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Abstract #1

Calcaneal Density in Collegiate Athletes and Non-Athletes: Association With Bone Injury, Menstrual Function, and Activity

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Context: Limited evidence exists regarding the relationship between calcaneal density and lower extremity overuse bone injury (LEOBI), menstrual function, or physical activity. The objectives of this study were to: 1) determine if there is an association between development of LEOBI (stress fractures & medial tibial stress syndrome) and calcaneal density, 2) compare calcaneal density of intercollegiate athletes and non-intercollegiate athlete college students, and 3) examine the influence of menstrual function and physical activity on calcaneal density. 84 collegiate athletes (64 females, 20 males) and 103 non-athlete college students (82 females, 21 males) consented to participate.

Methods: This research was completed in two phases. In Phase I, athletes were surveyed about injury history and for females, menstrual history. Calcaneal density was assessed using an ultrasound densitometer. The direct measure of density was speed of sound (SOS) in m/s and the instrument estimated calcaneal bone mineral density (cBMD) in g/cm². Height and weight were measured. Athletes were followed for 9-10 months, and athletes with potential LEOBI symptoms were referred to a physician for diagnosis. At the end of the study, athletes received a second cBMD measurement. In Phase II, non-intercollegiate athlete college students were surveyed about injury history, physical activity level, and, for females, menstrual history. Height, weight and calcaneal density were measured. Descriptive statistics (means and percentages), analyses of relationships (χ^2 and relative risk), and differences (t-tests) were calculated.

Findings/Results: In Phase I, 8/84 athletes (1 male, 7 females) were diagnosed with a LEOBI. Although there was no difference in initial cBMD ($P > .05$) between athletes with and without LEOBI, there was a trend towards

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decreased cBMD in athletes with LEOBI. At the end of the study, right cBMD ($P = .05$) and left cBMD ($P = .07$) were lower in athletes with LEOBI. In Phase II, the non-intercollegiate athlete college students had significantly lower bilateral cBMD ($P = .000$) and SOS ($P = .000$) than the athletes. Sub-analysis by gender revealed no difference in cBMD and SOS for males (non-athletes vs. athletes), but highly significant differences in SOS ($P = .000$) and cBMD ($P = .000$) for females (non-athletes vs. athletes). Comparison of the cBMD and SOS values between the 8 athletes with LEOBI and the 103 non-athletes revealed no significant differences. In athletes and non-athletes, there was no association between self-reported menstrual function and calcaneal density. In non-athletes, there was no association between total activity score or work, sport, and leisure activity subscores and calcaneal density.

Conclusions: Athletes with LEOBI occurrence had lower cBMD than athletes who did not have LEOBI occurrence. cBMD was significantly higher in female athletes compared to female non-athletes. Athletes with occurrence of LEOBI did not have significantly different cBMD than the non-athletes. The difference between calcaneal density in athletes and non-athletes may be activity related, but calcaneal density differences among non-athletes was not related to a total physical activity score or subscores. cBMD was not related to self-reported menstrual function. The non-invasive and safe cBMD measurement may provide information about risk of LEOBI in athletes and low cBMD in non-athletes.

Abstract #2

Using MeSH (Medical Subject Headings) to Enhance PubMed Search Strategies Related to Overuse Injury for Evidence-Based Practice in Athletic Training

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Context: Evidence suggests there are barriers to evidence-based practice for athletic trainers. Athletic trainers wanting to apply the best available evidence in the examination and intervention of overuse injuries should understand how database searches related to overuse injury are performed. The purpose of this study is to illustrate how Medical Subject Headings (MeSH), a controlled vocabulary thesaurus of indexing terms, can be used to assist with efficient searches related to overuse injury in PubMed, a freely available database.

Methods: Three a priori questions related to interventions, tests and measures, and risk factors for overuse injuries were created. For these three questions, a list of 80 search terms for PubMed was generated. Individual search terms or phrases when appropriate were entered into the PubMed query box on the main (home) PubMed search page and then searched. The Search details page was checked to determine how PubMed processed the search. Search results were categorized into 1 of 3 outcomes: outcome 1) the search term mapped to an appropriate MeSH term related to the overuse injury questions; outcome 2) the search term mapped to a MeSH term that was not appropriate to the overuse injury questions; and outcome 3) the search term did not map to a MeSH term. For search terms not mapping to a MeSH term (outcome 3), the MeSH database was searched to determine if an appropriate MeSH term could be found.

Findings/Results: Of the 80 terms searched, 28 mapped to an appropriate MeSH term (outcome 1); 13 mapped to a MeSH term that was not appropriate (outcome 2); and 39 did not map to a MeSH term (outcome 3). For the 39 terms from outcome 3, appropriate MeSH terms were found in the MeSH database for 15 of the search terms and appropriate MeSH terms were not found for 24 of the search terms.

