PHYSICAL THERAPY CONSIDERATIONS IN THE MANAGEMENT OF INDIVIDUALS WITH NON-ARTHRITIC SOURCES OF HIP AND SHOULDER SYMPTOMS: EXAMINATION SEQUENCE, TREATMENT, AND POTENTIAL BARRIERS TO THE RESTORATION OF FUNCTION

by

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I dedicate this dissertation to my family. Thank you for your steadfast love and support during this endeavor.

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ABSTRACT

PHYSICAL THERAPY CONSIDERATIONS IN THE MANAGEMENT OF INDIVIDUALS WITH NON-ARTHRITIC SOURCES OF HIP AND SHOULDER SYMPTOMS: EXAMINATION SEQUENCE, TREATMENT, AND POTENTIAL BARRIERS TO THE RESTORATION OF FUNCTION

by

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Musculoskeletal conditions are a common reason that patients seek a referral to physical therapy. The hip and shoulder have anatomical similarities and are prone to comparable pathologies. The increased mobility of the hip in the presence of hip dysplasia, increases the anatomical similarities between these 2 joints, and enhances the comparisons that can be made. The examination sequence in individuals with musculoskeletal pain is multifaceted with information obtained through a physical examination and/or the utilization of standardized outcome measures. When performing the physical exam, it can be difficult to differentiate between the potential sources of symptoms when the joints are anatomically adjacent to the spine. Symptom localization (SL) can be used to help determine the region, spinal segment, and/or structure(s) responsible for the source of symptoms. Regional testing is used to rule out the influence one joint has on the other when two adjacent joints could be responsible for causing symptoms. The proximity of the hip and the shoulder to the spine make this line of testing important to rule out the possibility of referred pain and/or neurogenic diagnosis.

Once the region has been determined, structural localization can be used to identify the structure(s) contributing to symptoms.

Another component of the physical therapy examination includes the use of outcome measures. For the purpose of this dissertation, I am dividing these outcome measures into two categories, functional and psychosocial. The functional questionnaires are used to help identify symptom characteristics, functional tasks, and activities that can be addressed during a course of therapy. Many of the common functional outcome measures used for the assessment of pathologies related to the upper and lower extremities, focus primarily on the ability to perform a task but give little to no consideration of the other factors that may be influencing performance such as psychosocial factors of depression, anxiety, stress, and/or fear-avoidance behaviors. The subsequent chapters of this dissertation will focus on two components of the examination process. First, symptom localization, the examination strategy utilized to differentiate between adjacent body regions to determine the source of symptoms and the sequencing of treatment in a patient with anterior shoulder pain. The second strategy is the use of outcome measures, these are used to investigate psychosocial impairments, using the Fear Avoidance Belief Questionnaire (FABQ), and the Depression Anxiety and Stress Scale (DASS-21) on an individual's function as measured through the International Hip Outcome Tool (iHOT) in individuals with hip dysplasia.

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LIST OF TERMS

Symptom Localization	Symptom localization (SL) is a systematic process that includes selectively alleviating and provoking body regions, spinal segments, and/or anatomical structures to determine the source of symptoms.
Regional Localization	Regional localization is used to determine symptom origin when the potential source of symptoms is along nerve pathways, at adjacent body regions, or when the patient's description of symptoms is vague.
Structural Localization	Once the region has been determined, the likely source of symptoms can be further specified through the application of segmental localization (spine) or structural localization to determine if the source of symptoms is a joint, muscle, tendon, nerve, or vascular structure.
Functional Outcome Measure	A functional outcome measure (FOM) is a standardized and objective tool used to capture information about a patient's symptoms, movement limitations, and function.
Hip Dysplasia	Hip dysplasia is an incongruency of the femoral head and acetabulum.
Functional Massage	Functional massage (FM) is a manual therapy technique that involves repeatedly moving the muscle into its primary or secondary movements in either a lengthening or shortening motion, combined with repetitive manual pressure (1 repetition every 2-3 seconds) to improve tissue mobility, decrease pain, and reduce edema.
Joint Mobilization	Joint mobilizations are manual therapy techniques that are used to address range of motion limitations and capsular restrictions. This is done by stabilizing one portion of the joint, while moving the joint partner, either perpendicular (traction) or parallel (joint glide) to the joint surface. This is done to restore normal roll and glide (arthrokinematics) of the joint.

LIST OF ABBREVIATIONS

ACL	Anterior Cruciate Ligament
AI	Acetabular Index
AIIS	Anterior Inferior Iliac Spine
BMI	Body Mass Index
CSA	Cross Sectional Area
CT	Computed Topography
DASS-21	Depression, Anxiety, and Stress Scale
FABQ	Fear Avoidance Belief Questionnaire
FAI	Femoral Acetabular Index
FOM	Functional Outcome Measure
HEP	Home Exercise Program
ICF	International Classification of Functioning, Disability, and Health
iHOT	International Hip Outcome Tool
LCEA	Lateral Central Edge Angle
MPT	Movement Pattern Training
MRI	Magnetic Resonance Imaging
PAO	Periacetabular Osteotomy
POP	Point of Pain
PSFS	Patient Specific Functional Scale
PT	Physical Therapy
qDASH	Quick Disabilities of the Arm, Shoulder, and Hand

RC	Rotator Cuff
ROM	Range of Motion
UE	Upper Extremity
UEFS	Upper Extremity Functional Scale
VOP	Verge of Pain

CHAPTER ONE

OVERVIEW

1.1 BACKGROUND

Physical therapy is a health care service routinely used to conservatively manage a variety of neurological and musculoskeletal conditions.[1] Musculoskeletal disorders can be defined as a condition that causes pain or damage resulting in changes in the joint, ligaments, and/or surrounding muscles. The shoulder and hip rank among the most affected joints that patients seek medical care for.[2,3] Although the shoulder and hip joints are regionally separated in the body, they have anatomical similarities that pre-dispose them to having comparable pathologies. Some of the common causes of pain include joint pathologies, tears of the labrum, inflammation or trauma to the soft tissue, and/or referral from the spine. It is pertinent that the physical therapist uses a systematic approach to not only determine the source of symptoms but comprehensive methods to understand the role of physical and psychosocial impairments on a person's function.

1.2 ANATOMY

The shoulder **[FIGURE 1]** is a triaxial ball and socket joint consisting of a convex humeral head that articulates with a shallow, concave glenoid fossa.[4–6] The glenohumeral joint works in combination with the acromioclavicular, sternoclavicular, and scapulothoracic joints to allow for motion in the sagittal, frontal, and transverse planes.[5] It relies heavily on the labrum to add to stability of the joint, by deepening the concavity of the glenoid fossa.[7] The shoulder joint relies on dynamic and static stability from the surrounding ligaments and the rotator cuff.[5]

The hip **[FIGURE 2]** is a triaxial ball and socket joint.[4] The articulation is comprised of a large spherical convex head of the femur, and a portion of the ilium, ischium, and pubis to form the concave acetabulum. It is an inherently deep and stable joint unless impacted by pathology.[8] The hip is further stabilized by ligaments, a labrum, and surrounding musculature. Changes in joint structure due to congenital anomalies and/or underlying pathology will result in varying degrees of stability. When a shallow acetabulum is observed with conditions such as hip dysplasia, there is increased mobility, while stability may be compromised.[8] The opposite is true when there is increased bony coverage in conditions like femoral acetabular impingement (pincer-type) or osteoarthritis.[5]

FIGURE 1: The Shoulder Joint

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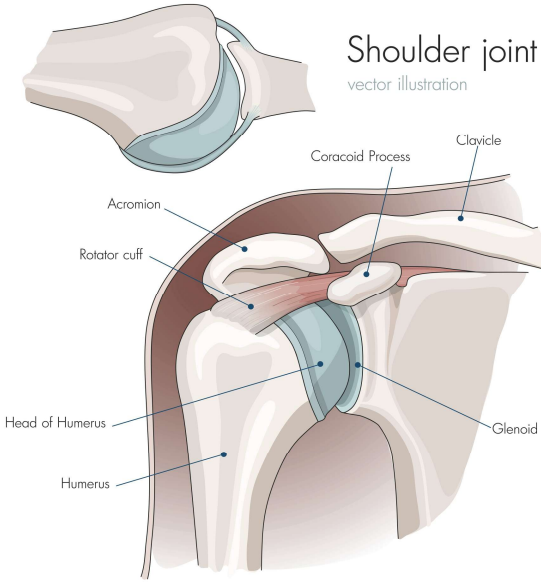

FIGURE 2: The Hip Joint

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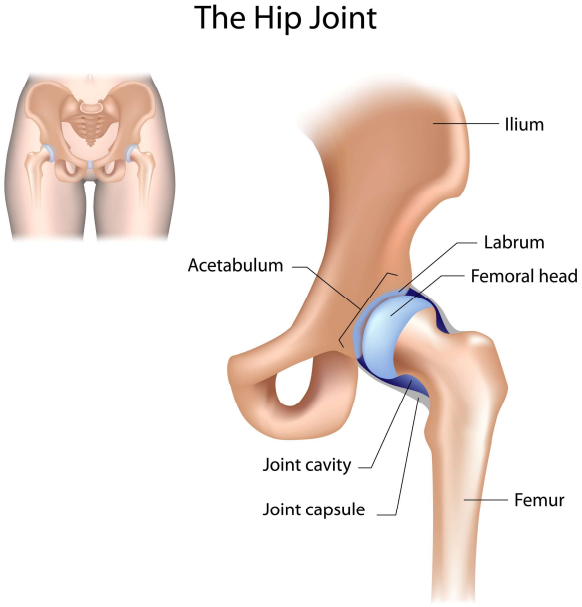

1.3 PATHOLOGY/PAIN-GENERAL

As a result of their similarities in structure, there are common pathologies that may impact both joints. These disorders can either affect the joint itself, the labrum, ligaments, and/or the surrounding musculature. Pain in the shoulder and hip can arise from pathologies impacting the joints themselves or they can be referred from the spine. **[FIGURE 3 and FIGURE 4]**.

1.3.1 PATHOLOGY-INSTABILITY

Pathologies that impact both the shoulder and hip joints can be caused by anatomical variations in the shape of either the convex or concave joint partner, resulting in instability. The anatomical structure of the shoulder joint yields the greatest amount of range of motion. However, when alterations in the shape and surface area of the glenoid fossa exist, instability can occur. There are many potential sources of glenohumeral instability, including congenital abnormality, trauma from a fall, a direct blow to the shoulder, or degenerative changes over time.[9]

Hip dysplasia is defined as an incongruency of the acetabulum in relationship to the femoral head. This may be due to changes in the shape or size of either the femoral head or acetabulum, due to trauma, and/or congenital deformities. These scenarios result in decreased congruency and stability of the joint.[10,11]

When instability is present in either the shoulder or the hip, there can be increased wear and tear of the joint, stress/strain on the labrum, and/or other extraarticular structures. In addition to soft tissue changes, this instability may result in early degenerative changes such as arthritis, precipitating the need for a joint replacement.[11–13]

1.3.2 PATHOLOGY-IMPINGEMENT

Impingement, another common joint pathology occurs where there is increased bone growth resulting in entrapment of soft tissue. In the shoulder, impingement commonly occurs where there is abnormal shape of the acromion or bone spurs on the undersurface of the subacromial arch, resulting in entrapment of the supraspinatus during overhead flexion.[14,15]

In the hip, bony overgrowth occurs on the acetabular rim (pincer) or on the neck of the femur (cam). These bony changes near the joint can lead to pain and limitations with range of motion. Lastly, if these pathologies are left untreated, they can lead to osteoarthritis or changes in the joint surface.[12,16,17]

1.3.3 PATHOLOGY-LABRUM

In both the shoulder and the hip, a labrum is present to deepen the concavity of these triaxial synovial joints. The labrum is defined as a dense ring of cartilaginous tissue that runs continuously around the borders of the acetabulum and the glenoid fossa.[5,9] If underlying instability exists, then increased stress and strain is placed on labral tissue. Tears of this structure tend to occur in the young athletic population resulting in decreased stability and abnormal movement patterns of the joint. Hypertrophy of the surrounding soft tissue may also accompany these changes to provide stability that is compromised by a shallow joint surface and tears in the labrum.[18] As a person ages, degenerative changes and fraying of the labrum may occur further decreasing the integrity and inherent stability of the structure.[19]

1.3.4 PATHOLOGY-CONTRACTILE

Changes in muscle function and structure occur in response to posture, underlying pathology, and/or overuse.[20] In the shoulder, the rotator cuff aids in dynamically stabilizing the shoulder while maintaining the humeral head in an optimal position in relation to the glenoid fossa.[5] In the hip, the deep internal and external rotators, and gluteal muscle groups work together to stabilize the hip.[11]

Changes in the joint and labrum will place different forces on the stabilizers of both the hip and shoulder.[20] In the shoulder, there may be weakness of the rotator cuff due to poor posture, and/or tightness in the upper quadrant.

In the presence of hip dysplasia, muscle recruitment patterns may change. There is increased use of hip flexors, and decreased volume and strength of the gluteal muscle group.[21–23] There can also be inflammation in structures near the musculature that results in bursitis, or inflammation of the fluid filled sac. When the bursa is healthy and showing no signs of inflammation, it will decrease friction and allow for improved movement of the tissues. In the presence of pathology, the structure and function of tendon and muscle may change over time.

1.3.5 PATHOLOGY-REFERRED SPINAL PAIN

As with many structures within the body, pain that originates in one area may be referred to a location away from the source of symptoms. The cervical spine can refer pain down the anterior lateral shoulder and into the forearm, wrist, and hand. Depending on the level of nerve root compression there may also be changes in strength, sensation, and reflexes. A similar pathology can occur in the hip but from the lumbar spine. This is

known as radiculitis or radiculopathy.[4] With both radiculitis and radiculopathy, changes in nerve tension may also exist.

FIGURE 3: Cervical Radiculitis/Radiculopathy

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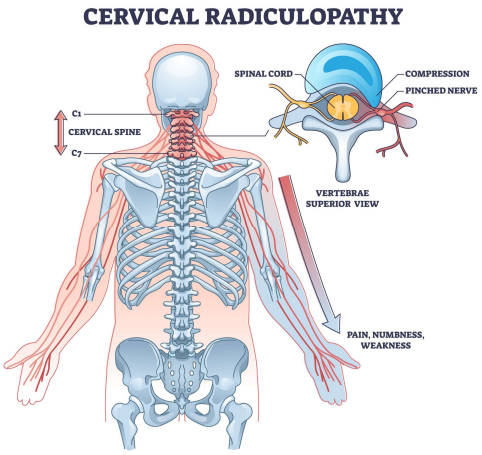

FIGURE 4: Lumbar Radiculitis/Radiculopathy

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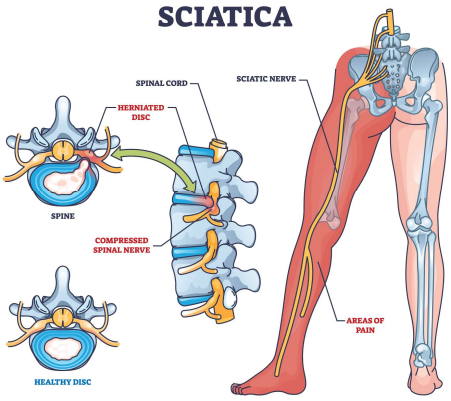


1.4 OUTCOME MEASURES

The biopsychosocial model was first described by George Engel in the 1970's, stating that a person's medical diagnosis/condition cannot be described by the pathology alone (biomedical model) but rather the influence of psychological and social domains **[FIGURE 5]**.[24] The biopsychosocial model was improved upon and served as the basis for The International Classification of Functioning, Disability and Health model (ICF), that was developed to define and organize information on a person's disability and their function.[26] This model **[FIGURE 6]** looks at the interplay of personal and environmental factors on a person's health condition on a variety of different domains (body structure and function, activities, and participation).[25] When considering the models that have been used in the delivery of healthcare services, the practitioner needs to consider that the source of the symptoms may not all be defined by a biological process but there are many factors that can influence a person's condition. Consideration should be made when developing a treatment plan that pain can have an influence on body structure and function, activities, and participation with the environment. To gain an understanding of a person's previous and current functional status a variety of examination measures are used. These can range from patient centered interviews to physical performance of functional tasks. One way to objectively capture information on a person's current functional status is through the utilization of a functional outcome measures (FOM).

Many of the common functional outcome measures used for the assessment of pathologies related to the upper and lower extremities focus primarily on the ability to perform a task but give little to no consideration of the other psychosocial variables that may influence performance such as depression, anxiety, stress, and/or fear-avoidance

behaviors. Some tests such as the International Hip Outcome Tool (iHOT) have subscales but only ask 4 questions on this topic.[26] This may not encompass all the potential deficits; a combination of tools may more effectively capture the clinical picture of the individual.

1.5 PHYSICAL THERAPY EXAMINATION PROCESS

With increasing prevalence of direct access across the United States and becoming more common internationally, patients may report to therapy without a screening by a medical doctor or inadequate imaging.[27,28] As a result, the physical therapist must interpret medical history and subjective complaints, scores on outcome measures, and presentation on the physical exam to arrive at an appropriate diagnosis.[28]

A physical examination is pertinent to understanding the primary complaint and the influence that remote regions may have on the symptoms.[29] When conducting the examination, a comprehensive and systematic approach can be utilized to manage the volume of information being obtained from both the subjective and objective components. One such examination strategy is called symptom localization (SL). SL is a systematic testing sequence to determine the region, structure, and/or source of symptoms. Regional localization is used when joints that are anatomically adjacent to one another could be the contributing to the symptoms. The proximity of the hip and the shoulder to the spine, make this line of testing extremely important to rule out the possibility of referred pain, and/or neurogenic diagnosis. Different symptom localization techniques may be utilized to determine if compression (load) or traction (unloading) changes the symptoms.[30] Once the region has been determined, the discerning therapist must determine the spinal segment or structures causing symptoms. Further confirmation testing can then be applied such as strength testing (break or myotomal), joint play

(hypomobility vs hypermobility), muscle play, neurological screening (myotomes, dermatomes, reflexes, and nerve tension), and range of motion.

1.6 TREATMENT

Treatment for pathologies of the hip and shoulder may be addressed both conservatively and surgically. Once the source of the symptoms has been identified, a treatment plan to address these impairments can be established. Treatment commonly addresses muscle, joint, nerve, or neuromuscular impairments. In some instances, psychosocial factors such as fear avoidance, depression, anxiety, and/or stress must be addressed. Both physical and psychosocial impairments serve as barriers to restoring function and performance.

The subsequent chapters of this dissertation will focus on components of the physical therapy exam, including the application and use of symptom localization and outcome measures. An in-context example of symptom localization is included in chapter 3, highlighting the sequence used to differentiate between adjacent body regions (cervical vs shoulder) to determine the source of symptoms, allowing for a targeted treatment approach. In both studies, outcome measures were used to evaluate the functional and psychosocial status of an individual. In chapter 4, the study highlights the need to consider the role that fear avoidance, depression, anxiety, and stress play on the return of function.

CHAPTER TWO

RELEVANT LITERATURE

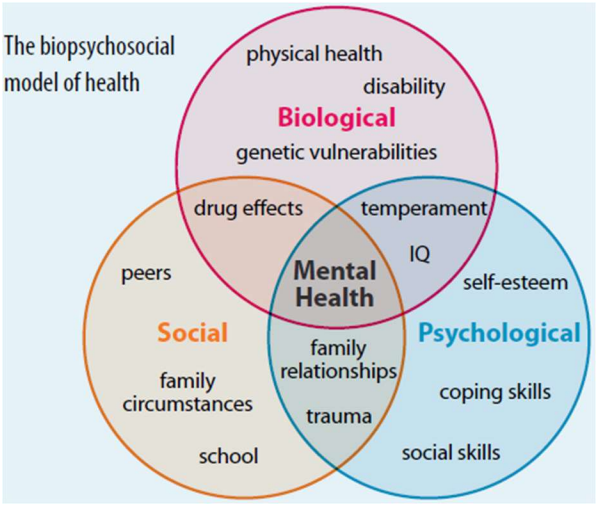
2.1 PROBLEM AND PURPOSE

There are many anatomical and pathological similarities in the hip and shoulder joints. When pathology is present, it may impact muscle performance, strength, function, and contribute to symptoms. It is important to consider not only the functional return to activity but also the psychosocial characteristics that may further impact their return of function.

2.2 MODELS OF ILLNESS AND OUTCOME MEASURES

The biopsychosocial model was first described by George Engel in the 1970's, stating that a person's medical diagnosis/condition cannot be described by the pathology alone (biomedical model) but rather the influence of psychological and social domains.[24]

FIGURE 5: Biopsychosocial Model[24]

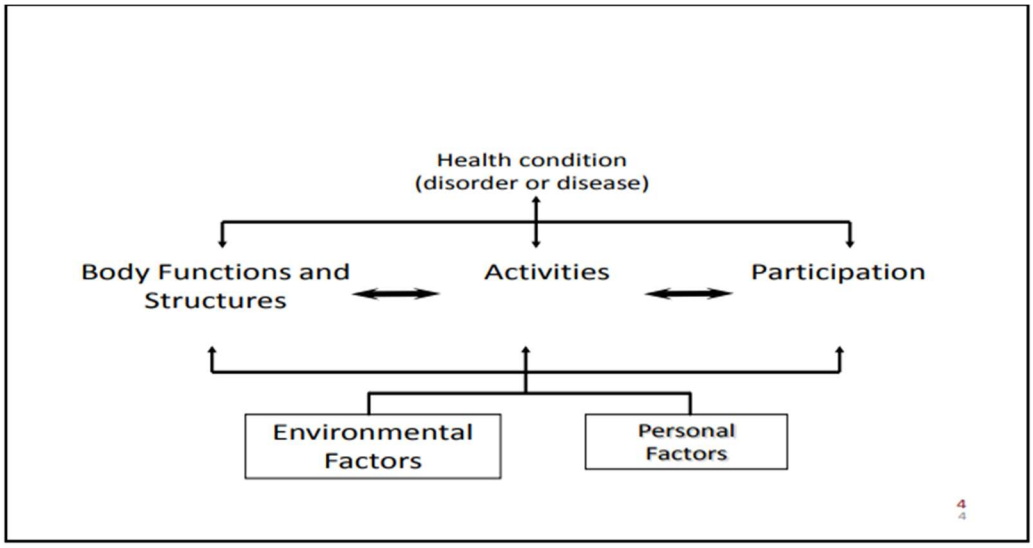


THE BIOPSYCHOSOCIAL MODEL OF MENTAL HEALTH[31]

The biopsychosocial model was improved upon and served as the basis for The International Classification of Functioning, Disability and Health model (ICF), that was

developed to define and organize information on a person's disability and their function. [25] This model looks at the interplay of personal and environmental factors on a person's health condition on a variety of different domains (body structure and function, activities, and participation). When considering the models that have been used in the delivery of healthcare services, the practitioner needs to consider that the source of the symptoms may not all be defined by a biological process but there are many factors that can influence a person's condition. Consideration should be made when developing a treatment plan that pain can have an influence on body structure and function, activities, and participation with the environment.

