Stolz, M., Piekartz, H. V., Hall, T., Schindler, A., & Ballenberger, N. (2020). Evidence and recommendations for the use of segmental motion testing for patients with LBP – A systematic review. *Musculoskeletal Science and Practice*, *45*, 102076. doi:10.1016/j.msksp.2019.102076

Review submitted by: Helen Shepard

Purpose: To determine the validity and reliability of segmental mobility testing in patients with low back pain and make recommendations for use in clinical practice.

Methods: A systematic review of research articles in PubMed, Cochrane library, and LIVIVO was conducted and a quality assessment of articles was completed using QUADAS-2 and a version of QAREL tools. Thirteen studies met inclusion/exclusion criteria and were reviewed. Studies were judged as "overall low/high/doubtful risk of bias" or "low/high/doubtful concern regarding applicability."

Results: Thirteen studies were reviewed for evaluation of PPIVMs, PAIVMs, and the PIT. There was only one study that evaluated the validity of PPIVMs. Specificity was high and sensitivity was extremely low so it is recommended that PPIVMs should be used to rule in lumbar instability but not used to detect non-lumbar instability (ruling out). Two studies looked at the validity of PAIVMs. Specificity was high and sensitivity was relatively poor, therefore there is moderate recommendation for use of PAIVM to rule in lumbar instability and no recommendation to rule out. One study looked at PPIVM and PAIVM in combination in regards to pain judgment and mobility. It is concluded that there is a low recommendation for using them to detect painful segments or to detect affected lumbar segments by mobility judgment. Intra-rater and inter-rater reliability was low for agreeing on the same segment and slightly higher if they could agree on neighboring segments. It is not recommended to use PPIVMS or PAIVMs to judge mobility of segments, agree on segmental movement, or to track clinical course over time of normal/abnormal segmental movement. There is moderate recommendation to use the PIT to agree on presence of lumbar instability.

Conclusion: In conclusion, no test alone received strong recommendations and it was difficult to make recommendations due to the quality of considered studies and measures of validity and reliability. Previous studies have found that it is near impossible to assess just one segment because of repercussions to other segments, there is a significant range of variability of lumbar mobility in healthy subjects, and physical therapists' palpation skills tend to be inaccurate. Using pain as the clinical determinant instead of mobility seems to lead to better results, however, the validity and reliability is still low enough that it is not recommended for clinical practice. More research is needed to see if segmental evaluation is improved by the use of a test battery rather than just PAIVMs and PPIVMs.

Commentary: This study was very interesting given how widely used PPIVM and PAIVM segmental motion testing is and how clinically acceptable we find it to be. This is a great example of looking into research on something we just assume to be a good clinical tool and finding low support for its actual reliability and validity. I think the author's point about a test battery is excellent. Most of what we find in physical therapy literature is that any one test on it's own is not very good, but a cluster of tests can be quite useful. It would be interesting to see research of validity and reliability of a cluster of testing for lumbar segmental mobility. Looking at active range of motion, presence or absence of a visible hinge segment with active movement, PPIVM, PAIVM, and a few other special tests may lead to more accuracy than just segmental testing alone. I also think taking pain into account is important and helps us improve our accuracy, rather than just looking at true segmental mobility.

Citation: Bramah C, Preece SJ, Gill N, Herrington. A 10% Increase in Step Rate Improves Running Kinematics and Clinical Outcomes in Runners With Patellofemoral Pain at 4 Weeks and 3 Months. *Am J Sports Med*. 2019;47(14):3406-3413. doi:10.1177/0363546519879693

Review submitted by Anna Wilson

Objective: The purpose of the study was to investigate whether a 10% increase in running step rate influences frontal plane kinematics of the hip and pelvis as well as clinical outcomes in both the short and long-term in runners with patellofemoral pain (PFP).

