

Evaluation Products Research References (2023 – 2013)

2023

2022

“Return-to-Work Predictions for Chinese Patients with Occupational Upper Extremity Injury: A Prospective Cohort Study.”

Bai Z, Zhang J, Tang C, et al. Return-to-Work Predictions for Chinese Patients with Occupational Upper Extremity Injury: A Prospective Cohort Study. *Frontiers in Med.* 2022;9 Article 805230

ABSTRACT

Objective: We created predictive models using machine learning algorithms for return-to-work (RTW) in patients with traumatic upper extremity injuries.

Methods: Data were obtained immediately before patient discharge and patients were followed up for 1 year. K-nearest neighbor, logistic regression, support vector machine, and decision tree algorithms were used to create our predictive models for RTW.

Results: In total, 163 patients with traumatic upper extremity injury were enrolled, and 107/163 (65.6%) had successfully returned to work at 1-year of follow-up. The decision tree model had a lower F1-score than any of the other models (t values: 7.93–8.67, $p < 0.001$), while the others had comparable F1-scores. Furthermore, the logistic regression and support vector machine models were significantly superior to the k-nearest neighbors and decision tree models in the area under the receiver operating characteristic curve (t values: 6.64–13.71, $p < 0.001$). Compared with the support vector machine, logistical regression selected only two essential factors, namely, the patient’s expectation of RTW and carrying strength at the waist, suggesting its superior efficiency in the prediction of RTW.

Conclusion: Our study demonstrated that high predictability for RTW can be achieved through use of machine learning models, which is helpful development of individualized vocational rehabilitation strategies and relevant policymaking.

Use of EvalTech: to measure the lifting strength of the bilateral UEs and the carrying strength at the waist and shoulder level

2021

“How fit are Special Operations Police Officers? A comparison with elite athletes from Olympic disciplines.”

Zwingmann L, Zedler M, Kurzner S, et al. How fit are Special Operations Police Officers? A comparison with elite athletes from Olympic disciplines. *Front Sports Act Living.* 2021;3:742655. doi: 10.3389/fspor.2021.742655

ABSTRACT

The diverse tasks of special operations police (SOP) units place high physical demands on every officer. Being fit for duty requires a wide range of motor abilities which must be trained regularly and in a structured manner. But SOP operators have to plan and manage large proportions of their training alone, which makes it difficult to control. Therefore, this study aimed to highlight strengths and deficits of the SOP operators’ fitness by comparing them to elite athletes, and to define future training goals. Retrospective data of 189 male SOP operators were used, who completed several isometric strength

tests, a graded exercise test to determine maximal oxygen uptake, and countermovement jumps to determine leg muscle power. On the basis of a literature search, performance data were then compared to a total of 3,028 elite male athletes from 36 Summer Olympic disciplines. Pooled means and standard deviations were calculated for each discipline and effect sizes were used to analyze their similarities and differences to the SOP unit. On average, SOP operators were taller, heavier, and stronger than elite athletes. But both the ability to convert this strength into explosive movement and aerobic power was significantly less developed. From this point of view, SOP operators should consider polarized endurance training to work efficiently on improving aerobic performance. In addition, regular plyometric training seems necessary to improve leg muscle power and agility.

Use: musculoskeletal evaluation – measurement of isometric strength (MVIC); using the Universal Task Master, maximum strength was measured when performing an upright pull, high lift, bench press, and arm lift.

“The effect of physical training modality on exercise performance with police-related personal protective equipment.”

Zwingmann L, Hoppstock M, Goldmann JP, et al. The effect of physical training modality on exercise performance with police-related personal protective equipment. *Appl Ergonom.* 2021; 93
<https://doi.org/10.1016/j.apergo.2021.103371>

ABSTRACT

Purpose: To investigate the influence of aerobic capacity, muscle strength, and body composition on performance and metabolic demands of men wearing personal protective equipment (PPE).

Methods: 45 men were assigned to one of four groups which significantly differed in upright pull isometric strength ($MVC \leq 1325$ N or ≥ 1531 N) and maximum oxygen uptake ($VO_{2max} \leq 51.9$ mL $\text{min}^{-1} \cdot \text{kg}^{-1}$ or ≥ 56.0 mL $\text{min}^{-1} \cdot \text{kg}^{-1}$): endurance-trained (low MVC, high VO_{2max}), strength-trained (high MVC, low VO_{2max}), endurance- and strength-trained (high MVC, high VO_{2max}), and untrained (low MVC, low VO_{2max}). Each participant underwent two test series consisting of a repeated 10 m dummy drag and a graded exercise test wearing either sportswear or PPE of a German riot police unit weighing 20.9 kg (statistics: two-way repeated measures ANOVA, stepwise multiple linear regressions).