Conclusions: Understanding how search terms map to MeSH terms as part of a PubMed search strategy should assist athletic trainers with conducting more-efficient and better-informed searches related to overuse injury examination and intervention and assist with decreasing potential barriers to evidence-based practice.

Abstract #3

Effectiveness of Low Level Light Therapy in Preventing Muscle Fatigue

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Context: Muscle fatigue causes a decrease in performance and increases injury risk. For example after 100 baseball pitches there is a decrease in pitch velocity and changes in pitching mechanics that could lead to an injury. Baseball uses the 100 pitch rule to help prevent injuries, which means a team will replace the pitcher after 100 pitches. Most pitching injuries occur either in preseason or toward the later third of a season. One of the main reasons for injury is muscle fatigue over the course of the season. Therefore, if a treatment could help reduce fatigue or speed up recovery it could result in a decrease in

shoulder injuries. Recently, low-level light therapy (LLLT) has been shown to speed up recovery post-exercise and decrease fatigue in quadriceps muscles. Due to the high incidence of injuries to the rotator cuff muscles in baseball pitcher the purpose of this study was to determine if treating the rotator cuff prior to exercise would decrease muscle fatigue.

Methods: Single blind randomized pre-test post-test crossover placebo control design. The independent variable was treatment (LLLT and placebo control (PC)). The dependent variables were the total number of repetitions during a concentric/eccentric shoulder fatigue protocol. Ten females (Mass = 75.3 ± 16.0 kg Height = 170.7 ± 10.0 cm.) participated in this study. LLLT treatments were given using two emitters each consisting of 6 super-pulsed laser diodes (905 nm), 4 Infrared diodes (875 nm) and 4 red diodes (660 nm). Treatments were given simultaneously for 5-minutes at 250 Hz with an overall output of 40 J per site: Supraspinatus and Infraspinatus muscles. The placebo control (PC) treatment consisted of placing the emitters on the shoulder and not turning on the machine. Each participant came to the laboratory three times: a familiarization and two data collection sessions which were at least 7 days apart. During each testing session the participant was treated with either the LLLT or PC followed by a 5-minute warm-up using an upper body ergometer. The participant completed a maximum voluntary contraction (MVC) to determine peak ER torque. The fatigue protocol used an ER concentric/eccentric protocol. The participant continued the protocol until they either had 3 consecutive repetitions under 50% their peak torque or reached 25 repetitions. They then immediately repeated the MVC procedure. The number of repetitions was analyzed using a paired one-tailed T-test significance level was set at $P < .05$ a-priori. A Fishers Exact test was used to analyze subject responsiveness to the laser treatment. Cohen Effect value was used to determine the treatment effect.

Findings/Results: We found significant differences in number of repetitions ($P = .001$; CI -0.9007 to 4.901) between treatment. Fisher's exact test showed that more LLLT treated participants improved in the total repetitions over baseline than those receiving placebo treatment ($P = .023$; LLLT 80% improved, Placebo 20% improved). The 80% that responded to LLLT had a 16% Increase in repetitions over baseline. Cohen Effect value (Cv = 0.308) indicated that this was a small effect.

Conclusions: Improvements in number of repetitions were seen in 80% of the laser treated participants versus 20% of the placebo treated. The 80% that responded to laser had a 16% Increase in repetitions over baseline. If we apply this to the 100 pitch rule in baseball the non-responder would fatigue after 100 pitches and the responder pitchers would fatigue after 116 pitches. This means that the pitcher could either pitch one more inning or if the team continued to follow the 100 pitch rule the pitcher would not be as fatigued when they were pulled from the game, which may prevent a future injury.

Abstract #4

Inter-Rater Reliability of Hand-Held Dynamometry at the Hip

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Context: Hand-held dynamometry (HHD) is a newer technique within athletic training and therapy, but little research has determined its reliability. Much of the previous HHD research focused on the upper extremity, but some have evaluated hip strength. Research indicates HHD is both a valid and reliable method to measure strength of the upper extremity with only the clinician providing resistance. The purpose of this study was to determine the inter-rater reliability (IRR) of HHD during six isometric hip motions between two clinicians with and without a stable resistance.

Methods: We used a quasi-experimental test-retest design to determine the IRR of HHD with and without stable resistance. Seventy-nine male ($n = 33$) and female ($n = 46$) volunteers with no history of hip injury participated. Two participants were excluded from data analysis for only completing the first session. Participants underwent two testing sessions, with a minimum of 24 hrs between sessions. Participants performed 6 isometric hip motions (flexion (FL), extension (EXT), abduction (ABD), adduction (ADD), internal rotation (IR), external rotation (ER)) against the resistance of the clinician (NB) and then against a stable brace (B). Participants held each contraction for three seconds. Following a rest period, the procedure was repeated with rater two. We randomized the order of the raters, leg used, and order of the motions for each participant, but maintained the same randomization between trials. Data from each trial were pooled and analyzed using a two-way random effect intraclass correlation coefficient (ICC) and a two-way ANOVA.