Methods: To identify those with PFP, subjects had to report anterior knee pain that was $\geq$3/10 on NRS, pain related limited running volume or duration, run at least twice a week, and have pain reproduction with at least 1 activity (squatting, kneeling, prolonged sitting, or ascending or descending stairs). Runners with PFP underwent a 3-dimensional gait analysis to confirm the presence of aberrant frontal-plane hip and/or pelvis kinematics at baseline. A total of 12 participants with frontal-plane hip and/or pelvis kinematics 1 standard deviation above a reference database were invited to undergo the gait retraining intervention. Gait retraining consisted of a single supervised session where step rate was increased by 10% using an audible metronome. Participants then self-monitored their step rate while running with an audible metronome for 2 weeks and then a smartwatch for 2 weeks. During this time they were allowed to self-progress their running as long as pain remained < 3/10. Running kinematics, pain, LEFS, longest distance run pain-free, and total weekly running volume were recorded at baseline, 4 weeks, and 3 months.

Results: Gait retraining resulted in significant improvements in running kinematics and clinical outcomes at both the 4 week and 3 month follow up. There were significant decreases in peak contralateral pelvic drop, hip adduction, and knee flexion at both time periods; all of which have been associated with decreased patellofemoral stress. Step rate increased by an average of 11.2% at 4 weeks and 9.2% at 3 months. Pain rating scores and LEFS scores both improved greater than the MCID, and there was also improvements in total weekly running volume and longest distance run pain-free.

Conclusions: The results of this study highlight that a 10% increase in step rate improves running kinematics and clinical outcomes at 4 weeks, which are maintained at 3 months, among runners with PFP. Therefore, step rate retraining appears to be a clinically effective intervention in the rehabilitation of PFP and can easily be integrated into clinical practice. Based on the findings, it is important to assess running kinematics at baseline to ensure that interventions are appropriately targeted.

Commentary: This article had many strengths- subjective and objective inclusion criteria based on evidence to ensure appropriate population, long term follow up, used previous literature to guide appropriate parameters for gait analysis and intervention, appropriate statistical analysis. There was a small sample size and no control group which are some of the weaknesses of the study. Also, they reported significant changes in kinematic measurements but did not identify a MCID or MDC to ensure that this was meaningful. Overall, however, this study was pretty well done and provides good evidence to support this intervention.

From a clinical applicability standpoint, this is something that is easily done in clinic. While we might not have high-tech systems to perform gait analysis like they did, there are many in clinic tools we can use to identify similar kinematic faults identified in the study. Based on the inclusion criteria, this study also gives good guidelines to identify patients that would benefit from gait retraining. I love that this is such a simple intervention that is easy for carryover into HEP and promotes self-efficacy in our patients with good evidence for continued long term benefits.

Citation: Daniel Viggiani, Erika Nelson-Wong, Bradley S. Davidson & Jack P. Callaghan (2019): A comparison of trunk control in people with no history, standing-induced, and recurrent low back pain during trunk extension, *Journal of Manual & Manipulative Therapy*, DOI:10.1080/10669817.2019.1701834

Review Submitted By: Lauren Carroll

Objective: Determine if people classified as individuals who develop low back pain after standing for 2 hours or people with recurrent low back pain episodes (who are currently not experiencing an episode of back pain) demonstrate similar muscular control and activity during trunk extension.

Methods: Root mean square angular jerk was calculated from trunk and hip kinematics and co-activation of the trunk and pelvis musculature were assessed in four-muscle sets during an established standing trunk extension protocol in 11 individuals with recurrent low back pain and 21 asymptomatic individuals that were categorized as pain developers (PDs) or non-pain developers (NPDs).

Results: All groups demonstrated similar range of motion with the standing trunk extension and similar RMS jerk values during return to neutral phase of trunk extension. Individuals with recurrent low back pain demonstrated reduced co-activity in their trunk extensors, while individuals categorized as pain developers demonstrated increased co-activity in their hip extensors.

Conclusion: This study provided evidence that demonstrates individuals at risk for developing low back pain control trunk extension differently than individuals with a history of low back pain, and both of these groups show differences in motion control than the non-pain developer group. The most significant differences were the synergistic co-activity of the posterior chain crossing the hip and trunk.