Results: With PPE, dummy drag and running performance were impaired by $14 \pm 9\%$ and $58 \pm 7\%$. Groups with high MVC dragged the dummy significantly faster than groups with low MVC (17.5 ± 1.8 s/ 17.6 ± 1.4 s vs. 23.4 ± 5.6 s/ 22.3 ± 3.5 s). Running distance was significantly higher in groups with high VO_{2max} (4.5 ± 0.8 km/ 4.4 ± 0.7 km vs. 3.1 ± 0.5 km/ 2.8 ± 0.5 km). Body composition variables partially correlated with performance (R ranging from -0.70 to 0.41) but were not significant predictors of the regression models in PPE.

Conclusions: Individuals who showed a certain degree of aerobic endurance, as well as muscle strength, performed consistently well during the test series. Therefore, none of these variables should be trained in isolation but optimized in combination to be capable in a variety of operational tasks.

Use of EvalTech UTM: measure isometric strength (MVC) in upright pull position

“Isometric hip strength and patient-reported outcomes of individuals with and without chronic ankle instability.”

Bain KA, Clawson PA, et al. Isometric hip strength and patient-reported outcomes of individuals with and without chronic ankle instability. *J Sport Rehabil.* 2021;31:53-59

ABSTRACT

Context: Strength deficits and decreased scores on generic, dimension-specific, and region-specific health-related quality of life (HRQL) PRO measures are commonly documented among individuals with

chronic ankle instability (CAI). However, it is unknown if there is a relationship between hip strength and self-reported patient-reported outcome (PRO) scores.

Objective: To compare isometric peak torque for hip-extension (H-EXT) and hip-abduction (H-ABD), as well as PRO scores between CAI, lateral ankle sprain copers (LAS copers), and uninjured controls (UC). The secondary purpose was to examine the relationship between isometric hip peak torque and PROs in participants with CAI.

Design: Cross-sectional.

Setting: Laboratory.

Participants: Sixty-three individuals, 45 women (23.02 [3.83] y, 165.91 [7.55] cm, 67.28 [11.95] kg) and 18 men (26.28 [5.43] y, 179.28 [9.01] cm, 83.87 [13.26] kg), grouped as uninjured control (n = 26), LAS copers (n = 15), or CAI (n = 22).

Main Outcome Measures: The Foot and Ankle Ability Measure was used to assess region-specific HRQL. The Fear Avoidance Beliefs Questionnaire was used to assess injury-related fear. The Disabling in Physically Active was used to assess global HRQL. Isometric peak torque was measured with a handheld dynamometer for H-EXT and H-ABD.

Results: No group differences were observed for H-ABD ($P = .34$) or H-EXT ($P = .35$). The CAI group had significantly worse scores on all PROs compared with LAS copers ($P < .001$) and HC ($P < .001$). Moderate-weak correlations were found between H-ABD and Foot and Ankle Ability Measure—activities of daily living ($P = .047$; $\rho = .392$) and Foot and Ankle Ability Measure-Sport ($P = .013$; $\rho = .482$) and H-EXT and Fear Avoidance Beliefs Questionnaire-Work ($P = .007$; $\rho = -.517$).

Conclusions: Individuals with CAI displayed lower HRQL based on worse scores on generic, dimension-specific, and region-specific PROs compared with LAS copers and uninjured controls. There were no significant between-group differences for H-EXT and H-ABD isometric peak torque production, but there was a moderate positive relationship between isometric H-ABD and self-reported ankle disability in individuals with CAI.

Use of Evaluator portable lad cell: measure isometric strength of hip extensors and abductors

“Comparison of the BTE tech EVJ handgrip to the Jamar hand dynamometer for measuring grip strength.”

Myers EJ, Dominguez DS, et al. Comparison of the BTE tech EVJ handgrip to the Jamar hand dynamometer for measuring grip strength. *Technology and Disability*. 2021;33:221-227

ABSTRACT

Introduction: This study compared the inter-instrument reliability of the Jamar Hand Dynamometer (Jamar) to the BTE EVJ Handgrip tool (EVJ). The EVJ is a new digital handgrip instrument designed by BTE Technologies Inc. (BTE Tech) utilizing Bluetooth technology to automatically upload data to a computer or electronic health record.

Method: This repeated measure study engaged 338 participants (N = 199 females, N = 139 males) ages 20 to 50. All participants were tested on both devices following the protocol established by the American Society of Hand Therapists (ASHT).

Results: Comparative statistics included ICC values (0.81–0.84), Pearson R (correlation coefficient) (0.68–0.77), and Bland Altman plots (93–95% of data within 2 SD), indicating good inter-instrument agreement.

Conclusions: The EVJ Handgrip, developed by BTE Technologies, demonstrated good inter-instrument reliability with the Jamar Hand Dynamometer and may be reliable to use when referencing the published normative values in the clinical environment.

Use of EVJ hand grip dynamometer: measure isometric hand grip strength

“Return-to-Work Predictions for Chinese Patients with Occupational Upper Extremity Injury: A Prospective Cohort Study.”

Amato AA, Hanna MG, Machado PM, et al. Efficacy and Safety of Bimagramab in Sporadic Inclusion Body Myositis. Long-term Extension of RESILIENT. *Neurol.* 2021;96:e1595-1607

ABSTRACT

Objective: To assess long-term (2 years) effects of bimagramab in participants with sporadic inclusion body myositis (sIBM).

