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The International Journal of Sports Physical Therapy is pleased to publish abstracts from the fourteenth Orthopaedic Summit (OSET) taking place in Las Vegas, September 13-18, 2024. The IJSPT hosted the third annual research forum and reception at OSET, sponsored by ATI Physical Therapy and Hyperice. The abstracts presented in the following pages were selected by the OSET Research Committee and editorial staff of the International Journal of Sports Physical Therapy. After careful review, a total of 18 research abstracts were accepted and presented at OSET 2024. Awards for outstanding abstracts were presented on September 14.

The 2024 abstracts include contemporary orthopaedic and rehabilitation topics across various research designs. Each abstract presents only a brief summary of a research project / presentation and does not permit full assessment of the scientific rigor with which the work was conducted. While the abstracts offer only preliminary results that may require further refinement and future validation, they do serve an important role in sharing new research ideas and rehabilitation advancements. This sharing of ideas helps to encourage dialogue among researchers, clinicians, and educators that will ultimately contribute to the orthopaedic and rehabilitation body of knowledge. We strongly encourage authors to continue pursuing the publication of their research as a full manuscript.

Thank you to all submitting abstracts for consideration. We look forward to another outstanding season of submissions for OSET 2025.

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EVIDENCE OF MAIN QUALITIES MEASURING BY UPPER EXTREMITIES FUNCTIONAL PERFORMANCE TESTS: A SYSTEMATIC REVIEW

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Background: Upper extremities Functional Performance Tests (FPTs) have been used to assess the impact of these shoulder impairment on an individual's ability to perform their desired activity. Studies recommend twenty-five upper extremities FPTs in clinical working. However, few of these upper extremities FPTs have evidence to show what they are supposed to measure.

Purpose: The purpose of this systematic review is to identify the purpose of the FPTs and the factors these tests measures.

Study Design: Systematic review.

Methods: Databases (PubMed, Medline, EMBASE) were searched in May 2024. One reviewer rated the methodological quality based on the Consensus-based Standards for the Selection of Health Measurement Instruments (COSMIN) checklist.

Results: Twenty-one studies were included with Twenty-five FPTs. The FPTs analyzed were Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST), Posterior Shoulder Endurance Test, Modified Closed Kinetic Chain Upper Extremity Stability Test (m-CKCUEST), Shoulder Endurance Test, The Athletic Shoulder Test, Upper Quarter Y-Balance Test, Seated medicine ball throw (SMBT), Ball abduction-external rotation test, Ball taps on wall test, Prone ball drop test, Push up test, Pull up test, One Repetition Maximum Bench Press Test, Unilateral Maximum Chest Press Test, Unilateral Pulling Assessment, Single Arm Pushing Assessment, Single Arm Seated Shot Put Test (SSPT), Upper Extremity Hop Test, Medicine Ball Explosive Power Test, Arm Jump Board Test, Upper Limb Rotation Test, Finger Hang Test, Two Arm Bent Hang Test, Pull Up Shoulder Endurance Test. Most FPTs are not supported by evidence what they suppose to measure. CKCUEST have moderate evidence supporting measuring upper extremities

stability and coordination. SMBT and SSPT have moderate to strong evidence supporting measuring power of upper extremities.

Conclusion: SMBT and SSPT are clinically valid in measuring strength and power of upper extremities. CKQUEST is considered to be a potential tool for accessing upper limb stability and coordination. More evidence is needed to clarify what main qualities are suppose to measure in other upper extremities FPTs.

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EFFECTS OF CORRECTIVE EXERCISE INTERVENTIONS ON THE FUNCTIONAL MOVEMENT SCREEN IN DIVISION I FOOTBALL ATHLETES

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Background: The Functional Movement Screen (FMS) is used to evaluate seven fundamental movement patterns in athletes. The FMS is not intended to diagnose orthopedic problems but to demonstrate opportunities for improving movement in athletes.

Purpose: The purpose of the current study was to evaluate the effects of a 4-week intervention on FMS total scores and FMS component scores in a subset of 18 Division I football athletes. Study Design: Oxford Centre for EBM Level 3 Non-randomized controlled Cohort study. Methods: Eighty-eight Northern Arizona University Division 1 football players were assessed using the FMS in the spring and summer before the athletic season. Eighteen football athletes (mean age, SD; 21.10 ± 1.96 years) received corrective exercise interventions over 4 weeks, considering FMS total and component scores and the Symmio Self-Screen conducted weekly. The intervention group was assessed for pain with movement, movement dysfunction, and deficits in dynamic balance in concordance with Matsel et al., 2023. Corrective exercise interventions were implemented by entry-level student physical therapists for 20 minutes per day, 3 times per week for 4 weeks. FMS scores from the corrective exercise group were compared to the control group.

