

## Predictive Validity of Functional Performance Tests and Psychological Factors in Return-to-Sport Decisions Following Hamstring Injuries and ACL Reconstruction

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### ABSTRACT

Return-to-sport (RTS) decisions following hamstring injuries and anterior cruciate ligament (ACL) reconstruction remain challenging due to high re-injury rates and suboptimal recovery outcomes. This study evaluates the predictive validity of functional performance tests and the influence of psychological factors on RTS outcomes. A mixed-methods approach was employed, combining quantitative assessments (Iso-Kinetic strength testing, single-leg hop tests, and sprint analysis) with qualitative insights from semi-structured interviews. Participants included elite athletes aged 18–35 years recovering from hamstring injuries or ACL reconstruction. Results demonstrated high predictive validity for functional tests, with Iso-Kinetic strength testing (AUC = 0.89) and single-leg hop tests (AUC = 0.91) significantly correlating with successful RTS. Psychological factors, including fear of re-injury ( $r = -0.62$ ) and confidence ( $r = 0.71$ ), were also critical determinants of RTS outcomes. Qualitative themes highlighted the role of motivation and support systems in RTS decisions. This study underscores the importance of integrating physical and psychological assessments in RTS protocols to optimize recovery and reduce re-injury rates.

**Keywords:** Return-To-Sport; Functional Performance Tests; Psychological Readiness; Hamstring Injuries; Acl Reconstruction

## 1. INTRODUCTION

### 1.1 Background

Hamstring injuries and anterior cruciate ligament (ACL) reconstructions are among the most prevalent and debilitating injuries in athletes, often resulting in prolonged recovery periods and alarmingly high re-injury rates<sup>1</sup>. These injuries not only sideline athletes for extended duration's but also pose significant challenges to their long-term performance and career sustainability. Despite considerable advancements in surgical techniques and rehabilitation protocols, recent studies indicate that less than 50% of athletes return to their pre-injury performance levels following ACL reconstruction<sup>2</sup>. This statistic underscores the limitations of current return-to-sport (RTS) protocols, which predominantly emphasize physical recovery while often overlooking the critical role of psychological factors in the rehabilitation process<sup>3</sup>.

The psychological impact of severe injuries, such as fear of re-injury, loss of confidence, and anxiety, has been increasingly recognized as a significant barrier to successful RTS outcomes<sup>4</sup>. Recent research highlights that athletes who fail to address these psychological challenges are at a higher risk of sub-optimal performance or re-injury upon returning to sport<sup>5</sup>. However, existing RTS frameworks remain largely focused on physical metrics, such as strength, range of motion, and functional

performance, with limited integration of psychological assessments<sup>6</sup>. This gap in current rehabilitation practices necessitates a more holistic approach to RTS, one that equally prioritizes both physical and psychological recovery.

The primary justification for this study lies in the urgent need to address the shortcomings of traditional RTS protocols. By integrating psychological assessments alongside physical evaluations, this research aims to develop a comprehensive RTS framework that optimizes recovery outcomes and reduces re-injury rates<sup>7</sup>. The proposed framework seeks to bridge the gap between physical and psychological rehabilitation, ensuring that athletes are not only physically prepared but also mentally resilient when returning to competitive sport.

The purpose of this study is to design and evaluate a multidisciplinary RTS framework that incorporates both physical and psychological components. By doing so, this research aims to enhance the overall recovery process, improve RTS success rates, and ultimately contribute to the long-term well-being and performance of athletes recovering from hamstring injuries and ACL reconstructions<sup>8</sup>.

## 1.2 Problem Statement

Existing RTS protocols frequently fail to incorporate psychological factors, such as fear of re-injury and confidence, alongside physical assessments<sup>9</sup>. This oversight can lead to premature RTS decisions, increasing the risk of re-injury and prolonged recovery<sup>10</sup>. The integration of functional performance tests and psychological readiness assessments is essential to ensure a holistic approach to RTS decision-making.

## 1.3 Objectives

To evaluate the predictive validity of functional performance tests for RTS following hamstring injuries.

To explore the influence of psychological factors on RTS outcomes after ACL reconstruction.

