tied to the results of the univariate statistics.

**Table 4.3**

*Univariate Analysis of Studied Variables (N=10)*

| | *F* | *Sig.* | $\boldsymbol{n_p^2}$ |
|---|---|---|---|
| Pain | 13.05 | .006* | .592 |
| PCS | 1.86 | .206 | .171 |
| TSK-11 | 14.19 | .004* | .612 |
| *Q*DASH | .005 | .943 | .001 |
| COPM-P | 4.28 | .069 | .322 |
| COPM-S | 14.66 | .004* | .620 |

*Note: * $p < .01$*

***Primary Analysis.***

**Pain.** Pain was the main variable of interest. Participants achieved a clinically and statistically significant reduction in pain, NRS *F(*1, 9) = 13.048, *p* = .006. The effect size was large ($n_p^2$ = 0.592). Research hypothesis 1a was supported.

***Secondary Analyses***

**Psychological Variables.** On the two psychological variables, the results were mixed. Univariate analysis indicated PCS was underpowered to detect statistical significance at the 95% level, PCS *F (*1, 9) = 1.858, *p = .206.* The effect size for pain catastrophizing was large ( $n_p^2$ = 0.171). Research hypothesis 2a was not supported.

However, the univariate analysis indicated a clinically and statistically significant reduction in kinesiophobia, TSK-11 *F (*1, 9) = 14.188, *p* = .004. The effect size was large ( $n_p^2$= .612). Research hypothesis 2b was supported.

**Social and functional variables.** For *social and functional* variables, the results were mixed. The participants did not improve functional scores on the *Quick*DASH from the pretest to the posttest. The *Quick*DASH was neither clinically nor statistically significant *F (*1, 9) = .005, *p = .943.* The effect size was extremely small ($n_p^2$ = 0.001). Research hypothesis 3a was not supported.

There was some improvement in the COPM for occupational performance from pretest to posttest. The COPM for performance met clinical significance, but the study was underpowered to detect statistical significance at the 95% level, *F (*1, 9) = 4.279, *p=.069.* The effect size was large *(* $n_p^2$ = 0.322). Research hypothesis 3b was not supported.

Although the participants' COPM performance was not statistically significant, the participants were satisfied with their occupational performance improvement from pretest to

posttest. COPM satisfaction achieved statistical significance ($F$ (1, 9) = 14.656, $p$ = .004) and clinical significance with a large effect size ($n_p^2$ = .620). Research hypothesis 3c was supported.

***Exploratory Analyses***

The six dependent variables were chosen for the main analyses because existing literature supports these outcome measures in similar studies using PNE with other populations. However, there are reasons to believe that additional variables may be worth investigating as beneficial outcomes. Due to the limited sample size of this pilot study, the following variables are analyzed for exploration, but no hypotheses were established.

**Mood.** The differences in mood on the Mood Scaling with a Suicide Floor between pretest and posttest were normally distributed. All assumptions were met. Participants achieved a statistically significant improvement in mood from pretest to posttest with ($F$ (1,9) = 5.335, $p$ = .046) with a large effect size ( $n_p^2 = .372$).

**Working alliance.** The Working Alliance Inventory-Short Revised (WAI-SR) was administered posttest and data was analyzed using a means calculation. The WAI-SR assessments identify three characteristics of therapeutic alliance, goals, tasks, and bond with a maximum score of 20 for each characteristic. Descriptive statistics identified higher levels of therapeutic alliance for goals, *M*= 18.5, 95% CI [17.14, 19.86], tasks, *M*= 17.2, 95% CI [15.45, 18.95], and bond, *M*= 18.7, 95% CI [17.69, 19.71]. The mean values for goals, tasks, and bond indicated the working alliance remained intact during the telehealth intervention.

**Participants' Perceived Efficacy and Satisfaction.** Participants were surveyed on their perceptions of the intervention. Using a Likert scale, they were asked, *"How helpful were the education sessions at reducing your pain?"* and *"How satisfied are you with your pain reduction?"* In terms of perceived efficacy, participants found the intervention moderately to

extremely helpful. None of the participants rated the intervention "slightly helpful" or below (Table 4.4). As for program satisfaction, participants were moderately to extremely satisfied with their pain reduction. No participant rated their satisfaction as "slightly satisfied" or below (Tables 4.5).

**Table 4.4**

*Perceptions of Intervention Efficacy in Percentage Distribution (N=10)*

| *How helpful were the education sessions at reducing your pain?* | *N* (%) |
|---|---|
| Extremely helpful | 4 (40%) |
| Very helpful | 4 (40%) |
| Moderately helpful | 2 (20%) |
| Slightly helpful | 0 (0%) |
| Not helpful at all | 0 (0%) |
| Total | 10 (100%) |

**Table 4.5**

*Participant Satisfaction with Pain Reduction in Percentage Distribution (N=10)*

| *How satisfied are you with your pain reduction?* | *N* (%) |
|---|---|
| Extremely satisfied | 4 (40%) |
| Very satisfied | 4 (40%) |
| Moderately satisfied | 2 (20%) |
| Slightly satisfied | 0 (0%) |
| Not satisfied at all | 0 (0%) |
| Total | 10 (100%) |

**Qualitative Feedback.** An open-end question was asked of participants to capture any comments not previously addressed: *"If you could change aspects of the program, what would they be and why?"* The following responses were collected:

- Some of the wording on the slides seemed a bit black and white. Could be nuanced a tad, though that might be asking too much for the purpose of this program.
- More sessions?

- Nothing maybe more sessions
- Nothing that I can think of right now
- None. I really enjoyed the visual presentation of videos and PowerPoint. It allowed me the opportunity to go back and review information that was very helpful with me developing better pain management coping skills
- Nothing. Poorer pain control during program was due to a flare that the program helped me manage. Pain went up but not likely as high as it would have.
- I feel the understanding of the role of the brain in the perception of pain was critical to overcoming some of the fear and misunderstanding of what to do to resolve the pain. My OTs were very helpful in the early stages as they acknowledged my pain which my Dr. had minimized and dismissed. They further began to explain the role of my brain, but the real story was revealed in the session on the psychosocial aspects. I think if I had known some of this earlier I would not have become as desperate and mistrustful. Early intervention seems the most promising and I wish this info was available to any patient in need. In my case the education of any DR., especially in a surgical capacity would be essential. Drs. are the ones who recommend OT, but often don't even put hands on their patients in a healing way. I presume most PT /OT providers know this info already, but of course good training for them as well.
- More interactive assignments to encourage engagement
- Maybe a mid-week check-in would be good to just briefly connect in between weekly meetings. It would just increase the level of engagement but overall, the current format of once a week meetings was still effective.

Some changes were suggested to improve the education sessions. Three of the ten respondents wanted more sessions. One person suggested changing some of the wording on the PowerPoint slides. One person would like more interactive assignments to encourage engagement. Overall, the participants were satisfied with their pain reduction and found the biopsychosocial pain education intervention helpful.

**Treatment**

Participants received a variety of treatments from other professionals prior to and during the intervention study. Physicians prescribed pharmaceutical interventions and referred clients to occupational therapists. Four participants reported using prescription medication to decrease nerve pain in the pre-intervention survey. Medications included gabapentin, amitriptyline, and lorazepam. Two individuals reported using ibuprofen. Many participants reported decreased use of medication to treat pain after the intervention. One participant was no longer taking amitriptyline, two were no longer taking gabapentin, and the two individuals taking ibuprofen continued taking the non-steroidal anti-inflammatory drugs at the post-intervention survey, but during the last interview, they reported reduced frequency. Three individuals received services from a psychologist. No information was available on the types of psychological services provided. The most common treatments received in occupational therapy were strengthening (ten respondents), hot or cold pack (nine respondents), active range of motion (eight respondents), functional activities (eight respondents), activities of daily living (eight respondents), and pain education (eight respondents). Other treatments in occupational therapy occurred less frequently. Seven respondents reported the use of orthoses and passive range of motion. Six respondents reported using active assistive range of motion, body mechanics, and soft tissue mobilization. Five respondents used over-the-counter braces, pacing, joint protection, mirror

therapy, mindfulness, and kinesiology taping. Four respondents used ergonomics, mental imagery, deep breathing, neuromuscular electrical stimulation, and scar management. Three respondents used ultrasound, fluidotherapy, and other treatments. Data on changes in the frequency of physician, occupational therapy, and psychological services were not collected. The only change reported was reduced use of pain medication.

