Evidence-based Practice Initiative – EvalTech and ER

**EvalTech and ER specific references:**


**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 portable load cell of EvalTech / ER: musculoskeletal evaluation of isometric strength of the knee.**


**ABSTRACT:**
Anterior cruciate ligament (ACL) neuromuscular training programs have demonstrated beneficial effects in reducing ACL injuries, yet further evaluation of their effects on biomechanical measures across a sports team season is required to elucidate the specific factors that are
modifiable. The purpose of this study was to evaluate the effects of a 10-week off-season neuromuscular training program on lower extremity kinematics. Twelve Division I female soccer players (age: 19.2 ± 0.8 years, height: 1.67 ± 0.1 m, weight: 60.2 ± 6.5 kg) performed unanticipated dynamic trials of a running stop-jump task pretraining and post-training. Data collection was performed using an 8-camera Vicon system (Los Angeles, CA, USA) and 2 Bertec (Columbus, OH, USA) force plates. The 10-week training program consisted of resistance training 2 times per week and field training, consisting of plyometric, agility, and speed drills, 2 times per week. Repeated measures analyses of variance (ANOVAs) were used to assess the differences between pretraining and post-training kinetics and kinematics of the hip, knee, and ankle at initial contact (IC), peak knee flexion (PKF), and peak stance. Repeated measures ANOVAs were also used to assess isometric strength differences pre-training and post-training. The alpha level was set at 0.05 a priori. The training program demonstrated significant increases in left hip extension, left and right hip flexion, and right hip adduction isometric strength. At IC, knee abduction angle moved from an abducted to an adducted position (-1.48 ± 3.65° to 1.46 ± 3.86°, \( p = 0.007 \)), and hip abduction angle increased (-6.05 ± 4.63° to -10.34 ± 6.83°, \( p = 0.007 \)). Hip abduction angle at PKF increased (-2.23 ± 3.40° to 6.01 ± 3.82°, \( p = 0.002 \)). The maximum knee extension moment achieved at peak stance increased from pre-training to post-training (2.02 ± 0.32 to 2.38 ± 0.75 N▪m▪kg⁻¹, \( p = 0.027 \)).

The neuromuscular training program demonstrated a potential positive effect in altering mechanics that influence the risk of incurring an ACL injury.

*Use of portable load cell of EvalTech / ER: musculoskeletal evaluation of isometric strength of the hip and knee.*


ABSTRACT:

**Context:** Insufficient lower extremity strength may be a risk factor for lower extremity injuries such as noncontact anterior cruciate ligament tears. Therefore, clinicians need reliable instruments to assess strength deficiencies.

**Objective:** To assess the intra-rater, inter-rater, intra-session, and intersession reliability of a portable fixed dynamometer in measuring the strength of the hip and knee musculature.

**Design:** Crossover study.

**Setting:** Sports medicine research laboratory.

**Patients or Other Participants:** Three raters (A, B, C) participated in this 2-phase study. Raters A and B tested 11 healthy college graduate students (2 men, 9 women) in phase 1. Raters A and C tested 26 healthy college undergraduate students (7 men, 19 women) in phase 2.

**Main Outcome Measure(s):** The dependent variables for the study were hip adductor, hip abductor, hip flexor, hip extensor, hip internal rotator, hip external rotator, knee flexor, and knee extensor peak force.

**Results:** The phase 1 intra-session intraclass correlation coefficients for sessions 1, 2, and 3
ranged from 0.88 to 0.99 (SEM 0.08–3.02 N), 0.85 to 0.99 (SEM 0.26–3.88 N), and 0.92 to 0.96 (SEM 0.52–2.76 N), respectively. Intraclass correlation coefficients ranged from 0.57 to 0.95 (SEM 1.72–13.15 N) for phase 1 intersession values, 0.70 to 0.94 (SEM 51.42–9.20 N) for phase 2 intra-rater reliability values, and 0.69 to 0.88 (SEM 5 1.20–8.50 N) for phase 2 inter-rater values.

**Conclusions:** The portable fixed dynamometer showed good to high intra-session and intersession reliability values for hip and knee strength. Intrarater and inter-rater reliability were fair to high, except for hip internal rotation, which showed poor reliability.

**Use of portable load cell of EvalTech / ER: musculoskeletal evaluation of isometric strength of the hip and knee.**


**ABSTRACT:**

**Introduction:** The purpose of this study was to quantify muscle strength and endurance in power grip.

**Method:** Workers (74 M and 74 F, 18–72 years) squeezed a dynamometer for a 60 s, 18-cycle test. Initial strength (IS) and final strength (FS) were calculated as the mean peak force for cycles 1–3 and 16–18, respectively. Endurance was defined by the strength decrement index (SDI) where SDI = (IS - FS)/IS 9 100. A grip strength-endurance analyzer was constructed from IS and SDI data which were depicted on two parallel, linearly scaled axes. Discrete IS and SDI scores were connected on each axis with a vector. The vector (Vmag) was measured directly from the analyzer and its direction identified from its slope. Integer scales transformed discrete IS and SDI scores into individual strength-endurance performance scores (SEPS).

