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Lower Extremity Return to Sport Testing: A Systematic Review

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Introduction

- Lower extremity injuries account for an enormous portion of sports medicine cases in the United States each year.
- There is no uniform criteria for return to sport testing.
- For knee injuries, specifically anterior cruciate ligament (ACL) injuries, the gold standard for strength testing is thought to be isokinetic dynamometry.¹⁻⁴
- There is debate whether hop testing with limb symmetry index (LSI) is valid to warrant clearing for RTS in the ACL population.
 - Alternative tests include LSI hop test battery of single leg hop for distance (SLHD,) triple hop for distance (THD,) cross-over hop for distance (CHD,) and 6-meter (6-m) timed hop.



Introduction (cont.)

- Regarding the hip and the ankle, there is an enormous paucity of functional testing research with no validated test battery to date.
- The purpose of this study is to review current literature for joint-specific and global lower extremity testing to determine the most valid functional test or series of tests that can be utilized to prevent re-injury as athletes RTS.



Methods

- Search Strategy:
 - To identify included studies, a search was performed using PubMed, PubMed Central, Cochrane Library, OVID, and Embase to gather all studies published before October 2021 that met the inclusion criteria.
- Search Terms:
 - Return to sport or RTS
 - Functional test (landing task, landing mechanics, hop test)
 - Lower Extremity (hip, knee, ankle)
- Inclusion Criteria:
 - Published in the English language
 - Human Studies
 - RTS or functional test assessment
 - Lower extremity injuries
 - Ages between 14 and 40