Findings/Results: We calculated means for all motions and found large differences between NB and B: ABD ($M_{NB} = 33.43 \pm 7.81$, $M_B = 46.01 \pm 16.39$), ADD ($M_{NB} = 29.69 \pm 7.63$, $M_B = 36.02 \pm 11.72$), FL ($M_{NB} = 36.99 \pm 10.64$, $M_B = 50.25 \pm 16.92$), EXT ($M_{NB} = 34.81 \pm 8.59$, $M_B = 46.42 \pm 14.75$), IR ($M_{NB} = 21.63 \pm 5.43$, $M_B = 28.44 \pm 8.78$), and ER ($M_{NB} = 21.80 \pm 6.81$, $M_B = 25.24 \pm 7.38$). Data analysis indicates poor IRR for NB ranging from ADD (ICC_{NB} = 0.05, 95% CI = -0.09-0.23) to IR (ICC_{NB} = 0.44, 95% CI = -0.06-0.72). We found moderate to high IRR for B ranging from ADD (ICC_B = 0.65, 95% CI = 0.50-0.76) to ABD (ICC_B = 0.85, 95% CI = 0.78-0.90). Two-way ANOVA calculations indicate significant simple main effects for condition for ABD ($F_{1,304} = 73.85$, $P < .001$, ES = 0.20), ADD ($F_{1,304} = 33.34$, $P < .001$, ES = 0.099), FL ($F_{1,304} = 67.65$, $P < .001$, ES = 0.182), EXT ($F_{1,304} = 71.87$, $P <$

.001, ES = 0.191), IR ($F_{1,304} = 70.45$, $P < .001$, ES = 0.188), and ER ($F_{1,304} = 18.671$, $P < .001$, ES = 0.058).

Conclusions: There is poor IRR with HHD when only clinician resistance is used. Higher IRR exists when using a stable source of resistance. Our results suggest HHD is unreliable for measuring hip strength without stable resistance. We suspect differences in practitioner strength as a source for the variability in measures. Clinically this suggests utilizing HHD during manual muscle testing without a fixed resistance may have little utility. Hip manual muscle testing should be measured using a stable resistance to diminish variability due to clinician strength. Clinically a wall or table would provide stable resistance and likely increase the consistency of strength measurements between clinicians. Our results also indicate large increases in patient strength against a stable resistance, meaning we may get a more accurate strength assessment as well.

Abstract #5

Comparing the Immediate Effects of a Total Motion Release Warm-Up and a Dynamic Warm-Up Protocol on the Dominant Shoulder in Baseball Athletes

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Context: A decrease in total range of motion (ROM) and internal rotation (IR) of the dominant shoulder may predispose baseball athletes to increased injury risk of the shoulder. Although therapeutic strategies (e.g., static stretching protocols) have been implemented to counteract motion loss and maintain IR, the most appropriate method for correcting ROM deficiency is unknown. In a previous study, the Total Motion Release® (TMR®) Trunk Twist (TT) and Arm Raise (AR) was found to be significantly more effective than a traditional dynamic warm-up program at increasing IR in the dominant shoulder of baseball players; however, further study is needed to assess the effectiveness of the TMR® protocol and its potential use within a dynamic warm-up protocol. The purpose of the study was to explore the immediate effects of the TMR® TT and AR intervention compared to a dynamic warm-up program, as well as the order of technique implementation on dominant shoulder IR and external rotation (ER) in baseball athletes.

Methods: Baseball athletes (males, $n = 20$; age, 18.45 ± 1.70 years) recruited from local teams were randomly assigned to one of two groups: TMR® treatment group (TMRG; $n = 10$) or traditional warm-up group (TWG; $n = 10$). After randomization, baseline IR and ER goniometry range of motion (ROM) measurements were recorded. The TMRG then completed the TMR® protocol and post-intervention measurements, while the TWG completed a traditional dynamic warm-up with stretching protocol followed by post-intervention measurements. After measurement completion, the TWG completed the dynamic warm-up protocol and post-intervention measurements, while the TWG completed the TMR® protocol and post-intervention measurements.

Findings/Results: For IR, the time main effect was significant ($\lambda = 0.160$, $F_{2,17} = 44.94$, $P < .001$) and the time × group interaction effect was significant ($\lambda = .295$, $F_{2,17} = 20.32$, $P < .001$). For ER, the time main effect was significant ($\lambda = 0.277$, $F_{2,17} = 22.14$, $P < .001$) and the time × group interaction effect was significant ($\lambda = .372$, $F_{2,17} = 14.34$, $P < .001$). Post hoc analysis revealed use of TMR® as the first treatment intervention produced significantly larger increases in mean IR ($18.2^\circ \pm 5.03^\circ$ vs. $6.2^\circ \pm 10.61^\circ$, $P = .005$, CIs: -19.80, -4.20, $d = 1.52$) and ER ($10.5^\circ \pm 4.67^\circ$ vs. $3.5^\circ \pm 7.14^\circ$, $P = .18$, CIs: -12.76, -1.33, $d = 1.22$) of the dominant shoulder. When the groups switched interventions, the TMRG experienced a decrease in mean IR ($-5.40^\circ \pm 9.06^\circ$) and mean ER ($-4.10^\circ \pm 6.52^\circ$) after completing the dynamic warm-up protocol. In contrast, the TWG, who now completed the TMR® protocol, experienced an increase in mean IR ($17.10^\circ \pm 6.0^\circ$) and mean ER ($11.40^\circ \pm 6.22^\circ$). The change following the crossover interventions was significant for IR ($P = .001$, CIs: 15.26, 29.72, $d = 3.08$) and ER ($P = .001$, CIs: 9.51, 21.50, $d = 2.56$).