**Summary**

A one-way repeated measures multivariate analysis was first used to determine the effects of the pain neuroscience educational program on biopsychosocial variables in ten participants within the United States with elbow, wrist, or hand pain. Due to difficulties in recruitment, the biological variables were dropped from the study to maintain power. The biopsychosocial variable was pain and was measured using the Numeric Rating Scale (NRS). The psychological variables were measured using the Pain Catastrophizing Scale (PCS) and the Tampa Scale for Kinesiophobia –11 (TSK-11). The social and functional variables were measured using the Quick Disabilities of the Arm, Shoulder, and Hand Outcome Measure (*Quick*DASH) and the Canadian Occupational Performance Measure (COPM). Preliminary assumption checking revealed that data was not normally distributed, there were inconsistencies with linearity among the variables causing loss of power, and there was multicollinearity between PCS and TSK11 in the posttest. The one-way repeated measures MANOVA could not be used because the assumptions were not met. Univariate analyses were used to assess clinical effectiveness. Participants improved from pretest to posttest in all variables in the primary analysis except for *Quick*DASH (PCS pre *M*=17.8, *SD*=11.8; PCS post *M*=15.9, *SD*=11.9; TSK-11 pre *M*=23.7, *SD*=6.2; TSK-11 post *M*=19.9, *SD*=5.0; *Q*DASH pre *M*=38.6, *SD*=27.6; *Q*DASH post *M*=38.9, *SD*=26.4; Pain pre *M*=3.9, *SD*=2.4; Pain post *M*=38.6, *SD*=27.6; COPM-P pre *M*=4.1, *SD*=1.3;

COPM-P post *M*=5.6, *SD*=1.9; COPM-S pre *M*=3.6, *SD*=1.7; and COPM-S post *M*=5.8, *SD*=2.1). Three of the six variables were found statistically significant and clinically significant with large effect sizes during univariate analysis. These variables include pain (*F (*1, 9) = 13.048, *p* = .006; $n_p^2$ = .592); kinesiophobia (*F (*1, 9) = 14.188, *p* = .004; $n_p^2$ = .612) as well as satisfaction with occupational performance (*F (*1, 9) = 14.656, *p* = .004; $n_p^2$ = .620). Two other variables achieved large effect sizes, pain catastrophizing ($n_p^2$ = .171) and occupational performance ($n_p^2$ = .322) but were underpowered to achieve statistical significance at the 95% level (PCS *p* = .206; COPM-P *p* = .069). Disabilities of the arm, shoulder and hand were neither statistically significant (*p* = .943*) nor* clinically significant ($n_p^2$ = .001).

Exploratory analyses indicated positive outcomes. Participants achieved a statistically significant improvement in mood from pretest to posttest with a large effect size *F*(1,9)=5.335, *p*=.046; $n_p^2 = .372$. A strong working alliance between the researcher and participants was achieved (goals, *M*= 18.5, 95% CI [17.14, 19.86], tasks, *M*= 17.2, 95% CI [15.45, 18.95], and bond, *M*= 18.7, 95% CI [17.69, 19.71]). Participants reported that the biopsychosocial pain neuroscience educational program was at least moderately to extremely effective at reducing their pain, and they were at least moderate to extremely satisfied with the intervention. Participants also reported reduced usage of medication to treat pain from pretest to posttest.

# CHAPTER 5: DISCUSSION

This study aimed at evaluating the initial efficacy of a pain neuroscience educational program based on a biopsychosocial model with a rehabilitation counseling lens with individuals with elbow, wrist, or hand injuries in the subacute and chronic rehabilitation phase. A pre-experimental design was used to determine the difference in pain, psychological, and social/functional areas for each participant from pre-intervention to post-intervention. The intervention materials were based on *Explain Pain Supercharged* (Moseley & Butler, 2017) and the delivery format was adapted from Werner, et al. (2016). In this chapter, discussion is presented in relation to the initial results, followed by the study's strengths and limitations, as well as future implications for practice, education, and research.

The research questions and hypotheses include:

1. Will the biopsychosocial pain neuroscience educational program significantly reduce pain?

   1a) It is hypothesized that participants will score significantly lower in the Pain Numeric Rating Scale (NRS) following the pain neuroscience educational program.

2. Will the biopsychosocial pain neuroscience educational program significantly reduce psychological variables of pain catastrophizing and kinesiophobia?

   2a) It is hypothesized that participants will score significantly lower in the Pain Catastrophizing Scale (PCS) following the pain neuroscience educational program.

   2b) It is hypothesized that participants will score significantly lower in the Tampa Scale for Kinesiophobia -11 (TSK-11) following the pain neuroscience educational program.

3. Will the biopsychosocial pain neuroscience educational program significantly improve social and functional participation?

3a) It is hypothesized that participants will score significantly lower in the *Quick*DASH following the biopsychosocial pain neuroscience educational program.

3b) It is hypothesized that participants will score significantly higher in performance in the Canadian Occupational Performance Measure following the biopsychosocial pain neuroscience educational program.

3c) It is hypothesized that participants will score significantly higher in satisfaction in the Canadian Occupational Performance Measure following the biopsychosocial pain neuroscience educational program.

## Clinical Efficacy

Regarding clinical efficacy, results from the one-way repeated measure MANOVA could not be used as it did not meet the assumptions. Based on univariate analyses, clinical efficacy is discussed in terms of pain, psychological aspects of kinesiophobia, pain catastrophizing, as well as social and functional aspects separately in the following sections.

### *Pain Outcome*

Pain perception was the primary variable of interest. Pain perception was reduced after the PNE intervention was implemented. This conclusion was consistently supported by ample existing literature, as demonstrated in three metanalytic studies (Dixon et al., 2007; Siddall et al., 2022; Watson et al., 2019). Specifically, Watson et al. (2019)'s meta-analytic study on 12 RCTs involving PNE interventions for adults with chronic musculoskeletal pain reported pain reduction in both the short-term and medium-term with similar frequency and duration of the current study. Similarly, Siddall et al. (2022)'s meta-analysis of five RCTs comparing effectiveness of PNE and exercise in the short-term also reported statistically significant reduction in pain. The third meta-analysis was on 27 RCTs involving psychological interventions for pain management for adult individuals with osteoarthritis and rheumatoid arthritis pain

without conjunctive therapies (Dixon et al., 2007). Dixon et al. reported a small effect for pain reduction in the short term and a wider range of frequencies (four to 20 sessions), but similar durations as Watson et al. (2019). Thus, it was unequivocally concluded that biopsychosocial education reduced the perceived pain following distal upper extremity injuries, as this study showed a large effect for pain reduction. It is worth noting that in the current sample of participants, most reported a relatively mild to moderate level of pain at pretest. Therefore, their pain tolerance appeared to be unexpectedly high.

Other factors of this sample could also mediate the pain outcome. Participants' education is one factor. Zajacova et al. (2020) investigated the relationship between education and pain among individuals 30 to 49 years old in the United States. They found that more educated individuals reported substantially less pain than less educated individuals. Although Zajacova et al. (2020) did not specifically address distal upper extremity pain, similar studies indicated that education levels can affect rehabilitation outcomes. For example, several studies on distal radius fractures reported that higher levels of education can predict rehabilitation outcomes, including pain (MacDermid et al., 2002; MacIntyre & DeWan, 2016; Paksima et al., 2014). Case et al. (2020) reported that pain issues are concentrated among Americans with less than a bachelor's degree. In this small sample, 80% of the participants achieved a bachelor's degree or higher. Therefore, education could have influenced their perceived levels of pain.

Another factor that influences pain perception is participants' employment status. Blanchflower & Bryson (2022) found that individuals who were unemployed had higher perceived pain than those who were employed. Other studies also reported a strong correlation between unemployment status and the reported level of pain (Blanchflower & Bryson, 2021; Krueger, 2017; Piper et al., 2023; Spencer, 2014). In this study, 80% of the participants were employed, thus, it is likely that their employment status reduced their pain perception.

### *Psychological Outcomes*

The psychological outcomes were conceptualized as pain catastrophizing and kinesiophobia, as these phenomena were strongly supported by PNE literature (Louw et al., 2016; Watson et al., 2019). Specifically, the results of this study showed clinically significant changes in kinesiophobia and pain catastrophizing, but only kinesiophobia was statistically significant.

In terms of kinesiophobia, participants were more fearful of motion and reinjury before the intervention compared with after the intervention, thus, showing that the PNE intervention was helpful in reducing the participants' fear of moving due to pain or re-injury. This result is consistent with Watson et al. (2019) and Siddall et al. (2022) meta-analyses indicating that PNE was effective at reducing kinesiophobia in as little as three months post intervention. Although many of the participants' kinesiophobia scores did not meet the clinical threshold for diagnosis as described in Chimenti et al. (2021), it predicts predict rehabilitation outcomes in the upper extremity (De, Vranceanu, & Ring, 2013). In individuals who do not recover from upper extremity injuries, kinesiophobia is more likely to remain unchanged throughout the year (Feleus, et al., 2007). Additional research is warranted to study kinesiophobia in the early stages of upper extremity rehabilitation to improve functional outcomes.

In this study, pain catastrophizing had a large effect size, indicating a clinically significant reduction in pain catastrophizing for this population sample. However, pain catastrophizing did not meet statistical significance. This could be a combination of the study being underpowered as well as a temporal effect. Watson et al. (2019) meta-analytic study did not find pain catastrophizing significant on a short-term basis but did for a more intermediate basis. On the other hand, Siddall et al. (2022) did find a statistically significant difference in pain catastrophizing in the short-term in their meta-analysis of PNE intervention studies.

