

RESEARCH ARTICLE

Psychological responses during anterior cruciate ligament rehabilitation: Associations with psychological readiness for return to sport

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Abstract

Background: Anterior cruciate ligament (ACL) injury involves physical and psychological challenges that may influence the rehabilitation process and athletes' perceptions of readiness to return to sport.

Objective: To explore the associations between mental health variables and psychological responses during ACL rehabilitation, and their relationship with psychological readiness for return to sport, including potential sex differences.

Methods: Eight federation-registered athletes with a previous ACL injury (three men and five women) participated in this exploratory retrospective case series. In a single assessment session, participants retrospectively reported psychological responses across six rehabilitation stages. Measures included trait anxiety, pain catastrophizing, mood states, psychological readiness for return to sport, and symptoms of depression, anxiety, and stress.

Results: Higher levels of trait anxiety and catastrophizing were associated with more negative mood states (e.g., trait anxiety correlated with depression, $p = 0.755$, $p < 0.05$) and lower psychological readiness for return to sport (anxiety and readiness: $p = -0.761$, $p < 0.05$). Descriptive differences were observed between men and women; however, findings should be interpreted cautiously, given the small sample size and retrospective design.

Conclusion: Psychological variables may represent relevant considerations during ACL rehabilitation. The exploratory nature of the study and its retrospective design warrant cautious interpretation and highlight the need for prospective research with larger samples.

Keywords: Anterior cruciate ligament; Return to sport; Mental health; Rehabilitation

1. Introduction

Injuries are an unavoidable aspect of professional sport, with repercussions that extend far beyond physical impairment. They affect performance continuity, athletic identity, team dynamics, and psychosocial functioning, while also generating substantial healthcare and economic costs.¹ Among severe sport injuries, anterior cruciate ligament (ACL) rupture is particularly relevant due to its high incidence, prolonged rehabilitation, and significant reinjury rates.² Women appear to have a two- to three-fold higher risk of ACL injury and reinjury compared with men,³ although the mechanisms underlying these differences are multifactorial and may include biomechanical, hormonal, and psychological components.

Beyond physical damage, ACL injury represents a major psychological stressor. Contemporary sport injury research increasingly recognizes that rehabilitation is not solely a biomechanical process but a complex biopsychosocial experience.³ The integrated model of response to sport injury proposed by Wiese-Bjornstal *et al.*⁴ provides one of the most influential theoretical frameworks in this domain. According to this model, personal factors (e.g., personality traits, psychological history, coping style) and situational variables (e.g., social support, competitive demands) shape cognitive appraisal processes following injury. Social support has been identified as a protective factor buffering post-injury depressive and anxiety symptoms.⁵ These appraisals influence emotional responses such as anxiety, frustration, or depression, which in turn affect behavioral outcomes, including adherence to rehabilitation and readiness to return to sport.

Within this framework, stable dispositional variables such as trait anxiety may predispose athletes to interpret injury-related uncertainty as threatening, thereby intensifying negative emotional responses. Similarly, catastrophizing, a cognitive-emotional tendency characterized by magnification, rumination, and helplessness, has been associated with heightened pain perception, emotional distress, and maladaptive coping strategies during rehabilitation.^{6,7} These constructs align with stress-appraisal models, suggesting that individuals with greater vulnerability traits may experience amplified psychological burden during recovery.

Recent evidence supports a bidirectional relationship between injury and mental health.⁸ Athletes sustaining severe musculoskeletal injuries demonstrate increased rates of depression, anxiety, and sleep disturbances.⁹ Conversely, pre-existing psychological vulnerability has been associated with poorer rehabilitation adherence and delayed return to sport.¹⁰ In this context, psychological readiness for return to sport has emerged as a central

construct. Psychological readiness encompasses confidence, perceived competence, emotional stability, and reduced fear of reinjury.^{11,12} From the perspective of the integrated model of response to sport injury, these emotional states constitute affective responses that mediate between cognitive appraisal of the injury and rehabilitation behavior. In this sense, Morgan's "iceberg profile" concept describes a mood pattern characterized by low levels of tension, depression, anger, fatigue, and confusion, together with high levels of vigor, and is considered an indicator of positive mental health in athletes.^{13,14} The progressive restoration of this profile during rehabilitation could be interpreted as a sign of adaptive emotional adjustment and greater psychological readiness to return to sport. Preoperative expectations regarding return to preinjury performance have also been associated with postoperative psychological adjustment and return outcomes.¹⁵ Fear of reinjury and lack of confidence remain among the most frequently reported barriers to return to sport,¹⁶ and high levels of kinesiophobia at discharge are linked to poorer performance and a 13-fold increase in reinjury risk.¹⁷ Although a high proportion of athletes return to sport following ACL reconstruction, a substantially smaller percentage regain their previous competitive level, highlighting the potential role of psychological factors in successful return.¹⁸