Conclusions: When utilized as the first intervention, the TMR® TT and AR protocol produced significant increases in IR and ER of the dominant shoulder compared to a traditional, dynamic warm-up. The use of the dynamic warm-up protocol after the TMR® protocol resulted in a decrease in IR and ER, while the use of the TMR® following the warm-up protocol produced significant improvement in IR and ER. Based on these results, the TMR® protocol appears more effective than the dynamic warm-up protocol for improving IR and ER of the dominant shoulder in baseball players. If the dynamic warm-up protocol is going to be used in conjunction with TMR®, it should be used prior to the application of TMR®.

Abstract #6

Problem-Based Animations for Developing Undergraduate Students' Diagnostic Reasoning for Overuse Injury

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Context: Diagnostic reasoning and decision-making is a challenging skill for undergraduate students to develop, with different approaches to addressing

this challenge having emerged. Student learners face differences in exposure to breadth and complexity of clinical cases while completing practice or placement learning during their training. This creates disparities in educational experiences and exposures, potentially impacting their diagnostic skills upon graduation. There is a particular need to address this issue with respect to overuse injury in sports, which are very common, but are often challenging to diagnose in comparison to acute traumatic injury.

Purpose: To create, implement and evaluate a differentiated, innovative electronic learning tool to provide problem-based, multimedia clinical case studies to develop students' diagnostic reasoning skills for overuse injury.

Research Design: A mixed methods approach was used to develop and evaluate the tool. This incorporated: student focus groups to explore user interfaces and activities that students find inspiring, realistic, innovative and engaging with regard diagnostic reasoning; clinician focus groups to develop authentic, differentiated, structured clinical cases that represent real clinical encounters of overuse injury; and an evaluation survey to measure usefulness and impact of the tool among undergraduate sports therapy student groups in a UK Higher Education institution.

Main Findings: Student focus groups indicated enjoyment of interactive components of the tool and short assessment activities with feedback. Students could see value for formative assessment and for rehearsing mental processes for practical tasks. These cases challenge students in several aspects of the diagnostic reasoning process, including hypothesis generation, hypothesis refinement, objective test interpretation and differential diagnosis.

Conclusions: Interactive learning tools can be used to enhance student development of higher-level challenging skills such as diagnostic reasoning. The tool and approach presented has the potential for further development and implementation within postgraduate practitioners, for continuing professional development provision and for interprofessional learning.

Abstract #7

Incorporating Health Outcomes Research into Interprofessional Education (IPE)

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Context: As IPE programs have been shown to improve students' knowledge and attitudes concerning working collaboratively with other health care professionals (Cooper, Carlisle, Gibbs, & Watkins, 2001), the next logical step is to help students understand the importance of health outcomes, in particular, how to study and measure such outcomes. This next step is particularly important as research continues to strive to bridge the gap between IPE and patient-outcomes. This implies a need for IPE programs to include a course on outcomes-research methodology to aid students in the ability to ask IPE/IPP-relevant questions and identify appropriate measures and methods to assess key patient outcomes. Furthermore, a course in health outcomes research methods supports many of the competencies associated with IPE programs, including: problem solving, decision making, communication, shared knowledge and skills, a focus on patient-centered practice, and working collaboratively as a team (Stevenson, Seenan, Morlan, & Smith, 2012).

Purpose: Recognizing the importance of building students' skill sets to address assessment of health outcomes from an interprofessional perspective, the Saint Louis University Center for Interprofessional Education and Research (SLU-CIER), along with the Saint Louis University Center for Outcomes Research (SLUCOR), implemented a health outcomes research course as part of the minor in Interprofessional Practice. A faculty member from SLUCOR (the lead author) joined the SLU-CIER curriculum team to develop appropriate learning objectives for the course.

Research Design: Students were divided into interprofessional small groups based on their major to emulate the collaborative nature of research as well as to emphasize the interprofessional nature of the course. The course utilized a scaffolding approach and assessed learning outcomes using two group presentations and one individual reflection paper. The final reflection papers asked students to examine and reflect on their experiences in the course, what they learned, and how their experiences have changed how they will approach problems in the future. A content analysis of the reflection papers for themes surrounding students' knowledge/experience gained, and in particular, newly garnered perceptions of the role of interprofessionalism in health outcomes research is the foundation of this report.