FIGURE 6: International Classification of Functioning (ICF), Disability and Health Model[25]



Capturing all this information may be difficult to ascertain through a physical examination and outcome measures may be used to gain further insight into a patient's function but also some of the psychosocial components of their condition. Two of the commonly used outcome measures for the shoulder are the Upper Extremity Functional

Scale (UEFS) and the quick Disabilities of the Arm Shoulder and Hand (qDASH). The UEFS is a 20-question survey that has been found to be valid and reliable in measuring functional change in individuals who have upper extremity (UE) pain. The survey that asks a variety of questions on a patient's ability to perform functional tasks that range from self-care related activities to sport.[32]

The quick Disabilities of the Arm Shoulder and Hand (qDASH) is an 11-item questionnaire that asks about functional performance and has two optional subsections on work and sport. It has been found to be valid, reliable, and responsive to change in patients in both a clinical and research settings.[33]

The iHOT, a functional outcome measure, has well established reliability, validity, and is responsive to change in a population of individuals with hip pain. This questionnaire is divided into 4 subsections: symptoms and functional limitations, sports and recreational activities, job related concerns, and social, emotional and lifestyle concerns. Respondents are asked to place a dash on a line that ranges from 0-100, with 0 indicating no difficulty with the activity and 100 being able to perform.[34]

The Patient Specific Functional Scale (PSFS) is an outcome measure that can be used in individuals regardless of the underlying pathology. The participant highlights meaningful functional tasks that are not included in other more rigid functional outcome measures. A systematic review conducted in 2022, showed that the PSFS is easy to administer and can be used with individuals who have a variety of musculoskeletal conditions.[35] It has been shown to have good reliability (0.83-0.89) and is sensitive to change (SEM of 0.63-0.9) in a variety of musculoskeletal conditions.[36,37] A limitation of

the PSFS is that it has limited content validity, likely a result of the patients' own selection for functional impairments. [38]

The Fear Avoidance Belief Questionnaire (FABQ) and Depression Anxiety and Stress Scale (DASS-21) are two outcome measures that are more commonly used in the social sciences. They can capture information on many of the psychometric properties of an individual.[39] The FABQ helps to provide insight on whether fear is a reason for avoiding certain activities. It is frequently administered to individuals who have low back and lower extremity pathologies.[40] It has been shown to be a reliable test in individuals who have low back and neck pain. There is limited evidence on its use in individuals with hip dysplasia, however a study looking at the impact of fear-avoidance beliefs and recovery from anterior cruciate ligament (ACL) reconstruction showed that such beliefs had an adverse effect on functional levels.[41]

The Depression Anxiety and Stress Scale (DASS-21) has been used in multiple studies to explore the psychological impact on function.[42] The DASS-21 was also selected because of the stress and anxiety that may be involved since many of the individuals living with hip dysplasia are diagnosed at a young age and are faced with a major corrective surgery in late adolescence or early adulthood.[43] There are many instances where these individuals have had to modify or change participation in sports or activities due to the new diagnosis. In addition to the selection and use of outcome measures, consideration must also be made on the sequence and structure of the physical examination.

2.3 SYMPTOM LOCALIZATION

The presence of pain is one of the main reasons why patients seek medical and physical therapy services.[44] The use of physical examination, diagnostic imaging, and trial treatments (pharmacologic or movement based) are some of the commonly used methods to arrive at a diagnosis. Each of these methods has potential pitfalls, the physical examination may not be comprehensive or specific enough, diagnostic imaging may not be able to pick up the movement impairment, and the trial treatment may be targeting the wrong structure or pathology.[44]

There are a variety of examination and treatment philosophies currently used in healthcare. Similarities exist in the examination sequence looking at posture/gait, range of motion, strength, joint mobility, and special tests. Differences occur when using and applying special tests to determine the source of the symptoms. Many of the well-researched and defined special tests used in physical therapy and with other medical practitioners are pathology specific and use either graded application of forces (compression, distraction, resistance) or specific movements to reproduce the chief complaint. Many of these tests aim to provoke symptoms rather than alleviate. If symptoms are provoked too early in the examination sequence, the tissue may be pre-sensitized to pain, and it may be difficult to determine the source of symptoms.

A systematic examination approach aimed at reducing these confounding variables is one described by Kaltenborn and Evjenth,[44,45] and further developed by Krauss[30,46] is symptom localization (SL). SL is a systematic process that includes selectively alleviating and provoking body regions, spinal segments, and/or anatomical structures to determine the source of symptoms. Regional localization is used to

determine symptom origin when the potential source of symptoms is along nerve pathways, at adjacent body regions, or when the patient's description of symptoms is vague. The likely source of symptoms can be further specified through the application of segmental localization (spine) or structural localization to determine if the source of symptoms is a joint, muscle, tendon, nerve, or vascular structure. This line of testing provides the regional, segmental, and/or structural impairment versus the pathology that is present. The results of symptom localization strategies correlate with established special tests to further support or confirm the underlying pathology. Evidence suggests that having a cluster of positive special tests is more indicative of having the actual impairment or pathology.[47]

Pain is alleviated first, when possible, through a combination of positional changes (active and/or passive) and/or graded application of manual pressures. To alleviate symptoms, the joint is positioned at the point symptoms begin, point of pain (POP), and then manual forces are utilized to reduce symptoms. Provocation is a way to cause a patient's symptoms by positioning the joint just prior to the onset of symptoms, verge of pain (VOP), and then using manual forces to increase symptoms. Alleviation and provocation may be used in sequence where the first test performed is confirmed by the second. During this dynamic and evolving process, the clinician must gather and integrate exam findings while applying knowledge of anatomy, arthrokinematics, and biomechanics to selectively identify the pain producing structures.

During this process the examiner will be able to collect information that will aid in the treatment of the patient. During regional localization, the examiner will be able to see how the patient moves, and if any compensatory movements are present. If the patient

is sensitive to loading/compressive forces the examiner will be able to determine how much force is required to provoke and/or unloading required to alleviate symptoms. During segmental and structural localization, they will be able to isolate the tissue(s) that are likely causing symptoms. Information on palpatory pressures and the presence of edema can be quickly gleaned during this portion of the exam and used to construct a comprehensive treatment plan. Understanding anatomy and commonly seen pathologies are helpful to determine the potential sources of symptoms, while also considering the role of psychosocial factors.

2.4 SHOULDER TENDINOPATHY BACKGROUND

Shoulder and neck pain are common reasons patients seek medical services.[48–50] The prevalence of shoulder pain in the general population ranges between 7-26%[49,50], and is one of the most common musculoskeletal complaints seen in orthopedic practice and physical therapy.[51] Anterolateral shoulder pain, a common clinical presentation, may potentially arise from the rotator cuff, acromioclavicular joint, structures within the subacromial space, and/or glenohumeral joint.[52–54] The C5-C6 nerve roots can also refer symptoms to the anterolateral arm, mimicking characteristics of rotator cuff pathology.[55,56] Physical therapy (PT) tests and measures commonly used to examine the cervical spine for radicular involvement may include: motion assessment, upper limb nerve tension test, myotomes, dermatomes, reflex screening, cervical traction, and/or compression, and Spurling's test.[57–59] Symptom localization, specifically regional localization, as described previously can be used to differentiate between the two potential sources of pain.

When examining the shoulder, the selection of tests and measures is dependent upon patient history, symptoms reported, and location. To improve the diagnostic accuracy of the clinical diagnosis, multiple special tests can be used.[47,54,60,61]

Shoulder tendinopathy is defined as inflammation and irritation of one or more of the rotator cuff tendons.[62] Subacromial impingement is a form of shoulder tendinopathy that is characterized as compression of the rotator cuff tendons between the humeral head and the acromion. It has been reported by,[14] that 75% of individuals presenting for medical care due to shoulder pain have underlying subacromial impingement syndrome. Subacromial impingement syndrome can be characterized as either primary, or secondary. Primary impingement is caused by compression of the superior portion of the rotator cuff between the humeral head and the distal third of the acromion,[15] while secondary tends to occur due to underlying hypermobility and poor recruitment and stabilization of the joint through contraction of the rotator cuff. The exact mechanism of subacromial impingement syndrome is not completely clear but it is believed to occur due to the shape of the acromion, hypermobility of the joint, underlying rotator cuff tendinopathy, posture, and/or changes in the coracoacromial ligament.[63]

2.5 SHOULDER TENDINOPATHY-INCIDENCE/ETIOLOGY

Shoulder impingement is more commonly seen in males versus females.[64] If the syndrome is left untreated it can progress to partial and full thickness rotator cuff tears. With progressive degeneration and tearing of the rotator cuff combined with arthritic changes that need for a reverse total shoulder may be warranted.[65]

Neer first defined the states of shoulder tendinopathy and impingement syndrome. The progression can be divided into 3 distinct phases. In stage 1, it is believed to be

characterized by inflammation and edema of the rotator cuff tendon. This commonly occurs in individuals under the age of 25 and is reversible with conservative care.[66] In stage 2, inflammation and degeneration to the rotator cuff tendon persists, leading to progressive damage to the tissue.[66] This more commonly occurs in individuals between the ages of 25-40 years old and may result in irreversible changes in the tendon.[66] Lastly in stage 3, there is are changes in the characteristics of the rotator cuff due to partial or complete tearing of the tendon. This may be accompanied by osteophytic lesions on the acromion further complicating the problem. This is commonly seen in individuals who are greater than 40 years of age.[66] Shoulder tendinopathy is believed to be degenerative in nature with an increased incidence rate from 9.7% in individuals aged 20 and younger to 62% of those 80 years and older.[67]

2.6 SHOULDER TENDINOPATHY CLINICAL CHARACTERISTICS-RISK FACTORS

Due to the progressive degeneration that occurs with shoulder tendinopathy and the changes observed in tendon structure it is more common to see this pathology in individuals 50 years and older.[68] However, they may have a history of shoulder impingement syndrome (stage I-II) that predispose this individual to further structural breakdown. Due to the arthrokinematics of the joint the overhead athlete or individuals whose work require them to perform repetitive activities overhead are more likely to develop shoulder impingement and potentially tendinopathy due to the compression of the supraspinatus tendon in the subacromial space.[68] Structurally, individuals with a hooked type of acromion (type III) are at a greater risk of shoulder impingement syndrome, followed by shoulder tendinopathy and later rotator cuff tear due to the

compression and stress on the muscle-tendon unit.[69,70] In addition to acromion type, there is believed to be a genetic pre-disposition to rotator cuff tendinopathy due to variations in gene expression.[71] A study by Harvie et al. found there to be a relative risk of 4.65 to the development of a rotator cuff tear in siblings when compared to the control group. Tragtrakulwanich et al. reported in 2012 that shoulder pathology was also linked to side sleeping position.[70] This is likely the result of further compression on the sensitive structures being compressed within the subacromial space. It was recommended by Michener et al.,[47] for a patient to support the affected arm on pillows while in a side lying position to decrease stress and strain on the shoulder joint and surrounding soft tissues. Lastly, it is believed that conditions that impair the vasculature and the body's ability to heal further complicate the pathology. Individuals who are diabetic[68] and/or smoke are at an elevated risk of developing shoulder tendinopathy.[70] Controversy exists whether there is a zone of hypo vascularization in the shoulder further complicating the healing process.

2.7 SHOULDER TENDINOPATHY CLINICAL CHARACTERISTICS-IMAGING

A variety of imaging modalities can be used to diagnose shoulder tendinopathy and shoulder impingement syndrome. Plain film radiographs may be used to investigate the structural anatomy of the shoulder complex to determine acromion type and any osteophytic spurring of the acromion.[66] Measurements of the supraspinatus outlet can also be made by plain film radiographs. The supraspinatus outlet is defined as the space between the coracoacromial arch and the supraspinatus bursa above and the humeral head below.[72] In a healthy, asymptomatic shoulder this space typically measures between 9-10 mm but when shoulder impingement is suspected there may be 7 mm of space or less.[72]

Radiographs can also be helpful to visualize calcium deposits in the muscle itself as observed with calcific tendonitis.[66]

Ultrasound and/or MRI can be used to visualize soft tissue and bony abnormalities of the shoulder. When looking specifically at tendinopathy, ultrasound had a sensitivity of 0.70 and specificity of 0.94. Ultrasound and MRI may be used for investigation of the rotator cuff partial and full thickness tears.[66] A systematic review and meta-analysis looking at the diagnostic accuracy of ultrasound, MRI, and arthrogram in the presence of rotator cuff disorders found similar sensitivity between MRI (0.67) and ultrasound (0.68), while arthrograms were higher (0.83). Specificity ranged from 0.93-0.94 for all imaging modalities when diagnosing partial thickness tears.[73]

2.8 SHOULDER TENDINOPATHY-EXAMINATION/DIAGNOSIS

A diagnosis of shoulder impingement is typically made by clinical examination (subjective complaints of pain when raising arm and painful arc), including special tests (Hawkins Kennedy, and Neer's), and through diagnostic imaging studies (radiograph and MRI).

The tests used to implicate structures within the subacromial space include: presence of a painful arc, Neer, and/or Hawkins-Kennedy.[54,59] The respective sensitivity, specificity and reliability are as follows: Painful Arc (73.5%; 80.5%; substantial); Neer (68.0%; 68.7%; poor to fair); and Hawkins-Kennedy (71.5%; 66.3%; poor to fair).[47,54,60,61,74–78] The sensitivity and specificity of diagnosing rotator cuff pathology improves when using a combination of multiple special tests.[47] The diagnostic accuracy of these tests varies; each test has the potential to provoke other structures within the shoulder.[60,75,77]

2.9 SHOULDER TENDINOPATHY-MUSCLE CHANGES

Tendons are positioned between the muscle and the bone, which allows for force transmission between the two and for functional movement of the joint to occur.[79] In the shoulder, the rotator cuff allows for dynamic stability of the glenohumeral joint by generating a force couple and allowing the instantaneous center of reaction to maintain optimal position on the glenoid fossa.[80] In the presence of pain and shoulder tendinopathy changes in the tendon are observed. Initial studies found that in individuals who had chronic tendonitis of the supraspinatus and subscapularis there was increased water content and decreased collagen compared to healthy tissue samples. Furthermore, when collagen matrix continues to change over time there is a weakening of the musculotendinous structure resulting in further breakdown and degeneration.[81] Longo et al.,[82] in a review of histopathology of the rotator cuff reports that in a pathological tendon there are changes in collagen structure (degeneration and disordered arrangement of the fibers), tenocytes (decrease in number and become a more rounded shape), cellularity, and vascularity (contradictory findings-some studies found that there is a zone of hypo vascularity and others that there is no change).[82] Imaging studies have observed atrophy of the rotator cuff musculature (supraspinatus) and increased fatty infiltrate in cases with chronic pathology of the muscle-tendon unit.[83] This finding was further supported by findings from a murine animal model study where decreased muscle volume, increased muscle atrophy, and increased fatty infiltration was observed.[84] The presence of both atrophy and fatty infiltrate correlates with higher re-tear rates and negative outcomes following surgical repair.[83]

2.10 SHOULDER TENDINOPATHY-STRUCTURAL CHANGES

There are four classifications of acromion types: flat (type I), curved (type II), hooked (type III) and convex or upturned (type IV). A curved acromion is believed to be the most common type of acromion. This is where the acromion runs parallel to the humeral head with a concave undersurface, allowing for the most space in the subacromial arch. Hooked is the second most common and linked to shoulder impingement and rotator cuff tears.[69,85] This is where the distal 1/3 of the acromion slopes downward and the anterior portion curves or hooks into the subacromial space.[85] The shape of the acromion will alter the number of compressive forces that are transmitted onto the supraspinatus tendon. The amount of compression and impingement can be further influenced by the posture that the patient is exhibiting. A forward head posture can lead to rounded shoulders and increased thoracic kyphosis that may result in an anteriorly tilted, downwardly rotated and protracted scapula. This position will reduce the space for the supraspinatus tendon and lead to subacromial impingement syndrome.[63]

2.11 SHOULDER TENDINOPATHY TREATMENT CONSIDERATIONS-OVERVIEW

The treatment for shoulder pain, shoulder tendinopathy, and impingement syndrome ranges from conservative to surgical. Conservative treatment is aimed at management of the symptoms through positioning, oral medication, injections, activity modification, and physical therapy.

Surgically, changes in the shape of the acromion can be made to decrease the pressure between the humeral head and the acromion during elevation. When symptoms and structural integrity of the tendon progresses, then a rotator cuff repair can be

performed to maintain the stability of the shoulder through the force coupling mechanics. If the shoulder reaches a point where the rotator cuff is unable to function, a reverse total shoulder or total shoulder arthroplasty may be performed.

2.11.1 SHOULDER TENDINOPATHY-CONSERVATIVE TREATMENT

Conservative treatment can be utilized to manage patients with shoulder tendinopathy to decrease pain, inflammation, and trauma to the musculotendinous unit. Physical therapy is one modality that can be utilized to manage these impairments and may consist of a combination of manual therapy, exercise, neuromuscular re-education, and activity modification. Manual therapy is defined as a grouping of hands-on techniques (joint mobilization, manipulation, massage, and manual stretching) that are implemented to modulate pain, decrease edema, and restore mobility of extraarticular soft tissue structures.[30,46] The anatomical components that are changed by the implementation of manual therapy techniques, include the skin, fascia, ligaments, joint capsule, and musculo-tendinous structures.[30,46] Individuals with shoulder pain who have impaired soft tissue mobility of the joint capsule and/or surrounding muscles may benefit from manual therapy interventions to address the muscle length/mobility of the periscapular and anterior chest musculature (rhomboids, levator scap, upper trap, pectoralis major/minor), and joint mobilization in a posterior and inferior direction to improve the arthrokinematics of the joint.[15] A study by Michener et al.,[47] found that adding manual therapy to the shoulder and thoracic spine during a course of treatment in individuals with shoulder pain they had decreased pain, improved range of motion, and increased function compared to an exercise alone group.

Strength training is the most frequently used form of exercise in the treatment of individuals with tendinopathy and exercise programs may be more effective when tailored based on pain.[86] It has also been found that the use of exercises to improve strength and neuromuscular control of the cervical spine and shoulder resulted in improved pain, decreased disability scores, and improved patient satisfaction.[47] However, it is pertinent that consideration is made on the reasoning for the impairments of muscle performance. Ellenbecker et al.,[15] when looking at the treatment of patients with shoulder pain determined that the lack of muscle performance can be due to muscle control and/or lack of muscle strength. A lack of muscle control may be due to impaired sequencing and coordination (neuromuscular coordination) of muscle contraction to allow for co-contraction and force coupling that occurs with more complex movement patterns. Neuro-muscular re-education can be defined as interventions that facilitate the improvement of movement, balance, posture, coordination, and proprioception.[87] Strength can further be assessed through the ability to produce force and maintain it for a given period (endurance).[15]

2.11.2 SHOULDER TENDINOPATHY-SURGICAL TREATMENT

There are surgical options for patients with complaints of shoulder pain who present to therapy. Treatment is focused on the underlying pathology and the potential source of symptoms. When pain is the result of a hooked type acromion leading to inflammation and/or impingement of the supraspinatus tendon a subacromial decompression can be performed. This can be combined with techniques to remove or debride the subacromial bursa to increase the opening of the subacromial space.

If degeneration of the tendon progresses with time, compressive forces, and/or increased tension, the need for tendon repair may also be needed to improve the ability to dynamically stabilize the shoulder and improve an individual's function. If the integrity of the rotator cuff is absent the need for a joint replacement may be necessary. A reverse total shoulder can compensate for the lack of a functional rotator cuff. In this scenario the deltoid becomes the primary mover of the shoulder, and the convex and concave bony partners are reversed to be able to maximally allow the deltoid to generate movement and force.[65]

2.12 REHAB CONSIDERATIONS-PSYCHOSOCIAL

Considerations must be made on the psychosocial aspects of physical recovery. A study by Kromer et al.[88] found that fear avoidance, patient expectations and the duration of symptoms was the most constant predictor of long-term patient outcomes. Additionally, a study by Leong et al[68] found that individuals who had increased work demand, low job decision authority, poor safety commitment, job dissatisfaction, and low coworker support had increased risk of rotator cuff tendinopathy. When structuring a treatment plan for individuals with shoulder pain, the patient's pain level, social support, and work demands should be accounted for to decrease the psychosocial impact on recovery. The use of screening tools should be considered during the initial examination and throughout the course of their care.[89]

2.13 REHAB CONSIDERATIONS-SUMMARY

In summary, treatment of shoulder pain, whether it is due to underlying shoulder tendinopathy, shoulder impingement or due to tears in the rotator cuff can range from conservative to surgical. Conservative treatment aims at limiting postures and shoulder

positions that lead to compression of the tissues (subacromial compression), management of inflammation, improvements in both translatoric and angular motion, and restoration of strength. There are many pharmacologic agents that can assist with the management of this condition. Lastly, there are surgical interventions that can be utilized based on the stage of impingement and the degree of tissue breakdown.

2.14 HIP DYSPLASIA-BACKGROUND

Hip dysplasia, is a developmental condition characterized as an incongruency of the femoral head and the acetabulum.[10,11] A shallow hip joint results in decreased joint stability and increased demands on the surrounding labrum, joint capsule, ligaments, and muscles.[10] These structural abnormalities may result in early degeneration of articular cartilage, ultimately impacting a person's quality of life, function, mobility, and gait.[10,11,90]

Hip dysplasia is reported to occur in 1-2% of all newborns[90] or 1.5-20 individuals/1,000 live births.[91] It is more common in females compared to males, at a ratio[92] of 8:1 or 4:1 as reported by Ellsworth et al.[90] If hip dysplasia is left untreated or diagnosed later in life, it is one of the leading causes resulting in a total hip arthroplasty prior to the age of 50.[12,16,17,93] Clohisy et al.[12] reported that after analysis of 710 hip radiographs in individuals who had a total hip arthroplasty (THA) at a young age, that 99% of the cases had evidence of either hip dysplasia (48%) or femoral acetabular impingement (FAI). Femoral acetabular impingement is a hip condition that results in the bony overgrowth of either the femur (cam) or the acetabulum (pincer) creating over-coverage of the femoral head.

In the case of under-coverage, there is an inherent lack of bony stability, resulting in thickening of the anterior labrum[94] and hypertrophy of the iliocapsularis, rectus femoris, and iliopsoas muscles. [11,95] These structural changes occur due to the proximity to the anterior hip and the secondary role they play in hip stabilization. Morphological changes have been observed because of excessive use and degeneration, leading to the presence of symptoms.[12] Conservative and operative management becomes critical in the treatment of individuals with hip dysplasia to restore stability and prevent the progression of articular changes.[10,11,90]

Several surgical procedures are being utilized to disrupt the cycle of premature wearing of the hip joint. They can be classified as procedures to reorientate, repair, reshape, and/or resurface the hip. In cases where there is under-coverage, a periacetabular osteotomy (PAO) is performed to reorientate the acetabulum to provide better femoral head coverage, improve joint mechanics, and delay the progression of joint degeneration. Although the bony congruency and stability of the joint are improved through surgical intervention, it has been found that there are changes in the musculature post operatively.[11] A labral repair may also be made in combination with this procedure or in isolation, to improve stability of the hip joint. When there is over-coverage of the femoral head in cases with FAI (Cam and Pincer Types), reshaping of the femoral head/neck can be done to improve the congruency of the hip joint to decrease symptoms, improve ROM, and restore joint arthrokinematics.[8] Lastly, if significant articular cartilage changes have occurred the need for a total hip arthroplasty may be necessary.