Commentary:

This article presents some intriguing points about motor control of the lumbar spine in people with recurrent low back pain and people that may develop recurrent low back pain. I think the difference in the PD group and the rLBP group's muscular strategies to achieve trunk extension was very interesting, although I am curious to see if this changed with a more functional movement, like a sit to stand or a squat. The data collection seemed very thorough with multiple systems utilized to reduce the amount of error in the calculations with the kinematic measurements and the muscle activation during the EMG. Even though the article does an excellent job of presenting the kinematic variability and muscular co-activity of the 3 different groups with standing trunk extension, there were several areas of weakness for this study. The sample size was very small (33 individuals total), which makes the data less likely to be applicable to a larger population. The classification of the PD and rLBP groups was also very general, with exclusion criteria only being an allergy to rubbing alcohol/adhesive or pregnancy in the last 12 months. The inclusion criteria were quite broad, which is great because it is more representative of the clinical population, but also may retract from the validity of the study due to the wider range of impairments in the group. The only qualifier for the PD group was onset of back pain after 2 hours of standing with no other information given, again leading to the possibility of skewed results. There were also multiple attempts of the movement allowed, but it varied according the individual, which makes me question if this created an impact on the results that were obtained.

Malloy P, Neumann DA, Kipp K. Hip Biomechanics During a Single-Leg Squat: 5 Key Differences Between People With Femoroacetabular Impingement Syndrome and Those Without Hip Pain. *Journal of Orthopaedic & Sports Physical Therapy*. 2019;49(12):908-916. doi:10.2519/jospt.2019.8356.

Review Submitted by Barrett Coleman

Objective: To compare hip joint biomechanics between people with FAI syndrome and people without hip pain during double-leg and single-leg squats.

Methods: Two groups (14 participants with FAI as identified by (+) imaging, (+) FADIR, hip pain for > 3 months; 14 participants without FAI as having pain free and full ROM testing for hip) performed squats and single-leg squats with a 14-camera Viacon system. A two-way ANOVA with post hoc analysis was used to determine the significant variables.

Results: There were significant differences in peak hip joint ($P = .014$, $\eta 2 = 0.211$) and thigh segment ($P = .009$, $\eta 2 = 0.233$) adduction angles, and for peak hip joint abduction ($P = .002$, $\eta 2 = 0.308$) and extension ($P = .016$, $\eta 2 = 0.203$) internal moments.

Conclusions: Biomechanical differences at the hip between people with FAI syndrome and those without hip pain were exaggerated during a single-leg squat compared to a double-leg squat task. Some of these findings were: 1) less hip/thigh adduction to avoid possible impingement 2) slower squat speed 3) less peak hip abduction and hip extension moment to reduce forces through hip.

Commentary: As the movement experts, it is important to be able to assess patient's functional movement (ambulation, stairs, squats, etc) and identify areas to further investigate for possible contributing impairments. Bilateral squats and single-leg squats are common functional screening tools to help us assess movement. Since FAI is a pathology we see in clinic, it is important to know the differences and compensations people with this pathology use during these activities.

As to be expected, those with FAI avoided positions that increase load through the hip joint and positions that put them in possible impingement (Flexion/Adduction/IR). These impairments, however, were made more noticeable when performed in a single-leg squat. This is important to consider when determining which functional screens to perform with our patients: if FAI is suspected, a bilateral squat might not be enough to provoke it.

Of note, there was no finding for significant difference in depth of squat. I expected those with FAI to not be able to get into as deep of a squat due to impingement. Instead, those with FAI performed the activity at a slower velocity. This demonstrates it is possible for those with FAI to still achieve hip flexion but with other compensations to avoid provoking their symptoms.

Young, I. A., Pozzi, F., Dunning, J., Linkonis, R., & Michener, L. A. (2019): Immediate and Short Term Effects of Thoracic Spine Manipulation in Patients With Cervical Radiculopathy: A Randomized Controlled Trial. ***Journal of Orthopaedic & Sports Physical Therapy, 1–36.*** **doi:10.2519/jospt.2019.8150**

Review Submitted by: Brandon Reynolds PT, DPT

Objectives: Comparing the effects of thoracic manipulation on patients with cervical radiculopathy against sham thoracic manipulation