Results: FMS total scores were statistically significant differences compared to the control group ($p=.003$; 95% CI -4.14, -0.31) and 6 of 7 FMS component scores for Deep Squat, Hurdle Step, Inline Lunge, Shoulder Mobility, Trunk Stability, and Rotary Stability were statistically significant (all $p<.05$).

Conclusion: The FMS can identify movement limitations, and individualized corrective exercises may improve FMS scores in football athletes. Future studies may consider how corrective exercises may improve performance.

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LARGE SAMPLE NORMATIVE DATA FOR THROWING ARM STRENGTH AND RANGE OF MOTION IN BASEBALL PLAYERS

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Background: Technological advancements have democratized access to objective data in athletes of all ages. Strength and range of motion (ROM) testing are critical in examining a pitcher's upper extremity. However, current sports medicine professionals rely on normative data published from small clinical sample sizes.

Purpose: To predict strength and ROM data in baseball pitchers using anthropometrics and provide normative data from a large population. We hypothesize height, weight, and age will be positive predictors of strength metrics, positive predictors of external rotation (ER) and flexion ROM, and negative predictors of internal rotation (IR) ROM.

Study Design: Original Research.

Methods: Data were collected on 7,654 pitchers between 7-30 years old. Strength variables of interest were IR, ER, scaption, and grip. ROM variables of interest were IR, ER, and flexion. Participants used an inertial measurement unit and dynamometer for self-assessment after viewing educational videos. IR, ER, and scaption strength measurements were taken in supine with the shoulder elevated 90-degrees. Grip strength was measured in half-kneeling with the shoulder in 90-degrees of abduction and ER. ROM tests were performed half-kneeling with the throwing arm fixed on a wall to prevent compensation.

Results: Age, weight, and height were positively associated with all strength measurements; however, height did not add predictability beyond age and weight. Strength variables could be predicted with the following equations: 1) $ER=0.64*(age)+0.16(weight)-3.54$ ($r^2=0.53$, $p<0.001$), 2) $IR=0.59*(age)+0.18(weight)$ ($r^2=0.42$, $p<0.001$), 3) $SCAPTION=0.54*(age)+0.12(weight)-2.63$ ($r^2=0.61$, $p<0.001$), 4) $GRIP=0.66*(age)+0.12(weight)$ ($r^2=0.41$, $p<0.001$). Age weakly predicted ER and IR ROM, using the following equations: 1) $ER=104.59+1.03*(age)$ ($r^2=0.03$, $p<0.001$), 2) $IR=100.38-1.01*(age)$ ($r^2=0.02$, $p<0.001$). Flexion ROM could not be predicted with an effect size $r^2>0.01$.

Discussion/Conclusion: IR, ER, scaption, and grip strength can be predicted with anthropometrics. Throwing arm ROM measurements are weakly dependent on anthropometrics and can likely be referenced to provided normative values with minimal regard for anthropometrics.

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SHOULDER YOUR ROLE: A CASE STUDY

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Introduction: Shoulder dislocations occur during athletic events due to the shallow glenoid and overall laxity of the joint. Shoulder dislocations are the most common dislocation that occur based on joint. It is more common

for the shoulder to dislocate then another other joint in the body. Hill-Sachs deformity can occur when the humerus makes contact with glenoid during the dislocation. Orthopedic surgeons treating patients with this condition commonly choose between arthroscopic bankart repair with remplissage or laterjet produce.

Case Description: The purpose of this case study was to delineate the rehabilitation specialist role in providing care to the patient deciding between bankart with remplissage and laterjet to assist in restoration of function.

Outcomes: This case was documented as part of general patient care. Following the patient's plan of care, it was determined that the case may be an opportunity to compare two surgical options for patients with recurrent shoulder dislocation competing in wrestling. Outcomes were based on the number of dislocations and patient's perceived level of stability in his shoulder. This is a clinical case study of one patient. The patient in this case had both the bankart with remplissage and laterjet surgery on this ipsilateral shoulder. The return to sport was similar with both surgeries but the number of redislocations was greater with the bankart with remplissage.