However, despite growing recognition of the psychological dimension of ACL rehabilitation, several conceptual and methodological gaps remain. First, many studies examine isolated psychological variables rather than analyzing how dispositional traits, mood states, and perceived readiness interact within an integrated framework. Second, although psychological readiness has been linked to return-to-sport outcomes, most investigations prioritize physical performance metrics, devoting comparatively limited attention to the internal cognitive-emotional processes articulated in theoretical models. Third, some studies have found sex differences in psychological responses following ACL injury. Depressive or anxious symptoms after surgery have been observed almost twice as frequently in women as in men,¹⁹ with a lower psychological readiness for return to sport,²⁰ and the decision to give up the sport after injury being more common in women.¹⁵ On the other hand, men's frustration and anxiety appear to stem primarily from physical limitations and slow recovery, although these individuals may benefit from greater self-efficacy associated with a positive mindset. In contrast, women tend to experience periodic changes in psychological distress due to the fluctuations in progress and the motivational benefits of social support,²¹ suggesting that both contextual and individual factors may moderate emotional adjustment.

Furthermore, while longitudinal prospective studies provide valuable insight into recovery trajectories, fewer investigations have explored how athletes retrospectively reconstruct their psychological experiences across rehabilitation stages. Memory-based reconstruction may not reflect objective change but can nevertheless reflect meaningful subjective integration of injury into the athlete's personal narrative and identity. Understanding these reconstructed perceptions may offer complementary insight into how psychological variables align with perceived readiness to return to sport.

Taken together, there is a need to examine the interrelations between stable psychological traits (e.g., trait anxiety), cognitive-emotional tendencies (e.g., catastrophizing), mood states across rehabilitation phases, and perceived readiness for return to sport within a coherent theoretical framework. Even in exploratory, small-scale designs, analyzing these associations may help clarify how individual psychological disposition interacts with perceived recovery experiences.

Therefore, the aim of this exploratory retrospective study was to examine the associations between mental health variables and psychological responses during ACL rehabilitation, and to explore their relationships with psychological readiness for return to sport, including potential sex differences and interrelations among these variables.

2. Materials and methods

2.1. Design

This study was considered an exploratory retrospective case series aimed at generating preliminary hypotheses rather than establishing confirmatory statistical inferences. Psychological states across six rehabilitation stages were retrospectively reconstructed in a single assessment session. This design allowed the examination of associations between psychological and mental health variables throughout the rehabilitation process following ACL injury, as well as their relationship with psychological readiness for return to sport. Given the small sample size, findings should be interpreted with caution.

2.2. Participants

Inclusion criteria were: (i) being a current or former federation-registered futsal player and (ii) having sustained an ACL injury. The final sample consisted of eight players (five women and three men), with a mean age of 26.13 years (range: 19–31 years). Female players competed in top-level divisions (first and second), and three had sustained a previous ACL injury before the injury considered in the present study. All male players, who competed at the

regional level (first and third division), had experienced their first ACL injury and were not actively competing at the time of assessment.

2.3. Instruments

Sociodemographic and injury-related data were collected, including age, sex, years of federation-registered futsal experience, and injuries sustained in the previous two years (type and severity). A semi-structured interview was conducted to explore participants' psychosocial background, injury circumstances, rehabilitation, and return-to-competition experiences.

Trait anxiety was assessed using the Trait subscale of the Spanish version of the State-Trait Anxiety Inventory (STAI-T),²² which consists of 20 items measuring a relatively stable anxious disposition. Higher scores indicate greater trait anxiety. Internal consistency was high (Cronbach's $\alpha = 0.89$).

Pain catastrophizing was measured using the 13-item Pain Catastrophizing Scale (PCS).²³ Participants reported their experiences during the first postoperative week. The scale comprises three dimensions, rumination ($\alpha = 0.74$), helplessness ($\alpha = 0.74$), and magnification ($\alpha = 0.62$), and assesses pain-related thoughts and emotions, with higher scores indicating greater catastrophizing. The overall internal consistency was adequate (Cronbach's $\alpha = 0.82$).

Emotional symptoms were evaluated with the 21-item Spanish version of the Depression, Anxiety, and Stress Scales (DASS-21).²⁴ The instrument includes three subscales (depression $\alpha = 0.80$; anxiety $\alpha = 0.73$; stress $\alpha = 0.81$), with higher scores reflecting greater symptom severity. Total internal consistency was excellent (Cronbach's $\alpha = 0.90$), and construct validity has been demonstrated in Spanish populations.