2.15 HIP DYSPLASIA-RISK FACTORS

A meta-analysis performed in 2012, found that there was agreement on risk factors for hip dysplasia including family history, genetics, female gender, breech birth position and clicking of the hips during the infant clinical exam.[96] According to the International Hip Dysplasia Institute, a person is 12 times more likely to have hip dysplasia if a family history exists.[97] There is a 30-fold increased risk for the development of hip dysplasia among siblings and children with previous family history of hip dysplasia and the condition is more prevalent in certain ethnic groups.[98] An epidemiological study performed by Loder and Skopelja,[99] found that certain ethnic groups are predisposed to hip dysplasia due to genetics and culturally acceptable ways to position an infant. A higher incidence of hip dysplasia was observed in Native Americans due to genetics and the high incidence of swaddling with the legs adducted and extended, compared to people of African descent who had a lower incidence due to an abducted carrying position of the child when supported on the parent's hip.[99] The pressure of the femur against the acetabulum in an abducted position allows the convex joint partner to mold the acetabulum. When swaddled, the position does not allow the femoral head to sit deep within the acetabulum, resulting in an abnormal shape.[90,98]

Children that are larger at birth or a multiple have an increased risk due to the positioning within the womb and the pressure placed on the infant's hip joint.[99] There is a reported increased incidence rate of hip dysplasia in infants born in the breech position ranging from 12-24%.[100] A correlation has been found between torticollis, congenital foot deformity, and hip dysplasia as there is impaired in-utero positioning.[99] Lastly, body mass

index (BMI) can influence the development of the joint and as the person matures it can place more stress on the joint.[16]

2.16 CLINICAL CHARACTERISTICS-IMAGING

Hip dysplasia may present itself at varying stages throughout the lifespan. In many countries, a medical practitioner will perform an initial screening at the time of birth through passive range of motion.[90,101] Signs of popping or clicking of the hips warrant further investigation and this test is repeated for the first several years of life. As the child begins to move and walk independently symptom presentation may change, as there may be limited active hip abduction (ABD), antalgic gait patterning or toe walking.[102] As time progresses there may be mild instability with or without presence of symptoms. Individuals with symptomatic hip dysplasia often complain of anteromedial or lateral hip pain.[101]

A diagnosis of hip dysplasia is made by the clinical presentation and key radiological findings. Prior to the age of 3 years old, an ultrasound is used to diagnose the condition and after that time a standing radiograph is preferred.[102] The lateral center edge angle (LCEA) is the primary measurement used to diagnose hip dysplasia. It is measured by drawing a perpendicular line through the center of the femoral head and another to the edge of the acetabulum.[63] An angle of less than 20 degrees indicates hip dysplasia and borderline dysplasia is considered for measurements between 20-25 degrees.[63]

The angle of inclination is a radiographic measurement taken by drawing a line through the shaft of the femur and another line through the neck of the femur. In individuals without pathology, it is commonly 125 degrees, and persons with hip dysplasia it is often greater than 125 degrees (coxa valga). A study performed by Clohisy

et al.[103] found that when studying 108 hips who were treated with a PAO, 44% of them had underlying coxa valga. This illustrates that patients with hip dysplasia not only have femoral head abnormalities but also changes at the proximal femur.[103]

Acetabular Index (AI) or Tonnis angle can also provide evidence for hip dysplasia, as this radiographic measurement indicates the area of weight-bearing surfaces utilized by the individual. Tonnis angle is measured by drawing a horizontal line from the medial edge of the acetabulum and a line that crosses through both the medial and lateral edges.[104] If the angle is greater than 14 degrees it indicates hip dysplasia, and less than 14 degrees indicates FAI.

2.17 HIP DYSPLASIA CLINICAL CHARACTERISTICS MUSCULAR CHANGES

2.17.1 CLINICAL CHARACTERISTICS-MUSCLE CHANGES ANTERIOR HIP

Due to the proximity of the anterior hip musculature to the joint capsule, there is increased demand on the iliocapsularis, iliacus, psoas, and rectus femoris to provide anterior stability of the joint. Studies by both Babst et al.[21] and Haefeli et al.[22] demonstrated that changes in iliocapsularis size, cross sectional area (CSA), and diameter increased whereas the level of fatty infiltrate decreased in patients who have hip dysplasia compared to individuals with acetabular over-coverage or FAI of pincer type.

Babst et al.[21] in 2011 performed a retrospective analysis of 45 patients who had radiographical evidence of hip dysplasia (LCEA < 25° and AI of >14°) compared to 40 hips who had radiographical evidence of FAI (LCEA >39° and AI of <14°). When comparing characteristics of the two groups they had similar proportions in terms of age, laterality of the hip, height, weight, and BMI. There was a difference in the distribution of gender, with 45% of the individuals in the hip dysplasia group identifying as male and

35% in the FAI group. Images were pulled from a digital archive of individuals who had magnetic resonance imaging (MRI) arthrogram to evaluate the muscular characteristics of iliocapsularis. This lesser-known muscle originates from the anterior inferior iliac spine (AIIS) and anterior hip capsule while inserting on the femur just distal to the lesser trochanter. It lays beneath the rectus femoris and lateral to iliacus.[23] Its action is relatively unknown, but it is believed to be an important stabilizer in dysplastic hips and an important surgical landmark in patients undergoing a PAO.

Measurements were taken 4 cm below anterior inferior iliac spine (AIIS) and at the first section beyond the femoral head. Prior to commencing the study, the examiners performed reliability testing that ranged from 0.85-0.95 for intra rater reliability and inter-rater reliability 0.79 to 0.89. It was observed that iliocapsularis muscle thickness, width, CSA, and partial volume increased in the hip dysplasia group and fatty infiltrate was lower compared to those who have FAI. They believed that the iliocapsularis plays a greater role in stabilizing the femoral head in patients with hip dysplasia or under-coverage than those with FAI or over-coverage.

There were limitations of this study as it relates to imaging. Due to the constraints of using arthrogram to evaluate the joint they were unable to measure the distal most portions of iliocapsularis in all images evaluated. The second, is regarding the two groups. There were substantially more males in the hip dysplasia (45%) group, compared to the FAI group (35%). Prior epidemiological studies report dysplasia being more common in females than males at a ratio of male to female of 1 to 4 or 1 to 8.[90] Therefore the sample may not be reflective of the population affected by the disorder. Lastly, images were obtained from a digital archive with little information regarding their

clinical presentation. It is possible that their current presentation may have had an impact on muscular characteristics.

In a follow up study, by Haefeli et al.[22] they again wanted to investigate the role of iliocapsularis as a means to stabilize the anterior hip but found that it had little clinical utility alone because the size of the individual may impact the size of the muscle. They used rectus femoris as reference value because their characteristics are relatively unchanged in patients with underlying hip pathology. Utilizing the same data set as Babst et al.[21] with the addition of a control group consisting of 26 individuals who did not have any underlying hip pathologies, they measured the muscle characteristics of both rectus femoris and iliocapsularis at the level of the femoral head using MRI arthrogram. They found that in the group with hip dysplasia they had increased iliocapsularis muscle characteristics (size) compared to rectus femoris resulting in ratio ranging from 1.31 to 1.35. In the pincer group, iliocapsularis was smaller compared to rectus femoris resulting in ratio of 0.71 to 0.90. Lastly, the control group had an iliocapsularis to rectus femoris ratio of 1.08 to 1.15. There were limitations to this study. The first is that the images collected were in patients without the presence of symptoms. The other is because of the study design being retrospective in nature it is difficult to determine if the hypertrophy is due to the underlying pathology or other training adaptations.

Jacobsen et al. [95] found similar findings as were previously reported by Babst et al.[21] and Haefeli et al.[22] In this study they looked retrospectively at 100 patients who met the radiographic criteria for hip dysplasia (LCEA < 25°), had the presence of groin pain for greater than 3 months, and were scheduled for a PAO. They used ultrasound to detect muscle-tendon abnormalities in 8 structures and assessed for the presence of pain through

varying pressure of the transducer head. Imaging was collected by 2 physical therapists with detailed procedures to capture muscle characteristics of each structure. Prior to beginning data collection, a preliminary pilot study was conducted for reliability. Intra-rater reliability was 76-92% and inter-rater reliability was 64-84%. They found that 81% of patients had tendon abnormalities. These abnormalities were commonly found in the iliopsoas tendon (50%), followed by adductor longus tendon (31%), and gluteal muscle group (27%). Pain accompanied both the iliopsoas and gluteal muscle groups. The authors believed that due to the shallow nature of the acetabulum, there is decreased weight bearing surfaces of the joint and increased stress on the anterior labral complex. Because of the proximity of the iliopsoas to the anterior hip capsule this may have led to increased stress and strain on the tendon resulting in a loss of normal fibrillar organization and diffuse margins.

A study by Bartschat et al.[11] performed a prospective analysis using MRI images to evaluate the muscular characteristics of 17 muscles in 6 individuals, pre- and post-operative PAO (Smith-Peterson Approach). In the anterior musculature they found both the diameter (D) and cross-sectional area (CSA) decreased in the iliacus (D: -14.6%, CSA: -8.1%), psoas (D: -4.9%, CSA: -21.6%), sartorius (D: -16.2%, CSA: -14.1%) and iliocapsularis (D: -10.8%, CSA: -4.3%). These findings indicate that the increased bony stability that was gained by having a PAO may have allowed for decreased reliance on the anterior soft tissue to stabilize the femoral head within the acetabulum. There were limitations of this study in that it was a smaller sample size that may not be reflective of the greater population under-going PAO procedures. Although this study had a smaller

sample size of patients who had one type of PAO, they provided preliminary information on the impact of muscle and cartilage to help target future rehabilitation measures.

2.17.2 CLINICAL CHARACTERISTICS-MUSCLE CHANGES LATERAL HIP

Patients with hip dysplasia may also present with lateral hip pain and/or gait abnormalities including Trendelenburg. The role of the gluteus medius and hip abductors is to help stabilize the pelvis during the midstance phase of gait. If weakness is present, a drop of the contralateral side of the pelvis or side bending through the trunk toward the affected side may be observed.[90] In a 2022 Delphi Consensus statement, experts agreed that Trendelenburg gait is present and that assistive devices should be used post-operatively until retraining of the lateral hip musculature can be performed to minimize gait deviations.[105]

In the study performed by Jacobsen et al.[95] they found tendon abnormalities and pain present in the gluteus medius and minimus in 27% of the individuals in the study. Pain and changes in structure may be a direct result of the increased demand to provide lateral stabilization during gait. This percentage may not truly be reflective of the incidence in patients with dysplasia because of this study's inclusion criteria of groin pain versus lateral hip pain. Lastly, this study aimed to gather information about structural changes and pain. It is possible that the change in pressure through the transducer head may have impacted the quality of the image as the gluteal muscle groups, as they have a deeper insertion that the anterior musculature than was discussed previously. Bartschat et al.[11] also noted changes in both diameter and CSA when considering gluteus medius, gluteus minimus and tensor fascia latae (TFL) as a group, they had a decrease in CSA by 9.3% along with clinical findings of Trendelenburg gait.

A study by Chen et al.[106] retrospectively analyzed computed topography (CT) scans of 63 hips with hip dysplasia and 54 normal hips based on radiographic criteria that were equal for age, gender, and laterality of hip. They also found that the CSA, width, thickness, and length of glut medius was less in the patients with hip dysplasia compared to the control group.

2.17.3 CLINICAL CHARACTERISTICS-MUSCLE CHANGES POSTERIOR HIP

Less has been reported on changes in the posterior hip musculature in patients with dysplasia with and without surgical intervention. Bartschat et al.[11] found that the greatest amount of CSA increase occurred in the external rotators of the hip and showed no signs of muscle atrophy post operatively. The greatest changes were observed in the superior gemelli (Diameter: 45.2% CSA 36.6%), inferior gemelli (Diameter: 9.4%, CSA: 27.7%), and obturator internus (Diameter: -0.3%, CSA 4.2%). The lack of atrophy and increase in size may be due to the fact that in the Bernese Ganz PAO the posterior bony column is preserved,[107] resulting in inherent bony stability potentially resulting in less impact on the soft tissue.

2.18 REHABILITATION CONSIDERATIONS

The rehabilitation for patients with hip dysplasia is multi-faceted and complex, as attention needs to be given to neuromuscular re-education, range of motion, strength, and functional deficits. There is limited research regarding muscle performance adaptations and a lack of consensus on rehabilitation guidelines for patients with hip dysplasia. Understanding the muscular changes that occur will help to guide the selection of exercise and/or retraining interventions to improve these muscle characteristics, increase dynamic stability, and allow for greater functional performance. Understanding the

rehabilitation considerations that must be made for individuals with hip dysplasia are important to reduce complications, decrease symptoms, improve strength, increase quality of life, and restore function.

2.18.1 REHABILITATION CONSIDERATIONS-ACTIVITY MODIFICATION

Several precautions have been described to protect the integrity of the hip joint with both conservative and post-operative care. In a study by Hunt et al.,[13] that investigated the conservative management of individuals with hip dysplasia they listed precautions as no straight leg raises (SLR), performance of pain free range of motion and avoidance of hip hyperextension, femoral anterior translation, and loaded rotation of the femur.[13] The listed restrictions by Hunt et al.[13] are partially in agreement with Dr. Ira Zaltz[108], a regional hip PAO expert. In my clinical experience working with his patients, the following non-operative and operative restrictions: no straight leg raise (SLR), no squatting past 90 degrees, no joint mobilization, and weight bearing as tolerated are given. Squatting is limited to 90 degrees to decrease the likelihood of impingement.[109] In a study by, Yoshimoto et al.,[110] the authors measured the distance from the femoral neck to acetabular rim in patients with hip dysplasia during a squat. Anterior hip approximation occurred when maximal hip flexion was achieved (between 95-100 degrees of hip flexion), there was increased risk for femoral acetabular impingement (FAI), and increased joint translation prior to surgical correction with a PAO.[110]

Straight leg raises are often limited secondary to the increased demand required of the hip flexor musculature. Prior studies have indicated hypertrophy of the anterior hip musculature when structural instability of the joint is present. Over-utilization of the hip

flexor musculature may also lead to iliopsoas tendonitis and care must be taken when performing progressive loading exercises.[105]

There is limited consensus on the post-operative rehabilitation considerations that must be made. To define a post-surgical protocol, Disantis et al.,[105] conducted a Delphi study, consisting of 3 rounds of surveys given to a panel of 16 physical therapists in North America who were identified as rehabilitation experts. Their findings agree that there should be 25% weight bearing for the first 6 weeks with gradual weight bearing to allow for a return to a normalized gait pattern. Regarding range of motion, it should be limited to 90 degrees of flexion and 20 degrees of external rotation for the first 6 weeks with the goal being to restore full functional range of motion in the weeks 7-12. When progressing strength short arc motions are preferred and the performance of a straight leg raise or long lever hip exercise is contraindicated for the first 12 weeks. Weight bearing exercises should progress as tolerated with careful consideration made not to provoke any symptoms. Running, jumping, hopping, and/or pivoting is contraindicated until weeks 20-26, again monitoring for symptoms.[105]

Although there are discrepancies among the precautions and restrictions that must be observed, the common themes are to protect the hip joint, limit flexion ROM to decrease impingement of the hip, and prevent secondary tendinopathy with the performance of long lever leg raises.

2.18.2 REHABILITATION CONSIDERATIONS-MANUAL THERAPY

There is limited evidence regarding the implementation of manual therapy in patients with hip dysplasia. However, when considering the post-operative status, techniques such as superficial effleurage and lymphatic drainage can be used.[111] A study

by Rodrigues et al.,[111] noted that superficial effleurage not only improved micro-circulation of the affected limb but systemic circulation, allowing for improved mobility and decreased pain. In addition, the utilization of soft tissue mobilization for individuals with non-arthritic hip pain has been shown to be effective in the management of muscle restrictions.[112] Gaining an understanding of the effects of manual therapy on muscle stiffness, rigidity, mobility, and muscle length are important areas for future research.

2.18.3 REHABILITATION CONSIDERATIONS-NEUROMUSCULAR RE-EDUCATION

Due to the proximity of the hip and lumbar spine and the patterns of hypertrophy/atrophy of the hip musculature, compensatory movement patterns may develop. There is agreement among the literature that there is a need for neuromuscular re-education within this population.

A study conducted by McGovern et al.,[112] reported findings of a literature review on the management of non-arthritic hip pain. Non-arthritic hip pain included the diagnosis of FAI, dysplasia, labral tears, chondral lesions, and ligamentum teres tears. They found 49 articles that met the inclusion criteria for the literature review with 35 of the studies looking at FAI, 4 at labral tears, 1 on dysplasia and 9 that were a combination of pathologies. The findings advocated for patients receiving an individualized training program that addressed hip musculature strengthening (hip ABD and deep ER), pelvic positioning, posture, hip and lumbar stabilization, proprioception, and balance training. They noted that some of these neuro-muscular techniques should be implemented to prevent the over dominance of the hamstrings and/or quadriceps and to work on retraining musculature when maintaining a sustained posture.[13,112] When having to

maintain prolonged sitting they advised sitting with a backward lean to decrease both pain and the amount of hip flexion present. Lastly, they described the importance of muscle retraining during the return to sport phase of therapy. Based on the findings of this literature review, a home exercise program (HEP) was recommended to include standing hip ABD, a mini lunge, a side lunge, wall slides (with no more than 90 degrees of knee flexion), single leg balance, lateral walking, eccentric hamstring stretch, and anterior step downs.[112]

Post operative considerations were discussed by Disantis et al.,[105] rehabilitation experts advocated for the early implementation of neuromuscular re-education to normalize the gait pattern. The use of an assistive device in the first 4 weeks post operatively during ambulation was also advised. Between weeks 4-8 isometric contraction of the hip musculature and retraining of lumbopelvic control in supine is utilized. During weeks 6-12 posture, lumbopelvic control, and contraction of the hip musculature in closed chain conditions are initiated. After 12 weeks, neuromuscular re-education is used primarily to re-establish stability and control of the hip in sport specific scenarios. When constructing a treatment plan to improve neuromuscular control of the lumbar spine and pelvis it is advised to start in supine and progress to weight bearing activities challenging the frontal and transverse planes to increase muscle activation of the gluteus medius and hip external rotators.

In a study by Harris-Hayes et al.,[113] they investigated the relationship between movement pattern training (MPT) and its impact on patients with chronic hip pain function and intensity of symptoms through a RCT using a time-controlled design. Individuals were included in the study if they were between the ages of 18-40 years of

and had deep anterior hip or groin pain that was present for the last 3 months and reproduced with the flexion, adduction, and internal rotation test (FADDIR). A total of 35 participants were randomized into two groups, 17 people were in the waiting group and 18 in the MPT group, those in the waiting group, were used as a control as they delayed participation in MPT so that they could be compared to the group that initially went through MPT. Training consisted of 6 one-hour sessions and performance of a HEP over the course of 6 weeks. The therapist working with the patient evaluated the performance of daily tasks and performance of strengthening exercises to aid in the improvement of the functional activity. When satisfactory performance of the functional movement pattern was achieved, they moved to the next functional deficit. Ability to control hip ADD through activation and control of the hip ABD was a primary focus and resulted in decreased pain and improved function in the MPT group compared to the control group.

2.18.4 REHABILITATION CONSIDERATIONS-STRENGTHENING/HOME EXERCISE PROGRAM

In a study by Jacobsen et al.,[95] they investigated the use of exercise and patient education in the management of patients with hip dysplasia who were electing non-surgical intervention. They recruited a total of 36 participants (6 in the usual care group and 30 in the exercise and education group) for their feasibility study and utilized both qualitative and quantitative analysis to understand the impact on patient symptoms and expectations. Participants were included in the study if they met the following inclusion criteria: between 18-50 years of age, radiographic evidence of hip dysplasia, electing for non-surgical intervention, negative impingement tests, BMI > 25, and reduced hip range of motion < 95 degrees and < 30 ABD. During the course of 6 months, participants were

offered a total of 8 supervised exercise sessions (2x/month for 2 months followed by 1x/month for 4 months) where they were given a total of 4 exercises (supine plank, side plank, squat, and single leg stability exercise) and their corresponding progression and regression. Patients were asked to perform 3 sets of at least 5 reps at a frequency of 3 times per week. In addition to exercises, they were provided with resources to assist in weight loss if applicable, pain management, importance of exercise adherence and advice on physical activity. Improvements in the Hip and Groin Outcome Scale (HAGOS pain), symptoms and physical hip function tests all improved. Clinically relevant changes were noted in all but one direction of the Y balance test. Lastly, strength changes were observed with most patients being able to progress their exercises by the end of the study duration. Exercise adherence was determined to be high with 84% of exercise sessions completed. Qualitatively, themes were identified within the areas of adherence (high self-efficacy for exercise, facilitating factors and barriers to exercise), expectations (exercise is beneficial), perception of exercise (past experiences and exercise is healthy) and benefits (regaining control and challenging exercises).

A similar study design was proposed by Reimer et al.,[114] where they tested the efficacy of a hip PAO against a protocol for progressive resistance training. They cited that the probability of a person with hip dysplasia developing hip OA without a PAO is 13%. Subjects were recruited to this single-blinded RCT if they had radiographic evidence of hip dysplasia (Wiberg's centre edge angle < 25 degrees and Acetabular Index >10 degrees), clinical symptoms of hip dysplasia, were between 18-40 years of age and had range of motion deficits (>15 degrees hip IR, >15 degrees hip ER, and >110 degrees hip flexion). Participants were then divided into two groups, a PAO group and usual care

and a progressive resistance training group. Those in the progressive resistance training group performed a 10-minute warm up followed by loaded squats, and 3 resisted cable column exercises (hip extension, hip flexion, and hip ABD), 2 sessions per week with the number of sets and repetitions changing on a two-week interval.

In both the study by Jacobsen et al.[115,116]and Reimer et al.[114] they are provided exercise interventions that were initially supervised and then given to the patient as part of a home exercise and self-management program.

2.18.5 REHABILITATION CONSIDERATIONS-PSYCHOSOCIAL

The rehab process for patients with hip dysplasia can be long and arduous. Previous research has found that when pain persists over time there are many factors that impact the way the individual will self-report the subjective pain level.[117,118] Due to the nature of recovery from a PAO pain persists for longer periods of time resulting in anxiety and insomnia, both of which alters the brains processing of pain. Hip pain can result in decreased function. Pain catastrophizing, anxiety, and depression can be linked to decreased function in patients with osteoarthritis.[119–122] Previous research has found that when the mental health aspects of recovery are addressed there is an improvement in function and quality of life but there is limited evidence in a population of patients with hip dysplasia.