Discussion: Following a shoulder dislocation patients may have questions about prognoses and return-to-sport plans. In specific sports or activities the rehabilitative specialist may be more well-versed in the biomechanics than the surgeon or other medical professionals. Providing the patient with previous examples of effect strategies while tailoring a patient centered plan around the chosen intervention can lead to long-term outcome improvements. The rehabilitation specialist can function as a guide to educate with research and practice-based evidence related to the specifics of the patient.

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HOW DO PHYSICALLY ACTIVE INDIVIDUALS IDENTIFY VIBRATIONAL STIMULI THROUGH COLOR?

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Background: Interventions involving mindfulness have been used to manage pain, stress, anxiety, and general wellness. When incorporated into physical rehabilitation these interventions can positively affect outcomes for physical and mental health. Vibrational therapy has emerged as a viable option for orthopedic conditions. Color therapy has many dimensions that harness the power of color to benefit the patient. It is assumed that vibrations of color (presumably different frequencies/wavelengths of visible light) influence one's body and mind.

Purpose: The purpose of this study was to explore the perceived colors participants felt during a therapeutic vibrational stimulus.

Study Design: Original Research.

Methods: A convenience sample of 30 student-athletes received tactile vibrational therapy from the Hypersphere Go (Hyperice, Irvine, California). All participants received the stimulus on their hamstring in a log sit position. Par-

ticipants were tested post-treatment after each vibrational setting (Low 45Hz, Medium 68Hz, High 92Hz) for their perception of color (red, yellow, or blue). Statistical analysis was completed to compare the perceived color to the vibrational frequencies.

Results: The vibrational frequencies were positively correlated ($r=.46$) to the hypothesized perceived color. The perceived colors of blue and yellow were selected with the hypothesized vibrational frequencies 43% of the time. Red was selected with the hypothesized vibrational frequency 73% of the time.

Discussion/Conclusion: Exploring the vibrational and color connection of tissue mobilization can add to this alternative therapy. The frequencies at which light travels to generate (blue, yellow, red) color did not correlate with the intensity of the vibration therapy (low, medium, high). It is more likely that individual beliefs and perceptions of what colors represent to them influence their selections. Blue was the most selected for "feeling the best." More research is needed on the relationship between color therapy and recovery techniques.

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A FINITE ELEMENT ANALYSIS MODEL TO SUPPORT LIGAMENTUM TERES FUNCTION

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Background: The function of the ligamentum teres (LT) continues to be an area of debate and interest. Cadaver studies found the LT to be a rotational stabilizer in all hip positions. Hip external rotation (ER) may be of particular interest as it relates to microinstability and focal rotational laxity of the iliofemoral ligament.

Purpose: To use finite element analysis (FEA) modeling to support the function of the LT as a structure that stabilizes the hip by limiting ER.

Study Design: Lab study

Methods: Onshape was first used to recreate the hip anatomy. FEA modeling during hip movement simulation was then performed with Ansys. These movements were segregated into two sequential steps: flexion in the first step and ER in the second step. Three flexion angles (0°, 30°, and 60°) were considered, with adduction set at 0°. The simulation captured the maximum von-Mises stress during various degrees of ER.

Results: The von Mises stress on the LT remained low until ER range of motion approached end range. Stress on the LT then increased exponentially as ER range of motion approached a maximum value. The increase in stress varied by the flexion angle, with the stress starting to increase exponentially at approximately 28°, 37°, and 42° of ER when the flexion angle was at 0°, 30°, and 60°, respectively. The

von-mises stress was allied with the LT limiting ER range of motion.

Conclusion: This FEA modeling study supports the function of the LT in restraining hip ER range of motion. It also supports a ball and string model to describe the function of the LT. The results endorse a ball and string model where the LT tightens with ER, increasing stress and presumably pulling the femoral head into the acetabulum to enhance stability at the end range of ER.

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DEFINING REGION AND DURATION-SPECIFIC SUBSTANTIAL CLINICAL BENEFIT VALUES FOR THE SIMPLIFIED CHINESE LOWER EXTREMITY FUNCTIONAL SCALE

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Background: A single substantial clinical benefit (SCB) value for the Simplified Chinese Lower Extremity Functional Scale (SC-LEFS) that can be applied generally to those with lower extremity musculoskeletal injuries is available. However, unique SCB values defined by specific body region and symptom duration may enhance the precision of the SC-LEFS in clinical assessments.