The low level of pain catastrophizing may explain why the change may not be substantial enough. Most participants did not meet the clinically relevant level of pain catastrophizing identified in Sullivan (2009). A lower level of pain catastrophizing is not uncommon for upper extremity injuries, as shown in studies using PCS to predict rehabilitation outcomes (Hirata & Inoue, 2021; Keogh et al., 2012; Swärd et al., 2022). Specifically, most participants in these cited studies also did not meet the clinical threshold for pain catastrophizing either, but still showed even low levels of pain catastrophizing can predict rehabilitation outcomes (De et al., 2013; Hirata & Inoue, 2021; Keogh et al., 2012). Therefore, pain catastrophizing is still considered a relevant and important variable to gauge treatment success in distal upper extremity injuries.

Another plausible explanation for the non-significant statistical result for pain catastrophizing in our study could be due to the temporal effect, particularly in relation to kinesiophobia and possibly other factors that could lead to pain catastrophizing. Results from this study showed non-significance in pain catastrophizing but significance in kinesiophobia. In Watson et al., the authors detected clinical significance in kinesiophobia in less than three months post-intervention. However, clinical significance in pain catastrophizing was shown at the three to six months post-intervention timeframe. This time frame can be further explained by Lim et al. (2020). They reported that threat predictions generated from schemas continued to influence pain perception despite increased prediction errors arising from the sensory evidence. In other words, as participants gradually increased their activity level, they experienced less intense and fewer adverse sensory inputs (prediction errors) that decreased their level of kinesiophobia. This explanation is consistent with Moseley and Butler's concept of the "Protectometer." When there is more evidence of safety and less evidence of danger, the individual's kinesiophobia will decrease, and they will experience less pain. However, changing a perception, such as

catastrophizing, may require repeated safe experiences of movement. More frequent experience of less pain with activity is required to provide the prediction errors needed to change the pain schema and decrease pain catastrophizing. Lim et al. (2020) also reported that these threat prediction errors arising from sensory evidence are not enough to change the pain schemas. Pain schemas are heavily reliant on past learning experiences, and when higher levels of pain catastrophizing are combined with lower levels of mindfulness, schemas are more heavily relied on than are sensory inputs. Therefore, individuals will also need education to better identify which past learning experiences were maladaptive and affect the pain schema. There may be a different relationship between these two variables not previously identified, that is, a reduction of kinesiophobia may be a precursor leading to a change in the pain schema. The relationship between these two variables needs further investigation as well as a longer time frame, and appropriate statistical power and analysis to test the longitudinal or mediation effects.

### *Social/Functional Performance Outcomes*

**Performance.** Social/functional performance was conceptualized using two different measures, the *Quick*DASH and the Canadian Occupational Performance Measure (COPM). Both tools measure the perceived ability to perform activities of daily living tasks. In addition, perceived satisfaction of selected activities of daily living (occupations) was measured by the COPM.

Results from this study showed that there was no statistically significant improvement in the perceived function from pre-intervention to post-intervention. These results are inconsistent with previous research. Both Watson et al. (2019)'s and Siddall et al. (2022)'s meta-analyses indicated statistically significant results indicating improved function/decreased disability in the short-term.

With clinical significance, results from the COPM showed significance but not from *Quick*DASH. Results from the current study could not draw any preliminary conclusion as to whether functional outcomes were improved due to the failure to establish convergent validity on the use of the two measures. With a careful and critical analysis of both measures, both measurement issues and confounding factors from participants may provide some insights for future consideration when using these measures.

Results from the QuickDASH measure showed that there were large standard deviations in the means due to unexpected events that caused substantial change in their choice and performance of their occupations. The *Quick*DASH did not detect improvements in performance as indicated by the COPM. The *Quick*DASH assessment only included eleven items. However, two optional modules could capture more items, a four-item Work module (W) and a four-item Sports/Performing Arts module (SPA). Perhaps, adding these two modules could better represent the variety of occupations and improve the outcomes.

Specifically, there were relevant factors that affected functional outcome measures post-intervention. Half of the participants had complications during the intervention and these unexpected circumstances prohibited some participants to stay with the original identified occupations in the COPM. Some of these complications included restrictions from a new procedure, caregiver burden, oral surgery, back injury, and fall with injury to non-affected hand. These complications affected their occupational performance score on the COPM as they could not participate as initially intended. Three of the five individuals who experienced complications during the intervention scored lower on the pretest than at posttest on the *Quick*DASH indicating a decline in function.

Functional improvement after the intervention was inconsistent with previous studies. Given no studies using the COPM and/or *Quick*DASH were used with the PNE, only general comparisons can be discussed. Occupational therapists use both the QuickDASH and the COPM to measure function in individuals with chronic pain. In one study, occupational therapists used an intervention design like this study. It included 45 participants with chronic pain which involved a Lifestyle Redesign method developed by Clark et al. (2015) where their treatment focused on patient education, occupational self-analysis, problem-solving, motivation building, and implementation of behaviors (Simon & Collins, 2017). The authors found significant improvements in both occupational performance and satisfaction, but their in-person program lasted 18 weeks (about 4 months) with approximately nine visits, whereas this telehealth program lasted approximately four weeks with only four visits. Carpenter et al. (2001) used the COPM as a functional assessment with 106 participants with chronic pain in an intensive four-week multidisciplinary chronic pain management program. Assessments occurred at baseline, discharge, and at a three-month telehealth (telephone) follow-up and analyses found significance in both occupational performance and satisfaction from baseline to discharge and continued at the three-month follow-up. Janela et al. (2022) performed a three session per week for 12-week, telehealth, physical therapy intervention with 296 individuals who had chronic shoulder pain. The authors used the *Quick*DASH to measure functional outcomes. After 12-weeks, the authors found a 51.6% improvement in *Quick*DASH from baseline. Janela et al. (2022) was different from this study in that their participants had a lower average baseline score of more than ten points on the *Quick*DASH and had approximately 36 sessions compared this study's four session. Janela et al. combined their cognitive behavioral program including mindfulness, acceptance and commitment therapy, and empathy-focused therapy with their physical therapy

program, whereas this program only contained the PNE intervention and the number of occupational therapy visits throughout the duration of this intervention was unknown. Janela et al. reported no co-occurring injuries to their participants during intervention like this study's participants experienced. All these studies had considerably more participants than this study.

Eight functional tools were utilized in the RCTs included in the Watson et al. (2019) meta-analysis, none of which were the *Quick*DASH nor COPM. Watson et al. noted high heterogeneity in both the short and medium term as researchers used many different tools to measure function. Use of different tools makes comparisons of functional outcomes difficult. The *Quick*DASH is used exclusively for the upper extremities, and many of the disability tools used in Watson et al. were exclusively for the spine. Using a general functional tool may benefit future studies to reduce heterogeneity and allow for cross-comparison. The COPM is not disease or injury specific and can be used as a general functional tool in many clinical samples.

Despite the non-significant change in the social/functional performance, the level of satisfaction of social/functional performance was significant. The participants were satisfied with their social/functional improvement after completing the intervention. Participant satisfaction results in this study are like the results found in Simons and Collins (2017) and Carpenter et al. (2001). Participant satisfaction is important to measure as it leads to improved participation in their care plans, improved healthcare outcomes, and efficient healthcare utilization (Otani et al., 2015). Participants may have experienced setbacks during this intervention affecting their social/functional performance, but their satisfaction in their progress indicates a greater chance of continued progress after the intervention was completed.

In addition to measuring satisfaction, results from this study further attested that the use and choice of measure to conceptualize function is imperative. The use of the COPM had

advantages over the *Quick*DASH for use with this intervention. First, it informed problem-solving in the intervention. The COPM uses a scaling system. For example, if the participant rated their participation in drumming as a three out of ten, where one is equal to "not able to do it at all" and ten is equal to "able to do it extremely well," the researcher followed up with questions based on solution-focused techniques (DeJong & Berg, 2013). "I see you rated your drumming performance as a three. Why not a two?" The researcher then asked the participant "What does a four look like?" This scaling technique assists the participant in problem definition and goal formation (DeJong & Berg, 2013) for the next step forward and assists in celebrating the "small wins" advocated by Moseley and Butler (2017). Participants remarked that they liked the COPM better than the *Quick*DASH because it was directly related to the occupations thus, it was more client-centered. Solution-focused therapy is consistent with the client-centered nature of the COPM. In solution-focused therapy, the client is seen as the expert on how to solve the problem, whether to follow through on suggestions provided, and when services are no longer needed (DeJong & Berg, 2013). Given the COPM's client-centered nature, compatibility with the solution-focused counseling technique, frequency in use with the chronic pain population, and larger effect size after the intervention, the COPM appears to be a better assessment in this population at detecting functional change.