Methods: Participants (aged 36–85 years) who completed the core study (RESILIENT [Efficacy and Safety of Bimagramab/BYM338 at 52 Weeks on Physical Function, Muscle Strength, Mobility in sIBM Patients]) were invited to join an extension study. Individuals continued on the same treatment as in the core study (10 mg/kg, 3 mg/kg, 1 mg/kg bimagramab or matching placebo administered as IV infusions every 4 weeks). The co–primary outcome measures were 6-minute walk distance (6MWD) and safety.

Results: Between November 2015 and February 2017, 211 participants entered double-blind placebo-controlled period of the extension study. Mean change in 6MWD from baseline was highly variable across treatment groups, but indicated progressive deterioration from weeks 24–104 in all treatment groups. Overall, 91.0% (n = 142) of participants in the pooled bimagramab group and 89.1% (n = 49) in the placebo group had ≥ 1 treatment-emergent adverse event (AE). Falls were slightly higher in the bimagramab 3 mg/kg group vs 10 mg/kg, 1 mg/kg, and placebo groups (69.2% [n = 36 of 52] vs 56.6% [n = 30 of 53], 58.8% [n = 30 of 51], and 61.8% [n = 34 of 55], respectively). The most frequently reported AEs in the pooled bimagramab group were diarrhea 14.7% (n = 23), involuntary muscle contractions 9.6% (n = 15), and rash 5.1% (n = 8). Incidence of serious AEs was comparable between the pooled bimagramab and the placebo group (18.6% [n = 29] vs 14.5% [n = 8], respectively).

Conclusion: Extended treatment with bimagramab up to 2 years produced a good safety profile and was well-tolerated, but did not provide clinical benefits in terms of improvement in mobility. The extension study was terminated early due to core study not meeting its primary endpoint.

Use of Evaluator portable load cell: measure isometric knee extension muscle strength

2020

“Decreased ankle and hip isometric peak torque in young and middle-aged adults with chronic ankle instability.”

Kosik KB, Johnson NF, Terada M, et al. Decreased ankle and hip isometric peak torque in young and middle-aged adults with chronic ankle instability. *Phys Ther Sport.* 2020;43:127-133.

ABSTRACT

Objectives: To compare ankle, knee and hip isometric peak torque between young and middle-aged adults with CAI, copers and un-injured controls.

Design: Cross-sectional.

Setting: Research Laboratory.

Participants: One hundred fifty-six young and middle-aged adults with or without CAI volunteered.

Main outcome measures: A handheld dynamometer measured isometric dorsiflexion, plantarflexion, knee extension, hip extension and hip abduction peak force during a 5 s trial. Average peak torque was calculated and normalized to body mass.

Results: A significant Age by Injury interaction for dorsiflexion suggest middle-aged un-injured controls ($p < 0.001$) and copers ($p < 0.001$) had lower isometric peak torque compared to their young adult counterparts, but there were no differences between young and middle-aged adults with CAI ($p > 0.05$). Significant Injury main effects suggest the CAI group had decreased plantarflexion ($p \frac{1}{4} 0.004$) and hip extension ($p \frac{1}{4} 0.010$) strength compared to un-injured controls, but not copers ($p > 0.05$). Significant Age main effects for all primary outcome measures were observed, indicating peak torque decreased with age

($p < 0.05$).

Conclusions: Regardless of age, isometric ankle and hip peak torque was lower in participants with CAI compared to un-injured controls, but not copers. These findings provide further evidence towards the impact of CAI in both young and middle-aged adults.

Use of Evaluator portable load cell: measure isometric dorsiflexion, plantarflexion, knee extension, hip extension and hip abduction peak force

2019

“Safety and efficacy of intravenous bimagrumab in inclusion body myositis (RESILIENT): a randomized, double-blind, placebo-controlled phase 2b trial.”

Hanna MG, Badrising UA, Benveniste O, et al. Safety and efficacy of intravenous bimagrumab in inclusion body myositis (RESILIENT): a randomized, double-blind, placebo-controlled phase 2b trial. *Lancet Neurol.* 2019;18:834-844

ABSTRACT:

Background: Inclusion body myositis is an idiopathic inflammatory myopathy and the most common myopathy affecting people older than 50 years. To date, there are no effective drug treatments. We aimed to assess the safety, efficacy, and tolerability of bimagrumab—a fully human monoclonal antibody—in individuals with inclusion body myositis.

Methods: We did a multicentre, double-blind, placebo-controlled study (RESILIENT) at 38 academic clinical sites in Australia, Europe, Japan, and the USA. Individuals (aged 36–85 years) were eligible for the study if they met modified 2010 Medical Research Council criteria for inclusion body myositis. We randomly assigned participants (1:1:1:1) using a blocked randomisation schedule (block size of four) to either bimagrumab (10 mg/kg, 3 mg/kg, or 1 mg/kg) or placebo matched in appearance to bimagrumab, administered as intravenous infusions every 4 weeks for at least 48 weeks. All study participants, the funder, investigators, site personnel, and people doing assessments were masked to treatment assignment. The primary outcome measure was 6-min walking distance (6MWD), which was assessed at week 52 in the primary analysis population and analysed by intention-to-treat principles. We used a multivariate normal repeated measures model to analyse data for 6MWD. Safety was assessed by recording adverse events and by electrocardiography, echocardiography, haematological testing, urinalysis, and blood chemistry. This trial is registered with ClinicalTrials.gov, number NCT01925209; this report represents the final analysis.