## 1.4 Hypotheses

Functional performance tests, such as Iso-Kinetic strength testing and single-leg hop tests, will predict successful RTS.

Psychological factors, including fear of re-injury and confidence, will significantly influence RTS outcomes.

## 2. MATERIALS AND METHODS

### 2.1 Study Design

The study employed a mixed-methods approach, combining quantitative and qualitative components to comprehensively evaluate the predictive validity of functional performance tests and psychological factors in return-to-sport (RTS) decisions following hamstring injuries and ACL reconstruction<sup>11</sup>.

#### Quantitative Component:

A prospective cohort study was conducted to assess the predictive validity of functional performance tests. Athletes were followed over a 6-month period post-injury or post-surgery to evaluate their RTS outcomes<sup>12</sup>.

A cross-sectional study was performed to examine psychological factors, including fear of rein-jury, confidence, and motivation, using validated psychometric tools<sup>13</sup>.

#### Qualitative Component:

Semi-structured interviews were conducted with a subset of athletes to explore their experiences, perceptions, and decision-making processes regarding RTS. The interviews were designed to provide deeper insights into the psychological and emotional aspects influencing RTS readiness<sup>14</sup>.

### 2.2 Participants

#### Inclusion Criteria:

Elite athletes aged 18–35 years who sustained hamstring injuries or underwent ACL reconstruction<sup>15</sup>.

Participants were required to be actively engaged in competitive sports at the regional, national, or international level.

Athletes were included if they were within 2–6 weeks post-injury or post-surgery at the time of recruitment.

#### Exclusion Criteria:

Athletes with chronic injuries (lasting >6 months) or a history of previous surgeries on the affected limb<sup>16</sup>.

Individuals with comorbidity such as cardiovascular, neurological, or musculoskeletal conditions that could confound the results.

Athletes who were not planning to return to competitive sports.

## 2.3 Materials and Instruments

### Functional Performance Tests:

Isokinetic strength testing (e.g., Hand Held Dynamometer) to assess hamstring and quadriceps strength<sup>17</sup>.

Single-leg hop tests, including the single-leg hop for distance and the crossover hop test, to evaluate lower limb symmetry and functional performance and sprint analysis<sup>18</sup>

### Psychological Assessment Tools:

ACL-RSI Scale: Assessed psychological readiness for RTS using a 12-item questionnaire scored on a 0–100 scale<sup>19</sup>.

Tampa Scale of Kinesiophobia: Measured fear of re-injury using a 17-item questionnaire scored on a 17–68 scale<sup>20</sup>

### Data Collection Instruments:

Semi-structured interview guides were developed to explore athletes' experiences and perceptions<sup>21</sup>.

Demographic and injury-related data were collected using a standardized questionnaire.

## 2.4 Procedures

### Recruitment:

Participants were recruited from sports medicine clinics, athletic training centers, and professional sports teams. Informed consent was obtained from all participants prior to enrollment<sup>22</sup>.

### Functional Testing:

Functional performance tests were conducted at baseline (2–6 weeks post-injury/post-surgery) and repeated at 3 and 6 months. Testing protocols were standardized, and all assessments were performed by trained physiotherapists.

### Psychological Assessment:

Psychological factors were assessed at baseline and at 6 months using the aforementioned psychometric tools<sup>24</sup>.

#### Qualitative Interviews:

Semi-structured interviews were conducted at 6 months post-injury/post-surgery. Interviews were audio-recorded, transcribed verbatim, and analyzed using thematic analysis<sup>25</sup>.

## 2.5 Data Analysis

Quantitative Analysis: Statistical methods, including sensitivity, specificity, ROC curves, and regression analysis.

Qualitative Analysis: Thematic analysis of interview transcripts to identify recurring themes.

## 2.6 Ethical Considerations

The study was approved by the Institutional Review Board (IRB) of Housabai College of Physiotherapy (Approval No. HCP/2024/43).

Written informed consent was obtained from all participants.

Confidentiality and anonymity of participants were maintained throughout the study.

## 3. RESULTS

### 3.1 Functional Tests

Predictive Validity: Iso-kinetic strength testing (AUC = 0.89) and single-leg hop tests (AUC = 0.91) demonstrated high predictive validity for successful return to sport (RTS).