**Exploratory Outcomes**

***Working Alliance***

Results from this study showed working alliance to be high, reaching close to the maximum endorsement for goals, tasks, and bonds, indicating a strong working alliance between the researcher and the participants after participating in the telehealth PNE. It seems logical to assume that in-person interaction can facilitate positive working relationships while virtual

interaction may take additional aspects to overcome elements that a virtual world may not be able to achieve as compared to in-person world. -Certainly, ample studies show that the therapeutic alliance can affect therapy outcomes when therapy was conducted in person. For instance, Munder et al. (2010)'s study showed the importance of building therapeutic alliance as an important aspect in affecting positive outcomes on a sample of individuals receiving inpatient and outpatient psychotherapy. There are studies regarding the effects of the working alliance in physical rehabilitation settings for individuals with chronic musculoskeletal pain, but there was considerable heterogeneity with how the working alliance concept was measured (Hall et al., 2010, Kinney et al., 2020). However, systematic reviews concluded that a strong working alliance between a therapist and a client had a positive effect on rehabilitation outcomes, including musculoskeletal pain (Hall et al. 2010, Kinney et al., 2020; Lakke & Meerman, 2016), function (Lakke & Meerman, 2016) and exercise adherence (Babatunde et al., 2017). However, none of these systematic reviews included studies utilizing a telehealth format. Alodaibi et al. (2018) also performed an in-person observational study investigating therapeutic alliance with physical therapists and individuals with low back pain. These authors also found evidence that the therapeutic alliance positively affected functional outcomes.

Other studies investigated the therapeutic alliance in psychological treatments using telehealth. Simpson and Reid (2014) found 23 studies investigating therapeutic alliance with telehealth in the form of videoconferencing. They found overwhelming evidence that the therapeutic alliance can be developed with clients using telehealth. They also reported telehealth is a viable format for providing access to psychological treatment in rural areas not traditionally serviced. Seuling et al. (2023) performed a meta-analysis of 18 studies investigating the difference in therapeutic alliance between psychotherapy in videoconferencing and

psychotherapy in person. The authors found no statistically significant difference between groups in therapeutic alliance reported by therapists and clients. However, Norwood et al. (2018) found contradictory evidence in their meta-analysis reporting that videoconferencing psychotherapy was inferior to psychotherapy in person regarding the working alliance, but the target symptom reduction was noninferior.

Although, no studies could be identified as using telehealth to deliver PNE and measuring the working or therapeutic alliance to directly compare the results of this study. There appears to be strong evidence in favor of the therapeutic alliance affecting rehabilitation outcomes and the efficacy of intervention.

***Mood***

Mood was improved after this intervention. This outcome is consistent with other studies investigating mood with PNE. Fersum et al. (2013) investigated PNE with physical therapy compared with therapy alone. Fersum et al. found a clinically and statistically significant change in mood in the PNE condition compared with physical therapy alone. Heleno et al. (2023) explored older adults' perceptions of an 8-week PNE program with exercise using focus groups. The researchers collected data using the Geriatric Depression Scale and found that compared with the control group, participants demonstrated lower levels of depression at the end of the intervention and continued to improve at the six-month follow-up. Measuring mood as an outcome measure with PNE is supported in the literature. Wijma et al. (2016) proposed assessing biopsychosocial factors that may provoke or perpetuate chronic pain as a precursor to PNE. This would be an important step has individuals with hand injuries can have psychological affects that inhibit rehabilitation outcomes (Grob et al., 2008) and psychological factors at admission were important variables in predicting employment outcomes (Dozois, Dobson, Wong, Hughes, &

Long, 1995). Tang et al. (2008) discussed the reciprocal relationship between depressed mood and pain. As depression increases so does pain and as depression decreases so does pain. Tang et al. (2008) induced depressed mood resulting in significantly higher ratings of pain. When they induced a happy mood, a significantly lower pain rating resulted. This phenomena were also observed in this study. Participants had a significant improvement in mood as well as pain.

## Non-clinical Benefits

In addition to the reduction in clinical symptoms as discussed above, the participation in the PNE program also showed other non-clinical benefits and results. Two aspects that will discuss here are use of medication and satisfaction.

### *Reduction in Medication to Remediate Pain.*

Participants reported a reduction in the type and frequency of pain medication used at the end of treatment. This result is consistent with previous research. Agarwal et al. (2020) described in a case study how a physician successfully used PNE to assist a patient to wean off opioids. The patient had chronic low back pain and was using opioids to mitigate pain for over 15 years. The opioids were causing adverse side effects of an acute episode of nausea, vomiting, abdominal pain, and shortness of breath. The internal medicine physician saw the patient seven times over nine months delivering PNE and closely tapered off all opioids and other medications associated with her chronic low back pain. Louw et al. (2020) performed a public health trial with 668 middle-school students to determine if increasing pain knowledge could promote healthier beliefs regarding pain. They divided the students into three groups: PNE only, PNE with two boosters, and usual curriculum pain education. The authors found that PNE with two boosters reduced pain medication usage by 30.6% in the last six-months compared to the usual

curriculum. Reduced use of pain medication following PNE needs additional research, but preliminary results are encouraging.

### *Participant Satisfaction*

Satisfaction questionnaires administered post-treatment indicated that participants believed the intervention was at least moderately to extremely effective at reducing their pain, and they were at least moderately to extremely satisfied with their pain reduction. Within the study, participant satisfaction with their pain reduction and the intervention itself is consistent with their reports on their satisfaction with improvement in their perceived functional ability. Patient satisfaction using PNE has been investigated in the literature. For instance, Louw et al. (2019) reported the PNE group had improved satisfaction with outcomes over the control group during preoperative total knee arthroplasty. Louw et al. (2014) reported the PNE group had improved satisfaction with outcomes over the control group during preoperative lumbar radiculopathy. Fersum et al. (2013) found in their study of individuals with non-specific chronic low-back pain of including PNE with exercise versus exercise alone that the PNE group was over three times more likely to be completely satisfied at three months and five times more likely to be satisfied at 12 months. On the other hand, Benedict et al. (2021) found only 54% of veterans with PTSD and pain would recommend the PNE program, but 69% found the intervention helpful. Kim and Lee (2022) found no significant difference between the control group and the PNE group on patient satisfaction for individuals with arthroscopic rotator cuff repairs. Not all PNE programs are the same, and they may need to be fine-tuned to the population to which it is presented. One difference between this study and Benedict et al. (2021) was that this program focused on participants' problem-solving strategies to increase exposure to their selected occupations. This

program approach was more client-centered than the general PNE booklet used with Benedict et al.

### *Suggestions for Improvement*

In the satisfaction survey, an open-ended item was available to capture feedback for future improvement for the current program. Participants offered suggestions to improve the PNE program. A few of the respondents suggested additional sessions. Perhaps offering additional visits may be necessary if this were to be performed in the clinic. Counseling sessions are typically terminated when the client no longer benefits from the counseling process. In this research process, termination of services was addressed in the informed consent. One person suggested changing some of the wording on the PowerPoint slides, but they did not provide specific feedback to discuss or implement changes. One person would like more interactive assignments to encourage engagement during the program. In this case, discussing preferred occupations may not be enough. Some participants may need more active participation to engage and meet their preferred learning style. Having check-ins within each session as well as during the week may be necessary for some individuals to assess their learning. Overall, the participants were satisfied with their pain reduction and found the biopsychosocial pain neuroscience education intervention helpful.

## Pain Neuroscience Education Using a Rehabilitation Counseling Lens

Although the literature supports an interdisciplinary or multidisciplinary approach to biopsychosocial pain education (Eneberg-Boldon, et al., 2020; HHS, 2019; Louw et al., 2019), descriptions of how rehabilitation counselors might practice in the interdisciplinary team are lacking. Professionals described in the interdisciplinary team typically include physicians, physical therapists, occupational therapists, and behavioral health professionals such as

psychologists. Rehabilitation counselors are well versed in psychological theories and counseling techniques and have expertise in disability and rehabilitation (Maki & Tarvydas, 2012). Counseling concepts used in this PNE intervention were not explored in previous literature are cognitive restructuring and affect labeling. Wellness, also known as health promotion, is another counseling concept used by rehabilitation counselors. Thus, the knowledge and skills of a rehabilitation counselor fit well in not only the conceptualization of a patient's needs but also the techniques used. Below a discussion of specific counseling concepts that were pertinent in the PNE intervention that rehabilitation counselors used are provided.

***Cognitive Restructuring***

Moseley and Butler (2017) reported that deep learning involves higher engagement in the treatment and acceptance that "not all pain equals danger." Education on how pain is conceived is an important component of diffusing the pain feedback loop. The client demonstrates their deep learning through their willingness to change their conception about pain. Another way to label this deep learning is called cognitive restructuring. Cognitive restructuring is the "elimination of distorted or invalid inferences, disputation of irrational thoughts or beliefs, and development of new and healthier cognitions and patterns of responding" and is "an essential component of cognitive behavioral applications with a range of problems" including pain (Comier, et al., 2017, p.392). This concept may be different from other pain interventions. For example, one concept of PNE that is different from traditional beliefs is that "pain and tissue damage rarely match." Pain is not a biological construct and cannot be objectively measured. Your body uses pain as an alarm to investigate the painful event rather than as an alarm to indicate damage. This metaphor allowed space to practice the Danger in Me (DIMS) and Safety in Me (SIMS) strategies. In this space, participants could identify triggers and possible

remediation techniques. It is important to remember that pain is one of our body's many protective systems to keep us safe. Pain is like a smoke alarm. Do not ignore it; investigate what is setting the alarm off. This example leads to critical thinking. Is this a new pain, or have I experienced this in the past? Were DIMs activated to trigger a pain neurotag? What strategies worked for me in the past (SIM)? Because stress can impair memory retrieval (Wolf, 2017), the DIM/SIM worksheet worked as a memory aid in future problem solving for pain remediation.