Main Findings: Detailed analysis of student papers is still in progress. However, initial analyses reveal that students firmly believed that stable interprofessional teams were essential for meeting the course objectives. Students felt that the team stability across the semester was useful for building the trust necessary to work effectively on their large projects. Once trust within the team was developed, their projects coalesced and they were able to work more effectively and more efficiently. Additionally, breaking down the research process via the scaffold approach made the difficult topic more manageable and less frightening to students who were initially worried about the larger tasks they were being asked to complete. Finally, several of the students were sophomores and had no clinical experience from which to draw. It was recommended that the course begin with a review of each profession and how they typically interact within clinical settings for students who do not yet have

clinical experience. Another potential mechanism for dealing with this problem is to restrict the course to juniors and seniors who have begun their field-specific training.

Implications for Practice: The development and implementation of the course in Interprofessional Health Outcomes Research was a positive experience for both students and the instructor. Utilizing scaffold, active learning strategies gave the students ownership of their learning allowing them to develop not only an understanding of the research process, but skills in team building and communication with other professionals. In future years, evaluation of short- and long-term learning outcomes will be conducted using a prospective design.

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Abstract #8

Interprofessional Education (IPE) and Athletic Training Students in a Clinical Setting: Piloting a Methodology

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Context: The goal of this pilot study was to investigate the relationship between IPE, Athletic Training (AT) students' attitudes towards interprofessional practice (IPP), and their behaviors in team settings. This study sought to examine whether students who complete a greater number of IPE courses develop more positive attitudes towards IPE and subsequently function more effectively as members of interprofessional healthcare teams.

Methods: A total of 40 AT students enrolled in the Commission on Accreditation of Athletic Training Education (CAATE) professional program at a large, private, urban university completed the Interprofessional Socialization and Valuing Scale (ISVS; King, Shaw, Orchard, & Miller, 2010), administered via Qualtrics, within the first two weeks of the students' clinical internship as part of a course assignment. The ISVS has three sub-dimensions that assess student's 1) self-perceived ability to work with others, 2) value in working with others, and 3) comfort in working with others. Nineteen students participated during their summer clinical internship, 21 students participated during their fall clinical internship; there were no duplicate students. At the end of the semester, each student's preceptor then completed the Team Skills Scale (Heppburn, Tsukuda, & Fasser, 1998), administered via Qualtrics, in which preceptors assessed students' teamwork behaviors. There was only one student per clinical site at any one time, so preceptors only assessed one student at a time. Students' assessments of their attitudes were then matched with their respective preceptor's assessment of their teamwork behaviors on-site. In addition to completing the ISVS, students also reported whether and/or when they transferred to the professional program, and how many IPE courses they have completed at, and outside, the university. All responses were kept confidential and no faculty member, student, or preceptor affiliated with the course had access to any identifying information. Once data were matched, they were deidentified, and data were only presented to faculty in aggregated form in order to maintain student and preceptor confidentiality.

Findings/Results: Whenever using a scale with a new sample, it is appropriate to assess the scale's reliability and validity as they apply to the particular study sample. Unfortunately, when evaluating the factor analysis, the ISVS items did not load onto the appropriate factors (sub-dimensions) and many items cross-loaded. Thus, 12 items were removed from the scale, resulting in a 12 item measure assessing students' general beliefs about working on a team. All relationships originally proposed using the ISVS were tested using the new General Beliefs about Teamwork (GBT) measure. Results indicated that students who started at the university as freshmen reported completing significantly more IPE courses ($M = 4.78$) than students who transferred in ($M = 3$). Unfortunately, no other relationships were significant. There were no differences between freshman-entry students and transfer students in their GBT or preceptor ratings on their teamwork behaviors. Additionally, total number of IPE courses completed was not a significant predictor of student attitudes toward teamwork or their team behaviors. Finally, students' attitudes toward teamwork did not significantly predict their teamwork behaviors as reported by the preceptor.

Conclusions: While many of the relationships between IPE courses completed, students' GBT, and team skills were not significant, we believe this study provides a valuable contribution in terms of its methodology. We tested and present a successful approach as a pilot study to gather interprofessional data from two sources, the student and his/her clinical preceptor. Moreover, the methodology was shown to work in a clinical setting, providing future researchers with a tested method to study interprofessionalism in an AT applied setting.

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Abstract #9

Conservative Treatment of Osteoarthritis in a Division 1 Collegiate Basketball Player: A Clinical Case Study

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Background: A 22-year old female division I basketball player reports to the clinic with a gradual insidious onset of left knee pain. She is 5 years s/p anterior cruciate ligament (ACL) reconstruction on the left knee with a bone tendon bone autograft. She reports receiving physical therapy following this surgery, and returning to basketball “within a few months.” Recently, her treatment included quadriceps strengthening, ultrasound, massage, and an unloader knee brace with no relief. Her current significant findings related to function and structure include L knee swelling, decreased knee range of motion, and inability to stand on her left leg in single leg stance. Radiographs reveal early moderate degenerative changes. These impairments lead to decreased activities of inability to squat and poor balance, resulting in decreased participation in basketball activities.