Previous research and literature reviews show that there are changes in bony morphology, and muscular characteristics when hip dysplasia is present. This ultimately results in changes in function and quality of gait. In both clinical and research settings these impairments are being captured using functional scales, such as the Lower Extremity Functional Scale (LEFS), International Hip Outcome Tool (iHOT), and the

Patient Specific Functional Scale (PSFS). The Fear Avoidance Belief Questionnaire (FABQ) and Depression Anxiety Stress Scale (DASS-21) are used in many populations to measure psychosocial impacts on function. Little research has been done on the potential relationship between fear avoidance, depression, anxiety, stress, and/or performance of functional activities in individuals with hip dysplasia. There is a potential that these psychosocial factors are impacting recovery of function.

2.18.6 REHABILITATION CONSIDERATIONS-SUMMARY

Many of the studies in this literature review considered treating the individual with some combination of activity modification, manual therapy, neuromuscular re-education, and therapeutic exercise. There was consensus in the following areas: strengthening the core and gluteal muscle groups, avoiding long lever hip flexion, and the progression of activities without increased pain. There was disagreement with the utilization of squatting and lunging. It is important to consider the patients' operative status, strength level, functional goals and required activities of daily living while constructing a rehabilitation program. We need to limit motions that may aggravate the surrounding soft tissue structures (long lever straight leg raise and squatting below 90 degrees) to limit any adverse outcomes. Consideration should also be given to the postural positioning assumed by the patient to decrease symptoms and prevent anterior hip impingement. Further studies are important to understand the impact of rehabilitation and its components on a patient's quality of life, mental health and return to prior level of function.

CHAPTER THREE

THE USE OF SYMPTOM LOCALIZATION IN THE DIFFERENTIAL DIAGNOSIS OF SHOULDER PAIN: A CASE REPORT.

3.1 ABSTRACT

BACKGROUND/PURPOSE: Shoulder pain is a common reason for seeking physical therapy. The origin of symptoms can arise from the shoulder or cervical spine. Symptom localization (SL) is a systematic method of selectively alleviating and provoking structures to identify the source of symptoms. The purpose of this case report is to illustrate the SL process used with a patient whose chief complaint was shoulder pain. CASE DESCRIPTION: A 29-year-old, right-handed female presented to PT with a 6-month history of right anterolateral shoulder pain that began after leaning on her right arm while driving. Symptoms were aggravated with lifting, reaching, and carrying items and alleviated by supporting her arm. A thorough history and medical screening was performed. The SL examination sequence: 1. Regional localization, 2. Structural localization 3. Confirmation testing. It was determined that the shoulder was the source of symptoms, more specifically the supraspinatus muscle tendon unit. Treatment was provided in phases, consisting of manual therapy and neuromuscular re-education. DISCUSSION: This case study provides an in-context example of using SL to rule out the cervical spine and identify the shoulder structure(s) producing pain. A limitation of a case report is that causality cannot be established. Further research is needed.

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3.2 BACKGROUND

Shoulder and neck pain are common reasons patients seek medical services.[48–50] The prevalence of shoulder pain in the general population ranges between 7-26%.[49,50] Anterolateral shoulder pain, a common clinical presentation, may potentially arise from the rotator cuff, acromioclavicular joint, structures within the subacromial space, and/or glenohumeral joint.[52–54] The C5-C6 nerve roots can also refer symptoms to the anterolateral arm, mimicking characteristics of rotator cuff pathology.[55,56] Physical therapy (PT) tests and measures commonly used to examine the cervical spine for radicular involvement may include: motion assessment, upper limb nerve tension test, myotomes, dermatomes, reflex screening, cervical traction, and/or compression, and Spurling's test.[6,57,58]

When examining the shoulder, the selection of tests and measures is dependent upon patient history, symptoms reported, and location. To improve the accuracy of the clinical diagnosis, multiple special tests can be used.[47,54,60,61] The tests used to implicate structures within the subacromial space include: presence of a painful arc, Neer, and/or Hawkins-Kennedy.[54,59] The respective sensitivity, specificity and reliability are as follows: Painful Arc (73.5%; 80.5%; substantial); Neer (68.0%; 68.7%; poor to fair); and Hawkins-Kennedy (71.5%; 66.3%; poor to fair).[47,54,60,61,74–78] The diagnostic accuracy of these tests varies; each test has the potential to provoke other structures within the shoulder.[60,77,78]

Given the complexity and intricate nature between the neck and shoulder, there is not an established examination process to differentiate between potential sources of symptoms and a variety of examination approaches may be used.[123] One method

described by Kaltenborn and Evjenth,[44,45] further developed by Krauss,[30,124] is symptom localization (SL). SL is a systematic process that includes selectively alleviating and provoking body regions, spinal segments, and/or anatomical structures to determine the source of symptoms. Regional localization is used to determine symptom origin when the potential source of symptoms is along nerve pathways, at adjacent body regions, or when the patient's description of symptoms is vague. The likely source of symptoms can be further specified through the application of segmental localization (spine) or structural localization to determine if the source of symptoms is a joint, muscle, tendon, nerve, or vascular structure.

Pain is alleviated first, when possible, through a combination of positional changes (active and/or passive) and/or graded application of manual pressures. To alleviate symptoms, the joint is positioned at the point symptoms begin, point of pain (POP), and then manual forces are utilized to reduce symptoms. Provocation, is a way to bring on a patient's symptoms by positioning the joint just prior to the onset of symptoms, verge of pain (VOP), and then using manual forces to increase symptoms. Alleviation and provocation may be used in sequence where the first test performed is confirmed by the second. During this dynamic and evolving process, the clinician must gather and integrate exam findings while applying knowledge of anatomy, arthrokinematics, and biomechanics to selectively identify the pain producing structures.

The purpose of this retrospective case report is to illustrate the SL process used with a patient whose chief complaint was shoulder pain.

3.3 CASE DESCRIPTION

3.3.1 PATIENT HISTORY

A 29-year-old, right-handed female presented to therapy with a chief complaint of right anterolateral shoulder pain. Pain began 6 months prior to the initial visit. The reported mechanism of injury (MOI) was resting on her right arm while driving for an extended period. The patient was unable to recall the specific neck and shoulder position that was maintained while driving. Symptoms were described as a shooting-clicking pain, aggravated by lifting, reaching, and carrying items, and alleviated by supporting the arm at her side. At the time of the examination, pain was reported as a 5/10 on the Numeric Pain Rating Scale (NPRS) and ranged from a 2-7/10 in the previous week **[TABLE 2]**. Primary functional limitations and goals of PT were identified as the ability to perform a shoulder raise, to do a push up, and improve shoulder mobility.

3.3.2 CLINICAL IMPRESSION (FOLLOWING THE PATIENT HISTORY)

The vague mechanism of injury, presentation of symptoms at the anterolateral shoulder, and pain along a nerve pathway may result from pathologies originating from either the cervical spine and/or shoulder. These are indications to perform regional localization.[30,124]

3.3.3 EXAMINATION

A thorough medical history, screening, and systems review did not identify flags suggesting medical pathologies. Postural assessment revealed rounded shoulders, increased upper trapezius and levator scapular muscle fullness bilaterally, and localized edema over the anterosuperior portion of the right shoulder.

Regional localization was utilized next, to differentiate between the neck and shoulder as potential sources of symptoms [**FIGURE 7**]. This began by defining the VOP and POP. POP was established by moving the patient completely out of symptoms and then slowly flexing the shoulder to the moment at which symptoms first returned. To determine VOP, the patient extended the shoulder out of pain completely and then moved back towards pain, stopping just prior to symptoms. Several repetitions were used to ensure consistent shoulder positioning prior to the application of SL.

The patient's shoulder was positioned at the POP and cervical traction was manually applied, resulting in no change in symptoms [**FIGURE 7**]. The shoulder was then positioned at the VOP and cervical compression was performed, resulting in no change in symptoms [**FIGURE 7**].

A second regional localization test was performed to evaluate the potential for nerve tension and foraminal compression. The patient's shoulder was positioned at the POP into flexion and then actively rotated the neck to the left and then right. No change in symptoms were noted and it was determined that the symptoms were more likely coming from the shoulder. [**FIGURE 7**]. Additionally, Spurling's test for the cervical spine was negative.

Regional localization findings reduced the likelihood of a cervical source; therefore, examination focused on the shoulder. During active and passive motion assessment, decreased range of motion into elevation on the right was identified [**TABLE 1**]. The presence of a painful arc was also noted during shoulder flexion active range of motion (AROM). Structural localization was performed by positioning the shoulder at the POP into elevation and then manually applying an inferior glide to the humerus. A

decrease in shoulder symptoms was noted. To confirm these findings the shoulder was positioned at the VOP and a superior glide of the humerus was applied resulting in the return of symptoms. [**FIGURE 8**].

Joint play was assessed using the 0-6 mobility scale,[45] hypomobility was noted in both inferior and posterior glides of the involved shoulder [**TABLE 1**]. Strength testing revealed weakness of the deltoid, middle/lower trapezius, supraspinatus, and infraspinatus when compared to the uninvolved side [**TABLE 1**]. A cluster of shoulder specific special tests (Hawkins-Kennedy, Neer, and Painful Arc) were positive. Active and passive muscle bowstring was positive for supraspinatus involvement [**FIGURE 9**]. Layered palpation identified tenderness of the upper trap, levator scapula, cervical paraspinals and the rotator cuff insertion on the greater tubercle.

3.3.4 CLINICAL IMPRESSION (FOLLOWING THE PHYSICAL EXAMINATION)

Structural localization findings indicated the supraspinatus as the source of symptoms. This was further supported by several positive special tests for the shoulder. Visceral contributions were ruled out with medical history, and cervical involvement was ruled out with regional localization.

3.3.5 DIAGNOSIS AND PROGNOSIS

The PT diagnosis was a muscle performance impairment of the supraspinatus with a suspected diagnosis of supraspinatus tendinopathy (ICD-10 codes: M75.41 and M75.91). The prognosis was good secondary to the absence of underlying medical comorbidities and the ability to manually and positionally alleviate symptoms.

3.3.6 INTERVENTION

Interventions were provided as outlined in [**TABLE 3**]. Considerations included tolerance to movement, acuity of symptoms, and stage of healing. Eccentric training was not selected first due to the level of pain and poor tolerance to load.

Intervention was divided into three phases. In the first phase, the primary focus was on pain reduction strategies. Soft tissues were managed by using techniques to decrease edema and improve tissue gliding through the application of grade I-II joint mobilization techniques and shortening functional massage techniques. Functional massage is a manual therapy technique that involves repeatedly moving the muscle into its primary or secondary movements in either a lengthening or shortening motion, combined with repetitive manual pressure (1 repetition every 2-3 seconds) to improve tissue mobility, decrease pain, and reduce edema.[124,125] Lastly, exercises were assisted by the therapist or supported an external suspension system (Red Cord).

The second phase of treatment focused on restoration of range of motion. Transition to this treatment phase began when pain decreased to 0-2/10 (NPRS) and assisted movements were tolerated without difficulty. Within this phase external support was removed and AROM within pain free range was initiated. Joint mobilizations were progressed to manage capsular restrictions and soft tissue techniques of the targeted muscles transitioned from shortening to lengthening.

The third phase, focused on restoration of muscle performance and strength. Soft tissue and joint restrictions were further addressed through lengthening functional massage and joint mobilization techniques respectively.

3.4 OUTCOMES

Symptom localization identified the shoulder as the region and supraspinatus as the structure. This was confirmed through special tests of the shoulder. Visceral contributions were ruled out with medical history. A targeted and phased treatment approach was implemented, yielding a decrease in pain (0-2/10) and return to prior functional activities. At the time of discharge, a score of 10/10 was recorded for all three items on the PSFS, a 4.5% on the qDASH, and 77/80 on the UEFS [**TABLE 2**].

3.5 DISCUSSION

Physical therapists have increased autonomy and incidence of direct access.[126] As a result, they need to have the ability to differentiate between all the potential sources of symptoms, especially when diagnostic imaging studies are not available or when the referral diagnosis is a symptom versus a pathology. The process of symptom localization provides a framework for the examiner to systematically determine the most likely source of symptoms.

Physical therapists may structure a musculoskeletal exam as a quick screen, a comprehensive exam, and/or a regionally focused examination.[86] The SL process lends itself well to the inclusion of all three components by progressing from regional localization to structural localization in response to findings during the examination.

It is currently recommended to perform a cluster of special tests for the diagnosis of shoulder or cervical pathologies.[47,53,60,61,74] There are mixed opinions on which special tests to select,[127] the optimal way to perform the tests and the best way to sequence their order during a physical exam.[128] In addition, physical special tests used to examine the neck and shoulder, such as Hawkins-Kennedy, Neer, Painful Arc, and Spurling's are all

provocation tests. If a provocation test is applied too soon in the examination sequence it is possible to irritate the structures, and a resolution of symptoms may not occur prior to the application of the next testing procedure. This may yield false positives and an inaccurate diagnosis.[128]

Symptom localization allows the practitioner to sequence testing to begin with alleviation prior to provocation, decreasing the likelihood of sensitizing the structures prior to the application of the next test. Beginning with alleviation testing provides the opportunity to build patient rapport and instill patient confidence in the practitioner, by demonstrating the ability to change symptoms. Pertinent information regarding palpatory pressure, movement tolerance and/or fear avoidance can be gained during the physical examination and used to structure an intervention plan. This information can also be utilized to build a set of self-management strategies the patient may use to manage their symptoms for their condition.[129]

This study is one example of the utilization of this process and is not without limitations. Its design, as a case report, limits the ability to draw inferences or define causality. In this scenario the patient was able to communicate both the movement and point in which symptoms began; however, not all patients are able to clearly articulate their symptoms.

3.6 CONCLUSION

The SL sequence allows the PT to selectively provoke and alleviate the potential sources of symptoms while considering the impact on adjacent structures. This case study provides an in-context example of using SL to rule out the cervical spine and identify the

shoulder structures producing pain. Further research is needed to determine the effectiveness of SL on a larger sample size with varying clinical presentations.

Figure 7: Regional Localization
Cervical vs Shoulder-Seated

Shoulder flexion with cervical traction

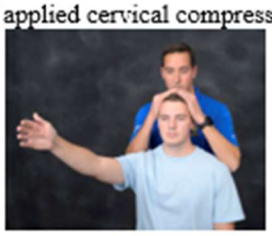
Patient positioned shoulder at POP in flexion

PT applied cervical traction

No change in symptoms were reported by the patient

Patients shoulder was positioned at VOP in flexion

PT applied cervical compression



No change in symptoms were reported by the patient

Shoulder flexion with cervical rotation

Patient positioned shoulder at POP in flexion

Patient was asked to rotate their head toward their affected (right) shoulder

No change in symptoms were reported by the patient

Patient was asked to rotate their head away from their affected shoulder

No change in symptoms were reported by the patient

Interpretation: Cervical spine is less likely the source of symptoms, proceed with structural localization of the shoulder.

Figure 8; Structural Localization
Shoulder Pain with Forward Flexion-Subacromial

Distraction (Alleviation)

Patient positioned shoulder at POP in flexion

The therapist supported the patient's arm at the POP and applied a caudally directed force

The patient reported a reduction of symptoms

Compression (Provocation)

Patient positioned shoulder at VOP in flexion

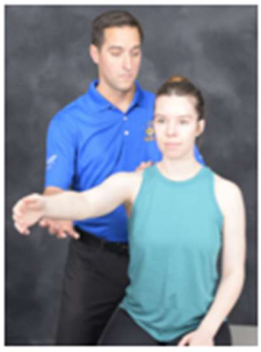
The therapist supported the patient's arm at the VOP and applied a cranially directed force

The patient reported a return of symptoms

Interpretation: Pain is provoked with subacromial compression and alleviated with subacromial distraction.

Figure 9: Structural Localization
Shoulder Pain with Forward Flexion-Bowstring

The therapist palpated the supraspinatus muscle belly and gradually applied pressure to the POP and then lessened pressure until symptoms had just begun to diminish (VOP)



The therapist maintained the same palpatory pressure at the VOP and began to ADD and IR the shoulder.

The patient reported the return of symptoms to the same level as the pre-determined POP.

The palpatory pressure was removed by the therapist and the patients pain resolved.

Interpretation: Positive supraspinatus passive muscle bowstring.

Table 1: Initial Examination Objective Findings

Table 1: Initial Examination Objective Findings

ROM			Joint Play*			Strength					
Direction	Left	Right	Direction	Left	Right	Muscle	Left	Right	Muscle	Left	Right
Flexion	180	150	Traction	4/6	2/6	Deltoid	4/5	3+/5	Infraspinatus & Teres Minor	4+/5	4-/5
Extension	50	30	Inferior	4/6	2/6	Middle Trapezius	4+/5	3+/5	Teres Minor	4+/5	4-/5
Abduction	180	150	Anterior	4/6	3/6	Lower Trapezius	4+/5	3+/5	Teres Major	4+/5	3+/5
Horizontal Abduction	20	10	Posterior	4/6	3/6	Supra-spinatus	4+/5	3/5	Rhomboids	4+/5	3+/5
Function External Rotation	T6	T6				Biceps Brachii	4+/5	4-/5			
Functional Internal Rotation	T9	T10									

* Joint play was assessed using the 0-6 mobility scale. (3/6 = normal, less than 3/6 = hypomobile, greater than 3/6 = hypermobile)

Table 2: Shoulder Outcome Measures

Table 2: Measurement Tool Findings					
Week	**UEFS**	**NPRS**	**qDASH**	**PSFS**	
Initial Evaluation	-	5/10	31.8%	Shoulder Raise Push Ups Reach Behind Back	2/10 2/10 4/10
Week 4	68/80	0/10	11.36%	Shoulder Raise Push Ups Reach Behind Back	4/10 4/10 5/10
Week 5-6	-	0/10	-	Shoulder Raise Push Ups Reach Behind Back	6/10 5/10 7/10
Week 8	77/80	1/10	4.5%	Shoulder Raise Push Ups Reach Behind Back	10/10 10/10 10/10
6 Month Follow Up Phone Call	-	0/10	-	Shoulder Raise Push Ups Reach Behind Back	10/10 10/10 10/10
2 Year Follow Up Phone Call	-	0/10	-	Shoulder Raise Push Ups Reach Behind Back	10/10 10/10 10/10

Table 3: Shoulder Intervention Summary Table

Table 3: Right Shoulder Treatment Interventions			
	Manual Therapy		Therapeutic Exercise
Treatment Phase*	Soft Tissue	Joint**	
Phase I: Pain Reduction	Shortening functional massage of the biceps long head, supraspinatus, upper trapezius, and levator scapula (supine)	Glenohumeral traction mobilization with & without soft tissue mobilization grades I-II Glenohumeral inferior glide grades I-II	Resting position with pillow (education on various ways to perform) Supported abduction & flexion in Red Cord
Phase II: Restoration of Range of Motion	Lengthening functional massage of upper trapezius & levator Scapula, & massage of the supraspinatus & biceps long head in mid-position	Prone thoracic bilateral facet separation at low velocity mobilizations with a wedge G II-III posterior to anterior direction	Supine scapular retraction Side-lying external rotation with a towel Low Salutes***
Phase III: Restoration of Strength	Lengthening functional massage of the infraspinatus, teres minor, and rhomboids	Scapular mobilizations Glenohumeral inferior glide grades I-III	Manually resisted low salutes Standing row, internal rotation, & external rotation with red TheraBand Wall push ups Prone row and extension with 2# weight
*Treatment phases do not correlate with stages of healing. ** Joint mobilization grades on the Kaltenborn-Evenith Scale ***Supine shoulder flexion to eye level with elbow bent to 90 degrees			

CHAPTER FOUR

THE RELATIONSHIP BETWEEN PSYCHOSOCIAL FACTORS AND PATIENT REPORTED FUNCTIONAL IMPAIRMENTS IN INDIVIDUALS WITH HIP DYSPLASIA: SURVEY RESEARCH

4.1 ABSTRACT

BACKGROUND: Hip dysplasia, a condition resulting in an incongruency of the hip joint, can lead to early cartilage breakdown, decreased strength, altered walking, decreased quality of life, and functional deficits. Conservative and at times operative management may be necessary to address altered arthrokinematics and delay articular cartilage changes. Rehabilitation is multi-faceted and complex for a variety of reasons. This study looked at the relationship between psychosocial factors and function. METHODS: An electronic survey consisting of demographic information, the International Hip Outcome Tool (iHOT), Fear Avoidance Belief Questionnaire (FABQ), and Depression Anxiety Stress Scale (DASS-21) was posted in physical therapy clinics and on social media support groups for individuals with hip dysplasia. RESULTS: A total of 84 participants met the inclusion criteria of having a history of hip dysplasia and did not meet the exclusion criteria (history of spinal fusion, and/or a total hip replacement). A linear relationship ($r^2 = 0.34$) was observed between the iHOT and psychosocial outcome measures (FABQ and DASS-21). A moderate relationship ($r = -0.59$) between function (iHOT) and fear avoidance behavior (FABQ), and a small relationship ($r= -0.24$) between function (iHOT) and the DASS-21 was observed in the sample population. Factors including pain frequency, pain intensity, HEP frequency, and participation in sport had an impact on iHOT, FABQ, and/or DASS-21 scores, although no single factor contributed more significantly than others. DISCUSSION/ CONCLUSION: Multiple factors should

be considered when treating individuals with hip dysplasia due to the linear relationships between FABQ, DASS-21, and iHOT scores. The impact on function may leave individuals less mobile and at increased risk of mental health conditions. The utilization of therapist directed strategies, self-management techniques, and use of an interdisciplinary team may be needed in the treatment of individuals with hip dysplasia.

4.2 BACKGROUND

Hip dysplasia is an orthopedic condition characterized by incongruency between the femoral head and the acetabulum.[10,11] As a result, structural changes can lead to impaired stability, and increased demands on the soft tissue.[10,11,90,94,95] If left untreated prolonged abnormalities in joint mechanics may result in early articular cartilage degeneration, decreased strength, altered gait, decreased quality of life, and functional deficits.[12,16,17,93] Common functional deficits in this population include difficulty with prolonged sitting, standing, walking, stairs, quick pivot motion, and transfers from sitting to standing.

Conservative and at times operative management are routinely used to improve joint mechanics, while attempting to decrease the progression of articular changes.[16,97,101–103,130,131] Conservative treatments are aimed at restoring strength and neuromuscular control of the hip stabilizers due to morphological changes of the iliocapsularis, rectus femoris, and iliopsoas muscles.[11,22,23,90,94,95] These structural changes occur due to the proximity to the anterior hip joint and the secondary role they play in hip stabilization. A decrease in gluteus medius cross-sectional area (CSA), decreased hip flexor volume (iliopsoas and iliocapsularis), and increased external rotator muscle volume has been observed.[21–23,106,107,110] Due to the nature of the underlying pathology,

morphological changes in the muscles, and time required to make strength and motor control gains, a longer course of physical therapy to return to desired activities may be needed.[132]

At times, surgical intervention is required to improve joint congruency through reorientation, resurfacing, reshaping, and/or soft tissue repair.[10] When significant joint degeneration has occurred, a joint replacement may be warranted.[11,109,110] Hip dysplasia is one of the leading causes of pre-mature hip osteoarthritis and the need for a total hip arthroplasty prior to age 50.[13,103] The course of rehabilitation may change based upon healing times, and individual variations. In both conservative and surgical care pain may persist for longer periods of time resulting in anxiety and insomnia,[121] both of which alter the processing of pain by the central nervous system.