**Results:** Better than 95% of the sample (n C 141) scored within acceptable test ranges defined as the combined sample mean ± 2SD, for SDI, Vmag and SEPS. Vmag was the best predictor for SEPS. Linear regression for SEPS was SEPS (combined) = 0.09 (Vmag) - 0.29: (SEE = 0.829). The analyzer revealed individual scores outside acceptable ranges for injured and uninjured efforts.

**Conclusion:** The development of a power grip strength-endurance analyzer provided a simple method to graph individual power grip performances. Converting strength and endurance scores to integers and summing them (SEPS) provided a simple means to represent individual estimates of power grip strength-endurance performance.

**Use of hand grip dynamometer of EvalTech / ER: musculoskeletal evaluation of isometric strength and endurance of the hand.**

**ABSTRACT:**
This study of the reliability of three new tests of work performance considered the effect of test reactivity on measured performance. The tests are components of an employment screening battery designed for placement of applicants in automotive assembly jobs. Statistical measures of reliability were compared with a simple measure of test reactivity in a sample of 51 healthy adults. The effect of test reactivity on employment selection decisions using various cut scores was studied. Test reactivity is found to be a significant threat to reliability that must be considered when skill-based performance tests are used on a serial basis. When intended for use on a serial basis, such tests should be studied for both reliability and reactivity. In addition to reporting traditional statistical indices of reliability, an index of the reactivity should be reported.

*Use of Functional Range of Motion board of EvalTech / ER: employment screening battery designed to aid in placement of applicants in automotive assembly jobs.*

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**Supporting Evidence:**


**ABSTRACT:**
**Objective:** To determine the reliability and validity of hand-held dynamometer (HHD) depending on its fixation in measuring isometric knee extensor strength by comparing the results with an isokinetic dynamometer.

**Methods:** Twenty-seven healthy female volunteers participated in this study. The subjects were tested in seated and supine position using three measurement methods: isometric knee extension by isokinetic dynamometer, non-fixed HHD, and fixed HHD. During the measurement, the knee joints of subjects were fixed at a 35° angle from the extended position. The fixed HHD measurement was conducted with the HHD fixed to distal tibia with a Velcro strap; non-fixed HHD was performed with a hand-held method without Velcro fixation. All the measurements were repeated three times and among them, the maximum values of peak torque were used for analysis.

**Results:** The data from the fixed HHD method showed higher validity than the non-fixed method compared with the results of the isokinetic dynamometer. Pearson correlation coefficients \(r\) between fixed HHD and isokinetic dynamometer method were statistically significant (supine-right: \(r = 0.806, p < 0.05\); seating-right: \(r = 0.473, p < 0.05\); supine-left: \(r = 0.524, p < 0.05\)), whereas Pearson correlation coefficients between non-fixed HHD and isokinetic dynamometer methods were not statistically significant, except for the result of the supine position of the left leg (\(r = 0.384, p < 0.05\)). Both fixed and non-fixed HHD methods showed excellent inter-rater reliability.
However, the fixed HHD method showed higher reliability than the non-fixed HHD method by considering the intraclass correlation coefficient (fixed HHD, 0.952-0.984; non-fixed HHD, 0.940-0.963).

**Conclusion:** Fixation of HHD during measurement in the supine position increases the reliability and validity in measuring the quadriceps strength.

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**ABSTRACT:**
Lower extremity muscle strength is important in predicting fall risk in older adults. Handheld dynamometry (HHD) is a tool used to measure isometric muscle strength in the older adult, but few studies have evaluated the utility of HHD for muscle groups beyond knee extension. The purpose of this study was to evaluate the reliability of HHD at the hip, knee, and ankle and to compare HHD strength values to other isometric dynamometry (ID) and to balance and recovery in older adults. This was a repeated measures study design of 18 men and women, age 65 to 92 years of age, who had HHD strength testing 3 to 7 days apart by the same examiner and repeat testing on the same day using 2 independent examiners. ID strength, balance, step length, and reaction time were measured once. HHD demonstrated good intra-rater and Inter-rater reliability for isometric strength at the hip and knee but was not a reliable measure for ankle strength. The HHD was a valid measure of isometric strength at the hip and knee, demonstrating moderate to high correlation values when compared to ID strength measures ($r = 0.57–0.86; p < 0.05$). Hip and knee strength was positively associated to step length and reaction time but not to balance ($r = 0.40–0.71; p < 0.05$). In conclusion, HHD is a reliable and valid assessment tool for measuring strength at the hip and knee in older adults, and greater strength in these muscles is associated with longer step length and in these muscles is associated with longer step length and decreased reaction time, which are important components of balance recovery in older adults. HHD can be used as an effective strength measurement tool for the older adult population.