Differential Diagnosis: Ligamentous laxity, chondromalacia, patella tendinopathy.

Treatment: Treatment was provided in-season and consisted of a combination of manual therapy, therapeutic exercise, and balance training. Manual techniques included a progression in accessory and physiologic Maitland tibiofemoral mobilizations to increase her total arc of motion. Grades III and IV mobilizations were used both at end range flexion and extension to improve this motion, with concomitant genu varus or traction to decrease symptoms with the technique. Grade II mobilizations were used at the beginning of the plan of care, and as transition mobilizations between techniques to decrease symptoms. The therapeutic exercises included quadriceps and hamstring strengthening with an emphasis on end range strength, and 1-joint hip abductor and extensor muscle strengthening. This incorporated hold-relax at end-range knee flexion and extension, and closed chain hip strengthening. Exercises also included basic balance training in single leg stance to improve her stability and tolerance to weightbearing. Outcome measures included goniometric measurements, the numeric pain scale (NPS) rating, the Knee Outcome Survey – Activities of Daily Living Score (KOS-ADL), and game minutes played. Her total arc of motion increased from 115° to 128° over a period of 6 weeks. The reported NPS rating varied with activity but decreased from the original rating. The KOS-ADL score did not improve with treatment; however, her minutes played increased.

Uniqueness: Knee osteoarthritis is a common condition in an older population, and is commonly related to overuse. This particular case refers to knee osteoarthritis in a relatively young athlete. Despite the demands of her sport, conservative management allowed her to increase her total arc of motion and appeared to relate to her improvement in function in competition. While it can be influenced by multiple factors, time spent in competition appears to have some utility in measuring function in an athlete.

Conclusions: Joint mobilizations, knee and hip strengthening, and balance training should be considered in athletes suffering from knee osteoarthritis following ACL reconstruction.

Abstract #10

Continuing Education Outcomes in the Medical and Health Professions: A Meta-Analysis

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Context: Limited and conflicting data exist examining the relationship between continuing education (CE) on actual clinician knowledge. A quantitative examination of the literature is warranted to better understand how CE influences actual clinician knowledge.

Objective: To determine if continuing education improves actual clinician knowledge.

Data Sources: We searched the following databases between March and June 2014 for the relevant articles: Academic Search Premier, Biomedical Reference, CINAHL, EBSCOhost, Google Scholar, Health Business FullTEXT, Health Source, Medline, and Sports Discuss. No date range was specified and searches were conducted to include all possible years of publication in each respective database. Key terms searched included: *continuing medical education; continuing education; outcomes of continuing education; effectiveness of continuing education, physicians; athletic trainers; physical therapists;*

occupational therapists; physician assistants; and nursing. We used single and combined key terms.

Study Selection: To be included, studies met four inclusion criteria: (1) reported outcomes related to actual knowledge of clinicians; (2) examined one or more of the following professions: athletic training, nursing, occupational therapy, medicine, physician assistant practice or physical therapy; (3) utilized a pre/post research design; and (4) reported sample size, means and standard deviation and/or inferential statistics.

Data Extraction: Data were extracted from text, tables, and figures. ImageJ was used to extract data from figures. Funnel plots were completed to check for publication bias at the outcome level. A fail-safe N was calculated for both overall analysis and sub-analyses to assess the number of unpublished works needed to nullify the statistical significance of the analysis. After data extraction, the data were examined by two trained investigators (E.M. and K.G.) to ensure all data were entered accurately. Data were placed into a custom spreadsheet database. A weighted, random-effects meta-analysis using the Hedges' g metric was completed for to examine the effect of CE on actual clinician knowledge. All statistical analyses were performed with Comprehensive Meta-Analysis. Statistical significance was set a priori at $\alpha \leq 0.05$ for all analyses.

Data Synthesis: We found 18 potential articles. Further examination yielded 9 studies meeting the inclusion criteria. CE was shown to positively influence actual clinician knowledge (Hedges' $g = 0.73$; 95% CI = 0.60–0.85). It appears from the funnel plot analysis that there is a publication bias towards dissemination of works that favor CE's effectiveness.

Conclusions: CE improves actual clinician knowledge. Upon further examination of the included studies, we found that there only studies including physicians met the inclusion criteria. All of the targeted health professions in this meta-analysis require CE, yet no work in the published literature has examined CE's effect on actual clinician knowledge in these professions. Additionally, none of the articles utilized an interprofessional approach to CE. This study should serve as a call to for research across the allied health professions to carefully examine CE's effect on actual knowledge as a step to improve patient care. Future research could also examine the differences on CE effectiveness between uniprofessional and interprofessional CE activities.