Findings: Between Sept 26, 2013, and Jan 6, 2016, 251 participants were enrolled to the study, of whom 63 were assigned to each bimagrumab group and 62 were allocated to the placebo group. At week 52, 6MWD change from baseline did not differ between any bimagrumab dose and placebo (least squares mean treatment difference for bimagrumab 10 mg/kg group, 17.6 m, SE 14.3, 99% CI –19.6 to 54.8; $p=0.22$; for 3 mg/kg group, 18.6 m, 14.2, –18.2 to 55.4; $p=0.19$; and for 1 mg/kg group, –1.3 m, 14.1, –38.0 to 35.4; $p=0.93$). 63 (100%) participants in each bimagrumab group and 61 (98%) of 62 in the placebo group had at least one adverse event. Falls were the most frequent adverse event (48 [76%] in the bimagrumab 10 mg/kg group, 55 [87%] in the 3 mg/kg group, 54 [86%] in the 1 mg/kg group, and 52 [84%] in the placebo group). The most frequently reported adverse events with bimagrumab were muscle spasms (32 [51%] in the bimagrumab 10 mg/kg group, 43 [68%] in the 3 mg/kg group, 25 [40%] in the 1 mg/kg group, and 13 [21%] in the placebo group) and diarrhoea (33 [52%], 28 [44%], 20 [32%], and 11 [18%], respectively). Adverse events leading to discontinuation were reported in four (6%) participants in each bimagrumab group compared with one (2%) participant in the placebo group. At least one serious adverse event was reported by 21 (33%) participants in the 10 mg/kg group, 11 (17%) in the 3 mg/kg group, 20 (32%) in the 1 mg/kg group, and 20 (32%) in the placebo group. No significant adverse cardiac effects were recorded on electrocardiography or echocardiography. Two deaths were reported during the study, one attributable to subendocardial myocardial infarction (secondary to gastrointestinal bleeding after an intentional overdose of concomitant sedatives and antidepressants) and one attributable to lung

adenocarcinoma. Neither death was considered by the investigator to be related to bimagrumab.

Interpretation: Bimagrumab showed a good safety profile, relative to placebo, in individuals with inclusion body myositis but did not improve 6MWD. The strengths of our study are that, to the best of our knowledge, it is the largest randomised controlled trial done in people with inclusion body myositis, and it provides important natural history data over 12 months.

Use of Evaluator portable load cell: measure isometric knee extension muscle strength

“Landing kinematics and isometric hip strength of individuals with chronic ankle instability.”

McCann R, Terada M, Kosik K, et al. Landing kinematics and isometric hip strength of individuals with chronic ankle instability. *Foot & Ankle International*. 2019;1-9. DOI:10.1177/1071100719846085

ABSTRACT:

Background: Chronic ankle instability (CAI) is associated with hip strength deficits and altered movement in the lower extremity. However, it remains unclear how hip strength deficits contribute to lateral ankle sprain (LAS) mechanisms. We aimed to compare lower extremity landing kinematics and isometric hip strength between individuals with and without CAI and examine associations between hip kinematics and strength.

Methods: Seventy-six individuals completed 5 single-leg landings, during which we collected three-dimensional ankle, knee, and hip kinematics from 200 milliseconds pre-initial contact to 50 milliseconds post-initial contact. We calculated average peak torque (Nm/kg) from 3 trials of isometric hip extension, abduction, and external rotation strength testing. One-way analyses of variance assessed group differences (CAI, LAS copers, and control) in hip strength and kinematics. Pearson product moment correlations assessed associations between hip kinematics and strength. We adjusted the kinematic group comparisons and correlation analyses for multiple comparisons using the Benjamini-Hochberg method.

Results: The CAI group exhibited less hip abduction during landing than LAS copers and controls. The CAI group had lower hip external rotation strength than LAS copers ($P = .04$, $d = 0.62$ [0.05, 1.17]) and controls ($P < .01$, $d = 0.87$ [0.28, 1.43]). Effect sizes suggest that the CAI group had deficits in EXT compared with controls ($d = 0.63$ [0.06, 1.19]). Hip strength was not associated with hip landing kinematics for any group.

Conclusion: Altered landing mechanics displayed by the CAI group may promote mechanisms of LAS, but they are not associated with isometric hip strength. However, hip strength deficits may negatively impact other functional tasks, and they should still be considered during rehabilitation.

Level of Evidence: Level III, case-control study.

Use of Evaluator portable load cell: measure isometric hip extension, abduction, and external rotation muscle strength

2018

“Isometric hip strength and dynamic stability of individual with chronic ankle instability.”