When pain persists over time there are many factors that impact the way an individual experiences and reports their pain level.[117,118] Chronic pain can cause central and/or peripheral sensitization to pain stimuli and heighten the perception of pain.[133] This may contribute to prolonged pain, and the potential development of anxiety, and/or depression, further compounding the pain experience.[133] Hip pain can result in decreased function, pain catastrophizing, anxiety and depression while being linked to decreased function in patients with hip dysplasia.[120,122] Previous research has found that when the mental health aspects of recovery are addressed there is an improvement in function and quality of life, but there is limited evidence in a population of patients with hip dysplasia.[41,122,134]

There is a lack of consensus on rehabilitation guidelines for patients with hip dysplasia.[105,110] Rehabilitation whether conservative or surgical, is multi-faceted and

complex, including neuromuscular re-education, range of motion, soft tissue restrictions, strength, and functional deficits.[30,105,111,112] The International Hip Outcome Tool (iHOT) is routinely used in clinical and research settings to capture a person's perceived functional level. The Fear Avoidance Belief Questionnaire (FABQ) is used to measure psychosocial impacts on function. The DASS-21 is a widely available screening tool, that can be used in the community, clinical, and in research settings. Little research has been done on the potential relationship between fear avoidance, depression, anxiety, stress, and/or perceived performance of functional activities in individuals with hip dysplasia. There is a potential for these psychosocial factors to impact recovery of function.

The purpose of this study is to explore the potential relationship between psychosocial factors (fear avoidance, depression, anxiety, and stress) and self-reported function, in individuals who have been diagnosed with hip dysplasia. It is hypothesized that there are psychosocial barriers to recovery and the return to prior level of function.

4.3 METHODS SUMMARY

This descriptive study was approved by the Institutional Review Board (IRB) of the sponsoring institution. Participants were then recruited through convenience, snowball, and/or purposive sampling using fliers placed in physical therapy clinics and via hip dysplasia social media support groups. Potential participants who were the age of majority, after providing electronic consent, were given access to take the survey. Surveys were made available to individuals aged 12-17 after receiving parent permission and assent forms. An electronic survey was completed via Qualtrics. Participants were included in the study if they reported a physician diagnosis of hip dysplasia, ability to access the internet, and ability to read at an 8th grade level. Exclusion criteria were

presence of an artificial hip joint, concurrent lumbar radiculopathy, lumbar stabilization procedures (i.e. spinal fusion), or inability to complete the survey.

The survey consisted of a de-identified demographic questionnaire, functional assessment (iHOT), and psychosocial measures (FABQ and DASS-21). The demographic portion of the survey included information regarding height, weight, past medical history, date of onset, treatments received, symptom characteristics including pain scores, participation in sport, and current function.

Participant current functional level was investigated through the utilization of the iHOT, a functional outcome measure that has well established reliability, validity, and is responsive to change.[135] The iHOT is a 33 item, 4 section (1. Symptom and function, 2. Sports and recreational activities, 3. Job related concerns, 4. Social, emotional and lifestyle concerns) outcome measure, that is used to assess the quality of life for young, active patients with hip problems. Those completing the iHOT are traditionally asked to indicate on a visual analog scale (VAS) line of 100 mm the level of difficulty with each item, with 'extreme difficulty' on the far left and 'no difficulty' on the right. A total score is calculated as a mean of all VAS scores, with a lower score indicating greater impairments in function. A study comparing the reliability of completing a VAS on paper and electronically found similar results when comparing the two methods of data collection. [136] This addressed concern about completion of the iHOT electronically versus on paper.

Information regarding the psychosocial status of participants was gained through the completion of both the fear avoidance belief questionnaire (FABQ), and the depression, anxiety, and stress scale (DASS-21). The FABQ is a 16 item, 2 section (1.

Physical Activity, and 2. Work) functional outcome measure that is frequently administered to individuals who have low back and lower extremity pathologies.[39,40] Those completing the FABQ are asked to respond to each question using a 7-point Likert scale, with 0 indicating they completely disagree to 6 meaning they completely agree. A maximum score of 96 is available with higher scores indicating greater levels of fear avoidance behavior. It has been shown to be a reliable test in individuals who have low back and neck pain. Although no studies were located that document the use of the FABQ in individuals with hip dysplasia, one study reports that fear avoidance beliefs adversely influenced functional levels in individuals recovering from ACL reconstruction.[41]

The DASS-21 consists of 21 items, that can be divided into 3 subscales (1. Depression, 2. Anxiety, 3. Stress). The DASS-21 is scored on a 4-point scale with 0 indicating the that the item 'does not apply' to 3 where the question 'applied to me very much or most of the time. Given the typical age of diagnosis, time spent in physical therapy, and/or recovery from major corrective surgery individuals with hip dysplasia have the potential to have increased levels of depression, anxiety, and/or stress. These individuals may have had to modify or change participation in sports/activities, limit their social interaction, or take time away from work as a result of their diagnosis. The DASS-21 has documented reliability and validity, and has been utilized in multiple studies to explore the psychological impact on function.[42,43,137]

Data was then analyzed using Microsoft excel for descriptive statistics, R and RStudio (version 2024.12.1+563) for Spearman rank correlation to investigate relationship between two variables and linear regression to study relationships among multiple variables.

4.4 RESULTS

Of the 245 respondents, a total of 84 participants **[FIGURE 10]**, 81 females and 3 males, with a mean age of 28.4 years old, and a mean BMI of 26.26 met inclusion criteria and completed the survey **[TABLE 4]**. Daily pain scores ranged from 1 to 8 out of 10 on the numeric pain rating scale (NPRS) **[TABLE 5]**, 39 (46%) of the participants experienced symptoms 7 days per week **[TABLE 5]**, and medications were used to manage symptoms in 36 (43%) participants **[TABLE 4]**. Scores on the iHOT (mean = 48.2), FABQ (mean = 35.4), and DASS 21 (mean = 31.6) indicated functional and psychosocial impairments **[TABLE 5]**.

Of the 84 respondents, 19 individuals did not have surgery and 65 had surgical intervention on their hip **[FIGURE 11]**. Of the 65 individuals who had surgery on their hip, 49 individuals reported surgical intervention and date of surgery with a mean time since surgical intervention of 2.57 years (range of 2 months to 11 years) **[FIGURE 11]**. Eleven individuals or 13.1% of the respondents were in the acute phase of recovery as defined for this study as being less than 1 year out from surgery **[FIGURE 11]**. The largest subset was those in the chronic phase of recovery and greater than 1 year out of surgical intervention **[FIGURE 11]**. This included 39 respondents or 46.4%.

A total of 14 (16%) participants self-reported ‘mental health’, ‘anxiety’, and/or ‘depression’ in their past medical history **[TABLE 4]**. FABQ, scores greater than or equal to 15 on the physical activity and 34 on the work subscales indicate high scores. A total of 49 (58.3%) of participants had elevated fear avoidance related to physical activity with a mean score of 14.9 **[TABLE 5]**. Two participants (2.4%) had elevated fear avoidance related to work with mean score of 12.65 **[TABLE 5]**. Results from the DASS-21

revealed 42 (50%) participants were above normal levels for depression, 31 (37%) for anxiety, and 39 (46%) for stress **[TABLE 5]**. When looking at the subscales of the DASS-21, depression (mean = 10.3 ± 8.9), anxiety (mean = 6.6 ± 6.6), and stress (mean = 14.7 ± 7.5) **[TABLE 5]**. Of those in the elevated ranges, 5 participants were at the 'extremely severe' range for anxiety, 5 for depression, and 0 for stress.

A moderate linear relationship (r = -0.59, p-value = 2.458e-09, 95% CI: -0.43 to -0.717) was observed between the FABQ and iHOT **[Figure 12].** A small correlation coefficient (r = -0.24, p-value = 0.028, 95% CI: -0.43 to -0.027) was noted when comparing the DASS-21 total score to the iHOT **[Figure 13]**. A linear relationship (r^2 = 0.34) exists between the iHOT and psychosocial outcome measures (FABQ and DASS-21) **[FIGURE 14]**.

Further analysis revealed a negative correlation between pain frequency (r = -0.58, p-value = 0.002), and pain intensity (r = -.68, p-value = 7.438e-12) when compared to the iHOT. Pain frequency (r = 0.34, p-value = 0.002) and pain intensity (r = 0.40, p-value = 0.0003) were positively correlated with the FABQ. A similar relationship was observed between the DASS-21 total scores and pain frequency (r = 0.23, p-value = 0.03), and pain intensity (r = 0.35, p-value = 0.001).

There was variation in responses regarding the highest level of sport that participants competed in (recreational to professional). At the time of the survey, 75% of the respondents reported that they are no longer participating in sports. There was a small and statistically non-significant relationship between participation in sport (r = -0.21, p-value = 0.07), and home exercise program (HEP) frequency (r = 0.20, p-value – 0.07) with scores on the FABQ. Analogous findings were observed for the DASS-21

HEP frequency (r = 0.10, p-value = 0.37) and still competing in sport (r = -0.25, p-value =0.03).

4.5 DISCUSSION

The purpose of this study is to explore the potential relationship between psychosocial factors (fear avoidance, depression, anxiety, and stress) and function in individuals who have been diagnosed with hip dysplasia.

In the demographic portion of the survey, 16% of participants self-reported mental health challenges. Scores on the psychosocial outcome measures were elevated in the areas of fear avoidances, depression, anxiety, and stress in 37-58% of the respondents. The relationship of the iHOT to the DASS-21 and FABQ had an r^2 value of 0.34 indicating that these two psychosocial outcome measures explain 34% of the variation in function as measured by the iHOT.

As FABQ and DASS-21 scores increased, a decrease in iHOT scores was observed. These relationships can be used to understand the impact the dimensions tested on the psychosocial outcome measures, have on functional status (iHOT). No single factor contributes more weight to this relationship, as there was a small and statistically non-significant relationship between psychosocial outcome measures scores on HEP performance and participation in sport/recreational activities. Patients who remain active in sport and HEP have lower fear avoidance scores, which may be related to the impact of exercise on mental health or having a management strategy in place.[138] Poorer mental health outcomes have been observed in individuals who are sedentary and have decreased function.[139]

As physical therapists, addressing only the physical side of recovery may not be sufficient, but rather a comprehensive approach may be needed. This can start by screening patients, modifying the delivery of care, and the training to identify and respond to mental health challenges. The relationships between iHOT, FABQ, and DASS-21 further illustrates the need for screening and possibly early multidisciplinary intervention. When the FABQ scores are greater than 15 on the physical activity section, and 34 on the work subscale, it indicates that they are at high risk for fear avoidance behavior.[140] When scores on the DASS-21 are elevated (depression greater than 10, anxiety greater than 8, and stress scores greater than 15) it suggests high levels of distress.[141] In both instances, referral to mental health professionals may be needed for further evaluation. When FABQ scores fall below a 15 and 34 for the physical activity and work subscales respectively, there are early interventions or considerations that can be incorporated into the plan of care. Physical therapists play a role in offering suggestions, modifications, or alternatives to increase interaction within their environment.

Screening for physical and psychosocial impairments and may consist of a variety of tools and/or training. This study provides evidence of the role that the DASS-21 and FABQ can play in detecting psychosocial impairments in this population. Mental health first aid training can provide therapists with the tools and strategies needed to identify and respond to individuals who may be at risk for a mental health issue. “Mental Health America” an online resource, offers free screening tools and other mental health resources- free to the public. When elevated levels are detected, a referral back to the

physician and or recommendation of consultation with a mental health professional, may be beneficial for those most at risk, as identified by the DASS-21 and FABQ.

Physical therapists have the freedom to modify the way in which each treatment session is structured. Modifications may consist of offering transition time, a quiet space, objective encouragement, and strategies such as mindfulness to those who have elevated levels of stress or anxiety.

Encouraging self-care, is another way that the physical therapist can advocate for overall patient wellness. We can suggest that our clients consider the 8 domains of well-being (emotional, physical, occupational, social, spiritual, intellectual, environmental, financial) with the goal of improving balance. Balance of these components provides optimal wellness; when one or more of these domains are out of balance then increased distress can occur. As indicated by the findings from this study, the use of outcome measures can identify functional and psychosocial impairments. With this information, we can guide patients to the appropriate resources within their medical team, and/or community.

Limitations of this study include smaller sample size, which may be the reason that a small and non-significant relationship between HEP performance and participation in recreational activities was observed. In addition, distribution was not sufficient to understand the impact of surgical vs non-surgical management on DASS-21, FABQ, and iHOT scores. The sample was largely comprised of females (81 of 84) which is reflective of a population of individuals with hip dysplasia and scores on the DASS-21 are often higher for women specifically in the areas of depression and anxiety. Therefore, elevated

scores on the DASS-21 could be influenced not only but the hip condition, but also by gender-related differences in how people experience stress, anxiety, and depression.

It is recommended that future research investigate the statistical impact of a larger sample size on the factors of HEP performance and participation in recreational activities. In addition, it would be of interest to evaluate the effectiveness of an early intervention plan for individuals with elevated FABQ and DASS-21 scores and determine if it would change their trajectory on the iHOT. Lastly, consideration should be made to see whether the impact of surgery changes the relationship between fear-avoidance and function. This analysis was not made in the current study as the subject sample did not have equal distribution between the two groups.

4.6 CLINICAL RELEVANCE

There are multiple factors that need to be considered when structuring a treatment plan for individuals with hip dysplasia. In addition to physical impairments, psychosocial status needs to be considered at the initial examination, and throughout the course of care. The utilization of the FABQ and DASS-21 in addition to the iHOT may be needed to make an accurate assessment of the individual psychosocial status and allow for a comprehensive approach when constructing a treatment plan. Mental Health First Aid, is a training course for community members and non-mental health providers, that can help to train the physical therapist to appropriately respond to elevated fear avoidance and distress levels.

4.7 CONCLUSION

A linear relationship between iHOT, FABQ and DASS-21 scores exists. As psychosocial outcome measure scores increased, a decrease in iHOT scores was

observed. No single factor contributes more weight to this relationship as small and non-statistically significant correlation was observed between FABQ and DASS-21 scores and HEP performance and participation in sport/recreational activities indicating that there are potential factors that explain the relationship between the two outcome measures. Those who stay active in sport and HEP have better FABQ and DASS-21 scores, which may be related to the impact of exercise on mental health or having a management strategy. This is a place where physical therapist and an interdisciplinary team could intervene through the structuring of a comprehensive intervention plan.

TABLE 4: Hip Dysplasia Demographics

Variable	
Age (year) mean ± SD	28.35 ± 6.45
Gender n (%)	
Male	3 (3.6%)
Female	81 (96%)
Ethnicity n (%)	
White	76 (90%)
Asian	3 (4%)
Asian + White	1 (1%)
African American + White	1 (1%)
Native American + White	1 (1%)
Hispanic/Latino	1 (1%)
Height (m) mean ± SD	1.66 ± 0.07
Weight (kg) mean ± SD	72.45 ± 15.25
BMI (kg/m^2)	26.26 ± 4.83
Variable	
Laterality n (%)	
Left	15 (18%)
Right	21 (25%)
Bilateral	48 (57%)
Surgery n (%)	
Yes	65 (77%)
No	18 (21%)
Maybe	1 (1%)
Medication n (%)	
Yes	36 (43%)
No	37 (44%)
Maybe	11 (13%)
Medication Category n (%)	
OTC	30 (36%)
RX	5 (6%)
OTC + RX	10 (12%)
Other	2 (2%)
NA or No	37 (44%)
Highest Level of Sport n (%)	
None	6 (7%)
Recreational	24 (29%)
Recreational + High School	9 (11%)
High School	22 (27%)
High School + College	1 (1%)
College	19 (23%)
College + Professional	1 (1%)
Professional	1 (1%)
Past Medical History n (%)	
Anxiety and Depression	14 (16%)

TABLE 5: Hip Dysplasia Functional Outcome Measures (FOM)

Functional Outcome Measure	
iHOT Total ($\overline{X}$ ± SD)	48.22 ± 20.83
Symptoms and Function	55.80 ± 22.29
Work	46.44 ± 26.97
Sports and Recreation	37.33 ± 25.24
Social and Emotional	38.21 ± 23.83
FABQ Total ($\overline{X}$ ± SD)	35.38 ± 16.16
Physical Activity	14.90 ± 5.34
Work	12.65 ± 9.78
DASS-21 Total ($\overline{X}$ ± SD)	31.57 ± 19.92
Depression	10.31 ± 8.88
Anxiety	6.55 ± 6.60
Stress	14.71 ± 7.51
Pain (NPRS) ($\overline{X}$ ± SD)	
Best	2.13 ± 2.02
Worst	7.55 ± 1.78
Current	3.67 ± 2.41
Pain Frequency n (%)	
0-1 Days	8 (10%)
1-2 Days	10 (12%)
2-3 Days	5 (6%)
3-4 Days	9 (11%)
4-5 Days	6 (7%)
5-6 Days	7 (8%)
7 Days	39 (46%)
Key: $\overline{X}$ = mean, SD= standard deviation, n = number	