Purpose: To determine unique SCB change scores values for the SC-LEFS based on symptom duration and body region.

Study Design: Longitudinal retrospective study

Methods: Patients aged 18-50 with knee or ankle/foot injuries completed the SC-LEFS at initial assessment and 4-weeks follow-up. Demographic information and duration of symptoms were obtained. Patients were classified into “improved” and “not improved” groups based on self-report after 4-weeks of physical therapy. SCB values were determined to best distinguish between the two groups. Receiver operator characteristic (ROC) curve analysis defined the sensitivity and specificity.

Results: 313 patients with a mean age of 33.7 (SD 9.3) years were included in the knee region and 354 with a mean age of 32.9 (SD 9.4) years in the ankle/foot region. For those with knee region injuries, SCB values of 9.5 and 5.5 were found for patients with symptom duration ≤ 3 months and symptom duration > 3 months, respectively. For those with ankle/foot injuries, SCB values 12.5 and 8.5 were found for patients with symptom duration ≤ 3 months and symptom duration > 3 months, respectively. The sensitivity and specificity for these SCB values ranged from 0.67 to 0.72 and from 0.66 to 0.68, respectively, with area under the curves (AUC) being between 0.67 to 0.72.

Conclusion: This study determined specific SCB values for the SC-LEFS after four weeks of physical therapy based on region of injury and symptom duration. These unique values may better allow clinicians to distinguish those “im-

proved” from “not improved” in Chinese-speaking patients with knee, ankle, or foot injuries.

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DEFINING SUBSTANTIAL CLINICAL BENEFIT VALUES BASED ON PATIENTS’ AND CLINICIANS’ PERCEPTIONS FOR THE SIMPLIFIED CHINESE LOWER EXTREMITY FUNCTIONAL SCALE

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Background: Substantial clinical benefit (SCB) values are used to define clinical improvement on patient reported outcome measures. However, it is unclear whether clinicians and patients agree on improvement and how these perceptions may affect Simplified Chinese Lower Extremity Functional Scale (SC-LEFS) SCB.

Purpose: To define agreement in perceived improvement between clinicians and patients as well as define SCB values for the SC-LEFS based on 1) patients’ and 2) clinicians’ rating of improvement.

Study Design: Longitudinal study

Methods: Patients aged 18-50 years with lower extremity injuries completed the SC-LEFS at initial assessment and 4-weeks follow-up. After 4-weeks of physical therapy, patients were classified into “improved” and “not improved” groups based on 1) patient self-report and 2) clinician rating. Quadratic weighted kappa was done to define the agreement between the patients’ and clinicians’ rating of improvement. Separate SC-LEFS SCB values were determined that best distinguished between the 2 groups for the patient and clinician rating. Receiver operator characteristic (ROC) curve analyses were done to define the sensitivity and specificity for these SCB values.

Results: 763 patients were included, with a mean age of 32.9 years (SD 9.4). 494 (64.7%) and 525 (68.8%) were classified as “improved” with 269 (35.2%) and 238 (31.1%) classified as “not improved” based on patient self-report and clinician rating, respectively. Agreement between patients’ and clinicians’ rating was substantial (kappa=0.8: 95% CI 0.77-0.84). SCB values of 9.5 were found for both patient report and clinician rating, with sensitivity and specificity ranging between of 0.66 and 0.72. The area under the curves (AUC) were 0.74 (95% CI 0.71-0.78) for both patient report and clinicians rating.

Conclusion: Patient and clinician agreed on improvement ratings after 4-weeks of physical therapy. SC-LEFS SCB values to define improvement were the same for both patients and clinicians.

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DETERMINING THE OPTIMAL NUMBER OF COMPONENTS IN ORDINAL SCALES FOR RELIABLE RATING OF VISUAL ASSESSMENT ON THE SINGLE LEG SQUAT TEST

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Background: There is evidence for reliability and validity with the single leg squat test (SLST) using a variety of visual rating methods. The optimal number of categories that should be used to visually rate movement quality with the SLST is currently unknown.

Purpose: To determine the number of ordinal scoring categories that would be most informative in describing performance with reliable results for visually rating the SLST.