McCann RS, Bolding BA, Terada M, et al. Isometric hip strength and dynamic stability of individual with chronic ankle instability. *J Athl Train*. 2018;53:000-000, doi: 10.4085/1062-6050-238-17

ABSTRACT:

Context: Compared with individuals who have a history of lateral ankle sprain (LAS) without markers of chronic ankle instability (CAI; LAS copers) and healthy people, those with CAI often exhibit

neuromuscular impairments and dynamic-stability deficits at the hip. However, the influence of hip-strength deficits on dynamic stability remains unknown.

Objective: To compare isometric hip strength and dynamic stability in individuals with or without CAI and examine the degree of dynamic-stability variance explained by isometric hip strength.

Design: Case-control study.

Setting: Research laboratory.

Patients or Other Participants: Sixty individuals (47 women, 13 men; age = 23.7 ± 4.6 years, height = 166.6 ± 7.7 cm, mass = 70.8 ± 15.7 kg) separated into CAI, LAS copers, and control groups based on previously established criteria.

Main Outcome Measure(s): Group differences in resultant vector time to stabilization (RVTTs) and isometric hip-extension, -abduction, and external-rotation strength were determined using 1-way analyses of covariance that controlled for sex and limb (dominant or nondominant) tested and Cohen d effect sizes (95% confidence intervals). Backward linear regressions and Cohen f^2 effect sizes (95% confidence intervals) determined the amount of RVTTs variance explained by isometric hip strength. Significance was set a priori at $P < .05$.

Results: The CAI group had less isometric hip-extension strength than LAS copers ($P = .02$, $d = 0.72$ [0.06, 1.34]) and controls ($P = .01$, $d = 1.19$ [0.50, 1.84]) and less external-rotation strength than LAS copers ($P = .03$, $d = 0.78$ [0.13, 1.41]) and controls ($P = .01$, $d = 1.02$ [0.34, 1.65]). No group differences existed for RVTTs ($F_{2,57} = 1.16$, $P = .32$) or abduction strength ($F_{2,57} = 2.84$, $P = .07$). Resultant vector time to stabilization was explained by isometric hip strength for LAS copers ($R^2 = 0.21$, $f^2 = 0.27$ [0.22, 0.32], $P = .04$) but not for the CAI ($R^2 = 0.12$, $f^2 = 0.14$ [0.06, 0.22], $P = .22$) or control ($R^2 = 0.10$, $f^2 = 0.11$ [0.03, 0.19], $P = .18$) groups.

Conclusions: Participants with CAI had decreased isometric hip strength, but that did not equate to dynamic-stability deficits. Clinicians should include hip-muscle strengthening in rehabilitation protocols for patients with CAI, yet these gains may not enhance dynamic stability when landing from a jump.

Use of Evaluator portable load cell: musculoskeletal evaluation of strength of hip musculature of healthy individuals and individuals with LAS and CAI

2017

“Determining sincerity of effort based on grip strength test in three wrist positions.”

Bhuanantanondh P, Nanta P, Mekhora K. Determining sincerity of effort based on grip strength test in three wrist positions. *Safety Health at Work*. 2017, <http://dx.doi.org/10.1016/j.shaw.2017.06.001>

ABSTRACT:

Background: Several grip strength tests are commonly used for detecting sincerity of effort. However, there is still no widely accepted standardized sincerity of effort test. Therefore, this study aimed to examine whether grip strength test in three wrist positions could distinguish between maximal and submaximal efforts.

Methods: Twenty healthy individuals (10 men and 10 women) with a mean age of 26.7 ± 3.92 years participated in this study. All participants completed two test conditions (maximal and submaximal efforts) in three wrist positions (neutral, flexion, and extension) using both hands. Each participant exerted 100% effort in the maximal effort condition and 50% effort in the submaximal effort condition. The participants performed three repetitions of the grip strength test for each session.

Results: The results showed that there is a significant main effect of the type of effort ($p < 0.001$), wrist position ($p < 0.001$), and hand ($p < 0.028$). There were also significant types of effort and wrist position interactions ($p < 0.001$) and effort and hand interactions ($p < 0.028$). The results also showed that grip strength was highest at the wrist in neutral position in both the maximal and the submaximal effort condition. Grip strength values of the three wrist positions in the maximal effort condition were noticeably greater than those in the submaximal effort condition.

Conclusion: The findings of this study suggest that grip strength test in three wrist positions can differentiate a maximal effort from a submaximal effort. Thus, this test could potentially be used to detect sincerity of effort in clinical setting.

Use of EvalTech hand grip dynamometer: musculoskeletal evaluation of hand grip strength in healthy individuals

“Hip strength and star excursion balance test deficits of patients with chronic ankle instability.”

McCann RS, Crossett ID, Terada M, et al. Hip strength and star excursion balance test deficits of patients with chronic ankle instability. *J Sci Med Sport*. 2017, <http://dx.doi.org/10.1016/j.jsams.2017.05.005>

ABSTRACT:

Objectives: To examine isometric hip strength in those with and without CAI, and determine the degree of Star Excursion Balance Test (SEBT) variance explained by isometric hip strength.