Mood states were assessed using the 29-item Spanish version of the Profile of Mood States (POMS).²⁵ It consists of five dimensions, tension ($\alpha = 0.83$), depression ($\alpha = 0.78$), anger ($\alpha = 0.85$), vigor ($\alpha = 0.83$), and fatigue ($\alpha = 0.82$), with higher scores indicating stronger expression of the corresponding mood state.

Finally, psychological readiness for return to sport was measured using the 10-item Psychological Readiness of Injured Athlete to Return to Sport (PRIA-RS) questionnaire.²⁶ This scale evaluates perceptions of confidence, personal state, insecurity, and fear of reinjury at the moment of medical clearance. Internal consistency was good (Cronbach's $\alpha = 0.81$).

All instruments demonstrated adequate reliability and validity indices in Spanish athletic populations, supporting the consistency and precision of the measurements.

2.4. Procedure

Participants were recruited through their physiotherapists under a collaboration agreement between the University of Murcia and the Football Federation of the Region of Murcia. Before participating, all subjects received detailed written and oral information about the study and provided electronic informed consent. Data were collected online via Google Meet and Google Forms to ensure accessibility, standardization, and confidentiality through unique alphanumeric codes.

A semi-structured interview was conducted to contextualize participants' injury and rehabilitation experiences; however, these data were not subjected to formal qualitative analysis and were used solely to provide background information.

All questionnaires were completed retrospectively on a single occasion, except the POMS, which was administered at six stages of rehabilitation: (i) injury, (ii) post-surgery, (iii) days 1–15, (iv) months 1–3, (v) months 3–6, and (vi) until medical clearance. A licensed psychologist supervised the entire data-collection process.

2.5. Ethical considerations

This study complied with the ethical principles of the Declaration of Helsinki and was approved by the Ethics Committee of the University of Murcia, Spain (No. CEI-4734-2023). All participants provided electronic informed consent. Data were anonymized, securely stored, and used exclusively for research purposes.

2.6. Data analysis

Given the small sample size, analyses were conducted for exploratory and descriptive purposes. Descriptive statistics and trend plots were used to summarize questionnaire scores.

Normality was assessed using the Shapiro–Wilk test. Due to the limited sample size and the data's distributional characteristics, nonparametric procedures were applied. Differences across POMS rehabilitation stages were examined using Friedman tests, followed by Durbin–Conover post hoc comparisons with Holm correction where appropriate. Effect sizes were calculated using Kendall's W and rank-biserial correlations (r_{sub}), interpreted cautiously following Cohen²⁷ and Kerby.²⁸

Coefficients of variation were computed to describe relative fluctuations in POMS scores across stages. Associations among variables were explored using Spearman's rho correlations, interpreted following Dancey and Reidy.²⁹ Given the exploratory nature of the study

and the small sample size, correlation coefficients should be interpreted as preliminary indicators of potential associations rather than stable estimates of population parameters.

Analyses were performed for the total sample and descriptively by sex using SPSS v28.0 (IBM, United States of America [USA]), JASP v0.19.0.0 (University of Amsterdam, The Netherlands), and Python v3.11 with Matplotlib (Python Software Foundation, USA).

3. Results

Given the exploratory design and the very small sample size, the following results are presented as descriptive patterns and should be interpreted with caution. Both groups had similar mean years of competitive experience, although the injury was more recent among female players. Males showed higher levels of trait anxiety, magnification, helplessness, and anxiety, while females reported higher stress and greater psychological readiness for return to play. No differences were observed in rumination or depression (DASS-21). Regarding mood states, the average scores for the six moments assessed in the POMS suggest that males tended to obtain higher scores across all factors except anger (Table 1).

The mood profile by sex did not reflect a clear iceberg profile in either subgroup according to Morgan's Mental Health Model.¹³ Elevated tension and anger, together with relatively low depression scores, were descriptively observed.

Table 2 presents the Friedman test results for each POMS factor across the rehabilitation stages. Exploratory analyses suggested differences in depression ($p < 0.001$; large effect size), vigor ($p < 0.01$; moderate effect size), and anger ($p < 0.01$; moderate effect size).

As illustrated in Figure 1, male participants displayed higher POMS scores for tension and depression at nearly all time points, except for M5 (3–6 months of rehabilitation), where female scores were similar or slightly higher. Similarly, males scored higher on the anger factor except at M5 and M6 (medical clearance). Conversely, female participants scored higher on vigor at M1 (injury onset) and on fatigue at M2 (after surgery).