### *Affect Labeling*

"Emotions are integral to the conceptualization, assessment, and treatment of persistent pain" (Lumley et al., 2011). "Name it to tame it" is a mindfulness technique coined by psychiatrist Dr. Dan Siegel, MD. This practice suggests putting emotions into words can reduce stress, improve self-awareness, and self-management (Fessel & Cherniss, 2020). Functional magnetic imaging supports this concept. Lieberman et al. (2007) found that affect labeling decreases brain activity concentrated in the emotion center, amygdala, and increases activity in the higher-ordered thinking areas of the brain concentrated in the right ventrolateral prefrontal cortex, noted for symbolic processing of emotional information.

The DIM/SIM worksheet was also explained to participants using affect labeling. Participants were questioned "how can they solve for problems if they don't know they exist?" When individuals experience pain or danger, they activate their sympathetic system of "fight, flight, or freeze" to protect themselves. Thus the technique of "name it" (DIMs) "to tame it" (SIMs) helped participants to better identify fears and pain (DIMs) and allowed space for participants to choose how they react with coping strategies, (SIMS). Coping strategies can be used to activate their parasympathetic system of "rest and digest" and return to homeostasis.

### *Wellness*

Central sensitization can be affected by an individual's total stress burden. These stressors can be considered threats. Moseley and Butler (2017) discussed that exposure to small, large, and multiple threats can affect how our immune response activates and, in turn, produces pain. The greater the frequency, degree, and more numerous the stresses in our lives, the more susceptible or sensitive we are to pain. The summation of these stressors is our total stress burden. Humans are bioplastic or capable of change. We can decrease our central sensitization by engaging in active treatment strategies and reduce our total stress burden. Active treatment strategies include exploring different ways to move, exercising, eating healthy, sleeping well, eliminating DIMs, and recognize and create SIMs. Active treatment strategies are like wellness practices.

Rehabilitation counselors are qualified to address wellness practices for individuals with disabilities and have done so for over thirty years. Brandon (1985) first discussed how wellness and health promotion services are integrated into rehabilitation services, including nutritional awareness, physical fitness, stress management, and principles of self-responsibility. Rehabilitation counselors work from a quality-of-life orientation, integrating holistic and wellness perspectives (Roesslier, 1990). In the 2017 CRCC Code of Ethics, it is written that rehabilitation counselors are sensitive to the needs of individuals with disabilities and advocate to improve their quality of life. Lifestyle factors have also been linked to long-term health complications and poor vocational outcomes following the onset of various disabling conditions (Rumrill & Koch, 2019). To improve both the health status and quality of life of people with disabilities and lower costs, Ravesloot et al. (2007) advocated for preventing secondary conditions through health promotion interventions. People with disabilities who have fewer or

less severe secondary conditions can increase their participation in society (e.g., employment) (Lynch & Chiu, 2009). Exercise is one health promotion activity with positive effects for employment. Exercise improved employment outcomes by 8.4% after controlling for demographics, severity of disability, and secondary health conditions (Ipsen, 2006). Vindholmen et al. (2015) identified pain intensity as a significant predictor of work ability response, where high pain intensity was linked to unfavorable work ability. Garza (2020) reported in their systematic review that using comprehensive pain management techniques with individuals with systemic lupus erythematosus improved physical activity, social function, pain reduction, better sleep, and improved quality of life. Rehabilitation counselors can use PNE with their clients to reduce pain levels, reduce kinesiophobia, and improve satisfaction in occupations to improve quality of life. Adding rehabilitation counseling to the multidisciplinary or interdisciplinary pain management teams would be beneficial. Rehabilitation counselors are uniquely qualified to present the biopsychosocial pain education program because many techniques used to deliver the intervention are aligned with their professional competencies and they are equipped to handle barriers commonly faced by individuals with disabilities.

**Strengths**

The telehealth format of the PNE intervention had many benefits. A telehealth format allowed for access to a broader population from the United States and flexibility treatment times outside of normal business hours and accommodate different time zones to meet the participants' needs. The COVID-19 pandemic caused many individuals to isolate themselves from others. Using a telehealth format decreased some types of isolation and increased access to services for those individuals with mobility deficits or transportation issues. Theodore et al. (2015) also found that

compared to the in-clinic chronic pain intervention, the telehealth option reduced the time from referral to initial assessment from 72 days to four days.

**Limitations**

The COVID pandemic caused multiple modifications. One modification was the conversion to a telehealth format. A limitation of this format was that individuals without internet access were unable to participate. Approximately 21 million Americans still do not have access to broadband (The Pew Charitable Trusts, 2019). Those areas that do not have access include 30% of rural America and 60% of health care facilities outside of metropolitan areas (The Pew Charitable Trusts, 2019). This limitation is diminishing. Access to broadband is improving with those lacking access declining 30% between 2017 and 2018 (U. S. Federal Communications Commission, 2020), individuals in the rural community have increased access to broadband service by 46% since 2016 (U. S. Federal Communications Commission, 2021b), and the broadband quality is improving with faster uploads and downloads (U. S. Federal Communication Commission, 2021a).

A second limitation could be the participants' knowledge of how to use a smartphone or computer. Perrin and Atske (2021) found that 7% of Americans do not use the internet. Those adults tend to be 65 years and older, have an income of less than $30,000 per year, and have a high school education or less. If an individual did not know how to use such technology, their participation would have been prohibited, or they would need assistance from another individual knowledgeable about using such technology. The number of possible participants who were excluded from this study is unknown.

Another limitation is that this intervention cannot stand alone. It must be used with other forms of rehabilitation, either occupational or physical therapy. Three individuals could not be

admitted due to non-participation in therapy. One of the three individuals could not participate in their occupational therapy services due to their high co-pay and the $100 incentive did not offset the cost of the co-pay.

Another limitation is interest in the study. Fewer individuals in the U. S. hand therapy population were interested in learning about pain to improve their quality of life, especially during the subacute phase as indicated by the difficulty in recruitment lasting two years. This could have occurred at the therapist or physician level in that they may not have presented the material to their clients as an opportunity. It could also occur at the client level in that they do not want to learn about pain, believe that this is a viable treatment option, or believe that the pain inhibits their function. Selection bias could threaten internal validity. Individuals who participated in the study may be fundamentally different than those who did not participate.

A small sample size limited outcome analysis and could be a threat to internal validity. Statistical conclusion validity threats include low power and range restriction. This was a pilot study with a small sample size. Vellutino & Schatschneider (2011) explained that fewer participants may affect the ability to detect change in the experimental condition. The primary (pain), two secondary kinesiophobia and occupational performance satisfaction), and one exploratory (mood) variables were sufficiently powered with ten participants to achieve statistical significance. Two other secondary variables (pain catastrophizing and occupational performance) achieved large effect sizes, but there were too few participants to achieve statistical significance. Other strategies for recruitment are needed to increase the sample size and sufficiently power the variables studied.

There were threats to external validity. The participants were drawn from the population that readily uses occupational therapy for upper extremity rehabilitation, but there is only one

experimental condition. A control group does not exist for random assignments. It is difficult to explain/generalize cause-effect relationships without randomization to either an experimental or control condition. To improve generalizability, the outcome measures selected were consistent with those used in current occupational therapy/hand therapy practice and research to improve content validity.

Lastly, only the author of this study designed, collected data, provided the intervention, analyzed the data, and funded the research. Using one researcher assisted in reducing the cost of performing the study but created bias.

**Implications to Practice**

Interest in providing this material on biopsychosocial pain education is increasing across the rehabilitation professions. Although this program was developed by physiotherapists, some physiotherapy providers do not feel adequately trained to provide this service. Zanwar et al. (2021) performed a systematic review of the biopsychosocial approach to treat musculoskeletal pain and found some barriers due to knowledge or competency deficits such as inability to screen or manage psychosocial factors, lack of counseling skills, and inability to use the biopsychosocial model holistically. In their methodology, they included only physical therapy literature, but not counseling or occupational therapy literature. As explained in chapter two, both counseling and occupational therapy professionals are well versed in holistic, biopsychosocial care. Physicians are still considered leaders of the multidisciplinary/interdisciplinary pain management teams, but research is lacking describing their participation in pain neuroscience education in the elbow, wrist, and hand injury population.