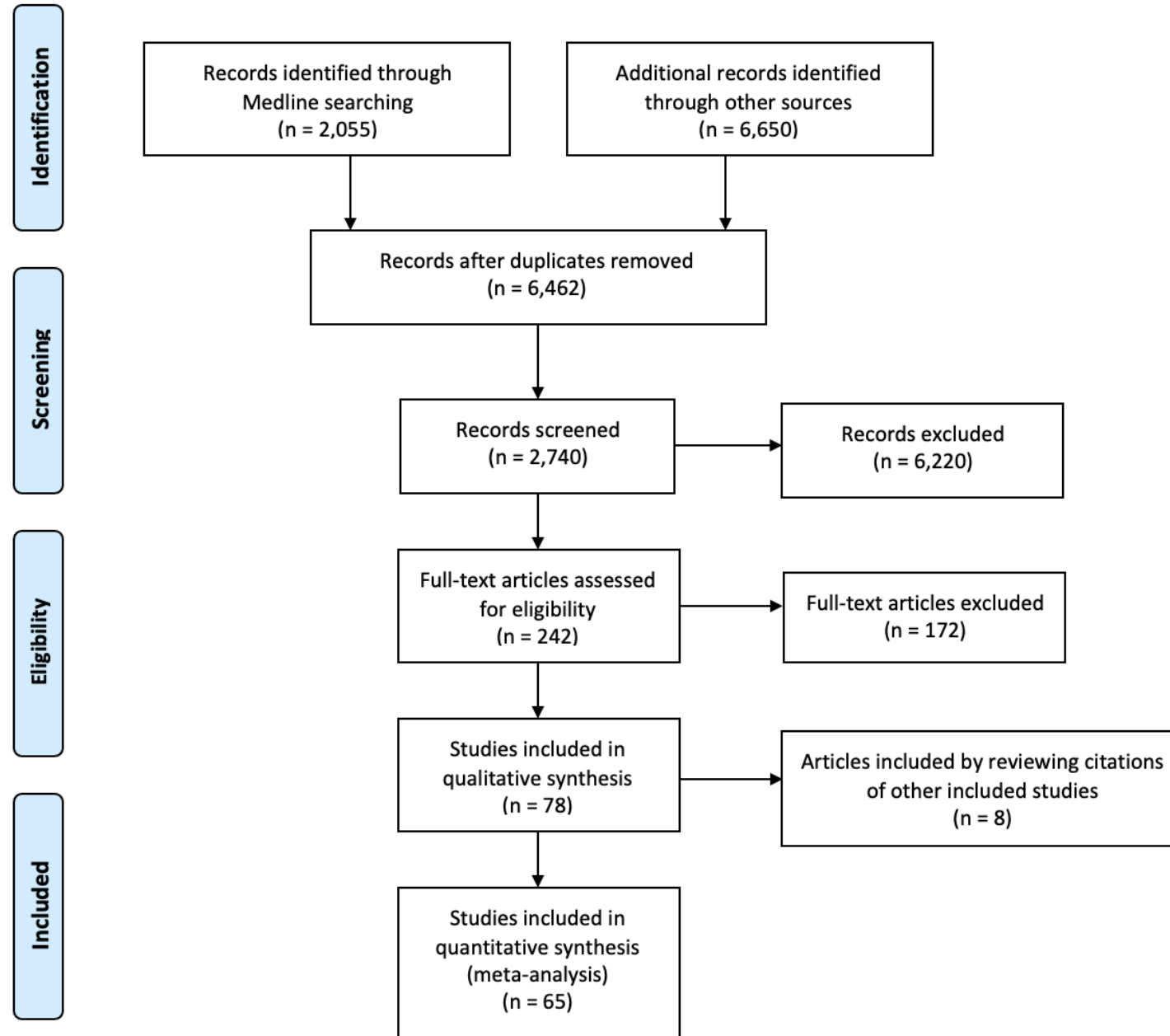


Results

- Of the 8,705 unique references identified in the search, 65 studies (0.75%) were ultimately included in this review.
- Eighty percent (52/65) of articles discussed RTS for the knee.
- Furthermore, 96% (50/52) specifically analyzed RTS following ACL reconstruction.
- The most common RTS test was isokinetic dynamometry testing which is seen in 73% (38/52) of studies.
- Unfortunately, only 6.2% (4/65) studies analyzed RTS for the hip and only 1.54% (1/65) study looked at ankle RTS.



PRISMA Chart



Results (cont.)

- Knee:
 - Isokinetic dynamometry was utilized in 42% (22/65) of articles.
 - Suggested benchmarks for RTS values with isokinetic testing:
 - Limb Symmetry Index (LSI) for quadriceps: 85%
 - LSI for hamstrings: 90%
 - Hamstring:Quadricep (H:Q) ratio: >70%
 - SLHD was mentioned in 62% (32/65) of articles.
 - Not sensitive enough to be used as sole criterion for RTS.
 - Strong correlation with knee extensor strength.
 - THD was discussed in 37% (19/65) of articles.
 - Strong predictor of lower limb muscular strength and power.



Results (cont.)

- Hip:
 - 70%+ of surgeons recommended the following for RTS criteria:
 - A time frame for RTS between 12 and 20 weeks.
 - Able to produce all motions involved in their respective sport without pain.
 - Pain-free running, jumping, lateral agility drills, and single-leg squats .
 - Medial triple hop test significantly reduced in the femoroacetabular impingement.
- Ankle:
 - Single leg heel-rise test:
 - Assesses gastrocnemius and soleus strength.
 - Normative value of 25 repetitions for testing purposes.
 - Hop tests (single limb, figure 8, side, 6-meter crossover, square) can identify functional ankle instability (FAI).
 - Star excursion balance test (SEBT) had excellent reliability and sensitivity for FAI.
 - Sargent/Vertical Jump test was reliable for estimation of explosive power.



Discussion

- No single test should be used in isolation to depict the functional status of an athlete prior to RTS.
- A battery of tests should evaluate multiple facets of strength, neuromuscular control, agility, power, and landing biomechanics.
- For knee injuries, quadriceps strength is of vital importance.
 - Iso-kinetic testing is the gold standard.
 - Several studies validate the use of handheld isometric dynamometry (HHD) against isokinetic.⁵
 - Hop tests are still considered widely necessary as functional movement capability needs to be present prior to RTS.

Figure 1.

Knee Functional Test
1) Strength with Hand-Held Dynamometry (or Isokinetic is available) <ul style="list-style-type: none">• Quadriceps• Hamstrings
2) Y-Balance
3) Single Leg Vertical
4) Single Leg Hop with Fatigue Protocol
5) Cross-Over Hop
6) Figure 8 Hop
7) Drop Landing Knee Excursion
8) Single Leg Press
9) Psychological Readiness



Discussion (cont.)

- For hip injuries, the following were diminished or painful in femoroacetabular impingement:
 - Medial triple hop test
 - Extension and external rotation strength testing with HHD
 - Depth during single leg balance tests
 - Decreased passive hip flexion
- For ankle injuries, hop test evaluations should include:
 - Figure 8 hop test
 - Side hop test
 - 6-meter crossover hop
 - Square hop test
- For all lower extremity injuries, patient reported outcomes is an enormous factor for successful RTS.

Figure 2.

Hip Functional Test

- 1) Strength with Hand-Held Dynamometry
 - Hip Abduction
 - Hip Extension
 - Hip External Rotation

2) Y-Balance

3) Single Leg Vertical

4) Single Leg Hop with Fatigue Protocol

5) Cross-Over Hop

6) Medial Triple Hop

7) Figure 8 Hop

8) Single Leg Press

9) Psychological Readiness

Figure 3.

Ankle Functional Test

1) Single Leg Heel Raise Test

2) Y-Balance

3) Single Leg Vertical

4) Single Leg Lateral Hop with Fatigue Protocol

5) Cross-Over Hop

6) Figure 8 Hop

7) Side Hop Test

8) Square Hop Test

9) Single Leg Press

10) Psychological Readiness



Conclusion

- More research is clearly required to identify the most valid functional test batteries for joint-specific RTS lower extremity testing.
- No standardized criterion exists for RTS clearance.
- There is a lack of available research for the hip and ankle RTS.
- We hope that the suggested test batteries from this review can serve as a framework for future research and validation for joint-specific RTS functional testing.



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