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Clinician-Friendly Physical Performance Tests for the Knee

Jerrod J. Harrison, MS, ATC; Marissa K. Yorgey, MS, ATC; Alexander J. Csiernik, MS, ATC; Joseph H. Vogler, MS, ATC; Kenneth E. Games, PhD, LAT, ATC

Neuromechanics, Interventions, and Continuing Education Research (NICER) Laboratory, Indiana State University, Terre Haute

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Clinical Question: Do individual physical performance tests (PPTs) used as measures for lower extremity function have any relationship to injuries in athletes aged 12 years or older?

Data Sources: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used to locate articles. The authors searched PubMed, EMBASE, and SPORTDiscus, in addition to searching by hand. The search strategy combined the terms *athlete*, *lower extremity*, and synonyms of *performance test* with the names of performance tests.

Study Selection: Studies were included if they involved a test that met the operational definition for a PPT. The included studies assessed components of sport function (eg, speed, agility, and power), determined readiness for return to sport, or predicted injury to the lower extremity. All PPT measures could be performed on the field, courtside, or in a gym with affordable, portable, and readily available equipment. Studies were excluded if they made use of 3-dimensional motion capture, force platforms, timing gates, treadmills, stationary bikes, metabolic charts, or another nonportable, costly testing device. Athletes were categorized on the Tegner Scale at a minimum of level 5, which is the lowest level that still encompasses competitive athletes. Studies were included if 50% or more of the participants were rated above 5 on the Tegner Scale. Studies were excluded if the sole purpose was to judge movement quality or range of motion. Studies were selected if they identified the knee or a knee injury as a focal point of the paper.

Data Extraction: The Consensus-Based Standards for the Selection of Health Measurement Instruments (COSMIN) was used to critique the methodologic quality of each paper with a 4-point Likert scale. The title and methods of each paper were extracted. Extracted data were summarized using ratings of *unknown*, *conflicting*, *limited*, *moderate*, and *strong*.

Main Results: An initial search revealed 3379 original articles for consideration. After initial review, 169 full-text articles were evaluated and 29 articles were included in the systematic review. Six tests were examined for the best evidence of methodologic quality: (1) 1-legged single hop for distance, (2) 1-legged triple hop for distance, (3) 6-m timed hop, (4) crossover hop for distance, (5) triple jump, and (6) 1-legged vertical jump. A summary of the methodologic properties of the 6 tests showed fair/poor reliability, fair/poor hypothesis testing, good criterion validity, and good/poor responsiveness. No tests predicted knee injury in athletes.

Conclusions: Although numerous authors have evaluated PPTs at the knee, evidence for the measurement quality of these functional tests is limited and conflicting. Ample opportunity exists for researchers to further examine PPTs for the knee. Until more knowledge is gained about these PPTs, clinicians should exercise caution when making clinical decisions based on the results of these tests.

Key Words: hop test, functional test, injury prediction, reliability, single-legged hop

COMMENTARY

Physical performance tests (PPTs), also referred to as functional tests, are used by clinicians to determine patients' injury risks and return-to-play readiness.[1] The authors of this study investigated 6 PPTs that are easy to use, are low in cost, require minimal training to perform, and have a minimal time commitment.[1] Despite numerous studies designed to research exactly what these tests offer clinicians, much of the data remain limited and conflicting.[1]

Functional and sport-specific conditioning tests play an important role for clinicians when making return-to-sport decisions.[2] Before returning a patient to activity, a clinician must assess the individual's functional ability. To better quantify this functional ability, researchers[3] have designed various functional performance tests, some of which simulate the stress the knee endures during physical activity. Additional information gained from these tests pertaining to functional performance would enhance the clinical decision-making process.[2,4]