Design: Single-blinded, cross-sectional, case-control study.

Methods: Thirty individuals with CAI, 29 lateral ankle sprain (LAS) copers, and 26 healthy controls participated. We assessed dynamic postural control with the SEBT anterior (SEBT-ANT), posteromedial (SEBT-PM), and posterolateral (SEBT-PL) reaches, and isometric hip extension (EXT), abduction (ABD) and external rotation (ER) strength with hand-held dynamometry. The CAI and LAS coper groups' involved limbs and randomly selected limbs in controls were tested. Separate Kruskal–Wallis tests compared SEBT scores and isometric hip strength between groups. Backwards linear regression models determined the degree of SEBT variance explained by isometric hip strength. Statistical significance was set a priori at $P < 0.05$.

Results: The CAI group had lower SEBT-ANT scores compared to LAS copers ($P = 0.03$) and controls ($P = 0.03$). The CAI group had lower ABD compared to LAS copers ($P = 0.03$) and controls ($P = 0.02$). The CAI group had lower ER compared to LAS copers ($P = 0.01$) and controls ($P = 0.01$). ER ($R^2 = 0.25$, $P = 0.01$) and ABD ($R^2 = 0.25$, $P = 0.01$) explained 25% of the CAI group's SEBT-PM and SEBT-PL variances, respectively.

Conclusions: The CAI group had deficient dynamic postural control and isometric hip strength compared to LAS copers and controls. Additionally, the CAI group's isometric hip strength significantly influenced dynamic postural control performance. Future CAI rehabilitation strategies should consider hip muscular strengthening to facilitate improvements in dynamic postural control.

Use of Evaluator portable load cell: musculoskeletal evaluation of strength of hip musculature of healthy individuals and individuals with CAI

2016

“Influence of functional capacity evaluation on physician’s assessment of physical capacity of veterans with chronic pain: a retrospective analysis.”

Peppers D, Figoni SF, Carroll BW, et al. Influence of functional capacity evaluation on physician's assessment of physical capacity of veterans with chronic pain: a retrospective analysis. *Am Acad Phys Med Rehabil*. <http://dx.doi.org/10.1016/j.pmrj.2016.10.011>.

ABSTRACT:

Background: Physicians have difficulty predicting patients' occupational limitations, abilities, and success from clinical evaluation (CE) of pathology and impairments, especially in the presence of chronic pain. Additional information from a functional capacity evaluation (FCE) may improve the accuracy of their

physical capacity assessments. It is not known whether FCE information will change these assessments. No such study has been published using Veterans or non-Veterans.

Objective: To determine the influence of FCE data on the physician's assessment of the US Department of Labor's Dictionary of Occupational Titles (DOT) work capacity levels of Veterans with chronic moderate-intensity pain.

Design: Retrospective analysis.

Setting: Tertiary care medical center.

Participants: Veterans aged 18-60 years with moderate chronic musculoskeletal pain who were seeking employment.

Methods: Two kinesiotherapists performed FCEs on all participants, namely, the lumbar protocol of the EvalTech Functional Testing System (BTE, Inc, Hanover, MD). One physiatrist performed CEs in all participants. Two other physiatrists assessed DOT physical capacity levels using CE data alone and later using combined CE and FCE data.

Main Outcome Measurements: DOT physical capacity level (sedentary = 1, light = 2, medium = 3, heavy = 4, very heavy = 5).

Results: Of 55 charts reviewed, 27 met inclusion/exclusion criteria. The mean age was 38 years, and there were 25 male and 2 female participants. The predominant pain location was the lower back. DOT scores for 2 physicians were averaged. The mean \pm SD DOT scores for CE only and CE+FCE conditions were 2.04 ± 0.33 and 2.40 ± 0.90 , respectively. In all, 65% of DOT scores changed (17% decreased and 48% increased at least 1 level) after FCE data were considered. A 1-sample *t* test revealed that the mean CE+FCE DOT score was significantly greater than the mean CE-only score (by 20%, $P = .02$). Interrater agreement (weighted *k*) for CE+FCE-based DOT scores was much higher than for CE alone (0.715 versus 0.182).

Conclusion: The addition of FCE data to CE changed the majority of physician-assigned DOT levels. FCE significantly increased the mean DOT physical work capacity level provided by the physician to Veterans with chronic moderate-intensity pain, especially if the initial assessment was designated as "light." FCE may facilitate a more objective and accurate determination of Veterans' work capacity.

Use of EvalTech system: musculoskeletal evaluation of functional capacity of veterans.

"Predictive neuromuscular fatigue of the lower extremity utilizing computer modeling."

Samaan MA, Weinhandl JT, Hans SA, et al. Predictive neuromuscular fatigue of the lower extremity utilizing computer modeling. *J Biomech Eng.* 2016;138:011008-1-10.