FIGURE 10: Hip Dysplasia: Survey Response Diagram

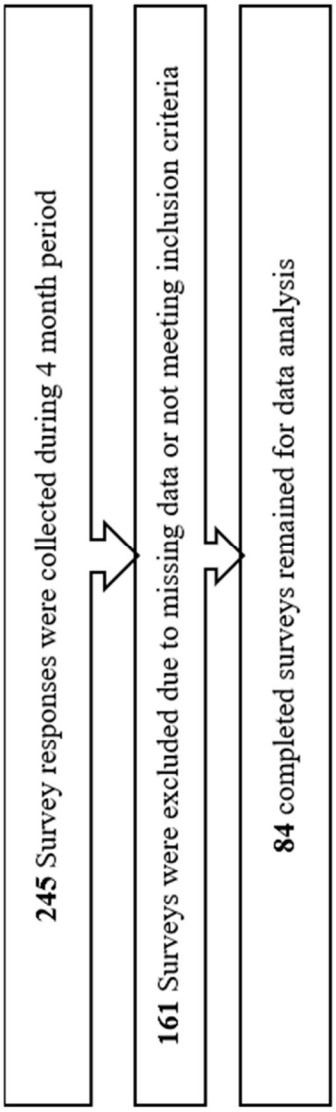


FIGURE 11: Length of time since surgery

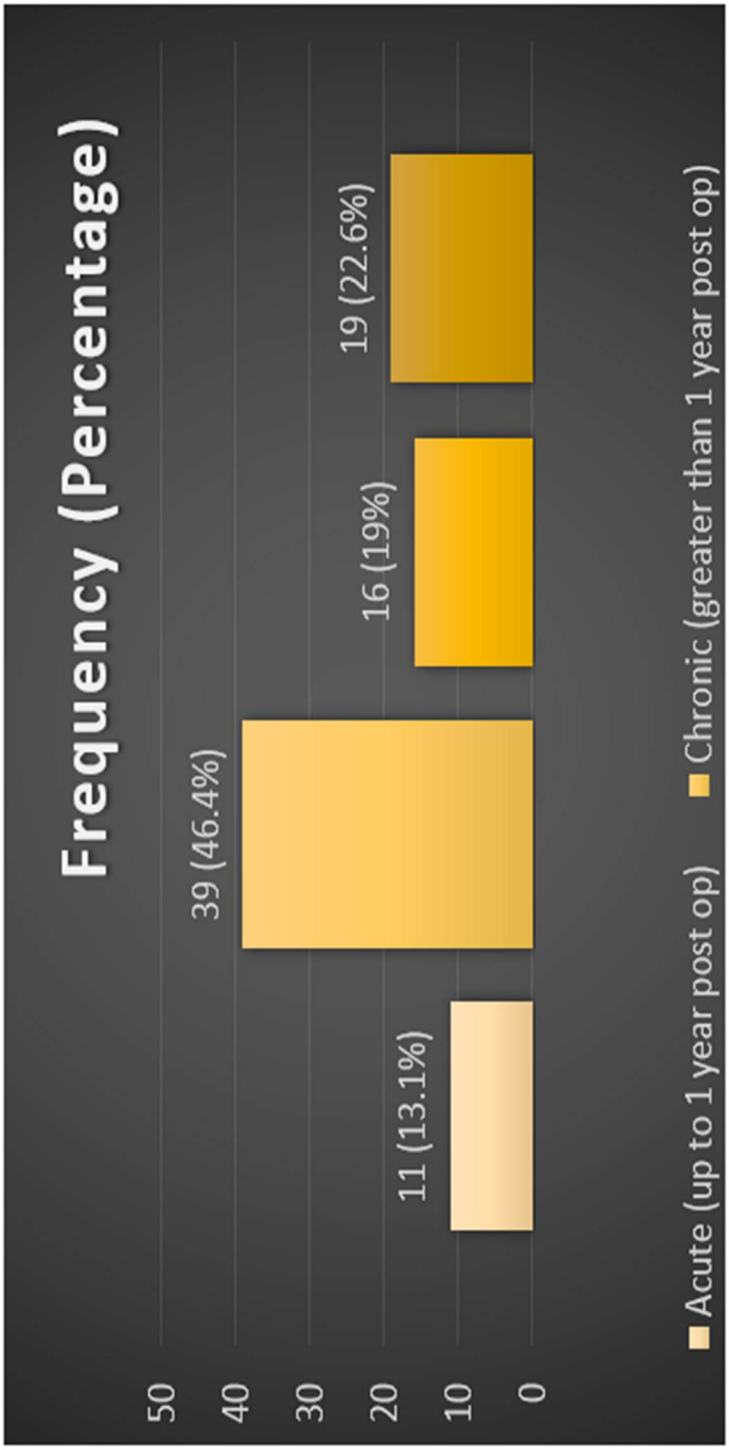


FIGURE 12: Hip Dysplasia: iHOT vs FABQ Correlation

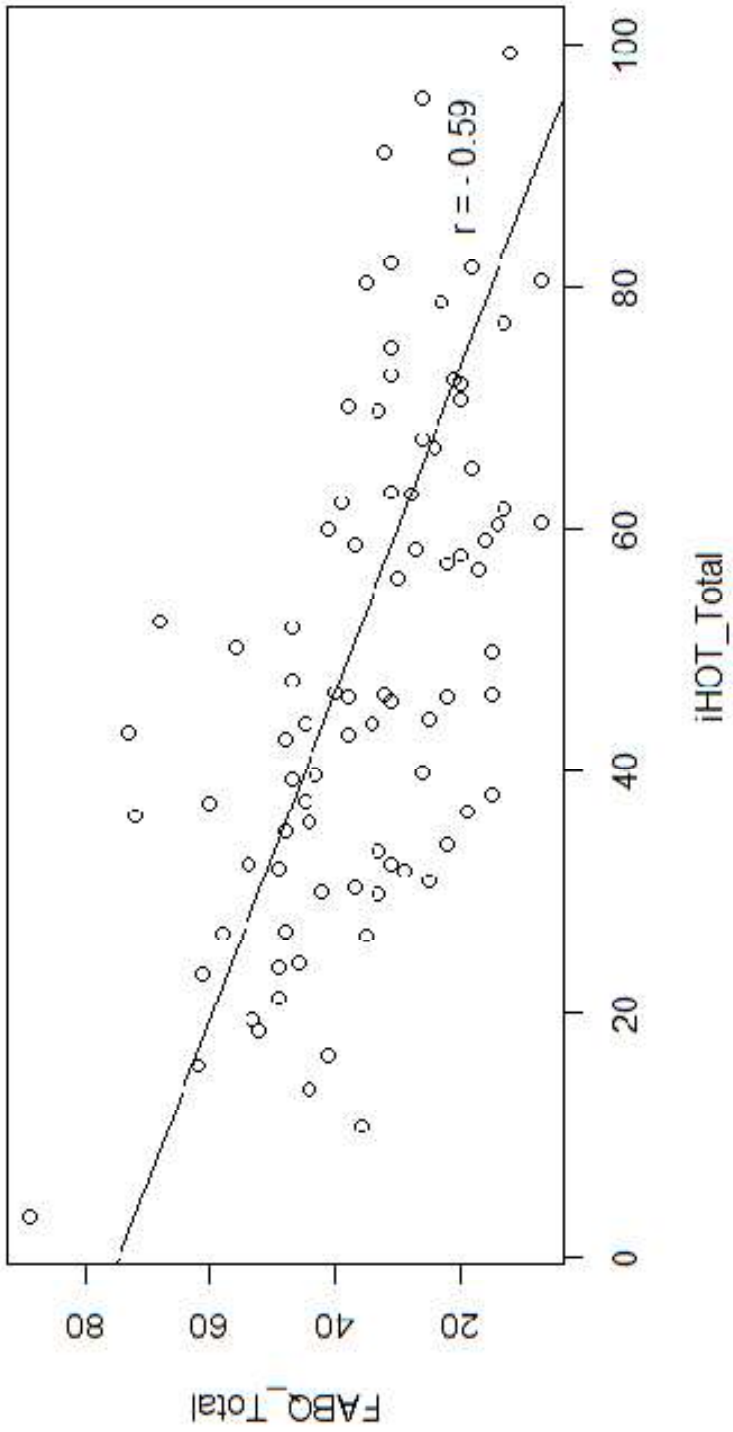


FIGURE 13: Hip Dysplasia: DASS-21 vs iHOT Correlation

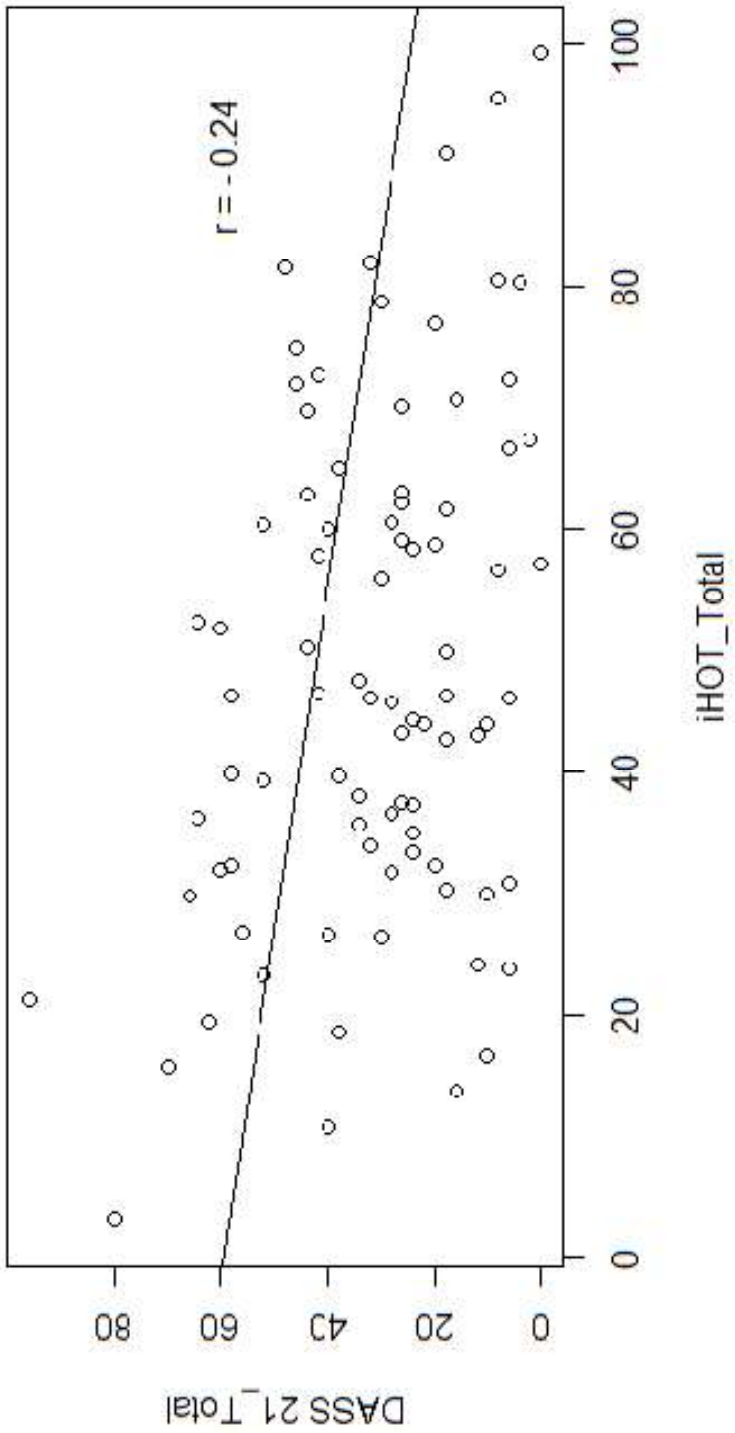
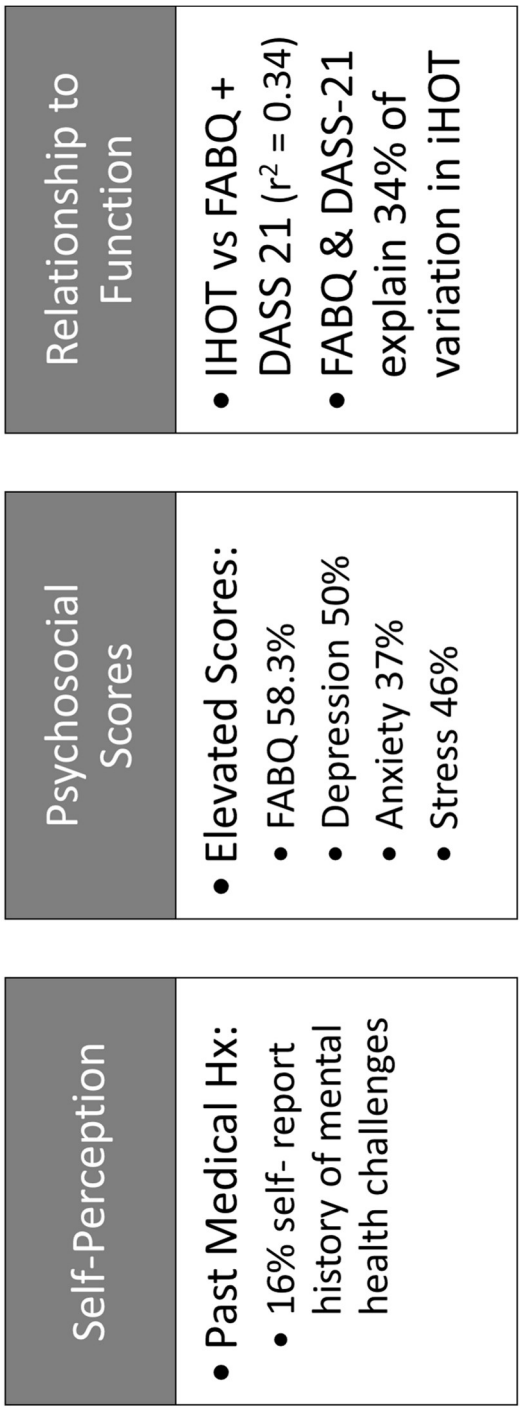


FIGURE 14: Relationship between iHOT, FABQ, and DASS-21



CHAPTER FIVE

RESEARCH AGENDA

5.1 RESEARCH AGENDA

I have a passion to explore and understand the world around me. As a clinician I am constantly trying to understand the patient's chief complaint, the mechanism of injury, the possible diagnosis, and best course of care. To do this I must ask questions of myself and my abilities, the patient and what they value, and of the research to understand the current concepts and practices. This internal drive led me to begin work on a case report included in this dissertation. Through this process, I continued to learn and grow as a clinician and researcher. That quest for knowledge and the ability to integrate new concepts and ideas, has led me to continue research in physical therapy. The two manuscripts within this dissertation provide a foundation to develop these two research pathways that are related yet create unique trajectories.

The shoulder case study provides an in-context example of the application of symptom localization to evaluate an individual presenting to therapy with vague complaints of shoulder pain. This case study illustrates the SL process of ruling out the cervical spine and identifying the shoulder as the region producing pain. This article serves as a starting point for further research. From my clinical experience, I also have examples of cases in which SL identified the neck as the source of shoulder pain and the low back as the source of hip symptoms. Each case can be developed into a publishable case report.

Hip dysplasia is a condition that results an incongruency of the hip joint. When left untreated, hip dysplasia is a common reason for individuals to have a hip replacement

prior to the age of 50.[12,13] This can lead to increased utilization of the health care system, increased time off work, and decreased function/mobility leading to impact on the community level. Several studies have investigated various types of treatment, changes to muscle and joint structure/function, and suggestions for rehabilitation. There are limited studies investigating the factors that impact the return to prior function and sport. Due to the potential large-scale implications of untreated hip dysplasia, I plan to focus my research here, as my current research study provides a foundation for the future.

In the second study of this dissertation, I investigated the relationship between psychosocial factors and function in individuals with hip dysplasia. The findings suggest that factors such as BMI, pain, and participation in their preferred sport all have a relationship with function, however the magnitude of its impact is small. Due to the large volume of data and gaps within the literature, there are several potential directions that this could be explored (outlined below).

First, I will assess the impact of mental health factors on function. In studies investigating the patients return to function post operative ACL reconstruction, it was found that fear avoidance behavior and mental health play a role in return to sport in this population. However, there is little research to date in a population of individuals with hip dysplasia. I plan to use my existing data that demonstrated a relationship between function, depression, anxiety, stress, and pain to compare individual items on the International Hip Outcome Tool (iHOT) to the Depression Anxiety and Stress Score (DASS-21) and the Fear Avoidance Belief Questionnaire (FABQ). This information can be used to aid in the examination process, structure treatment plans, and generate

potential referrals to mental health professionals, so both physical and psychosocial aspects of rehabilitation are addressed.

I intend to use data from my survey to determine if there is a link between the Patient Specific Functional Scale (PSFS) and participation in sport. The PSFS is an open-ended functional outcome measure that allows individuals to identify the functional components that they are having difficulty with, often unique to the participant and not captured on other outcome measures. The PSFS has good reliability (0.83-0.89) and is sensitive to change (SEM of 0.63-0.9) in patients with a variety of musculoskeletal conditions.[38] This work is complementary to the research that I am completing with my committee chair. In this retrospective comparison study, we are analyzing the results of a patient's change in function based on the outcomes of patient selected goals using the Patient Specific Functional Scale (PSFS) and comparing them to the International Hip Outcome Tool (iHOT) and Lower Extremity Functional Scale (LEFS). With both studies, my goal is to find better ways to document patient progress and develop an individualized treatment plan that considers unique patient goals.

To further expand on this research, I plan to conduct a prospective intervention study investigating balance strategies that are used in individuals with hip pain versus those without. Depending on the direction of these findings, I will investigate some of the unique gait compensations in patients who have hip pain/dysplasia. This would initially start as a case-series and potentially grow into a larger study.

The survey research in my dissertation and a future case series on balance and gait considerations will lay the foundation for a study comparing the effectiveness of treatment. In the next 10-15 years I intend to continue to work with a population of

individuals with hip dysplasia. I would like to compare the effectiveness of early weight bearing exercises versus suspension training (red cord) in individuals with hip dysplasia to see if it alters the return to prior level of function. This type of research can guide the rehabilitation approach for these individuals and facilitate a return to activities that they perform daily (self-care, recreational, and/or sport).

After successful completion and defense of my dissertation, I will submit my case study entitled: "The Use of Symptom Localization in the Differential Diagnosis of Shoulder Pain: A Case Report" to the Journal of Orthopedic and Sports Physical Therapy-Cases. This is a journal that focuses on the publication of case studies/series within the field of Physical Therapy.[142] A secondary journal for submission is Cureus, an open access journal whose aim is to publish unique research articles on a variety of medical sciences.[143] "The Relationship of Psychosocial Factors and Patient Reported Functional Impairments in Individuals with Hip Dysplasia: Survey Research" Will be submitted to the Journal of Back and Musculoskeletal Rehabilitation. This journal is dedicated to publishing studies that take an interdisciplinary approach to the treatment and management of individuals who have musculoskeletal conditions.[144] A secondary journal for submission is the Journal of Orthopedic and Sports Physical Therapy (JOSPT). This journal is dedicated to the advancement of musculoskeletal and sports related medical practice.

My overall goal is to be a positive contributor to the field of orthopedic physical therapy by conducting research including case, descriptive, survey and intervention-based studies. It is my intent to conduct research that is clinically applicable.

REFERENCES

1. Sharpe JA, Martin BI, Fritz JM, et al. Identifying patients who access musculoskeletal physical therapy: a retrospective cohort analysis. *Fam Pract*. 2020;38(3):203-209. doi:10.1093/fampra/cmaa104

2. Luime JJ, Koes BW, Hendriksen IJM, et al. Prevalence and incidence of shoulder pain in the general population; a systematic review. *Scand J Rheumatol*. 2004;33(2):73-81. doi:10.1080/03009740310004667

3. French HP, Deasy M, Gallagher R, O'Grady A, Doyle F. Prevalence of Hip or Groin Pain in Adolescents: A Systematic Review and Meta-Analysis. *Pain Pract*. 2020;20(7):792-811. doi:10.1111/papr.12907

4. Kaltenborn, Freddy. *Manual Mobilization of the Joints: Joint Examination and Basic Treatment of the Extremities*. Vol 1. 6th ed. Orthopedic Physical Therapy Products,; 2007.

5. Neumann D. *Kinesiology of the Musculoskeletal System: Foundations for Physical Rehabilitation*. 1st ed. Mosby; 2002.

6. Neumann D. *Kinesiology of the Musculoskeletal System: Foundation for Rehabilitation*. 2nd ed.; 2010.

7. Almajed YA, Hall AC, Gillingwater TH, Alashkham A. Citation for: Anatomical, functional and biomechanical review of the glenoid labrum. *Wiley Online Libr*. Accessed April 6, 2025. https://onlinelibrary.wiley.com/action/showCitFormats?doi=10.1111%2Fjoa.13582

8. Bowman KF, Fox J, Sekiya JK. A Clinically Relevant Review of Hip Biomechanics. *Arthrosc J Arthrosc Relat Surg*. 2010;26(8):1118-1129. doi:10.1016/j.arthro.2010.01.027

9. Ladd LM, Crews M, Maertz NA. Glenohumeral Joint Instability: A Review of Anatomy, Clinical Presentation, and Imaging. *Clin Sports Med*. 2021;40(4):585-599. doi:10.1016/j.csm.2021.05.001

10. Adler KL, Cook PC, Yen YM, Giordano BD. Current Concepts in Hip Preservation Surgery: Part I. *Sports Health*. 2015;7(6):518-526. doi:10.1177/1941738115587270

11. Bartschat NI, Fatemi N, Westermann R, et al. Changes in Muscle Volume and Composition After Treatment of Hip Dysplasia with Periacetabular Osteotomy. *Iowa Orthop J*. 2021;41(2):34-39.

12. Clohisy JC, Dobson MA, Robison JF, et al. Radiographic structural abnormalities associated with premature, natural hip-joint failure. *J Bone Joint Surg Am*. 2011;93 Suppl 2:3-9. doi:10.2106/JBJS.J.01734

13. Hunt D, Prather H, Harris Hayes M, Clohisy JC. Clinical outcomes analysis of conservative and surgical treatment of patients with clinical indications of prearthritic, intra-articular hip disorders. *PM R*. 2012;4(7):479-487. doi:10.1016/j.pmrj.2012.03.012

14. Ostör AJK, Richards CA, Prevost AT, Speed CA, Hazleman BL. Diagnosis and relation to general health of shoulder disorders presenting to primary care. *Rheumatol Oxf Engl*. 2005;44(6):800-805. doi:10.1093/rheumatology/keh598

15. Ellenbecker TS, Cools A. Rehabilitation of shoulder impingement syndrome and rotator cuff injuries: an evidence-based review. *Br J Sports Med*. 2010;44(5):319-327. doi:10.1136/bjsm.2009.058875

16. LaPrade MD, Melugin HP, Hale RF, et al. Incidence of Hip Dysplasia Diagnosis in Young Patients With Hip Pain: A Geographic Population Cohort Analysis. *Orthop J Sports Med*. 2021;9(3):2325967121989087. doi:10.1177/2325967121989087

17. Sewell MD, Eastwood DM. Screening and treatment in developmental dysplasia of the hip—where do we go from here? *Int Orthop*. 2011;35(9):1359-1367. doi:10.1007/s00264-011-1257-z

18. Nwachukwu BU, Gaudiani MA, Marsh NA, Ranawat AS. Labral hypertrophy correlates with borderline hip dysplasia and microinstability in femoroacetabular impingement: a matched case-control analysis. *Hip Int J Clin Exp Res Hip Pathol Ther*. 2019;29(2):198-203. doi:10.1177/1120700018807860

19. Drury NJ, Ellis BJ, Weiss JA, McMahon PJ, Debski RE. The Impact of Glenoid Labrum Thickness and Modulus on Labrum and Glenohumeral Capsule Function. *J Biomech Eng*. 2010;132(121003). doi:10.1115/1.4002622

20. Dalton SE, Snyder SJ. Glenohumeral instability. *Baillières Clin Rheumatol*. 1989;3(3):511-534. doi:10.1016/S0950-3579(89)80006-8

21. Babst D, Steppacher SD, Ganz R, Siebenrock KA, Tannast M. The iliocapsularis muscle: an important stabilizer in the dysplastic hip. *Clin Orthop*. 2011;469(6):1728-1734. doi:10.1007/s11999-010-1705-x

22. Haefeli PC, Steppacher SD, Babst D, Siebenrock KA, Tannast M. An increased iliocapsularis-to-rectus-femoris ratio is suggestive for instability in borderline hips. *Clin Orthop*. 2015;473(12):3725-3734. doi:10.1007/s11999-015-4382-y

23. Mac Dermott KAD, Venter RG, Bergsteedt BJ, Pękala PA, Henry BM, Keet K. Anatomical features of the iliocapsularis muscle: a dissection study. *Surg Radiol Anat SRA*. 2022;44(4):599-608. doi:10.1007/s00276-022-02905-y

24. Wade DT, Halligan PW. The biopsychosocial model of illness: a model whose time has come. *Clin Rehabil*. 2017;31(8):995-1004. doi:10.1177/0269215517709890

25. ICF Case Studies - The Integrative Bio-psycho-social Model of Functioning, Disability and Health. Accessed February 16, 2025. https://www.icf-casestudies.org/introduction/introduction-to-the-icf/the-integrative-bio-psycho-social-model-of-functioning-disability-and-health

26. Mohtadi NGH, Griffin DR, Pedersen ME, et al. The Development and validation of a self-administered quality-of-life outcome measure for young, active patients with symptomatic hip disease: the International Hip Outcome Tool (iHOT-33). *Arthrosc J Arthrosc Relat Surg Off Publ Arthrosc Assoc N Am Int Arthrosc Assoc*. 2012;28(5):595-605; quiz 606-610.e1. doi:10.1016/j.arthro.2012.03.013

27. Direct Access Advocacy. APTA. Accessed January 18, 2025. https://www.apta.org/advocacy/issues/direct-access-advocacy

28. Hieck J, Lazaro R. *Goodman and Snyder's Differential Diagnosis for Physical Therapists: Screening for Referral*. 7th ed. Elsevier; 2023.

29. Sueki DG, Cleland JA, Wainner RS. A regional interdependence model of musculoskeletal dysfunction: research, mechanisms, and clinical implications. *J Man Manip Ther*. 2013;21(2):90-102. doi:10.1179/2042618612Y.0000000027

30. Krauss J, Smith C, Evjenth O. *Extremity Orthopedic Lab Manual*. 2nd ed. Lakeview Media; 2021.

31. Engel GL. The need for a new medical model: a challenge for biomedicine. *Science*. 1977;196(4286):129-136. doi:10.1126/science.847460

32. Upper Extremity Functional Index. Physiopedia. Accessed May 28, 2025. https://www.physio-pedia.com/Upper_Extremity_Functional_Index

33. QuickDASH. APTA. Accessed May 28, 2025. https://www.apta.org/patient-care/evidence-based-practice-resources/test-measures/quickdash

34. Mohtadi IHOT 33 2012.

35. Measurement Properties of the Patient-Specific Functional Scale and Its Current Uses: An Updated Systematic Review of 57 Studies Using COSMIN Guidelines. doi:10.2519/jospt.2022.10727

36. Chatman AB, Hyams SP, Neel JM, et al. The Patient-Specific Functional Scale: Measurement Properties in Patients With Knee Dysfunction. *Phys Ther*. 1997;77(8):820-829. doi:10.1093/ptj/77.8.820

37. Stratford P, Gill C, Westaway M, Binkley J. Assessing disability and change on individual patients: A report of a patient specific measure. *Physiother Can*. 1995;47(4):258-263. doi:10.3138/ptc.47.4.258

38. Pathak A, Wilson R, Sharma S, et al. Measurement Properties of the Patient-Specific Functional Scale and Its Current Uses: An Updated Systematic Review of 57 Studies Using COSMIN Guidelines. *J Orthop Sports Phys Ther*. 2022;52(5):262-275. doi:10.2519/jospt.2022.10727

39. Lee KC, Chiu TTW, Lam TH. Psychometric properties of the Fear-Avoidance Beliefs Questionnaire in patients with neck pain. *Clin Rehabil*. 2006;20(10):909-920. doi:10.1177/0269215506072186

40. Jacob T, Baras M, Zeev A, Epstein L. Low back pain: reliability of a set of pain measurement tools. *Arch Phys Med Rehabil*. 2001;82(6):735-742. doi:10.1053/apmr.2001.22623

41. Ross MD. The relationship between functional levels and fear-avoidance beliefs following anterior cruciate ligament reconstruction. *J Orthop Traumatol Off J Ital Soc Orthop Traumatol*. 2010;11(4):237-243. doi:10.1007/s10195-010-0118-7

42. Osman A, Wong JL, Bagge CL, Freedenthal S, Gutierrez PM, Lozano G. The Depression Anxiety Stress Scales-21 (DASS-21): further examination of dimensions, scale reliability, and correlates. *J Clin Psychol*. 2012;68(12):1322-1338. doi:10.1002/jclp.21908

43. You M, Yang S, Li J, Chen G. Effect of Psychosocial Interventions for Individuals Who Underwent Arthroscopy in Femoroacetabular Impingement: A Randomized Controlled Trial. *J Clin Med*. 2023;12(11):3612. doi:10.3390/jcm12113612

44. Evjenth O, Gloeck C. *Symptom Localization in the Spine and the Extremity Joints*. Orthopedic Physical Therapy Products; 2006.