### *Occupational Therapists*

Lagueux et al. (2018) performed a scoping review of occupational therapy literature identifying their unique contribution to chronic pain management as improving activities and participation, using the Canadian Model of Occupational Performance lens addressing the person, occupation, and the environment, and using the COPM to measure outcomes. The AOTA recently published a position statement on "The Role of Occupational Therapy in Pain Management." In it, they compare how occupational therapy practice recognizes the connection of the mind-body-spirit on occupational engagement and health (AOTA, 2020b) is consistent with the World Health Organization's (2006) view that health is a state of social, mental, and physical well-being. On the other hand, hand therapists were surveyed to identify their knowledge of pain neurophysiology (Stern & Howe, 2020). Results indicated that hand therapists had limitations in knowledge of pain neurophysiology. In a follow up qualitative study drawing from the same sample, Stern et al. (2021) found that hand therapist appreciated the biopsychosocial approach, but they focused on the structural pathology only. These results indicate additional training is needed. Although the professional standards state these professionals should be able to deliver the material, many do not feel confident in delivering the material using counseling techniques.

### *Rehabilitation Counselors*

To date, no literature has identified research on the delivery of PNE by a rehabilitation counselor, specifically or counselor generally. Heleno et al. (2021) published their study of the perceptions of older adults with chronic pain on PNE in *Patient Education and Counseling*, but the researchers did not publish their counseling background, and they did not deliver PNE. Wodzinski et al. (2023) investigated the lived experiences of licensed counselors treating clients

with chronic pain and co-morbid mental health conditions but only reported that PNE and a wellness model were the most used treatments. More research is needed to identify the unique perspectives these counselors bring to the delivery of the PNE and its effectiveness.

**Changes in Telehealth and Access to Medicare.** Individuals experiencing pain need improved access to counseling professionals. In April of 2020, Congresses passed the Coronavirus Aid Relief, and Economic Security Act (CARES Act) to allow for previously ineligible providers to perform telehealth services during the COVID-19 pandemic (https://www.cms.gov/newsroom/press-releases/trump-administration-issues-second-round-sweeping-changes-support-us-healthcare-system-during-covid). These providers included occupational therapists, physical therapists, speech therapists, and others. During the 117th Congress, legislation called the Expanded Telehealth Access Act (H.R. 2168/S.3193) was under debate to make these telehealth services permanent for Medicare beneficiaries. This bill was not voted on before the end of the congressional term. New legislation must be introduced in the 118th Congress to continue the debate and telehealth services permanent. The Consolidated Appropriations Act of 2023 extended some of the telehealth flexibility waivers that were passed under the Consolidated Appropriations Act of 2022 through December 31, 2024.

To improve access to telehealth services for persons with disabilities, the technology gap should be closed. The Pew Research center surveyed U. S. adults between January 25 and February 8, 2021, and found that 62% of adults with a disability reported having a laptop or desktop computer compared with 81% of adults surveyed who were without a disability. When it came to smartphones, 72% of persons with disabilities had ownership of the type of device compared with 88% of persons without a disability (Perrin & Atske, 2021). Although there are

gaps in access to broadband and devices, most U.S. adults currently have access to the internet, devices, and telehealth services.

Missing from the list of Medicare providers were licensed professional counselors or LPCs. Since 1989, Medicare covers psychologists, psychiatrists, and clinical social workers for behavioral health, but not counselors (https://www.counseling.org/government-affairs/federal-issues/medicare-reimbursement). There are approximately 43 million Americans aged 65 and older who are covered by Medicare, and 10 million Americans who have disabilities. Counselors have been advocating to provide behavioral health services to meet the needs of these individuals. Fortunately, the bipartisan Mental Health Access Improvement Act (S.828/HR432) was passed and signed into law on December 23, 2022. LPCs will be able to provide behavioral health services for Medicare beneficiaries, including those with disabilities beginning January 1, 2024 (https://www.counseling.org/docs/default-source/government-affairs/faqs-on-the-passage-of-mha-improvement-act_2022.pdf?sfvrsn=3222332c_2). Help may not come soon enough for some individuals, and other individuals may not qualify for Medicare benefits. Rehabilitation Counselors can provide services without this Medicare barrier. For example, in Michigan, many rehabilitation counselors are employed by the State of Michigan under Michigan Rehabilitation Services (MRS). This state agency is designated as the State Vocational Rehabilitation Services General Program under Title IV of the Rehabilitation Act of 1973 amended by the Workforce Innovation and Opportunity Act (https://www.michigan.gov/leo/-/media/Project/Websites/leo/Folder27/Michigan_Rehabilitation_Services_Manual_Rev_5-2021.pdf). MRS is funded by a grant to operate a comprehensive vocational rehabilitation program that includes counseling services for individuals with disabilities. Rehabilitation

counselors may provide better access to biopsychosocial pain neuroscience education due to different funding sources.

### *Physicians*

No referrals in this study came from physicians generally and those physicians specializing in hand therapy specifically. The literature supports the use of PNE with a variety of healthcare professionals (Eneberg-Bolden et al., 2020; Louw et al., 2019; Traeger et al., 2015). Traeger et al. (2015) found in their meta-analysis of PNE studies in primary care settings with individuals who had acute and subacute low back pain that interventions delivered by physicians were significantly more reassuring than when delivered by a nurse or physiotherapist. Agarwal et al. (2020) described how physicians could use PNE to successfully wean clients off opioids. Literature authored by hand surgeons on the use of PNE is lacking, but Gob et al. (2008) advocated for hand surgeons use of the biopsychosocial model to improve rehabilitative outcomes. Knowledge of the intervention could be a factor in the lack of referrals from physicians for this study. Given the benefits of physician involvement in the delivery of PNE on participants' assurance and the reduction of opioid use, studies involving hand surgeons' delivery of PNE is warranted.

## Implications to Education

Multiple levels of education need to be addressed as it applies to biopsychosocial pain neuroscience education including preprofessional and continuing education. Physicians, physical therapists, occupational therapists, and rehabilitation counselors are all professionals that could deliver this intervention. Given they participate in interdisciplinary and multidisciplinary teams, each would benefit from gaining competency in the content and delivery method. The U. S. department of Health and Human Services published "Pain Management Best

Practices" (2019) concluding that pain management should be based on the biopsychosocial model, have individualized patient-centered care to facilitate the therapeutic alliance, and include a multidisciplinary approach including physicians, physical and occupational therapists, and behavioral health professionals as needed. An effective treatment plan must focus on improvements in quality of life, improved function, and activities of daily living. This biopsychosocial pain neuroscience education is consistent with the recommendations presented in this report.

Louw et al. (2019) performed research on interdisciplinary pain neuroscience education in Minneapolis Veterans Affairs Health Care System. The professionals included in the study were physicians, psychologists, nurses, social workers, pharmacists, physical therapists, and occupational therapists. All professionals improved their pain neuroscience education knowledge directly after the presentation, but the scores faded after one year. Louw et al. (2019) found that these professionals retained positive beliefs and attitudes toward chronic pain. This research provides information on the retention of education and indicates the need for frequent review of continuing education material to maintain knowledge of pain neuroscience.

Development of the interdisciplinary biopsychosocial pain neuroscience education must begin in the preprofessional stage of development. The Affordable Care Act (2010) requires interprofessional collaboration and partnership with clients. As evidence-based practitioners who aspire to provide holistic care indicated by their codes of ethics, physicians, rehabilitation counselors, and occupational therapists can collaborate to provide biopsychosocial pain neuroscience education. One area to develop would be the internship phase of practice. Situated learning occurs with everyday learning or learning that is "situated" in the activity, context, and culture in which it is developed (Brown, Collins, & Duguid, 1988). Practicing biopsychosocial

pain neuroscience education in the internship phase of preprofessional education under the guidance of a professional with competency in the material may improve professional practice upon graduation. For appropriate training at the preprofessional level, professionals need to gain competency in biopsychosocial pain neuroscience education to provide adequate supervision.

**Implications to Research**

Further research is needed in the development of biopsychosocial pain neuroscience education in hand therapy. This pilot study provided effect sizes for some assessment tools to study pain within the biopsychosocial model. These effect sizes can provide a better prediction for appropriate power in future randomized controlled trials for individuals with hand, wrist, and elbow injuries as a population of study. In this study, the *QuickD*ASH was found to be non-responsive to changes in client-centered function compared with the COPM. Additional research is warranted to identify why the previously compatible upper extremity functional assessment is unresponsive in this chronic pain population. Recruitment for individuals in the population was difficult. Development of a list serv to access hand therapists notifying them of intervention studies is warranted to decreased time for recruitment. This study identified a greater demand for this intervention in individuals with chronic pain population than subacute pain. Researchers may want to include individuals with acute, subacute, and chronic pain conditions to ensure a larger sample and decrease time needed for recruitment. Time of assessment could be a variable of interest in future studies investigating pain catastrophizing using the PCS in individuals with elbow, wrist, and hand injuries. Researchers may want to extend the assessment time to at least three months post intervention to detect meaningful change in pain catastrophizing. Additional research is warranted to understand the effects of pain catastrophizing, to establish normative data on pain catastrophizing, and the relationship of pain catastrophizing to other rehabilitation

outcomes in the distal upper extremity injury population. And finally, additional research using an interdisciplinary or multidisciplinary approach including rehabilitation counselors, occupational therapists certified in hand therapy, and hand surgeons is needed to improve biological, psychological, and social outcomes of individuals with upper extremity injuries.

