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# Limited evidence for return to sport testing after ACL reconstruction in children and adolescents under 16 years: a scoping review


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## INTRODUCTION

- ACL injuries are a severe injury of the paediatric and adolescent knee
- Return to sport rates are high in this population
- There are several concerns with return to sport after ACL injury and reconstruction in this population
  - There are high rates of secondary ruptures after ACL reconstruction
  - Due to physiological development, it is not known whether the specific clinical and functional milestones in rehabilitation can be applied in children [1,10]
  - Return to sport criteria after ACL injury and reconstruction are unknown

## AIM

The aim of this scoping review is to provide and overview of the current evidence of tests evaluating readiness for return to sport after ACL injury or ACL reconstruction in children and adolescents (<18 years of age).

Based on the outcomes of this scoping review, the hiatus in the current evidence is shown and advice is given for future research.

## METHOD

- This scoping review was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)
- In- and exclusion criteria are shown in Table 1.
- A systematic search was performed at the 30th of March 2020 by an independent information specialist in PubMed (Medline) and EMBASE databases.
- Two authors independently screened the abstracts for eligibility and extracted all relevant data after inclusion.
  - Disagreements were solved by discussion.

Table 1. Overview of inclusion and exclusion criteria for this scoping review

| | Inclusion criteria | Exclusion criteria |
|---|---|---|
| **Participants** | Children (average age < 18 years) | Average age ≥ 18 years |
| **Injury** | ACL rupture or reconstruction | ACL revision surgery |
| | | Multi-ligament injury of the knee |
| | | Fractures |
| **Tests** | Any test concerning return to sport, including: | |
| | - Strength tests | |
| | - Hop tests | |
| | - Movement quality tests | |
| | - Physical examination | |
| | - PROMs | |
| **Outcomes** | Diagnostic values | |
| | Prognostic information | |
| **Study design** | Cross-sectional studies | |
| | Longitudinal studies | |

## RESULTS

- Twenty six studies were included in this socping review (Figure 1)
- The inter-reviewer agreement had a Cohen's Kappa of 0.94
- All 26 studies were published in the last 10 years and 22 in the last 5 years

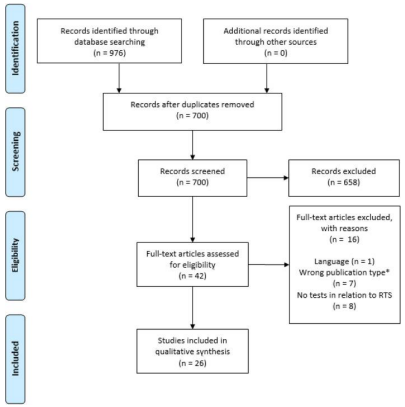


Figure 1. PRISMA flow diagram of inclusion process. *including abstracts of presentations

- **Study characteristics:**
  - Cross-sectional design: 15 studies
  - Longitudinal design: 11 studies
  - Sixteen studies were from the Cincinatti Children's Hospital Medical Center Research Group
    - Ten studies were reported to be part of a larger prospective study (ACL RELAY study)

- **Demographic characteristics:**
  - Exact number of included difficult to estimate due to inclusion of participants from the same prospective study (ACL RELAY)
  - Range of participants in studies are 14 to 384
  - The age distribution of the participants are shown in Figure 2

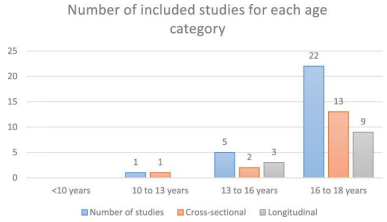


Figure 2. Age distribution among studies

- **Tests regarding return to sport:**
  - Muscle strength
    - Thirteen studies
      - Quadriceps (13), Hamstrings (8), Hip abduction (4), Hip exorotation (1)
  - Hop tests
    - Four studies
      - Noyes' hop test battery (2), Single hop for distance (2), Vertical hop test (1), Side hop test (1)
  - Movement quality
    - Fourteen studies
      - Great variety of different parameters and tests, most common test:
        - Biomechanical properties during landing task (8)
  - Patient reported outcome measures (PROMs)
    - Ten studies
      - IKDC, ACL-RSI, Tegner Activity Scale, Pedi-IKDC
  - Physical examination
    - Five studies
      - Joint laxity (KT-1000 arthrometer), range of motion
  - Test battery
    - Two studies
      - Muscle strength, Hop test and IKDC

- Return to sport clearance criteria
  - Seven studies included definition of return to sport clearance criteria (Table 2)

Table 2. Overview of tests used as return to sport clearance criteria

| Studies | Strength tests | Hop tests | Movement quality | Subjective outcomes* | Physical examination ** | Time based |
|---|---|---|---|---|---|---|
| Astur [2] | X | | X | | | |
| Boyle [3] | X | | X | X | X | X |
| Burland [4] | X | X | | | X | |
| Capin [5] | X | X | | X | | |
| Hannon [7] | X | | X | | X | |
| McPherson [8] | X | | X | | X | |
| Palmieri-Smith [9] | X | | | | X | |

## CONCLUSIONS

The most important finding of this scoping review was that many studies have evaluated strength tests, hop tests, movement quality and PROMs regarding return to sport in adolescents after ACL reconstruction, but that only few studies have been conducted in children and adolescents under 16 years of age.

There is currently sparse evidence for specific testing regarding return to sport in younger children. However, in the category of 16 to 18 years many studies have been conducted, both comparing different tests at the moment of RTS as well as evaluating prognostic values of tests with regard to ACL graft re-rupture, achieving return to preinjury sport level or subjective outcomes.

The following recommendations are made based on the results of this scoping review and expert opinions of the authors:

- Rehabilitation must be guided by clinical and functional milestones and to advise the child not to return to pivoting sports within 12 months after ACL reconstruction. [1,10]
- Age 16-18 years: quadriceps and hamstring strength, hop tests, movement quality during sport specific tasks and PROMs (adult or paediatric)
- Age 12–16 years: hop tests, movement quality and paediatric PROMs.[6] Strength tests in this age category are debatable as there is only sparse evidence of muscle strength tests and outcomes in this age category.
- Age < 12 years: there is currently very limited evidence and based on the physiological characteristics of this group, less emphasize should be on muscle strength and more on movement quality. In this age category, only paediatric PROMs are recommended to evaluate subjective outcomes. [6]

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