45. Kaltenborn, F. *Manual Mobilization of the Joints: Joint Examination and Basic Treatment of the Spine*. Vol 2. Orthopedic Physical Therapy Products; 2012.

46. Krauss J, Smith C, Evjenth O. *Spinal Orthopedics Lab Manual*. 6th ed. Lakeview Media; 2021.

47. Michener A Lori A, PhD, PT, Walsworth P Matthew K, MD, MD WCD, MD KPM. Reliability and Diagnostic Accuracy of 5 Physical Examination Tests and Combination of Tests for Subacromial Impingement. *Arch Phys Med Rehabil*. 2009;90(11):1898-1903. doi:10.1016/j.apmr.2009.05.015

48. Lucas J, van Doorn P, Hegedus E, Lewis J, van der Windt D. A systematic review of the global prevalence and incidence of shoulder pain. *BMC Musculoskelet Disord*. 2022;23(1):1073. doi:10.1186/s12891-022-05973-8

49. Urwin M, Symmons D, Allison T, et al. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. *Ann Rheum Dis*. 1998;57(11):649-655. doi:10.1136/ard.57.11.649

50. Hodgetts C, Walker B. Epidemiology, common diagnoses, treatments and prognosis of shoulder pain: A narrative review. *Int J Osteopath Med*. 2021;42:11-19. doi:10.1016/j.ijosm.2021.10.006

51. Garving C, Jakob S, Bauer I, Nadjar R, Brunner UH. Impingement Syndrome of the Shoulder. *Dtsch Arzteblatt Int*. 2017;114(45):765-776. doi:10.3238/arztebl.2017.0765

52. Mitchell C, Adebajo A, Hay E, Carr A. Shoulder pain: diagnosis and management in primary care. *BMJ*. 2005;331(7525):1124-1128. doi:10.1136/bmj.331.7525.1124

53. Kennedy MS, Nicholson HD, Woodley SJ. The morphology of the subacromial and related shoulder bursae. An anatomical and histological study. *J Anat*. 2022;240(5):941-958. doi:10.1111/joa.13603

54. Diercks R, Bron C, Dorrestijn O, et al. Guideline for diagnosis and treatment of subacromial pain syndrome: A multidisciplinary review by the Dutch Orthopaedic Association. *Acta Orthop*. 2014;85(3):314-322. doi:10.3109/17453674.2014.920991

55. Kang KC, Lee HS, Lee JH. Cervical Radiculopathy Focus on Characteristics and Differential Diagnosis. *Asian Spine J*. 2020;14(6):921-930. doi:10.31616/asj.2020.0647

56. Karaman ÇA, Oz B, Aylin S. Investigation of the frequency of C5-C6 radiculopathy and shoulder rotator cuff lesions coexistance. *North Clin Istanb*. Published online 2018. doi:10.14744/nci.2018.04796

57. Iyer S, Kim HJ. Cervical radiculopathy. *Curr Rev Musculoskelet Med*. 2016;9(3):272-280. doi:10.1007/s12178-016-9349-4

58. Blanpied PR, Gross AR, Elliott JM, et al. Neck Pain: Revision 2017: Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability and Health From the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther*. 2017;47(7):A1-A83. doi:10.2519/jospt.2017.0302

59. Magee D. *Orthopedic Physical Assessment*. 6th ed.

60. MacDonald PB, Clark P, Sutherland K. An analysis of the diagnostic accuracy of the Hawkins and Neer subacromial impingement signs. *J Shoulder Elbow Surg*. 2000;9(4):299-301. doi:10.1067/mse.2000.106918

61. Park HB, Yokota A, Gill HS, El Rassi G, McFarland EG. Diagnostic Accuracy of Clinical Tests for the Different Degrees of Subacromial Impingement Syndrome. *J Bone Jt Surg Am*. 2005;87(7):1446. doi:10.2106/JBJS.D.02335

62. Shoulder Impingement Rotator Cuff Tendinitis. Accessed May 22, 2025. https://www.orthoinfo.org/en/diseases--conditions/shoulder-impingementrotator-cuff-tendinitis/

63. Lewis JS, Green A, Wright C. Subacromial impingement syndrome: The role of posture and muscle imbalance. *J Shoulder Elbow Surg*. 2005;14(4):385-392. doi:10.1016/j.jse.2004.08.007

64. Yamamoto A, Takagishi K, Osawa T, et al. Prevalence and risk factors of a rotator cuff tear in the general population. *J Shoulder Elbow Surg*. 2010;19(1):116-120. doi:10.1016/j.jse.2009.04.006

65. Hermena S, Rednam M. Reverse Shoulder Arthroplasty. In: *StatPearls*. StatPearls Publishing; 2025. Accessed June 2, 2025. http://www.ncbi.nlm.nih.gov/books/NBK574545/

66. Khan Y, Nagy MT, Malal J, Waseem M. The Painful Shoulder: Shoulder Impingement Syndrome. *Open Orthop J*. 2013;7:347-351. doi:10.2174/1874325001307010347

67. Teunis T, Lubberts B, Reilly BT, Ring D. A systematic review and pooled analysis of the prevalence of rotator cuff disease with increasing age. *J Shoulder Elbow Surg*. 2014;23(12):1913-1921. doi:10.1016/j.jse.2014.08.001

68. Leong HT, Fu SC, He X, Oh JH, Yamamoto N, Hang S. Risk factors for rotator cuff tendinopathy: A systematic review and meta-analysis. *J Rehabil Med*. 2019;51(9):627-637. doi:10.2340/16501977-2598

69. Epstein RE, Schweitzer ME, Frieman BG, Fenlin JM, Mitchell DG. Hooked acromion: prevalence on MR images of painful shoulders. *Radiology*. 1993;187(2):479-481. doi:10.1148/radiology.187.2.8475294

70. Tangtrakulwanich B, Kapkird A. Analyses of possible risk factors for subacromial impingement syndrome. *World J Orthop*. 2012;3(1):5-9. doi:10.5312/wjo.v3.i1.5

71. Chaudhury S, Carr AJ. Lessons we can learn from gene expression patterns in rotator cuff tears and tendinopathies. *J Shoulder Elbow Surg*. 2012;21(2):191-199. doi:10.1016/j.jse.2011.10.022

72. Faruqi T, Rizvi TJ. Subacromial Bursitis. In: *StatPearls*. StatPearls Publishing; 2025. Accessed June 2, 2025. http://www.ncbi.nlm.nih.gov/books/NBK541096/

73. Roy JS, Braën C, Leblond J, et al. Diagnostic accuracy of ultrasonography, MRI and MR arthrography in the characterisation of rotator cuff disorders: a systematic review and meta-analysis. *Br J Sports Med*. 2015;49(20):1316-1328. doi:10.1136/bjsports-2014-094148

74. Cadogan A, Laslett M, Hing W, McNair P, Williams M. Interexaminer reliability of orthopaedic special tests used in the assessment of shoulder pain. *Man Ther*. 2011;16(2):131-135. doi:10.1016/j.math.2010.07.009

75. Alqunaee M, Galvin R, Fahey T. Diagnostic Accuracy of Clinical Tests for Subacromial Impingement Syndrome: A Systematic Review and Meta-Analysis. *Arch Phys Med Rehabil*. 2012;93(2):229-236. doi:10.1016/j.apmr.2011.08.035

76. Johansson K, Ivarson S. Intra- and interexaminer reliability of four manual shoulder maneuvers used to identify subacromial pain. *Man Ther*. 2009;14(2):231-239. doi:10.1016/j.math.2008.03.003

77. E J Hegedus, A Goode, S Campbell, et al. Physical examination tests of the shoulder: a systematic review with meta-analysis of individual tests. *Br J Sports Med*. 2008;42(2):80. doi:10.1136/bjsm.2007.038406

78. Hegedus EJ, Goode AP, Cook CE, et al. Which physical examination tests provide clinicians with the most value when examining the shoulder? Update of a systematic review with meta-analysis of individual tests. *Br J Sports Med*. 2012;46(14):964-978. doi:10.1136/bjsports-2012-091066

79. Bordoni B, Black AC, Varacallo MA. Anatomy, Tendons. In: *StatPearls*. StatPearls Publishing; 2025. Accessed May 23, 2025. http://www.ncbi.nlm.nih.gov/books/NBK513237/

80. Phadke V, Camargo P, Ludewig P. Scapular and rotator cuff muscle activity during arm elevation: A review of normal function and alterations with shoulder impingement. *Rev Bras Fisioter Sao Carlos Sao Paulo Braz*. 2009;13(1):1-9. doi:10.1590/S1413-35552009005000012

81. Riley GP, Harrall RL, Constant CR, Chard MD, Cawston TE, Hazleman BL. Tendon degeneration and chronic shoulder pain: changes in the collagen composition of the human rotator cuff tendons in rotator cuff tendinitis. *Ann Rheum Dis*. 1994;53(6):359-366. doi:10.1136/ard.53.6.359

82. Longo UG, Berton A, Khan WS, Maffulli N, Denaro V. Histopathology of rotator cuff tears. *Sports Med Arthrosc Rev*. 2011;19(3):227-236. doi:10.1097/JSA.0b013e318213bccb

83. Osti L, Buda M, Del Buono A. Fatty infiltration of the shoulder: diagnosis and reversibility. *Muscles Ligaments Tendons J*. 2014;3(4):351-354.

84. Croen BJ, Carballo CB, Wada S, et al. Chronic subacromial impingement leads to supraspinatus muscle functional and morphological changes: Evaluation in a murine model. *J Orthop Res*. 2021;39(10):2243-2251. doi:10.1002/jor.24964

85. Gaillard F. Acromial types | Radiology Reference Article | Radiopaedia.org. Radiopaedia. doi:10.53347/rID-842

86. Cooper K, Alexander L, Brandie D, et al. Exercise therapy for tendinopathy: a mixed-methods evidence synthesis exploring feasibility, acceptability and effectiveness. *Health Technol Assess Winch Engl*. 2023;27(24):1-389. doi:10.3310/TFWS2748

87. medisys. Understanding Neuromuscular Re-education CPT Code 97112. Leading Medical Billing Outsourcing Services Company in the USA. July 19, 2023. Accessed June 8, 2025. https://www.medisysdata.com/blog/understanding-neuromuscular-re-education-cpt-code-97112/

88. Kromer TO, Sieben JM, de Bie RA, Bastiaenen CHG. Influence of fear-avoidance beliefs on disability in patients with subacromial shoulder pain in primary care: a secondary analysis. *Phys Ther*. 2014;94(12):1775-1784. doi:10.2522/ptj.20130587

89. Mallows A, Debenham J, Walker T, Littlewood C. Association of psychological variables and outcome in tendinopathy: a systematic review. *Br J Sports Med*. 2017;51(9):743-748. doi:10.1136/bjsports-2016-096154

90. Ellsworth BK, Sink EL, Doyle SM. Adolescent hip dysplasia: what are the symptoms and how to diagnose it. *Curr Opin Pediatr*. 2021;33(1):65-73. doi:10.1097/MOP.0000000000000969

91. U.S. Preventive Service Task Force. Screening for developmental dysplasia of the hip: recommendation statement. *Am Fam Physician*. 2006;73(11):1992-1996.

92. Sioutis S, Kolovos S, Papakonstantinou ME, Reppas L, Koulalis D, Mavrogenis AF. Developmental Dysplasia of the Hip: A Review. *J Long Term Eff Med Implants*. 2022;32(3):39-56. doi:10.1615/JLongTermEffMedImplants.2022040393

93. Vaquero-Picado A, González-Morán G, Garay EG, Moraleda L. Developmental dysplasia of the hip: update of management. *EFORT Open Rev*. 2019;4(9):548-556. doi:10.1302/2058-5241.4.180019

94. Sankar WN, Beaulé PE, Clohisy JC, et al. Labral morphologic characteristics in patients with symptomatic acetabular dysplasia. *Am J Sports Med*. 2015;43(9):2152-2156. doi:10.1177/0363546515591262

95. Jacobsen JS, Bolvig L, Hölmich P, et al. Muscle-tendon-related abnormalities detected by ultrasonography are common in symptomatic hip dysplasia. *Arch Orthop Trauma Surg*. 2018;138(8):1059-1067. doi:10.1007/s00402-018-2947-4

96. de Hundt M, Vlemmix F, Bais JMJ, et al. Risk factors for developmental dysplasia of the hip: a meta-analysis. *Eur J Obstet Gynecol Reprod Biol*. 2012;165(1):8-17. doi:10.1016/j.ejogrb.2012.06.030

97. What Causes Hip Dysplasia? - International Hip Dysplasia Institute. Accessed January 20, 2025. https://hipdysplasia.org/developmental-dysplasia-of-the-hip/causes-of-ddh/

98. Zamborsky R, Kokavec M, Harsanyi S, Attia D, Danisovic L. Developmental Dysplasia of Hip: Perspectives in Genetic Screening. *Med Sci Basel Switz*. 2019;7(4):59. doi:10.3390/medsci7040059

99. Loder RT, Skopelja EN. The epidemiology and demographics of hip dysplasia. *ISRN Orthop*. 2011;2011:238607. doi:10.5402/2011/238607

100. Bache CE, Clegg J, Herron M. Risk factors for developmental dysplasia of the hip: ultrasonographic findings in the neonatal period. *J Pediatr Orthop Part B*. 2002;11(3):212-218. doi:10.1097/00009957-200207000-00004

101. The American Academy of Orthopedic Surgeons. https://orthoinfo.aaos.org/en/diseases--conditions/adolescent-hip-dysplasia/.

102. Nandhagopal T, Tiwari V, De Cicco FL. Developmental Dysplasia of the Hip. In: *StatPearls*. StatPearls Publishing; 2025. Accessed January 20, 2025. http://www.ncbi.nlm.nih.gov/books/NBK563157/

103. Clohisy JC, Nunley RM, Carlisle JC, Schoenecker PL. Incidence and characteristics of femoral deformities in the dysplastic hip. *Clin Orthop*. 2009;467(1):128-134. doi:10.1007/s11999-008-0481-3

104. Beltran LS, Rosenberg ZS, Mayo JD, et al. Imaging evaluation of developmental hip dysplasia in the young adult. *AJR Am J Roentgenol*. 2013;200(5):1077-1088. doi:10.2214/AJR.12.9360

105. Disantis AE, Ruh E, Martin R, Enseki K, McClincy M. Rehabilitation Guidelines for Use Following a Periacetabular Osteotomy (PAO): A North American Based Delphi Consensus. *Int J Sports Phys Ther*. 2022;17(6):1002-1015. doi:10.26603/001c.38043

106. Chen L, Wu Y, Chen Z, et al. What happens to the gluteus medius in young and middle-aged patients with hip dysplasia? *Int Orthop*. 2022;46(4):761-768. doi:10.1007/s00264-021-05271-3

107. Kamath AF. Bernese periacetabular osteotomy for hip dysplasia: Surgical technique and indications. *World J Orthop*. 2016;7(5):280-286. doi:10.5312/wjo.v7.i5.280

108. Zaltz I, Baca G, Kim YJ, et al. Complications associated with the periacetabular osteotomy: a prospective multicenter study. *J Bone Joint Surg Am*. 2014;96(23):1967-1974. doi:10.2106/JBJS.N.00113

109. Zaltz I. How to properly correct and to assess acetabular position: an evidence-based approach. *J Pediatr Orthop*. 2013;33 Suppl 1:S21-28. doi:10.1097/BPO.0b013e31828114af

110. Yoshimoto K, Hamai S, Higaki H, et al. Dynamic hip kinematics before and after periacetabular osteotomy in patients with dysplasia. *J Orthop Sci Off J Jpn Orthop Assoc*. 2020;25(2):247-254. doi:10.1016/j.jos.2019.03.019

111. Monteiro Rodrigues L, Rocha C, Ferreira HT, Silva HN. Lower limb massage in humans increases local perfusion and impacts systemic hemodynamics. *J Appl Physiol Bethesda Md 1985*. 2020;128(5):1217-1226. doi:10.1152/japplphysiol.00437.2019

112. McGovern RP, Martin RL, Kivlan BR, Christoforetti JJ. NON-OPERATIVE MANAGEMENT OF INDIVIDUALS WITH NON-ARTHRITIC HIP PAIN: A LITERATURE REVIEW. *Int J Sports Phys Ther*. 2019;14(1):135-147.

113. Harris-Hayes M, Steger May K. Reduced Hip Adduction Is Associated With Improved Function After Movement-Pattern Training in Young People With Chronic Hip Joint Pain.

114. Reimer LCU, Jakobsen SS, Mortensen L, et al. Efficacy of periacetabular osteotomy followed by progressive resistance training compared to progressive resistance training as non-surgical treatment in patients with hip dysplasia (PreserveHip) - a protocol for a randomised controlled trial. *BMJ Open*. 2019;9(12):e032782. doi:10.1136/bmjopen-2019-032782

115. Jacobsen JS, Thorborg K, Nielsen RØ, et al. Comparing exercise and patient education with usual care in the treatment of hip dysplasia: a protocol for a randomised controlled trial with 6-month follow-up (MovetheHip trial). *BMJ Open*. 2022;12(9):e064242. doi:10.1136/bmjopen-2022-064242

116. Jacobsen J, Thorborg K, Sorensen, D. Feasibility and acceptability of a six-month exercise and patient education intervention for patients with hip dysplasia: A mixed methods study.

117. Gudmundsson P, Nakonezny PA, Lin J, Owhonda R, Richard H, Wells J. Functional improvement in hip pathology is related to improvement in anxiety, depression, and pain catastrophizing: an intricate link between physical and mental well-being. *BMC Musculoskelet Disord*. 2021;22(1):133. doi:10.1186/s12891-021-04001-5

118. Hampton SN, Nakonezny PA, Richard HM, Wells JE. Pain catastrophizing, anxiety, and depression in hip pathology. *Bone Jt J*. 2019;101-B(7):800-807. doi:10.1302/0301-620X.101B7.BJJ-2018-1309.R1

119. Zimmerer A, Schneider MM, Nietschke R, Miehlke W, Sobau C. Is Hip Arthroscopy an Adequate Therapy for the Borderline Dysplastic Hip? Correlation

Between Radiologic Findings and Clinical Outcomes. *Orthop J Sports Med*. 2020;8(5):2325967120920851. doi:10.1177/2325967120920851

120. Ferraro SL, Williams DN, Millis MB. A qualitative study of the impact of a periacetabular osteotomy on patients' lives. *Bone Jt J*. 2022;104-B(7):781-785. doi:10.1302/0301-620X.104B7.BJJ-2021-1775.R1

121. Prather H, Creighton A, Sorenson C, et al. Anxiety and Insomnia in Young and Middle-Aged Adult Hip Pain Patients With and Without Femoroacetabular Impingement and Developmental Hip Dysplasia. *PM R*. 2018;10(5):455-461. doi:10.1016/j.pmrj.2017.10.007

122. Gambling TS, Long A. Psycho-social impact of developmental dysplasia of the hip and of differential access to early diagnosis and treatment: A narrative study of young adults. *SAGE Open Med*. 2019;7:2050312119836010. doi:10.1177/2050312119836010

123. Walker T, Cuff A, Salt E, Lynch G, Littlewood C. Examination of the neck when a patient complains of shoulder pain: a global survey of current practice (2019). *Musculoskeletal Care*. 2020;18(3):256-264. doi:10.1002/msc.1458

124. Krauss J, Smith C, Evjenth O. *Extremity Orthopedics*. 2nd ed. Lakeview Media; 2021.

125. Krauss J. Massage and Soft Tissue Mobilization. In: *Orthopaedic Physical Therapy Secrets.* 3rd ed. Elsevier; 2017:95-101.

126. Jiandani M, Mhatre B. Physical therapy diagnosis: How is it different? *J Postgrad Med*. 2018;64(2):69-72. doi:10.4103/jpgm.JPGM_691_17

127. Gismervik SØ, Drogset JO, Granviken F, Rø M, Leivseth G. Physical examination tests of the shoulder: a systematic review and meta-analysis of diagnostic test performance. *BMC Musculoskelet Disord*. 2017;18(1):41. doi:10.1186/s12891-017-1400-0

128. Acker R, Swain N, Perry M, Wassinger C, Sole G. "Thinking about pain in a different way": Patient perspectives of a neuroscience-informed physiotherapy programme for rotator cuff-related shoulder pain. *Musculoskelet Sci Pract*. 2023;63:102691. doi:10.1016/j.msksp.2022.102691

129. Anekstein Y, Blecher R, Smorgick Y, Mirovsky Y. What is the best way to apply the Spurling test for cervical radiculopathy? *Clin Orthop*. 2012;470(9):2566-2572. doi:10.1007/s11999-012-2492-3

130. Lewis CL, Khuu A, Marinko LN. Postural correction reduces hip pain in adult with acetabular dysplasia: A case report. *Man Ther*. 2015;20(3):508-512. doi:10.1016/j.math.2015.01.014

131. Screening for Developmental Dysplasia of the Hip: Recommendation Statement. *Am Fam Physician*. 2006;73(11):1992-1996.