Post hoc Durbin–Conover comparisons (Table 3) suggested that the depression factor showed significant reductions between M1 and M3–M6, and between M2 and M3/M6 ($p < 0.05$). For anger, significant differences were found between M1 and M3–M6 ($p < 0.05$). Regarding vigor, significant increases were observed from M1 to M5 and M6 ($p < 0.05$). No significant differences were detected in tension or fatigue. All significant contrasts showed large

Table 1. Participant characteristics and psychological instrument outcomes by group

Participant characteristics and psychological instruments	Males (<i>n</i> = 3)		Females (<i>n</i> = 5)	
	Mean	SD	Mean	SD
Age (years)	30.33	0.58	23.6	3.91
Playing in federation-registered competitions (years)	12	5.20	12.4	3.85
Years since ACL injury	7.64	3.18	1.60	0.89
STAI-T	20.67	4.73	18.4	7.77
Magnification (PCS)	6.67	5.03	5.2	2.68
Rumination (PCS)	10	4.58	10	2.92
Helplessness (PCS)	12.33	1.15	11.8	7.46
Depression (DASS-21)	8	6	8	8.49
Anxiety (DASS-21)	8.67	5.77	7.2	6.87
Stress (DASS-21)	14.67	9.45	16	7.75
Tension (POMS)	13.06	1.67	11.30	4.61
Depression (POMS)	6.83	3.50	4.67	5.12
Anger (POMS)	10.83	1.89	11.03	9.02
Vigor (POMS)	10.33	3.48	8.50	4.54
Fatigue (POMS)	7.67	1.17	6.77	4.83
PRIA-RS	36	4.58	40.2	6.18

Note: POMS values represent mean scores across the six retrospectively assessed rehabilitation stages.

Abbreviations: ACL: Anterior cruciate ligament; DASS-21: 21-item of the Depression, Anxiety, and Stress Scales; PCS: Pain Catastrophizing Scale; POMS: Profile of Mood States; PRIA-RS: Psychological Readiness of Injured Athlete to Return to Sport; STAI-T: State-Trait Anxiety Inventory.

effect sizes.

Figure 2 shows the mean POMS scores at all stages of rehabilitation. The most notable moments are M1, where anger predominates over the other factors, and M6, where a pattern resembling the “iceberg profile” appears to emerge, although this observation should be interpreted with caution, given the exploratory and retrospective nature of the study. Figure 3 reflects a pattern in which negative factors (tension, depression, anger, and fatigue) generally scored higher in the early stages, while the vigor factor was higher in the later stages.

The coefficient of variation for each POMS factor is

presented in Table 4. Depression and vigor exhibited the greatest fluctuations over time, whereas tension showed the least variability, indicating higher temporal stability. Overall, females displayed greater variability in mood states than males, except for depression and anger.

The results of Spearman’s rho correlations between the main psychological instruments are displayed in Table 5. Exploratory correlations indicated potential associations between the magnification and helplessness dimensions of the PCS and the DASS-21 subscales (strong to very strong). Conversely, the PRIA-RS correlated negatively with the anxiety subscale ($\rho = -0.761$, $p < 0.05$), indicating that