## Conclusion

This study provided a unique perspective on the delivery of biopsychosocial pain neuroscience education (PNE) involving individuals with subacute and chronic pain following injuries to their elbows, wrists, and hands. Previous rehabilitation counseling, occupational therapy, and hand surgery literature lacked investigation of PNE use in this population. This study showed, even with a small sample size, that participants can have meaningful changes in pain, kinesiophobia, mood, and satisfaction with occupational performance with the application of brief PNE in a telehealth format using a rehabilitation counseling lens.

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# APPENDIX A: IRB DOCUMENT

MICHIGAN STATE
UNIVERSITY

**Modification / Update APPROVAL**
**Revised Common Rule**

July 14, 2021

To: Ka Lai Gloria Lee

Re: **MSU Study ID:** STUDY00003750
**IRB:** Biomedical and Health Institutional Review Board
**Principal Investigator**: Ka Lai Gloria Lee
**Category:** Expedited 6, 7
**Submission:** Modification / Update MOD00004022
**Submission Approval Date:** 7/13/2021
**Effective Date:** 7/13/2021
**Study Expiration Date:** **None; however modification and closure submissions are required (see below).**

Title: Chronic Pain Prevention Using Biopsychosocial Education for Individuals with Subacute Hand and Wrist Injuries: A Pilot Study

This submission has been approved by the Michigan State University (MSU) Biomedical and Health Institutional Review Board. The submission was reviewed by the Institutional Review Board (IRB) through the Non-Committee Review procedure. The IRB has found that this study protects the rights and welfare of human subjects and meets the requirements of MSU's Federal Wide Assurance (FWA00004556) and the federal regulations for the protection of human subjects in research (e.g., 2018 45 CFR 46, 21 CFR 50, 56, other applicable regulations).

This letter notes approval for the expanded eligibility criteria as well as the revised consent & flyer.

**How to Access Final Documents**
To access the study's final materials, including those approved by the IRB such as consent forms, recruitment materials, and the approved protocol, if applicable, please log into the Click™ Research Compliance System, open the study's workspace, and view the "Documents" tab. To obtain consent form(s) stamped with the IRB watermark, select the "Final" PDF version of your consent form(s) as applicable in the "Documents" tab. Please note that the consent form(s) stamped with the IRB watermark must typically be used.

**Expiration of IRB Approval:** The IRB approval for this study does not have an expiration date. Therefore, continuing review submissions to extend an approval period for this study are not required. **Modification and closure submissions are still required (see below).**

**Modifications:** Any proposed change or modification with certain limited exceptions discussed below must be reviewed and approved by the IRB prior to

**Office of Regulatory Affairs**
**Human Research Protection Program**

4000 Collins Road
Suite 136
Lansing, MI 48910

517-355-2180
Fax: 517-432-4503
Email: irb@msu.edu
www.hrpp.msu.edu

implementation of the change. Please submit a Modification request to have the changes reviewed.

**New Funding**: If new external funding is obtained to support this study, a Modification request must be submitted for IRB review and approval before new funds can be spent on human research activities, as the new funding source may have additional or different requirements.

**Immediate Change to Eliminate a Hazard:** When an immediate change in a research protocol is necessary to eliminate a hazard to subjects, the proposed change need not be reviewed by the IRB prior to its implementation. In such situations, however, investigators must report the change in protocol to the IRB immediately thereafter.

**Reportable Events:** Certain events require reporting to the IRB. These include:

- Potential unanticipated problems that may involve risks to subjects or others
- Potential noncompliance
- Subject complaints
- Protocol deviations or violations
- Unapproved change in protocol to eliminate a hazard to subjects
- Premature suspension or termination of research
- Audit or inspection by a federal or state agency
- New potential conflict of interest of a study team member
- Written reports of study monitors
- Emergency use of investigational drugs or devices
- Any activities or circumstances that affect the rights and welfare of research subjects
- Any information that could increase the risk to subjects

Please report new information through the study's workspace and contact the IRB office with any urgent events. Please visit the Human Research Protection Program (HRPP) website to obtain more information, including reporting timelines.

**Personnel Changes**: Key study personnel must be listed on the MSU IRB application for expedited and full board studies and any changes to key study personnel must to be submitted as modifications. Although only key study personnel need to be listed on a non-exempt application, all other individuals engaged in human subject research activities must receive and maintain current human subject training, must disclose conflict of interest, and are subject to MSU HRPP requirements. It is the responsibility of the Principal Investigator (PI) to maintain oversight over all study personnel and to assure and to maintain appropriate tracking that these requirements are met (e.g. documentation of training completion, conflict of interest). When non-MSU personnel are engaged in human research, there are additional requirements. See HRPP Manual Section 4-10, Designation as Key Project Personnel on Non-Exempt IRB Projects for more information.

**Prisoner Research:** If a human subject involved in ongoing research becomes a prisoner during the course of the study and the relevant research proposal was not reviewed and approved by the IRB in accordance with the requirements for research involving prisoners under subpart C of 45 CFR part 46, the investigator must promptly notify the IRB.

**Site Visits:** The MSU HRPP Compliance office conducts post approval site visits for certain IRB approved studies. If the study is selected for a site visit, you will be contacted by the HRPP Compliance office to schedule the site visit.

**For Studies that Involve Consent, Parental Permission, or Assent Form(s):**

**Use of IRB Approved Form**: Investigators must use the form(s) approved by the IRB and must typically use the form with the IRB watermark.

**Copy Provided to Subjects**: A copy of the form(s) must be provided to the individual signing the form. In some instances, that individual must be provided with a copy of the signed form (e.g. studies following ICH-GCP E6 requirements). Assent forms should be provided as required by the IRB.

**Record Retention:** All records relating to the research must be appropriately managed and retained. This includes records under the investigator's control, such as the informed consent document. Investigators must retain copies of signed forms or oral consent records (e.g., logs). Investigators must retain all pages of the form, not just the signature page. Investigators may not attempt to de-identify the form; it must be retained with all original information. The PI must maintain these records for a minimum of three years after the IRB has closed the research and a longer retention period may be required by law, contract, funding agency, university requirement or other requirements for certain studies, such as those that are sponsored or FDA regulated research. See HRPP Manual Section 4-7-A, Recordkeeping for Investigators, for more information.

**Closure:** If the research activities no longer involve human subjects, please submit a Continuing Review request, through which study closure may be requested. Closure indicates that research activities with human subjects are no longer ongoing, have stopped, and are complete. Human research activities are complete when investigators are no longer obtaining information or biospecimens about a living person through interaction or intervention with the individual, obtaining identifiable private information or identifiable biospecimens about a living person, and/or using, studying, analyzing, or generating identifiable private information or identifiable biospecimens about a living person.

**For More Information:** See the HRPP Manual (available at hrpp.msu.edu).

**Contact Information:** If we can be of further assistance or if you have questions, please contact us at 517-355-2180 or via email at IRB@msu.edu. Please visit hrpp.msu.edu to access the HRPP Manual, templates, etc.

**Expedited Category.** Please see the appropriate research category below for the full regulatory text.

**Expedited 1.** Clinical studies of drugs and medical devices only when condition (a) or (b) is met.
**(a)** Research on drugs for which an investigational new drug application (21 CFR Part 312) is not required. (Note: Research on marketed drugs that significantly increases the risks or decreases the acceptability of the risks associated with the use of the product is not eligible for expedited review.)
**(b)** Research on medical devices for which (i) an investigational device exemption application (21 CFR Part 812) is not required; or (ii) the medical device is cleared/approved for marketing and the medical device is being used in accordance with its cleared/approved labeling.

**Expedited 2.** Collection of blood samples by finger stick, heel stick, ear stick, or venipuncture as follows:
**(a)** from healthy, nonpregnant adults who weigh at least 110 pounds. For these subjects, the amounts drawn may not exceed 550 ml in an 8 week period and collection may not occur more frequently than 2 times per week; or
**(b)** from other adults and children, considering the age, weight, and health of the subjects, the collection procedure, the amount of blood to be collected, and the frequency with which it will be collected. For these subjects, the amount drawn may not exceed the lesser of 50 ml or 3 ml per kg in an 8 week period and collection may not occur more frequently than 2 times per week.

**Expedited 3.** Prospective collection of biological specimens for research purposes by noninvasive means.
Examples: (a) hair and nail clippings in a nondisfiguring manner; (b) deciduous teeth at time of exfoliation or if routine patient care indicates a need for extraction; (c) permanent teeth if routine patient care indicates a need for extraction; (d) excreta and external secretions (including sweat); (e) uncannulated saliva collected either in an unstimulated fashion or stimulated by chewing gumbase or wax or by applying a dilute citric solution to the tongue; (f) placenta removed at delivery; (g) amniotic fluid obtained at the time of rupture of the membrane prior to or during labor; (h) supra- and subgingival dental plaque and calculus, provided the collection procedure is not more invasive than routine prophylactic scaling of the teeth and the process is accomplished in accordance with accepted prophylactic techniques; (i) mucosal and skin cells collected by buccal scraping or swab, skin swab, or mouth washings; (j) sputum collected after saline mist nebulization.