Study Design: Cross-sectional study

Methods: 29 subjects (11 male 18 female; mean age = 23.1 years) with lower extremity injuries participated in this study. Reliability was evaluated by two physical therapists using ordinal scales of four, three, and two categories to assess trunk deviation, hip adduction, and lower extremity internal rotation during the SLST. Interrater reliability between the two raters was assessed by unweighted kappa(κ) value.

Results: The overall inter-rater reliability total score was $\kappa=0.65$, 0.5, and 0.26 for the two, three, and four-category scales, respectively. When specifically looking at trunk deviation, hip adduction, and lower extremity internal rotation, inter-rater reliability was good to excellent ($\kappa=0.65-0.86$) for two-category, good to excellent ($\kappa=0.69-0.86$) for three-category and fair to excellent ($\kappa=0.55-0.76$) for four-category.

Conclusion: This study supports visual assessment of trunk deviation, hip adduction, and lower extremity internal rotation using a three-category ordinal scale with the SLST for patients with lower extremity injuries. Two physical therapists could reliably assess trunk deviation, hip adduction, and lower extremity internal rotation with visual assessment of the SLST. When comparing two, three, and four categories, the three-category ordinal rating scale produced the best results effectively balancing detailed evaluation with high inter-rater reliability.

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NEUROMUSCULAR CONTROL AND STRENGTHENING EXERCISES CAN STABILIZE HIP PERFORMANCE DURING THE SINGLE LEG SQUAT TEST

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Background: The single leg squat test (SLST) has been used in movement system assessment to analyze dynamic lower extremity alignment during functional movement. Hip strengthening and neuromuscular control training often aim to improve SLST performance. However, it is unclear whether these exercises can improve performance by reducing the amount of variation in hip frontal plane motion during the SLST.

Purpose: To determine whether neuromuscular control and strengthening exercises can reduce variation in hip frontal plane performance during the SLST.

Study Design: Cohort study.

Methods: Twenty-five healthy subjects (10 males, 15 females; mean age = 26 years, SD = 5.3) performed three SLST trials on both legs at initial assessment and at a 4-week follow-up. Subjects participated in a neuromuscular control and strengthening exercise program every other day for 4 weeks, including side plank abduction, front plank with hip extension, and single-leg squat exercises. Kinematic data for hip abduction and adduction during the SLST were collected using a 3D-motion analysis system at both time points. The performance was defined by the amount of variation in frontal plane hip movement with standard deviation (SD) of the movements. For each subject, the largest SD (ie poorest performance) across the three SLST trials from either leg was used for analysis. A paired t-test compared the SDs of the kinematic data between the initial assessment and the 4-week follow-up.

Results: The SD of kinematic hip frontal plane data across the three trials significantly decrease ($p<0.05$) after 4-week neuromuscular control and strengthening exercises. This change represented a large effect with a Cohen's d of 1.0 (95% CI: 0.52, 1.4) with the SD decreased from 1.6 degrees at the initial assessment to 1.0 degrees at the 4-week follow-up.

Conclusion: A 4-week neuromuscular control and strengthening exercise program can improve SLST performance by reducing the variation in hip frontal plane movement.

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MANAGING WHIPLASH-ASSOCIATED DISORDER IN A 16-YEAR-OLD FEMALE WITH CERVICAL PROPRIOCEPTIVE TECHNIQUES: A CASE REPORT

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Introduction: Symptoms of whiplash-associated disorder (WAD) transition from acute to chronic at high rates. Physical therapy (PT) literature shows efforts to decrease this prevalence has not been effective. Joint position error (JPE) is reported to occur after a whiplash injury, however, there is limited evidence for the PT management of this impairment. The purpose of this case report is to present the outcomes of managing WAD with the addition of cervical proprioceptive training to improve JPE.

Case Description: A sixteen-year-old, female presented to physical therapy after a whiplash injury with complaints of cervical pain. She demonstrated a Neck Disability Index of 16%, a numeric pain rating scale (NPRS) of 5/10, cervical flexion of 45°, cervical extension of 35°, cervical right rotation of 45°, cervical left rotation of 65°, a right rotation JPE of 6.02°, and a left rotation JPE of 9.02°. She participated in a rehabilitation program for 8 visits (1x/week) with interventions used to address pain, mobility, postural reeducation, and cervical proprioception. In addition, the treatment of JPE included head repositioning accuracy and precision tracing activities.