Abstract #11

Muscle Activations of Youth Baseball Pitchers During a Simulated Game

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Context: It is generally accepted that playing with fatigue is a primary predictor of injury in youth baseball, as muscular fatigue is believed to alter mechanics during the arm cocking and acceleration phases.¹ To the authors' knowledge, there have been no studies examining muscle activations in youth baseball pitchers during the first and last innings of a simulated game. Therefore, the purpose of this study was to quantitatively describe gluteal and upper extremity muscle activations in youth baseball pitchers during a simulated game.

Methods: Twenty-three youth baseball players (11.2 ± 0.8 years; 151.4 ± 8.7 cm; 47.5 ± 10.8 kg) participated. Data were collected via a Delsys Bagnoli-8-channel electromyography (EMG) system. Single differential electrodes (inter-electrode distance: 10 mm) were attached to the bilateral gluteus maximus (GMax) and medius (GMed) and throwing side latissimus dorsi (LD), lower trapezius (LT), serratus anterior (SA), and upper trapezius (UT). Following warm-up, participants were instructed to throw randomly provided game situations over a regulation distance (46 feet; 14.02 meters) to a catcher. Participants were limited to their age restricted pitch count, 75 pitches. Three, four-seam fastballs for strikes, thrown in the first and last inning of the simulated game, were selected for analysis. The pitching motion was divided into three phases: [1] foot contact to maximum shoulder external rotation (MER), [2] MER to ball release (BR), and [3] BR to maximum shoulder internal rotation.

Findings/Results: Repeated measures ANOVA revealed no significant differences in muscle activations between the first and last inning of pitching. Mean activation of the GMed and GMax decreased 5% MVIC and 1% MVIC, respectively. Muscle activations of the LD, SA, and UT all increased 19% MVIC, 25% MVIC, 25% MVI C, respectively. The LT exhibited a decrease in activation during phases one and two (< 26% MVIC), and an increase in activation in phase three (< 31% MVIC).

Conclusions: Efficient dynamic movement of the upper extremity is a product of the functional interaction of the lower extremity, pelvis, and scapula. The gluteal muscle group, specifically the GMed, dynamically stabilizes the pelvis. While the trapezius and SA stabilize the scapula and the LD provides both pelvic and scapular mobility and stability. The decrease in gluteal activity and increase in upper extremity activity may indicate decreased pelvic stability that increased the demand on the scapula stabilizers. Increased LT activity during phase three may be eccentrically contracting to maintain shoulder stability as the arm decelerates. Training programs that focus on endurance of the gluteal and scapular stabilizing muscles may be beneficial for youth pitchers to help maintain a stable pelvis and scapula during extended pitching performances.

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Abstract #12

Evidence-Based Treatment of Achilles Tendinosis with Instrument-Assisted Soft-Tissue Mobilization Combined with Eccentric Exercise: A Case Report

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Background: A 53-year-old freelance photographer presented with recurrent episodes of left Achilles pain. The initial trauma was caused by a crush injury to the left lower leg approximately 20 years prior. Recurrent episodes of Achilles pain were reported with subsequent repetitive overuse activity. Previous Physical Therapy (PT) treatments provided temporary relief, but symptoms would return with increases in activity. The most recent episode started after repetitive treadmill use 2 weeks prior to the current PT episode. Symptoms included mid-portion Achilles pain rated 4/10, and functional limitations. The Lower Extremity Functional Scale (LEFS) score was 58/80.

Differential Diagnosis: Physical examination revealed limitations in left passive ankle dorsiflexion and 1st metatarsal-phalangeal extension. Resisted ankle plantarflexion was strong but painful. Weaknesses were identified in the posterior tibialis and toe flexors. There was no evidence of swelling; however, a prominent fibrotic adhesion was evident along the mid portion of the Achilles tendon, and was tender to palpation. Limitations were identified with functional movements. Instrument-assisted soft-tissue assessment revealed restrictions in soft-tissue mobility through the medial gastrocnemius, the plantar fascia, and the fascial interface between the medial aspect of the Achilles and the deep posterior compartment.

Treatment: Initial treatment consisted of instrument-assisted soft-tissue mobilization (IASTM) to the gastrocnemius, Achilles tendon, plantar fascia, and the fascial interface between the Achilles tendon and the deep posterior compartment. Stretching exercises targeting the restricted tissues were also performed. The patient was seen twice weekly, with the intensity of the IASTM progressively increased by adding more aggressive treatment strokes, active motion, and progressive weight-bearing. High repetition / low resistance strengthening exercises were incorporated targeting the weak structures. On the 6th session, eccentric heel raises on a leg press machine were added and progressed according to the Alfredson protocol. On the 10th visit, IASTM was performed to the gastrocnemius and Achilles while the patient performed unilateral eccentric heel raises on a 4" box. On the final (14th) visit, 7 weeks after initiating treatment, a reassessment revealed full ankle dorsiflexion and metatarsal phalangeal extension. Resisted ankle plantarflexion, toe flexion, and posterior tibialis strength was graded 5/5 and was pain free. The patient rated pain less than 1/10 with manual palpation and functional activities. LEFS score was 77/80. The patient was able to exercise on a treadmill for 30 minutes, including 12 minutes of running, with minimal pain. At follow-up 2 months later, the patient reported progressive improvement in functional ability, with less pain than reported at the last visit.