ABSTRACT:

This paper studies the modeling of lower extremity muscle forces and their correlation to neuromuscular fatigue. Two analytical fatigue models were combined with a musculoskeletal model to estimate the effects of hamstrings fatigue on lower extremity muscle forces during a side step cut. One of the fatigue models (Tang) used subject-specific knee flexor muscle fatigue and recovery data while the second model (Xia) used previously established fatigue and recovery parameters. Both fatigue models were able to predict hamstrings fatigue within 20% of the experimental data, with the semimembranosus and semitendinosus muscles demonstrating the largest (11%) and smallest (1%) differences, respectively. In addition, various hamstrings fatigue levels (10–90%) on lower extremity muscle force production were assessed using one of the analytical fatigue models. As hamstrings fatigue levels increased, the quadriceps muscle forces decreased by 21% ($p < 0.01$), while gastrocnemius muscle forces increased by 36% ($p < 0.01$). The results of this study validate the use of two analytical fatigue models in determining the effects of neuromuscular fatigue during a side step cut, and therefore, this model can be used to assess fatigue effects on risk of lower extremity injury during athletic maneuvers. Understanding the effects of fatigue on muscle force production may provide insight on muscle group compensations that may lead to altered lower extremity motion patterns as seen in noncontact anterior cruciate ligament (ACL) injuries.

Use of EvalTech portable load cell: musculoskeletal evaluation. In context of the study, the device served as a portable fixed dynamometer and was used to induce fatigue of the hamstring muscles of healthy females.

2015

“Sustained isometric shoulder contraction on muscular strength and endurance: a randomized clinical trial.”

Myers NL, Toonstra JL, Smith JS, et al. Sustained isometric shoulder contraction on muscular strength and endurance: a randomized clinical trial. *J Sports Phys Ther.* 2015;10(7):1015-1025.

ABSTRACT:

Background: The Advanced Throwers Ten Exercise Program incorporates sustained isometric contractions in conjunction with dynamic shoulder movements. It has been suggested that incorporating isometric holds may facilitate greater increases in muscular strength and endurance. However, no objective evidence currently exists to support this claim.

Hypothesis/Purpose: The purpose of this research was to compare the effects of a sustained muscle contraction resistive training program (Advanced Throwers Ten Program) to a more traditional exercise training protocol to determine if increases in shoulder muscular strength and endurance occur in an otherwise healthy population. It was hypothesized that utilizing a sustained isometric hold during a shoulder scaption exercise from the Advanced Throwers Ten would produce greater increases in shoulder strength and endurance as compared to a traditional training program incorporating a isotonic scapular plane abduction (scaption) exercise.

Study Design: Randomized Clinical Trial.

Method: Fifty healthy participants were enrolled in this study, of which 25 were randomized into the traditional training group (age: 26±8, height: 172±10 cm, weight: 73±13 kg, Marx Activity Scale: 11±4) and 25 were randomized to the Advanced Throwers Ten group (age: 28±9, height: 169±23 cm, weight: 74±16 kg, Marx Activity Scale: 11±5). No pre-intervention differences existed between the groups (P>0.05). Arm endurance and strength data were collected pre- and post-intervention using a portable load cell (BTE Evaluator, Hanover, MD). Both within and between group analyses were done in order to investigate average torque (strength) and angular impulse (endurance) changes.

Results: The traditional and Advanced Throwers Ten groups both significantly improved torque and angular impulse on both the dominant and non-dominant arms by 10–14%. There were no differences in strength or endurance following the interventions between the two training groups (p>0.75).

Conclusions: Both training approaches increased strength and endurance as the muscle loads were consistent between protocols indicating that either approach will have positive effects.

Use of Evaluator portable load cell (PLC): musculoskeletal evaluation of isometric torque and endurance via angular impulse of shoulder abductor muscles of healthy adults. The PLC served as a portable fixed dynamometer. Intersession reliability was established and ICC, SEM, and MDC were calculated for average torque and angular impulse using the PLC

2013

“Comparison of isometric portable fixed dynamometry to isokinetic dynamometry for assessment of hip strength.”

Kollock R, Van Lunen B, Linza J, et al. Comparison of isometric portable fixed dynamometry to isokinetic dynamometry for assessment of hip strength. *Int J Athl Ther Train.* 2013;18:1-6

ABSTRACT:

Purpose: To investigate the relationship between isometric peak torque and isokinetic peak torque at 60°·s⁻¹ for various hip motions.

Design: Cohort Study

Methods: Three isokinetic repetitions at 60°·s⁻¹ and three isometric contractions of 5 s each for the hip flexors (HFs), hip extensors (HEs), hip abductors (ABs), hip adductors (ADs), hip external rotators (ERs), and hip internal rotators (IRs). Pearson correlation coefficients of determination were calculated for both absolute and allometric-scaled peak torque values.

Results: Meaningful associations between isometric and isokinetic peak torque values were found for each hip motion. Allometric-scaled strength values demonstrated stronger correlations than absolute strength values.

Conclusions: The results suggest that portable fixed isometric testing of hip strength is an alternative to isokinetic testing at 60°·s⁻¹.