Outcome: At discharge, the patient demonstrated a Neck Disability Index of 4%, a NPRS of 0/10, cervical flexion of 65°, cervical extension of 60°, cervical right rotation of 70°, cervical left rotation of 70°, a right rotation JPE of 6.47°, and a left rotation JPE of 2.41°. Treatment resulted in significant improvements in disability, pain, range of motion, and JPE in left rotation.

Conclusion: This case demonstrated the use of cervical proprioceptive training as an effective tool to manage WAD symptoms. The assessment and rehabilitation of JPE could be considered in the clinical setting as a treatment option to promote recovery after a whiplash injury and to reduce the risk of transitioning to a chronic state of symptoms.

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DOPPLER ULTRASOUND COMPARISON OF THE EFFECTIVENESS OF BRACHIAL ARTERY OCCLUSION BETWEEN BLOOD FLOW RESTRICTION DEVICES

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Background: Commercial blood flow restriction (BFR) devices range in price from \$200 to \$5000. Despite their

benefits for muscle hypertrophy and strength, the efficacy of commercial BFR devices has not been compared to standard blood pressure cuffs in inducing blood flow restriction.

Purpose: This pilot study assessed 2 BFR devices (SmartCuff, BStrong cuff) and a standard sphygmomanometer for effectiveness in inducing blood flow restriction.

Study Design: Observational cross section.

Methods: Fifteen healthy students (ages 21-26) participated. Parameters including brachial artery diameter, area, peak systolic velocity, end diastolic velocity, and time were measured utilizing Doppler ultrasound (Butterfly IQ). Mean flow velocity of the brachial artery assessed blood flow restriction effectiveness.

Results: A one-way repeated measures ANOVA test revealed a statistically significant difference between the pre-test and 3 BFR conditions ($p=0.046$); however, there was no significant difference between the BFR devices and the sphygmomanometer ($p=.16$). The sphygmomanometer had a very large effect on BFR ($d=1.1$) compared to the moderate effect of the commercial devices ($d=0.48$).

Discussion/Conclusion: The study suggests comparable efficacy between commercial BFR devices and a standard sphygmomanometer in reducing blood flow. In essence, the brand of the blood restriction device is unlikely to significantly influence the brachial artery occlusion percentage. Nevertheless, when a sphygmomanometer is inflated to an equivalent pressure as the SmartCuff, it results in a more pronounced brachial artery occlusion compared to the other groups. This research supports the comparable effectiveness of commercial BFR devices and a standard sphygmomanometer in inducing blood flow restriction. BFR outcomes research using sphygmomanometers is warranted.

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QUANTIFYING THE DECELERATION INDEX USING THE 1080 SPRINT DEVICE: A PILOT STUDY

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Background: The “Deceleration Index” (DI) theory is based on the assumption that deceleration forces and speed should be at least equivalent to acceleration forces and speeds.¹ An increased efficiency in the ability of an athlete to decelerate or “break” during a change in direction of movement may be associated with improved performance and lowered risk of injury.

Purpose: The purpose of this pilot study is to develop the methods to quantify the DI during change-of-direction (COD) via the “5-10-5” sprint test using the 1080Sprint device (1080Motion, Sweden).

Study Design: Observational Cross Section Research.

Methods: Moderately active, healthy adults were eligible for this pilot study. Five trials were completed by each participant. Subjects were attached to the 1080 device cable at the waist and performed a “5-10-5” shuttle run: 5

yard “assisted” sprint, changed direction, and performed a 10 yard “resisted” sprint, and reversed direction for a 5 yard “assisted” sprint. Raw data were exported at a sampling rate of 333 Hz and were averaged across the middle 3 repetitions. The peak velocity of each phase was determined. Points of interest at 50% of peak velocity were identified during the 2 assisted and resisted phases of each COD. The DI ratios of velocity and acceleration were determined from points of interest for COD 1 (Assisted-Resisted) and COD 2 (Resisted-Assisted).

Results: 10 subjects participated. The average DI for COD 1 and COD 2 for deceleration/acceleration were 1.43+.44 and 1.66+.95, respectively. The DIs for speed were .86+.09 and .87+.7 at COD 1 and COD 2, respectively. The coefficients of variation were generally high for COD 2 in speed and acceleration, and for COD 1 during acceleration (.81, .57, and .31).

Conclusion: Quantifying the DI may help improve athletic performance or identify parameters for return to sport. These methods should be repeated in an athletic population.