**Expedited 4.** Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.)
Examples: (a) physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy; (b) weighing or testing sensory

acuity; (c) magnetic resonance imaging; (d) electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography; (e) moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual.

**Expedited 5.** Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis). (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(4). This listing refers only to research that is not exempt.)

**Expedited 6.** Collection of data from voice, video, digital, or image recordings made for research purposes.

**Expedited 7.** Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.)

**Expedited 8.** Continuing review of research previously approved by the convened IRB as follows:
**(a)** where (i) the research is permanently closed to the enrollment of new subjects; (ii) all subjects have completed all research-related interventions; and (iii) the research remains active only for long-term follow-up of subjects; or
**(b)** where no subjects have been enrolled and no additional risks have been identified; or
**(c)** where the remaining research activities are limited to data analysis.

**Expedited 9.** Continuing review of research, not conducted under an investigational new drug application or investigational device exemption where categories two (2) through eight (8) do not apply but the IRB has determined and documented at a convened meeting that the research involves no greater than minimal risk and no additional risks have been identified.

**APPENDIX B: RECRUITMENT FLYER**

# Biopsychosocial Education for Individuals with Subacute and Chronic Pain in the Hand, Wrist, or Elbow: A Pilot Study

**Research Participants Needed**

Researchers at Michigan State University are studying how to better serve individuals recovering from hand, wrist, or elbow injuries. We are looking for people who meet the following criteria:

- Experienced a hand, wrist, or elbow **injury** at least six weeks age
- Currently have pain from the hand, wrist, or elbow injury
- Age 18 or older
- Read and speak English
- Currently receiving occupational / hand therapy

Participation includes 4 video conferences on pain education lasting between 30 min to 1 hour. Participants receive a $100 gift card after the fourth session.

**Amy De Maagd, MS, OTRL, CLT, CHT (Doctoral Candidate)**
**Michigan State University**
**Rehabilitation Counselor Education**
**(616) 546-0311 or demaagda@msu.edu**

## APPENDIX C: INFORMED CONSENT

**Research Participant Information**

You are being asked to participate in a research study. Researchers are required to provide the necessary information to inform you about the research study. You should feel free to ask the researchers any questions you may have.

**Study Title: Biopsychosocial Education for Individuals with Subacute and Chronic Pain in the Hand, Wrist, or Elbow: A Pilot Study.**

Researcher and Title: Amy De Maagd, MS, OTRL, CLT, CHT, Doctoral Candidate, Rehabilitation Counselor Education; Counseling, Educational Psychology, and Special Education; Michigan State University

Gloria K. Lee, Ph.D., CRC, Advisor/Principal Investigator, Professor; Rehabilitation Counselor Education; Counseling, Educational Psychology, and Special Education; Michigan State University

### 1. EXPLANATION OF THE RESEARCH and WHAT YOU WILL DO:

- The purpose of this study is to identify if providing you with pain education at least six weeks after your hand, wrist, or elbow injury occurred can reduce pain and improve function.

- You will take an online survey and videoconference with the researcher so we can learn about you as a person, identify what types of treatment you had, learn how you think and feel about pain and activities.
- After the above data collection, you will videoconference with the researcher one time a week for four weeks for approximately 30 minutes to receive education on how your body creates pain and how to reduce pain.
- After completion of the fourth session, the researcher will identify how you think and feel about pain and activities, what you think about the education program, and how well you worked with the researcher using videoconferencing and an online survey.
- The researcher is seeking 10 participants.

### 2. YOUR RIGHTS TO PARTICIPATE, SAY NO, OR WITHDRAW:

- Your participation in this research project is completely voluntary. You can choose not to participate. You may change your mind at any time and withdrawal from the study. You may choose not to answer specific questions or participate in assessments or education sessions at any time. You also have the right to ask questions about the study at any time.

### 3. RISKS & BENEFITS OF PARTICIPATION:

- There are no known risks associated with the participation in this study. You may or may not directly benefit from this intervention. Your participation in this study may contribute to the understanding of clients' beliefs about pain and how to reduce it. You will receive information on your progress with activity participation at the end of the fourth session. After 10 participants

finish their post-intervention survey, all of the information will be pooled together and tested to see if this intervention should be studied further with more participants. Information on this research may be presented at a rehabilitation conference or published in a rehabilitation journal.

**4. COSTS AND COMPENSATION FOR BEING IN THE STUDY:**

- There are no costs associated with your participation in this research study. To thank you for your participation in this research study, you will be mailed a $100 gift card after completion of all education sessions and the post-intervention online survey.

**5. CONFIDENTIALITY:**

- Your confidentiality will be protected to the maximum extent allowable by law. The data obtained from this research study will not contain any personal information that will allow you to be identified. All participants will be given a number. The data will be entered into a computer with password protection and will be housed at Michigan State University for three years after the project closes under the supervision of Dr. Gloria Lee, Ph.D., and Michigan State University's Human Research Protection Program. Participants' information collected as part of the research will have all identifiers removed and may be used for future research studies.

**6. CONTACT INFORMATION FOR QUESTIONS AND CONCERNS:**

- If you have concerns or questions about this study, such as scientific issues, how to do any part of the study, or to report an injury, please contact the researchers, Dr. Gloria Lee, Erickson Hall room 459, 620 Farm Lane, East Lansing, MI 48824, leekalai@msu.edu, (517) 432-3623 or Amy De Maagd, demaagda@msu.edu, (616) 546-0311. If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program by phone 517-355-2180, Fax 517-432-4503, e-mail irb@msu.edu or regular mail at 4000 Collins Rd, Suite 136, Lansing, MI 48910.

**7. CONFLICT OF INTEREST:**

- There are no conflicts of interest to report.

**8. By participating in the interview, you are providing consent that you are willing to participate in this study.**

**Signature**_____ **Date**_____

## APPENDIX D: PRE AND POST TREATMENT SURVEY

Participant number: _____ Date:_____

Age: _____

Gender: M F

Hand Dominance: Right Left Ambidextrous

Race/Ethnicity: African American American Indian/Alaska Native Asian Caucasian Native Hawaiian/other Pacific Islander
Other: _____

Education Level Completed: Did not graduate high school High School or GED Some College College Degree Some postgraduate education

Do you have any surgery three months prior to date of distal wrist fracture? Yes No

Do you have a current diagnosis of cancer? Yes No

Do you have phantom limb pain? Yes No

Do you have a psychiatric condition not including depression or anxiety? Yes No

Do you have a neurological condition such as multiple sclerosis, Parkinson's disease, dementia, spinal cord injury or stroke? Yes No

Are you employed? Yes No

Are you off work due to this injury? Yes No

Were you injured at work? Yes No

Were you injured in an auto accident? Yes No

What type of health insurance do you have?

_____

### Treatment Received

**Medical**

Open reduction internal fixation External fixation Closed reduction

Medications:_____
_____
_____
_____
Past Medical
History:_____
_____
_____

**Occupational Therapy**

Orthosis Fracture Brace Over the counter brace

Active range of motion Active assisted range of motion Passive range of motion

Functional activities Activities of Daily Living

Pacing Joint protection Body Mechanics Ergonomics

Strengthening

Mirror Therapy Mental Imagery Mindfulness Deep Breathing Pain Educ.

Ultrasound Neuromuscular electrical stimulation Fluidotherapy

Hot/Cold packs

Kinesiology taping Leukotaping

Soft tissue mobilization Scar management

**Psychological Therapy**

Counselor Psychologists Psychiatrist

## APPENDIX E: WEEKLY PROGRESS SCALES

**Numeric Rating Scale (NRS)**

**Select the number that best describes your pain during the past 24 hours (Circle one number only)**

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **No pain** | | | | | | | | | | **Worst possible pain** |

Retrieved from Farrar, J.T., Young, J.P. Jr, LaMoreaux L., Werth J.L., & Poole, R.M. (2001). Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain, 94*, 149–58.

**Mood Scale With a Suicide Floor**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| **Worst Mood** | | | | | | | | | **Best Mood** |

Retrieved from Sommers-Flanagan, J. & Shaw, S. L. (2017). Suicide risk assessment: What psychologists should know. *Professional Psychology: Research and Practice, 48*, 2, 98-106.

Have there been any recent changes in your hand, wrist, or elbow? yes no

If yes, please describe:_____

## APPENDIX F: DANGER IN ME/ SAFETY IN ME WORKSHEET

Identify Danger In Me (DIM) and Safety In Me (SIM) with daily activities.

| DIM | Category | SIM |
|---|---|---|
| | Things you see, hear, smell, touch, taste | |
| | Things you do | |
| | Things you say | |
| | Things you think and believe | |
| | Places you go | |
| | People in your life | |
| | Things happening in your body | |

Retrieved from Beames & Johnson (2017). Graded Motor Imagery. *Neuro Orthopaedic Institute*: Adelaide City West, South Australia.