Use of Evaluator portable load cell: musculoskeletal evaluation of the lower extremity of physically active young adults. Isometric and isokinetic modes were utilized to measure MVIC and peak torque of the hip muscles

“Electrical stimulation for chronic non-specific low back pain in a working-age population: a 12-week double blinded randomized controlled trial.”

These MS, Hughes M, Biggs J. Electrical stimulation for chronic non-specific low back pain in a working-age population: a 12-week double blinded randomized controlled trial. *BMC Musculoskel Disord*. 2013; 14:117-126.

ABSTRACT:

Background: Non-invasive electrotherapy is commonly used for treatment of chronic low back pain. Evidence for efficacy of most electrotherapy modalities is weak or lacking. This study aims to execute a high-quality, double blinded randomized controlled clinical trial comparing 1) H-Wave® Device stimulation plus usual care with 2) transcutaneous electrical nerve stimulation (TENS) plus usual care, and 3) Sham electrotherapy plus usual care to determine comparative efficacy for treatment of chronic non-specific low back pain patients.

Methods/Design: Patients- Chronic non-specific low back pain patients between ages of 18–65 years, with pain of at least 3 months duration and minimal current 5/10 VAS pain. Patients will have no significant signs or symptoms of lumbosacral nerve impingement, malignancy, spinal stenosis, or mood disorders.

Study design: Double blind RCT with 3 arms and 38 subjects per arm. Randomization by permuted blocks of random length, stratified by Workers Compensation claim (yes vs. no), and use of opioids. The null hypothesis of this study is that there are no statistically significant differences in functional improvement between treatment types during and at the end of a 12-week week treatment period. Data collection- Subjective data will be collected using Filemaker Pro™ database management collection tools. Objective data will be obtained through functional assessments. Data will be collected at enrollment and at 1, 4, 8, and 12 weeks for each participant by a blinded assessor.

Interventions- H-Wave® device stimulation (Intervention A) plus usual care, transcutaneous electrical nerve stimulation (TENS) (Intervention B) plus usual care, and sham electrotherapy plus usual care (control). Each treatment arm will have identical numbers of visits (4) and researcher contact time (approximately 15 hours).

Outcomes- Primary outcome measure: Oswestry Disability Index. Secondary measures include: Rowland Morris Instrument, VAS pain score, functional evaluation including strength when pushing and pulling, pain free range of motion in flexion and extension. Outcome measures assessed at baseline, 1, 4, 8, and 12 weeks. Treatment failure will be defined if patient terminates assigned treatment arm for non-efficacy or undergoes invasive procedure or other excluded cointerventions. Data will be analyzed using intention-to-treat analysis and adjusted for covariates related to LBP (e.g. age) as needed.

Discussion: Study strengths include complex randomization, treatment group allocation concealment, double blinding, controlling for co-interventions, rigorous inclusion criteria, assessment of compliance, plans for limiting dropout, identical assessment methods and timing for each treatment arm, and planned intention-to-treat analyses.

Use of EvalTech system: musculoskeletal evaluation of functional capacity of patients with non-specific chronic low back pain. Tests include lumbar AROM, shoulder height push and pull, cart height push and pull.

“Test-Retest reliability and validity of isometric knee-flexion and –extension measurement using 3 methods of assessing muscle strength.”

Toonstra J, Mattacola CG. Test-Retest reliability and validity of isometric knee-flexion and –extension measurement using 3 methods of assessing muscle strength. *J Sport Rehabil.* 2013; Feb 18; Technical Notes(7). pii:2012-0017.

ABSTRACT:

Context: Physicians and clinicians need portable, efficient, and cost-effective assessment tools to determine the effectiveness of rehabilitation programs after knee injury. Progress in rehabilitation should be evaluated using valid and reliable measurement methods.

Objective: To examine the test–retest reliability of portable fixed dynamometry (PFD), handheld dynamometry (HHD), and isokinetic dynamometry (IKD). In addition, the authors sought to examine the validity of PFD and HHD by comparing differences in peak torque of the knee flexors and extensors to that of the “gold standard” IKD.

Design: Repeated measures.

Participants: 16 healthy subjects (age 29.3 ± 7.2 y, height 167.4 ± 8.04 cm, mass 73.7 ± 20.0 kg).

Main Outcome Measures:

The dependent variables were peak torque (normalized to body weight) of the knee flexors and extensors; the independent variables were trial (trial 1, trial 2) and instrument (IKD, PFD, and HHD).

Results: Test–retest reliability was high for both PFD and IKD. However, fair to poor reliability was found for HHD. There were no differences in peak torque (Nm) between IKD and PFD. However, significant differences in peak torque were observed between IKD and HHD and between PFD and HHD.

Conclusions: PFD provides reliable measures of strength and also demonstrates similar output measures as IKD. Its portability, ease of use, and cost provide clinicians an effective means of measuring strength.

Use of Evaluator portable load cell (PLC): in context of study, the PLC was used as a portable fixed dynamometer to measure isometric peak torque of the knee flexor and extensor muscles of healthy population. Device was compared to “gold standard” measurement device and reliability measures were established.