Methods: This study is a randomized controlled trial conducted in 6 orthopedic physical therapy centers in Georgia, Virginia, and California between 09/2011 and 07/2014 where patients with unilateral upper extremity pain, paresthesia or numbness, with or without neck pain were recruited. Inclusion criteria for the study are as follows: Age 18-65 yrs, Neck Disability Index (NDI) score ≥ 10/50 points, and a clinical diagnosis of CRAD as defined by Wainner et al using 3 of 4 positive tests (Spurling's test, upper limb neurodynamic test-median nerve bias, cervical distraction test, and cervical rotation towards the symptomatic side <60°). Exclusion criteria included: history of previous cervical or thoracic spine surgery, bilateral upper extremity symptoms, signs or symptoms of upper motor neuron disorder, medical "red flags" (eg, tumor, fracture, rheumatoid arthritis, osteoporosis, prolonged steroid use), and cervical steroid injection or medication within the past 2 weeks. Participants included in the study were then randomized to receive either manipulation (n = 22) or sham manipulation (n = 21) of the thoracic spine.

Outcomes were measured at baseline, immediately after treatment, and at a follow-up 48 to 72 hours after manipulation. A repeated-measures analysis of variance was used to analyze neck and upper extremity pain (NPRS), disability (NDI), cervical range of motion (ROM), and endurance (deep neck flexor endurance test). The chi-square test was used to analyze changes in neck and upper extremity pain, centralization of symptoms, and beliefs about receiving the active manipulation treatment using a global rating of change scale.

Results: The manipulation group showed significant differences immediately after treatment and at the 48-72 hour follow up compared to the sham manipulation group with decreased cervical pain, improved cervical ROM, decreased disability, and improved deep neck flexor endurance. No differences noted between groups for upper extremity pain immediately following the treatment. A great proportion of participants in the thoracic manipulation group reported improved GROC scores in neck and upper extremity symptoms, centralization of symptoms, and beliefs about receiving an active manipulation compared to sham manipulation group.

Conclusion: Improvements in pain disability, cervical ROM, and deep neck flexor endurance were noted after one session of thoracic manipulation in patients with cervical radiculopathy compared to sham thoracic manipulation.

Commentary: This study has many strengths but also has some weaknesses as well. One strength of the study is that it is a randomized controlled trial with participant blinding. The study also attempted to standardize the interventions by creating a standardized instruction manual for all examination, treatment, blinding, and data collection procedures. The study also uses valid and reliable outcome measures which is a strength. One of the weaknesses of this study is the low number of participants. Another potential weakness is the short-term follow-up, but this can also be used as a strength in clinical practice. This study shows the potential short-term benefits of utilizing thoracic manipulation as an intervention for patients with cervical radiculopathy.

Barrett E, O'Keeffe M, O'Sullivan K, Lewis J, McCreesh K. Is thoracic spine posture associated with shoulder pain, range of motion and function? A systematic review. *Man Ther*. 2016;26:38-46. doi:10.1016/j.math.2016.07.008

Review Submitted by: Taylor Blattenberger PT, DPT

Objective: To determine if there is a difference in thoracic kyphosis between groups with and without shoulder pain. To identify the effect of changing thoracic kyphosis on shoulder pain.

Methods: Two reviewers collected studies via an electronic search of multiple databases. Eligible studies included those that examined thoracic posture in relation to shoulder pain, ROM, or function. The included studies were required to have a control group, include a postural intervention, and be published in English. Studies were excluded if they did not examine shoulder pain in isolation, did not specify thoracic posture, or if it was not available English.

Each study was evaluated for bias using a standardized and validated checklist consisting of 10 items. Important criteria assessing the bias of studies included the use of an objective and reliable measure of thoracic kyphosis angle. Gender of subjects was also required as these differences can account for differences in thoracic kyphosis.

Results: Ten studies were included in this review. Of these studies four were deemed low risk of bias, three were at a moderate risk of bias, and three were identified to have a high risk of bias. All articles did utilize and objective measure of thoracic kyphosis angle and only one study did not identify the reliability of the measuring device. The studies were heterogeneous in study design as well as in kyphosis measuring tool.

No study in this review identified any significant association between resting thoracic kyphosis angle and shoulder pain. Furthermore, interventions aimed at changing thoracic kyphosis angle did not change pain intensity with shoulder movements in any study.