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RELIABILITY OF SCAPULAR KINEMATIC MEASURES USING INERTIAL MOTION UNITS

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Background: Abnormal scapular movement (“scapular dyskinesis”) has been identified as a possible contributor to shoulder pain. Scapular kinematics are typically quantified through biomechanical analysis using high speed cameras and markers; however, this method can be expensive and inconvenient. Inertial Motion Units (IMUs) are now used to assess kinematics without cameras or markers; however, few researchers have used IMUs to quantify scapular kinematics.

Purpose: The purpose of this study was to assess the reliability of measuring scapular kinematics using Noraxon® Ultium IMUs (Noraxon USA, Scottsdale AZ).

Study Design: Original Research.

Methods: 15 healthy adult subjects participated between 21 and 28 years old. IMUs were placed on the scapular spine, posterolateral acromion, spinous process of T1, and deltoid insertion of the dominant arm. Subjects performed 2 sets of shoulder flexion and scaption (6 reps at 60/s) while their 3-dimensional scapular kinematics were captured. ICC (3,1) values were calculated for each scapular sensor and direction of motion.

Results: Excellent reliability ($\geq .90$) was noted for upward rotation and anterior tilt from the acromion-based sensor during flexion and scaption. Excellent-to-good reliability ($> .75$) was noted using the acromion-based sensor for internal rotation. The scapular spine sensor ranged from poor to excellent reliability across all conditions (.36 to .97). The scapular motions at the acromion during averaged 49.5

to 52.2o for upward rotation and 15.2 to 15.6o for anterior tilt. The measures for internal rotation were -45.8 to -50.9o.

Discussion/Conclusions: Traditional IMU measurements of scapular motion have used sensors placed on the scapular spine, with researchers often reporting various results. The Noraxon Ultium IMUs demonstrated high reliability in measuring scapular kinematics when placed on the acromion of healthy subjects. More research is needed using larger samples of both healthy and injured populations, as well as validation against gold-standard kinematic assessment.

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PATIENT BELIEFS AND DISABILITY DRIVE TREATMENT CHOICE IN PATIENTS WITH SPINE CONDITIONS

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Background: A musculoskeletal (MSK) pathway was established between a physical therapy (PT) organization and a health system (Med) to promote early PT for patients with MSK conditions. To understand the influence of patient beliefs and preferences on care decisions, investigators established a REDCap protocol that surveyed patients after their first MSK PT or Med visit. The REDCap survey collected outcomes (Modified Oswestry Low Back Pain Disability Questionnaire [MDQ], Neck Disability Index [NDI], Veteran’s RAND 12-Item Health Survey Mental (MCS) and Physical (PCS) Component Scores), and validated beliefs & preference questions.

Purpose: The purpose was to understand factors associated with first provider (PT vs Med) in patients with spine conditions.

Study Design: Prospective Cohort

Materials and Methods: Patients were surveyed via REDCap for patient reported outcomes (PROs), beliefs, and preferences after first MSK visit. REDCap data was combined with that of large PT and orthopedic repositories. The belief question asked if patients believed PT would improve their condition. The preference question asked patients to spread 100 points across pain, mobility, activity, and strength by relative importance. If any preference achieved ≥ 50 points, it was considered dominant. Logistic regression predicted first provider considering preference, belief in PT, body region, MDQ/NDI score, sex, MCS, and PCS. Odds ratios (OR) were derived from regression coefficients.

Results: Patients (n=482) were mostly female (72%), 49.1 $\pm$ 10.8 years, had back pain (89%), and moderate initial

disability (MDQ 38.9 ± 18.2 ; NDI 36.9 ± 15.5); all were health system beneficiaries. Most (54%) had no preference dominance, pain (38%) was a strong preference; the rest were not (total 8%). Most (66%) had belief in PT. Men (OR 3.2 [95% CI $1.6, 6.7$]), higher disability (1.1 [$1.0, 1.1$]), and higher MCS (1.1 [$1.1, 1.1$]) were more likely to seek Med care. Belief in PT (0.2 [$0.1, 0.4$]) and neck conditions (0.1 [$0.1, 0.2$]) were more likely to seek PT first.

Conclusion: Beliefs and preferences should be considered when designing and implementing alternative care models to improve value.