132. Tumkur Anil Kumar N, Oliver JL, Lloyd RS, Pedley JS, Radnor JM. The Influence of Growth, Maturation and Resistance Training on Muscle-Tendon and Neuromuscular Adaptations: A Narrative Review. *Sports*. 2021;9(5):59. doi:10.3390/sports9050059

133. Hoegh M. Pain Science in Practice (Part 4): Central Sensitization I. *J Orthop Sports Phys Ther*. 2023;53(1):1-4. doi:10.2519/jospt.2023.11569

134. Gatchel RJ, Peng YB, Peters ML, Fuchs PN, Turk DC. The biopsychosocial approach to chronic pain: scientific advances and future directions. *Psychol Bull*. 2007;133(4):581-624. doi:10.1037/0033-2909.133.4.581

135. Scott EJ, Willey MC, Mercado A, Davison J, Wilken JM. Assessment of Disability Related to Hip Dysplasia Using Objective Measures of Physical Performance. *Orthop J Sports Med*. 2020;8(2):2325967120903290. doi:10.1177/2325967120903290

136. Byrom B, Elash CA, Eremenco S, et al. Measurement Comparability of Electronic and Paper Administration of Visual Analogue Scales: A Review of Published Studies. *Ther Innov Regul Sci*. 2022;56(3):394-404. doi:10.1007/s43441-022-00376-2

137. Oei TPS, Sawang S, Goh YW, Mukhtar F. Using the Depression Anxiety Stress Scale 21 (DASS-21) across cultures. *Int J Psychol*. 2013;48(6):1018-1029. doi:10.1080/00207594.2012.755535

138. Smith PJ, Merwin RM. The Role of Exercise in Management of Mental Health Disorders: An Integrative Review. *Annu Rev Med*. 2021;72(Volume 72, 2021):45-62. doi:10.1146/annurev-med-060619-022943

139. Rodriguez-Ayllon M, Cadenas-Sánchez C, Estévez-López F, et al. Role of Physical Activity and Sedentary Behavior in the Mental Health of Preschoolers, Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Med Auckl NZ*. 2019;49(9):1383-1410. doi:10.1007/s40279-019-01099-5

140. Wertli MM, Rasmussen-Barr E, Weiser S, Bachmann LM, Brunner F. The role of fear avoidance beliefs as a prognostic factor for outcome in patients with nonspecific low back pain: a systematic review. *Spine J Off J North Am Spine Soc*. 2014;14(5):816-836.e4. doi:10.1016/j.spinee.2013.09.036

141. Dass - ..... - A Guide to the Depression, Anxiety and Stress Scale (DASS 21) By Fernando - Studocu. Accessed May 19, 2025. https://www.studocu.com/es-mx/document/centro-universitario-de-sonora/psicologia/dass/13280712

142. https://www.jospt.org/page/authors. JOSPT. Accessed April 19, 2025. https://www.jospt.org/page/authors

143. The Cureus Journal of Medical Science: Peer-Reviewed, Open Access. Accessed April 19, 2025. https://www.cureus.com/?utm_source=google&utm_medium=cpc&utm_campaign=google-cureus-search-europe2&utm_content=cta-submit-my-article&gad_source=1&gbraid=0AAAADiJ1VhIWmDYiLIBjLePHWZCk9moR&gclid=CjwKCAjw8IfABhBXEiwAxRHlsJPYsYY1g_4vnUhO3scyyfnyUBP2xAqc06GTmw5VRNTFYxZ6zU3diRoCsdgQAvD_BwE

144. Sage Journals: Discover world-class research. Sage Journals. Accessed April 19, 2025. https://journals.sagepub.com/overview-metric/BMR

Appendix 1: IRB Approval Letter-Shoulder Case Study

IRB Approval Letters

OAKLAND UNIVERSITY

Institutional Review Board

Date: May 4, 2023

Study #: IRB-FY2023-278

Study Tile: THE USE OF SYMPTOM LOCALIZATION IN THE DIFFERENTIAL DIAGNOSIS OF ROTATOR CUFF TENDINOPATHY: A CASE REPORT

Submission Type: Initial

IRB Decision: Not Research

Research Team:
Brian Venglar
Melodie Kondratek

The above referenced study has been has been determined to be Not Research according to federal regulations. The IRB decision is based on the following:

- **Case Report Projects.** The project is limited to a report about the experiences or observations of ***three or fewer individuals***, in which there were no research interventions and no intention to contribute to generalizable knowledge.
- More specifically, this is a retrospective chart review case study of one patient.

Please retain a copy of this correspondence for your records. If you have any questions, please contact the IRB staff.

Thank you.

The Oakland University IRB

Appendix 2: IRB Approval Letter-Hip Survey Research

OAKLAND UNIVERSITY

Institutional Review Board

Date: April 30, 2024

Study #: IRB-FY2024-143

Study Tile: THE RELATIONSHIP OF PSYCHOSOCIAL FACTORS AND PATIENT-REPORTED FUNCTIONAL IMPAIRMENTS IN INDIVIDUALS WITH HIP DYSPLASIA: SURVEY RESEARCH

Submission Type: Initial

IRB Decision: Approved

Research Team:

Brian Venglar
Melodie Kondratek
Maria Beam, Lindsay Brandt

Based on applicable federal regulations, the above referenced study has been determined to involve no more than minimal risk to participants and to be Approved, with the following expedited categories:
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.)

This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

Notes for Researcher(s):

This submission includes the following approved documents:

- Hip Survey Research Flier
- Date-Stamped Adult Consent Form for Hip Survey
- Date-Stamped Parental Permission for Hip Survey
- Date-Stamped Child Assent (13-17 yoa) for Hip Survey
- Hip Survey Questionnaires

Letter and Consent Document:

This letter along with the IRB approved (date-stamped) consent document can be found in Cayuse in the Submission Details page under Letters and Attachments, respectively.

The IRB approved version of the consent document must be used in consenting participants. Federal regulations require that each participant receive a copy of the consent document unless a waiver is granted by the IRB. Signed consent forms must be retained for a minimum of three years after the completion of the project. Please remember that informed consent is a process that continues throughout the project, starting with recruitment and assurance of participant understanding of the project, and followed by a signed consent form when applicable.

Permission from Research Sites:

Please note the following:

- This IRB approval letter means that the research has met the federal criteria for approval per 45 CFR 46.111 Criteria for IRB Approval of Research.
- Before the research is initiated, permission to conduct research at a given site must be obtained from all research locations listed in the IRB submission. You must keep copies of all such permission letters for your records.
- It is the responsibility of each researcher to follow all applicable policies and procedures of any outside institution where the research will be conducted.

Modifications:

Any changes to the approved project must be approved by the IRB prior to initiation by submitting a MODIFICATION request. Do not collect data while the changes are being reviewed. Data collected during this time cannot be used in research.

Incidents:

All unanticipated problems involving risks to participants or others, serious and unexpected adverse events,
non-compliance issues and/or serious complaints regarding this project must be reported promptly to the IRB by submitting an INCIDENT report.

You are approved to start the research. Please retain a copy of this notification

for your records. If you have any questions, please contact the IRB office.

Thank you.

The Oakland University IRB

Appendix 3: The Upper Extremity Functional Scale (UEFS)

UPPER EXTREMITY FUNCTIONAL SCALE
(UEFS)

Patient Name: _____ **Date:** _____

We are interested in knowing whether you are having any difficulty at all with the activities listed below because of your upper limb problem for which you are currently seeking attention. Please provide an answer for each activity.

Today, do you or would you have any difficulty at all with: (circle one number on each line)

Activities	Extreme Difficulty or Unable to Perform Activity	Quite a Bit of Difficulty	Moderate Difficulty	A Little Bit of Difficulty	No Difficulty
Any of your usual work, household or school activities	0	1	2	3	4
Your usual hobbies, recreational or sporting activities	0	1	2	3	4
Lifting a bag of groceries to waist level	0	1	2	3	4
Lifting a bag of groceries above your head	0	1	2	3	4
Grooming your hair	0	1	2	3	4
Pushing up on your hands (i.e. from bathtub or a chair)	0	1	2	3	4
Preparing food (i.e. peeling, cutting)	0	1	2	3	4
Driving	0	1	2	3	4
Vacuuming, sweeping, or raking	0	1	2	3	4
Dressing	0	1	2	3	4
Doing up buttons	0	1	2	3	4
Using tools or appliances	0	1	2	3	4
Opening doors	0	1	2	3	4
Cleaning	0	1	2	3	4
Tying or lacing shoes	0	1	2	3	4
Sleeping	0	1	2	3	4
Laundering clothes (i.e. washing, ironing, folding)	0	1	2	3	4
Opening a jar	0	1	2	3	4
Throwing a ball	0	1	2	3	4
Carrying a small suitcase with your affected limb	0	1	2	3	4
Column Totals					

UEFS Score _____/80 ***Maximal Function (UEFS Score)/80 x 100 =*** _____%. ****Medicare Rating:*** _____%
****For a Medicare patient, the Impairment/Limitation/Restriction % is the opposite of the Maximal Function for UEFS. Example: 60/80 x 100 = 75% (UEFS %) and 100% – 75% = 25% (MCR rating)***

Provider Signature: _____

Appendix 4: Quick Disability of the Arm, Shoulder, and Hand (qDASH)

THE QuickDASH OUTCOME MEASURE

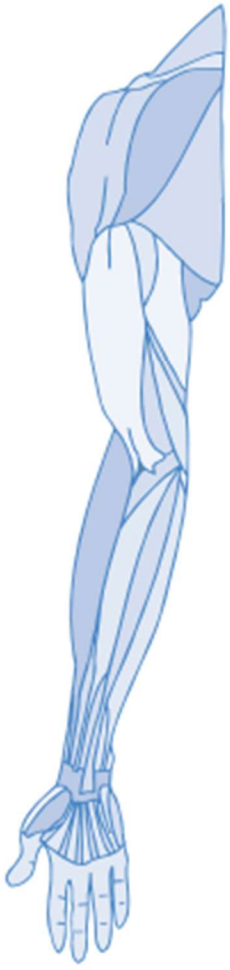
INSTRUCTIONS

This questionnaire asks about your symptoms as well as your ability to perform certain activities.

Please answer *every question*, based on your condition in the last week, by circling the appropriate number.

If you did not have the opportunity to perform an activity in the past week, please make your *best estimate* of which response would be the most accurate.

It doesn't matter which hand or arm you use to perform the activity; please answer based on your ability regardless of how you perform the task.



QuickDASH

Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a tight or new jar.	1	2	3	4	5
2. Do heavy household chores (e.g., wash walls, floors).	1	2	3	4	5
3. Carry a shopping bag or briefcase.	1	2	3	4	5
4. Wash your back.	1	2	3	4	5
5. Use a knife to cut food.	1	2	3	4	5
6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	1	2	3	4	5

	NOT AT ALL	SLIGHTLY	MODERATELY	QUITE A BIT	EXTREMELY
7. During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?	1	2	3	4	5

	NOT LIMITED AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	1	2	3	4	5

Please rate the severity of the following symptoms in the last week. *(circle number)*	NONE	MILD	MODERATE	SEVERE	EXTREME
9. Arm, shoulder or hand pain.	1	2	3	4	5
10. Tingling (pins and needles) in your arm, shoulder or hand.	1	2	3	4	5

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	SO MUCH DIFFICULTY THAT I CAN'T SLEEP
11. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand? *(circle number)*	1	2	3	4	5

QuickDASH DISABILITY/SYMPTOM SCORE = $\left(\left[\frac{\text{sum of n responses}}{n}\right] - 1\right) \times 25$, where n is equal to the number of completed responses.

A QuickDASH score may <u>not</u> be calculated if there is greater than 1 missing item.

QuickDASH

WORK MODULE (OPTIONAL)

The following questions ask about the impact of your arm, shoulder or hand problem on your ability to work (including homemaking if that is your main work role).

Please indicate what your job/work is:_____

❒ I do not work. (You may skip this section.)

Please circle the number that best describes your physical ability in the past week.

Did you have any difficulty:	**NO DIFFICULTY**	**MILD DIFFICULTY**	**MODERATE DIFFICULTY**	**SEVERE DIFFICULTY**	**UNABLE**
1. using your usual technique for your work?	1	2	3	4	5
2. doing your usual work because of arm, shoulder or hand pain?	1	2	3	4	5
3. doing your work as well as you would like?	1	2	3	4	5
4. spending your usual amount of time doing your work?	1	2	3	4	5

SPORTS/PERFORMING ARTS MODULE (OPTIONAL)

The following questions relate to the impact of your arm, shoulder or hand problem on playing *your musical instrument or sport or both*. If you play more than one sport or instrument (or play both), please answer with respect to that activity which is most important to you.

Please indicate the sport or instrument which is most important to you:_____

❑ I do not play a sport or an instrument. (You may skip this section.)

Please circle the number that best describes your physical ability in the past week.

Did you have any difficulty:	**NO DIFFICULTY**	**MILD DIFFICULTY**	**MODERATE DIFFICULTY**	**SEVERE DIFFICULTY**	**UNABLE**
1. using your usual technique for playing your instrument or sport?	1	2	3	4	5
2. playing your musical instrument or sport because of arm, shoulder or hand pain?	1	2	3	4	5
3. playing your musical instrument or sport as well as you would like?	1	2	3	4	5
4. spending your usual amount of time practising or playing your instrument or sport?	1	2	3	4	5

SCORING THE OPTIONAL MODULES: Add up assigned values for each response; divide by 4 (number of items); subtract 1; multiply by 25.
An optional module score may <u>not</u> be calculated if there are any missing items.

Institute for Work & Health | Research Excellence Advancing Employee Health

Appendix 5: The International Hip Outcome Tool (iHOT)

QUALITY OF LIFE QUESTIONNAIRE FOR YOUNG, ACTIVE PEOPLE WITH HIP PROBLEMS

INSTRUCTIONS

- These questions ask about the problems you may be experiencing in your hip, how these problems affect your life, and the emotions you may feel because of these problems.
- Please indicate the severity by marking the line below each question with a slash.
  - If you put a mark on the far **left**, it means that you **feel you are significantly impaired**. For example:

SIGNIFICANTLY IMPAIRED / _____ NO PROBLEMS AT ALL

  - If you put a mark on the far **right**, it means that you **do not think that you have any problems** with your hip. For example:

SIGNIFICANTLY IMPAIRED _____ / NO PROBLEMS AT ALL

  - If the mark is placed in the middle of the line, this indicates that you are moderately disabled, or in other words, between the extremes of 'significantly impaired' and 'no problems at all'. It is important to put your mark at either end of the line if the extreme descriptions accurately reflect your situation.

TIP If you don't do an activity, imagine how your hip would feel if you had to try it.

- Please let your answers describe the typical situation in the last **month**.

SECTION 1 | SYMPTOMS AND FUNCTIONAL LIMITATIONS

The following questions ask about symptoms that you may experience in your hip and about the function of your hip with respect to daily activities. Please think about how you have felt most of the time over the past month and answer accordingly.

Q01 How often does your hip/groin ache?

CONSTANTLY _____ NEVER

Q02 How stiff is your hip as a result of sitting/resting during the day?

EXTREMELY STIFF _____ NOT STIFF AT ALL

Q03 How difficult is it for you to walk long distances?

EXTREMELY DIFFICULT _____ NOT DIFFICULT AT ALL

Q04 How much pain do you have in your hip while sitting?

EXTREME PAIN _____ NO PAIN AT ALL

Q05 How much trouble do you have standing on your feet for long periods of time?

SEVERE TROUBLE _____ NO TROUBLE AT ALL

Q06 How difficult is it for you to get up and down off the floor/ground?

EXTREMELY DIFFICULT _____ NOT DIFFICULT AT ALL

Q07 How difficult is it for you to walk on uneven surfaces?

EXTREMELY DIFFICULT _____ NOT DIFFICULT AT ALL

Q08 How difficult is it for you to lie on your affected hip side?

EXTREMELY DIFFICULT _____ NOT DIFFICULT AT ALL

Q09 How much trouble do you have with stepping over obstacles?

SEVERE TROUBLE _____ NO TROUBLE AT ALL

Q10 How much trouble do you have with climbing up/down stairs?

SEVERE TROUBLE _____ NO TROUBLE AT ALL

Q11 How much trouble do you have with rising from a sitting position?

SEVERE TROUBLE _____ NO TROUBLE AT ALL

Q12 How much discomfort do you have with taking long strides?

EXTREME DISCOMFORT _____ NO DISCOMFORT AT ALL

Q13 How much difficulty do you have with getting into and/or out of a car?

EXTREME DIFFICULTY _____ NO DIFFICULTY AT ALL

Q14 How much trouble do you have with grinding, catching or clicking in your hip?

SEVERE TROUBLE _____ NO TROUBLE AT ALL

Q15 How much difficulty do you have with putting on/taking off socks, stockings or shoes?

EXTREME DIFFICULTY _____ NO DIFFICULTY AT ALL

Q16 Overall, how much pain do you have in your hip/groin?

EXTREME PAIN _____ NO PAIN AT ALL

SECTION 2 | SPORTS AND RECREATIONAL ACTIVITIES

The following questions ask about your **hip** when you participate in sports and recreational activities. Please think about how you have felt most of the time over the past **month** and answer accordingly.

Q17 How concerned are you about your ability to maintain your desired fitness level?

EXTREMELY CONCERNED _____ NOT CONCERNED AT ALL

Q18 How much pain do you experience in your hip after activity?

EXTREME PAIN _____ NO PAIN AT ALL

Q19 How concerned are you that the pain in your hip will increase if you participate in sports or recreational activities?

EXTREMELY CONCERNED _____ NOT CONCERNED AT ALL

Q20 How much has your quality of life deteriorated because you cannot participate in sport/recreational activities?

EXTREMELY DETERIORATED _____ NOT DETERIORATED AT ALL

Q21 How concerned are you about cutting/changing directions during your sport or recreational activities?

☐ I do not do this action in my activities

EXTREMELY CONCERNED _____ NOT CONCERNED AT ALL

Q22 How much has your performance level decreased in your sport or recreational activities?

EXTREMELY DECREASED _____ NOT DECREASED AT ALL

SECTION 3 | JOB RELATED CONCERNS

The following questions relate to your hip with respect to your current work. Please think about how you have felt most of the time over the past month and answer accordingly.

☐ I do not work because of my hip *(please skip section)*

☐ I do not work for reasons other than my hip *(please skip section)*

Q23 How much trouble do you have pushing, pulling, lifting or carrying heavy objects at work?

☐ I do not do these actions in my activities

SEVERE TROUBLE _____ NO TROUBLE AT ALL

Q24 How much trouble do you have with crouching/squatting?

SEVERE TROUBLE _____ NO TROUBLE AT ALL

Q25 How concerned are you that your job will make your hip worse?

EXTREMELY CONCERNED _____ NOT CONCERNED AT ALL

Q26 How much difficulty do you have at work because of reduced hip mobility?

EXTREME DIFFICULTY _____ NO DIFFICULTY AT ALL

SECTION 4 | SOCIAL, EMOTIONAL AND LIFESTYLE CONCERNS

The following questions ask about social, emotional and lifestyle concerns that you may feel with respect to your hip problem. Please think about how you have felt most of the time over the past month and answer accordingly.

Q27 How frustrated are you because of your hip problem?

EXTREMELY FRUSTRATED _____ NOT FRUSTRATED AT ALL

Q28 How much trouble do you have with sexual activity because of your hip?

☐ This is not relevant to me

SEVERE TROUBLE _____ NO TROUBLE AT ALL

Q29 How much of a distraction is your hip problem?

EXTREME DISTRACTION _____ NO DISTRACTION AT ALL

Q30 How difficult is it for you to release tension and stress because of your hip problem?

EXTREMELY DIFFICULT _____ NOT DIFFICULT AT ALL

Q31 How discouraged are you because of your hip problem?

EXTREMELY DISCOURAGED _____ NOT DISCOURAGED AT ALL

Q32 How concerned are you about picking up or carrying children because of your hip?

☐ I do not do this action in my activities

EXTREMELY CONCERNED _____ NOT CONCERNED AT ALL

Q33 How much of the time are you aware of the disability in your hip?

CONSTANTLY AWARE _____ NOT AWARE AT ALL

Appendix 6: The Patient Specific Functional Scale (PSFS)

Patient-specific activity scoring scheme (Point to one number):

0 1 2 3 4 5 6 7 8 9 10

Unable to perform activity

Able to perform activity at the same level as before injury or problem

(Date and Score)

Activity	Initial					
1.						
2.						
3.						
4.						
5.						
Additional						
Additional						

Total score = sum of the activity scores/number of activities
Minimum detectable change (90%CI) for average score = 2 points
Minimum detectable change (90%CI) for single activity score = 3 points

PSFS developed by: Stratford, P., Gill, C., Westaway, M., & Binkley, J. (1995). Assessing disability and change on individual patients: a report of a patient specific measure. Physiotherapy Canada, 47, 258-263.

Appendix 7: Fear Avoidance Belief Questionnaire (FABQ)

Fear-Avoidance Beliefs Questionnaire (FABQ)

Here are some of the things which other patients have told us about their pain. For each statement please circle any number from 0 to 6 to say how much physical activities such as bending, lifting, walking or driving affect or would affect *your* back pain.

	Completely disagree			Unsure			Completely agree
1. My pain was caused by physical activity.....	0	1	2	3	4	5	6
2. Physical activity makes my pain worse.....	0	1	2	3	4	5	6
3. Physical activity might harm my back.....	0	1	2	3	4	5	6
4. I should not do physical activities which (might) make my pain worse	0	1	2	3	4	5	6
5. I cannot do physical activities which (might) make my pain worse.....	0	1	2	3	4	5	6

The following statements are about how your normal work affects or would affect your back pain.

	Completely disagree			Unsure			Completely agree
6. My pain was caused by my work or by an accident at work.....	0	1	2	3	4	5	6
7. My work aggravated my pain.....	0	1	2	3	4	5	6
8. I have a claim for compensation for my pain.....	0	1	2	3	4	5	6
9. My work is too heavy for me.....	0	1	2	3	4	5	6
10. My work makes or would make my pain worse.....	0	1	2	3	4	5	6
11. My work might harm my back.....	0	1	2	3	4	5	6
12. I should not do my normal work with my present pain.....	0	1	2	3	4	5	6
13. I cannot do my normal work with my present pain.....	0	1	2	3	4	5	6
14. I cannot do my normal work till my pain is treated.....	0	1	2	3	4	5	6
15. I do not think that I will be back to my normal work within 3 months.	0	1	2	3	4	5	6
16. I do not think that I will ever be able to go back to that work.	0	1	2	3	4	5	6

Scoring
Scale 1: fear-avoidance beliefs about work – items 6, 7, 9, 10, 11, 12, 15.
Scale 2: fear-avoidance beliefs about physical activity – items 2, 3, 4, 5.

 Waddell G, Newton M, Henderson I, et al. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. *Pain*. 1993;52(2):157–168.

Appendix 8: The Depression Anxiety and Stress Scale (DASS-21)

Data collected in survey but results reported elsewhere

No.	Question	Never	Sometimes	Often	Almost Always		D	A	S
1	I found it hard to wind down	0	1	2	3				
2	I was aware of dryness of my mouth	0	1	2	3				
3	I couldn't seem to experience any positive feeling at all	0	1	2	3				
4	I experienced breathing difficulty (eg. Excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3				
5	I found it difficult to work up the initiative to do things	0	1	2	3				
6	I tended to over-react to situations	0	1	2	3				
7	I experienced trembling (e.g. in the hands)	0	1	2	3				
8	I felt that I was using a lot of nervous energy	0	1	2	3				
9	I was worried about situation in which I might panic and make a fool of myself	0	1	2	3				
10	I felt that I had nothing to look forward to	0	1	2	3				
11	I found myself getting agitated	0	1	2	3				
12	I found it difficult to relax	0	1	2	3				
13	I felt down-hearted and blue	0	1	2	3				
14	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3				
15	I felt I was close to panic	0	1	2	3				
16	I was unable to become enthusiastic about anything	0	1	2	3				
17	I felt I wasn't worth much as a person	0	1	2	3				
18	I felt that I was rather touchy	0	1	2	3				
19	I was aware of the action of my heart in the absence of physical exertion (ex. sense of heart rate)	0	1	2	3				
20	I felt scared without any good reason	0	1	2	3				
21	I felt that life was meaningless	0	1	2	3				
					Total				