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**ABSTRACT:**
Evaluation of functional capacities of patients suffering of neuromuscular disorders, particularly muscle strength, is a critical issue for their diagnosis and follow-up. Within the framework of the natural history of any given disease, such an evaluation may improve the
clinician’s knowledge of the pathophysiological processes involved, and may help to anticipate and sometimes prevent deleterious consequences as the disease progresses. It is also helpful for identifying correlation between the severity of organic damage and the functional impact of the disease. The measurement of functional capacities must be done with accuracy, sensitivity and reliability, essentially when used as an outcome measure for therapeutic trials. Several evaluation tools for measuring muscle strength are available. They are usually classified into two groups: manual muscle testing (MMT) methods and quantified muscle testing (QMT) methods. In this article, we present the principles of strength measurements, and the different tools and materials that are commonly used in clinical settings. Their limitations and drawbacks are illustrated through several examples. Although QMT is theoretically and potentially more consistent than MMT to precisely follow the muscle capacities of the patients, precise and robust procedures must be elaborated and validated for each tested muscle function. Strength measurements must be performed by trained and experimented clinical evaluators. This issue is critical in the follow up of multicentric therapeutic trials. Inter-rater reliability must be assessed to guarantee the statistical power of the trial.


ABSTRACT:
Context: Injuries involving the lumbar spine and lower extremities in athletes are among the most disabling. Lack of trunk and hip strength may predispose athletes to such injuries.
Objective: To measure trunk endurance and hip strength in a population of National Collegiate Athletic Association Division III athletes.
Design: Cross-sectional design of 5 collegiate athletic teams.
Setting: An athletic training facility during pre-participation physical examinations.
Patients or Other Participants: 105 Division III athletes.
Main Outcome Measure(s): The series of tests included the 60-second back-extension endurance and 60-second tall-kneeling tests. The scores of these tests were reported in repetitions. A handheld dynamometer was used to measure maximal hip external rotation strength bilaterally. The double-leg lowering test was measured in degrees, and the Star Excursion Balance Test was measured in 4 directions as a percentage of the subject’s leg length. Descriptive statistics were calculated for each exercise and each team.
Results: The average score for the 60-second back-extension endurance test was 53 ± 13 repetitions. The 60-second tall-kneeling test had an average score of 30 ± 8 repetitions. For the 2 hip external-rotation strength tests, the average score was 7 ± 4 kg (12% ± 6% of body weight). Average scores were 50° ± 10° for the double-leg lowering test and 94 ± 9 cm (105% ± 9 % of leg length) for the Star Excursion Balance Test.
Conclusions: The descriptive data from these trunk and hip tests allow for the development of baseline values for each test. By investigating these measures in an athletic population, we hope to provide health care professionals with further insights about the trunk and hip muscle performance in athletes to prevent and rehabilitate athletic injuries.
Martin HJ, Yule V, Syddall HE, Dennison EM, Cooper C, Sayer AA: Is hand-held dynamometry useful for the measurement of quadriceps strength in older people? A comparison with the gold standard Biodex dynamometry. Gerontol. 2006;52:154-159

ABSTRACT:

Background: The lower limb muscle strength is an important determinant of physical function in older people. However, measurement in clinical and epidemiological settings has been limited because of the requirement for large-scale equipment. A protocol using a novel, versatile hand-held dynamometer (HHD) has been developed to measure the quadriceps strength in a supine position.

Objective: The objective of this study was to assess the validity of this new methodology for measuring the lower limb muscle strength compared to the gold standard Biodex dynamometer.

Methods: The supine quadriceps strength was measured twice with each of the Biodex and the HHD in 20 men and women, aged 61–81 years, on their non-dominant leg. The agreement between the peak torques obtained by Biodex and HHD was analyzed.

Results: The mean peak Biodex and HHD results were 83.4 ± (SD) 28.0 Nm and 68.9 ± 19.6 Nm, respectively. The HHD undermeasured the quadriceps strength by an average of 14.5 Nm (95% CI 8.5, 20.6) compared to the Biodex, and this effect was most marked in the strongest participants. Nevertheless, there was a good correlation between the measures (r = 0.91, p < 0.0001). Classification of individuals into tertiles of muscle strength showed good agreement between the two methods (Kappa = 0.69, p < 0.0001).

Conclusions: Our findings suggest that the HHD using a supine positioning offers a feasible, inexpensive, and portable test of quadriceps muscle strength for use in healthy older people. It underestimates the absolute quadriceps strength compared to the Biodex particularly in stronger people, but is a useful tool for ranking muscle strength of older people in epidemiological studies. It may also be of value for quick and objective assessment of physical function in the clinical setting.


ABSTRACT:
The tests of a patient’s positional tolerance for the performance of work-related activities are a valuable tool in the assessment of an individual’s safe and dependable return to work subsequent to an injury. Endurance, the critical factor in positional tolerance testing, is often forsaken in the interests of clinical expediency and fee schedule limitations. The result of poorly designed positional tolerance tests is a misplaced attack upon the evaluating physician relying upon the report of a third-party provider of a functional capacity evaluation service for the formulation of his/her opinion. The limitations of test methods are discussed, and the authors provide recommendations as to appropriate guidelines for the assessment of increased endurance requirements defined by the United States Department of Labor.