Level of Evidence: Level III

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LONG-TRACK MSK CERTIFICATION DRIVES VALUE IN PHYSICAL THERAPY

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Background: Continuing education (CE) courses have yielded improved participant knowledge, but few have demonstrated a positive influence on patient reported outcomes (PROs). The Musculoskeletal Certificate (MSK Cert), a self-paced, long-form educational program, was made available to clinicians across a national platform at no cost. Course content centered around clinical practice guidelines and used a treatment-based classification approach.

Purpose: The purpose was to compare PRO change and visit utilization before, during, and after MSK Cert.

Study Design: Retrospective Cohort

Materials and Methods: Therapists that enrolled and completed the MSK Cert program between 2022 and 2023 were included. Patient episodes completed 2021-Q2 2024 and managed by included therapists were considered. Episodes were classified as: pre-, mid-, post- program if 75% of days in an episode were completed within the classification dates. Patient demographics, PROs, and visit counts were derived from the Patient Outcomes Registry.

Analyses of covariance compared visits, final PRO, and PRO change between program periods controlling for age, sex, payer, initial PRO, BMI categorization, body region, and specific PRO utilized. Tukey's post-hoc tests quantified differences when significance was observed.

Results: Patient episodes ($n=193,882$) were 58.6% female, 52.1 ± 19.0 years old, and largely insured by commercial (64.5%) and Medicare (15.7%) payers. Significant differences in visits, final PRO, and PRO change between program classification cohorts ($p < 0.001$). Visits were 11.8 ± 0.4 , 12.3 ± 0.4 , & 11.1 ± 0.04 ; final PRO was 67.3 ± 0.9 , 67.9 ± 0.9 , & 68.3 ± 0.9 ; and PRO change was 13.2 ± 0.9 , 13.8 ± 0.9 , & 14.2 ± 0.9 . This demonstrates a consistent tra-

jectory of improvement during and after the education intervention. Tukey's post-hoc tests identified that all differences were significant at $p < 0.001$ aside from final PRO mid- vs. post- program ($p = 0.001$).

Conclusion: Clinicians completing a 30-week CE program demonstrated significant improvements in PROs and doing so more efficiently with post-course episodes on average having one fewer visit. When combined, the improvements in metrics result in a sizable improvement in patient value.

Level of Evidence: Level IV

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PROFESSIONAL BASEBALL PITCHERS' PATTERNS OF USE AND RESULTS OF WEIGHTED BALL TRAINING: AN INTERIM STUDY

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Background: Professional pitchers demonstrate an average fastball velocity of 91-93 miles per hour. Based on perceived importance of velocity, development of velocity is a focus for pitchers. Pitchers use traditional (weight training) and non-traditional training methods (weighted ball training [WBT]) to improve velocity. Studies have demonstrated that higher velocity increases load on the elbow and upper extremity injury risk in pitchers. Little is known about the benefits and risks associated with WBT use by professional baseball pitchers.

Purpose: To 1) describe WBT and injuries in professional pitchers; 2) compare injury rates between professional pitchers that used WBT during the 2023 pre and regular season with pitchers that used no WBT (NWBT) prior to or during the last three seasons.

Study Design: Prospective Cohort.

Materials and Methods: Pitchers were surveyed on their use of WBT prior to spring training. Throughout spring training and the MiLB season, pitchers were monitored for athletic exposures and injuries. Injury rates per 1000 game exposures (GE) were calculated by WBT cohort and grouped by body part.

Results: Of 88 pitchers included, 52% were in the WBT cohort, and 28 injuries were reported (Upper extremity = 20; Trunk/Core = 8; Lower Extremity = 0). Pitchers that used WBT suffered 8 more injuries at a 1.1 greater injury rate per 1,000 exposure days compared to pitchers in the NWBT co-

hort. WBT pitchers arm injury rate was 11.8 per 1000 GE compared to 7.5 per 1000 GE in the NWBT cohort; and WBT pitcher core injury rate was 5.9 per 1000 GE compared to 2.1 per 1000 GE in NWBT pitchers.

Conclusion: Pitchers presented with similar workload and velocity regardless of WBT cohort. Results of the initial analysis were important because of the number and types of injuries in this WBT cohort. The major limitation of this ongoing study is that it is currently underpowered.

Level of Evidence: Level III

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Authors who provided posters for visual reference can be found in the supplemental file.

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SUPPLEMENTARY MATERIALS

Supplemental File 1

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