The 1-legged hop for distance was the most studied test of the 6 examined in the present study. The 1-legged hop test has been shown to differentiate between the anterior cruciate ligament (ACL)-deficient knee and the uninvolved knee in an age-matched control group, in addition to detecting differences in the ACL-repaired knee and the uninvolved

knee in the same person.[1] The 1-legged hop test should be performed barefoot, while standing on 1 leg. The patient is asked to jump forward as far as possible. The clinician then measures and records the distance from the patient's toes (starting point to the end of the jump) to the nearest 0.01 meter. If the patient loses balance or falls during the test, the trial is considered *invalid* and must be repeated.[5]

Limb symmetry index (LSI) scores have been examined in healthy and ACL-injured populations. The 1-legged hop-for-distance test, crossover hop-for-distance test, triple hop-for-distance test, and 6-m timed hop test have all been studied in relation to ACL injury.[6] The 1-legged hop test had an LSI greater than 90% in healthy recreational athletes, and 73% of these participants had an LSI greater than 95%.[7] Another study[8] identified a difference in LSI scores greater than 15% as abnormal in patients with ACL injury. Patients with significant limb-to-limb deficits should engage in therapeutic exercises aimed at decreasing these deficits.[6]

The crossover hop-for-distance test provided discriminating information to the clinician at 4 and 8 months after ACL reconstruction. This test detected decreased performance and function in the ACL-repaired limb compared with the uninvolved limb.[1] However, the results of this test did not correlate with the patients' self-rated function or identify differences in the ACL-deficient population. This test can be useful after ACL surgery to identify functional differences between limbs. An LSI of 94.9% was optimal,[6] and 100% of healthy patients had an LSI greater than 90%.[7] To perform this test, the clinician must place a line 6-m long and 15-cm wide on the floor. The patient then completes 3 hops over the line. When starting with the right leg, the patient stands to the left of the line and then hops laterally to the right, back to the left, and finishes to the right of the line. This test is conducted on only 1 leg at a time. The distance is measured from the starting line to the heel of the patient at the final hop position.[4]

The authors of the systematic review[1] determined that it remained unknown whether knee performance tests can predict the risk of knee injury in an athletic population. Isolated performance tests lack the necessary reliability, validity, and known meaningful change to serve as discriminating outcome measures during sport rehabilitation after injury or surgery.[9] Clinicians should use PPTs in conjunction with other tests to examine the patient's overall function (range of motion, strength, etc) and determine readiness to return to sport (patient-reported outcomes). No studies included in this systematic review[1] identified a minimal clinically important difference for any of the tests. Once these values are identified, clinicians will have useful information to guide the progression of their patients and recognize important changes in function and performance.

Although current researchers have not been able to identify the risk of knee injury in the athletic population, clinicians can use PPTs to compare limbs during the rehabilitation of knee injuries and especially ACL injuries. Clinicians can also use these tests to measure quantitative differences between the injured and uninjured limbs in order to target rehabilitation programs with the goal of decreasing limb-to-limb differences. Continuing research advances on these PPTs will expand the clinician's ability to measure patient care outcomes.

As indicated, further studies involving strong methodologic characteristics are needed to identify the clinical usefulness of these tests, especially for the knee.[1] Although results vary on PPTs for the knee, evidence-based practice also involves patient values and clinician expertise, making it necessary for clinicians to implement PPTs with caution to identify possible areas for progression during rehabilitation. Although clinicians should also exercise caution when making clinical decisions on knee function based solely on PPT results,[1] these tests may reveal useful information about the patient's function, particularly limb-to-limb differences in postsurgical ACL patients. As clinicians, we must be part of the conversation about future investigations on PPTs. Research should be conducted on a variety of patient populations to strengthen the current literature and elucidate the clinical usefulness of PPTs in predicting injuries to the knee.

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Address correspondence to Jerrod J. Harrison, MS, ATC, Neuromechanics, Interventions, and Continuing Education Research (NICER) Laboratory, Indiana State University, 567 North 5th Street, Room 254, Terre Haute, IN 47809. Address e-mail to jharrisonatc@gmail.com.