Uniqueness: This case demonstrated the successful treatment of a patient with a 20 year history of Achilles tendinopathy. Prior therapeutic interventions were unsuccessful, but this was the first treatment program which targeted peripheral soft tissue restrictions identified with an instrument-assisted soft tissue assessment. It is theorized that these restrictions in the kinetic chain were contributing to the primary lesion in the tendon. This was the patient's first treatment episode incorporating progressive loading of the tendon through IASTM in conjunction with eccentric exercise. The Alfredson Protocol is a 12 week program. This case resulted in a successful outcome in 7 weeks. Eccentric exercises and IASTM have both been shown to have positive histological effects on tendinopathic tissue. This case demonstrated a quicker outcome when these two interventions were combined.

Conclusions: While eccentric exercise has been shown to be effective in the treatment of Achilles tendinosis, compliance can be poor due to pain, the frequency in which the exercises are to be performed, and the length of the protocol. This presentation describes the treatment protocol and progression of IASTM used in conjunction with eccentric exercise to successfully treat a 20-year-old case of Achilles tendinosis.

Abstract #13

The Reliability of Methods to Measure Range of Motion of the Hip

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Context: In athletic training, range of motion (ROM) measurement is an important tool to aid in making objective clinical decisions and improving our likelihood of billing for service. While independent clinical decision making is certainly a necessary part for the best patient care, the tools providing outcome measurements to formulate these clinical decisions should be consistent, reliable and cost-effective. Currently, the clinical gold standards for measuring ROM in clinical practice is the goniometer and the inclinometer. Both present problems: 1) goniometry has low inter-rater reliability; 2) the digital inclinometer is not clinically cost effective. The ImageJ program is a free visual-capture measurement tool provided by the National Institute of Health and a preliminary study found it to be reliable in measuring Q angle at the hip. The purpose of this study was to determine the inter-rater and intra-rater reliabilities of flexion, extension, abduction, adduction, internal rotation and external rotation at the hip.

Methods: We conducted a quasi-experimental test-retest design to determine the inter-rater and intra-rater reliabilities. Participants (n = 79: females = 46, males = 33) included anyone over the age of 18, who had not had a hip surgery in the last 12 months. We excluded two participants because they only completed the first session. The participants underwent testing on two separate days, with the second session occurring at least 24 hours after the first session, in which both testers image captured all six ROMs at the hip with tablet computers. The pictures from the tablets were downloaded to a laptop computer and analyzed 3 times by each tester with ImageJ. Reliabilities were then determined by using a two-way random effect intraclass correlation (ICC).

Findings/Results: During session 1 ImageJ displayed poor inter-rater reliability for adduction (ICC = 0.277) and flexion (ICC = 0.081). Good inter-rater reliability was shown for abduction (ICC = 0.465), extension (ICC = 0.632), internal rotation (ICC = 0.497), and external rotation (ICC = 0.570). In session 2, ImageJ displayed good inter-rater reliability for adduction (ICC = 0.553), abduction (ICC = 0.456), extension (ICC = 0.549), internal rotation (ICC = 0.766), and external rotation (ICC = 0.753). Excellent reliability was shown for flexion (ICC = 0.806). ImageJ was determined to have poor intra-rater reliability in rater 1 for adduction (ICC = 0.290) and flexion (ICC = 0.035), but good reliability for abduction (ICC = 0.416), extension (ICC = 0.420), internal rotation (ICC = 0.429), and external rotation (ICC = 0.572). For rater 2, inter-rater reliability was determined to be poor for external rotation (ICC = 0.351), but good for abduction (ICC = 0.487), adduction (ICC = 0.501), flexion (ICC = 0.420), extension (ICC = 0.423), internal rotation (ICC = 0.590).

Conclusions: Overall, ImageJ is a moderately reliable tool for measuring joint ROM at the hip. This finding is consistent with the reliabilities of the goniometer, but it is less reliable than the inclinometer. Intra-rater reliability is good, however, in situations where clinicians share patients, like in an interprofessional or intraprofessional clinic, this may not be an effective tool for joint measurement. Although not within the scope of this study, it is possible that ImageJ may provide further benefits than current standard joint ROM measurements by increasing patient compliance and motivation through visual feedback. Future research should focus on measurement at different limbs, use of variable body positions (gravity dependence, standing, functional, etc., and alternative image capturing devices to determine effect on inter- and intra-rater reliability. Moreover, inter- and intra-rater reliability of palpation is also a future line of inquiry that may enhance the clinical usefulness of any image capturing joint measurement method.