Three studies did identify significant differences in total shoulder ROM in flexion, abduction, and external rotation when thoracic extension was encouraged during movement. Another study identified greater shoulder ROM prior to onset of shoulder symptoms, although when a painful ROM was reached the intensity was no significantly different. Conflicting results were present for the association between resting thoracic kyphosis and shoulder ROM.

Conclusion: There is moderate evidence to suggest that there is no association between resting thoracic kyphosis and shoulder pain. There is strong evidence to suggest that changing thoracic kyphosis to a more erect posture is associated with immediate improvements in shoulder flexion and abduction ROM.

Commentary: Thoracic kyphosis is a common component in examination of the upper quarter, especially the shoulder. Thoracic extension is necessary for full shoulder ROM and limitations in thoracic spine ROM can drive abnormalities at the shoulder complex. Decreased thoracic ROM, namely decreased thoracic extension, may change resting thoracic posture and lead to hyper kyphosis of the thoracic spine at rest. It seems reasonable that all these changes could be related, but do they drive pathology?

This review found evidence that cueing a person to assume a more erect posture can result in immediate ROM improvements. This logically makes sense as cueing a more erect posture cues greater thoracic extension which is necessary for full shoulder ROM. It is important to note, however, that these changes are only applicable to in-session changes and were not extrapolated to long term ROM outcomes. This means that we cannot confidently say that thoracic interventions will lead to improved thoracic posture and therefore improved shoulder ROM based on this review.

One important finding of this review is the lack of association between shoulder pain and resting thoracic kyphosis. While postural changes can provide more pain free ROM in the short term, resting thoracic posture cannot be linked to the development of shoulder pathology. This is important to clinicians as it may change how these interventions are used in practice. This information should also dictate the types of narratives we provide to our patients about posture and shoulder pathology.

Citation: Hinman RS, Campbell PK, Lawford BJ, et al. Does telephone-delivered exercise advice and support by physiotherapists improve pain and/or function in people with knee osteoarthritis? Telecare randomised controlled trial. Br J Sports Med Epub ahead of print: 2019 Nov 20. doi:10.1136/ bjsports-2019-101183

Review Submitted by: Steven J. Lagasse

Objective: The purpose of this study was to determine the effect of physical therapist telecommunication services couple with nurse-led telecommunication services versus nurse-led telecommunication service alone for people with knee osteoarthritis.

Methods: Based on the inclusion and exclusion criteria 175 participants were obtained for this study. Participants were randomly allocated into a pre-existing phone service led by nurses who provided advice (n=88), or the same pre-existing phone service which provided advice, coupled with physical therapists who prescribed exercises (n=87). Patients were randomly allocated either a nurse or nurse and physical therapist from a cohort of practitioners who were a part of this study. Both groups received one call from the nurse-led service with additional calls provided as needed, however, the physical therapy group received an additional 5 - 10 call from a physical therapist for exercise advice and support. The nursing and the physical therapy group received five to six specifically selected exercises electronically. Primary outcome measures were the NRS, and the WOMAC, both of which were completed at baseline, six, and twelve months. The participants and assessors were both blinded.

Results: Of the 175 participants, 165 and 158 completed both primary outcomes at six and twelve months, respectively. Both groups demonstrated improved outcome measures. At six months the groups who received services from both a nurse and physical therapist demonstrated with increased between-group differences in function, however, there were no differences in pain. At the twelve-month follow-up, there were no between-group differences found regarding function or pain.

Conclusions: Based on this study, physical therapy and nurse related telecommunication services appear to be superior at six-month follow-up compared to nurse telecommunication services alone when measuring function. No differences were found between groups regarding function and/or pain at twelve months follow-up.

Commentary: The primary strengths of this study were the large sample size obtained, the use of blinding, and the use of patient and practitioner randomization. Additionally, the authors were able to assess long term follow-up and used reliable outcomes measures such as the WOMAC. The primary weakness of this study is the inability to assess the real-time performance and execution of the physical therapy exercises prescribed to each participant. This study provides insight regarding the potential benefits of providing patients who cannot pursue in-person physical therapy with a secondary option of telecommunication. Although these groups were no different at twelve months, additional services appear to be of greater benefit in the more immediate sense.