Re-injury Rates: Athletes who passed functional tests had a significantly lower re-injury rate (12%) compared to those who failed (38%).

### 3.2 Psychological Factors

Fear of Re-injury: Significantly correlated with delayed RTS ( $r = -0.62$ ,  $p < 0.001$ ).

Confidence: Positively correlated with successful RTS outcomes ( $r = 0.71$ ,  $p < 0.001$ ).

### 3.3 Qualitative Insights

Themes included fear of re-injury, confidence, motivation, and the role of support systems in influencing RTS decisions.

**Table 1. Participant Demographics**

Demographic	Mean ± SD	Range
Age (years)	24.3 ± 4.1	18–35
Height (cm)	175.6 ± 8.2	160–190
Weight (kg)	72.5 ± 9.3	58–90
Time since injury (months)	6.2 ± 2.4	3–12

#### 4. DISCUSSION

The results of this study highlight the importance of both functional and psychological factors in determining successful return to sport (RTS) outcomes.

##### Functional Tests:

The high predictive validity of iso-kinetic strength testing (AUC = 0.89) and single-leg hop tests (AUC = 0.91) underscores their utility as reliable tools for assessing an athlete's readiness to return to sport. These findings align with previous research emphasizing the role of objective physical performance metrics in RTS decision-making.

**Table 2. Test Performance Metrics**

Test	AUC (ROC Curve)	Sensitivity (%)	Specificity (%)	p-value
Iso-Kinetic Strength	0.89	85	82	<0.001
Single-Leg Hop Test	0.91	88	84	<0.001
Sprint Analysis	0.78	75	70	0.002

**Predictive Validity:** Iso-kinetic strength testing (AUC = 0.89) and single-leg hop tests (AUC = 0.91) demonstrated high predictive validity for successful return to sport (RTS).

The significant difference in re-injury rates between athletes who passed and failed functional tests (12% vs. 38%) further supports the importance of incorporating these tests into RTS protocols. This suggests that functional tests not only predict successful RTS but also help mitigate the risk of re-injury.

##### Psychological Factors:

Fear of re-injury emerged as a significant barrier to timely RTS, with a strong negative correlation ( $r = -0.62$ ). This finding is consistent with existing literature that identifies psychological readiness as a critical component of RTS.

Conversely, confidence showed a strong positive correlation ( $r = 0.71$ ) with successful RTS outcomes, highlighting the need for interventions that build athlete confidence during rehabilitation.

**Table 3. Psychological Factors**

Psychological Factor	Correlation Coefficient (r)	p-value
Fear of Re-injury	-0.62	<0.001
Confidence	0.71	<0.001

Fear of Re-injury: Significantly correlated with delayed RTS ( $r = -0.62, p < 0.001$ ).

Confidence: Positively correlated with successful RTS outcomes ( $r = 0.71, p < 0.001$ ).

#### **Qualitative Insights:**

The qualitative data revealed additional themes such as motivation and the role of support systems (e.g., coaches, family, and medical staff) in influencing RTS decisions. These findings suggest that RTS is not solely determined by physical readiness but is also shaped by the athlete's psychological state and external support.

#### **Implications for Practice:**

Clinicians and sports professionals should adopt a holistic approach to RTS, integrating both functional tests and psychological assessments.

Interventions aimed at reducing fear of re-injury and enhancing confidence, such as cognitive-behavioral therapy or graded exposure to sport-specific activities, should be considered.

The role of support systems should not be underestimated, and efforts should be made to involve coaches and family in the rehabilitation process.

#### **Future Research:**

Longitudinal studies are needed to explore the long-term impact of functional and psychological factors on RTS outcomes.

Further investigation into the effectiveness of interventions targeting psychological barriers (e.g., fear of re-injury) is warranted.

Comparative studies could evaluate the relative contribution of functional tests versus psychological factors in predicting RTS success.

## **5. CONCLUSION**

In conclusion, this study provides valuable insights into the multifactorial nature of RTS decision-making. By addressing both physical and psychological aspects, clinicians can better support athletes in achieving successful and sustainable returns to sport.

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#### **Conflict of Interest**

The authors declare no financial or non-financial conflicts of interest related to this study.

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