Table 2. Profile of Mood States scores and Friedman test results

POMS factors	Males (<i>n</i> = 3)	Females (<i>n</i> = 5)	Total sample (<i>n</i> = 8)	Mean rank	Chi-square	<i>p</i> -value	Kendall's W
	Mean (SD)	Mean (SD)	Mean (SD)				
Tension							
M1	16.33 (2.52)	14.20 (5.76)	15.00 (4.69)	5.25	10.696	0.058†	0.27
M2	13.67 (3.06)	11.60 (7.13)	12.38 (5.73)	3.88			
M3	14.33 (2.08)	10.60 (5.59)	12.00 (4.78)	3.31			
M4	12.33 (5.77)	9.40 (5.03)	10.50 (5.13)	2.81			
M5	10.00 (2.00)	10.60 (3.78)	10.38 (3.07)	2.69			
M6	11.67 (2.89)	11.40 (6.35)	11.50 (5.04)	3.06			
Depression							
M1	13.67 (2.52)	7.80 (5.81)	10.00 (5.50)	5.38	22.802	0.000***	0.57
M2	8.67 (6.66)	5.80 (6.14)	6.88 (6.03)	4.75			
M3	5.67 (4.16)	3.60 (5.94)	4.38 (5.13)	2.81			
M4	7.33 (2.52)	3.80 (5.72)	5.13 (4.88)	3.44			
M5	3.00 (4.36)	5.00 (6.20)	4.25 (5.34)	2.94			
M6	2.67 (4.62)	2.00 (3.46)	2.25 (3.62)	1.69			
Anger							
M1	23.00 (2.00)	17.40 (8.47)	19.50 (7.11)	5.63	19.563	0.002**	0.49
M2	12.00 (5.29)	11.00 (11.25)	11.38 (8.98)	4.19			
M3	8.67 (4.04)	8.60 (9.79)	8.63 (7.71)	2.31			
M4	9.67 (2.08)	9.40 (11.57)	9.50 (8.82)	3.25			
M5	6.33 (3.21)	11.80 (10.43)	9.75 (8.55)	3.38			
M6	5.33 (1.53)	8.00 (5.39)	7.00 (4.38)	2.25			
Vigor							
M1	2.67 (2.08)	3.40 (5.41)	3.13 (4.26)	1.50	18.833	0.002**	0.47
M2	10.67 (4.93)	7.60 (8.44)	8.75 (7.09)	3.50			
M3	10.67 (6.81)	8.40 (6.99)	9.25 (6.52)	3.19			
M4	10.00 (2.65)	9.80 (6.14)	9.88 (4.85)	3.38			
M5	12.67 (4.04)	9.00 (3.00)	10.38 (3.66)	4.06			
M6	15.33 (1.53)	12.80 (2.95)	13.75 (2.71)	5.38			
Fatigue							
M1	9.67 (4.04)	6.00 (5.20)	7.38 (4.87)	3.75	9.318	0.097†	0.23
M2	8.00 (2.00)	10.80 (6.06)	9.75 (4.92)	4.88			
M3	9.67 (0.58)	6.60 (6.19)	7.75 (4.95)	4.00			
M4	7.00 (2.00)	6.60 (6.27)	6.75 (4.86)	3.00			
M5	6.00 (4.58)	5.40 (5.13)	5.63 (4.60)	2.50			
M6	5.67 (6.03)	5.20 (4.27)	5.38 (4.57)	2.88			

Note: M1: time of sports injury; M2: after surgery; M3: 15 days of rehabilitation; M4: 1–3 months of rehabilitation; M5: 3–6 months of rehabilitation; M6: 6 months of rehabilitation–medical clearance. † denotes $p < 0.10$; * denotes $p < 0.05$; ** denotes $p < 0.01$, and *** denotes $p < 0.001$.

Abbreviation: POMS: Profile of Mood States.

Table 3. Durbin–Conover post hoc comparisons of Profile of Mood States scores across evaluation time points

Pair	Tension			Depression			Anger			Vigor			Fatigue		
	<i>t</i> -stat	<i>p</i> -value	<i>r</i> _{rb}	<i>t</i> -stat	<i>p</i> -value	<i>r</i> _{rb}	<i>t</i> -stat	<i>p</i> -value	<i>r</i> _{rb}	<i>t</i> -stat	<i>p</i> -value	<i>r</i> _{rb}	<i>t</i> -stat	<i>p</i> -value	<i>r</i> _{rb}
M2–M1	1.627	1.000	0.500	0.995	1.000	0.762	2.075	0.409	0.861	2.800	0.099	–1.000	1.323	1.000	–0.524
M3–M1	2.292	0.336	0.889	4.079	0.003*	1.000	4.782	< 0.001*	1.000	2.362	0.191	–0.929	0.294	1.000	–0.190
M4–M1	2.884	0.093	0.786	3.084	0.044*	1.000	3.428	0.020*	0.944	2.625	0.128	–1.000	0.882	1.000	0.028
M5–M1	3.032	0.068	1.000	3.880	0.005*	0.889	3.248	0.031*	0.944	3.587	0.014*	–0.889	1.470	1.000	0.361
M6–M1	2.588	0.181	1.000	5.870	< 0.001*	1.000	4.872	< 0.001*	1.000	5.425	< 0.001*	–1.000	1.029	1.000	0.286
M3–M2	0.666	1.000	0.107	3.084	0.044*	1.000	2.707	0.104	1.000	0.437	1.000	–0.056	1.029	1.000	0.417
M4–M2	1.257	1.000	0.500	2.089	0.308	0.607	1.353	0.947	0.536	0.175	1.000	–0.107	2.205	0.444	0.750
M5–M2	1.405	1.000	0.389	2.885	0.060	0.694	1.173	0.947	0.381	0.787	1.000	–0.357	2.793	0.126	0.750
M6–M2	0.961	1.000	0.278	4.875	< 0.001*	1.000	2.797	0.092	0.679	2.625	0.128	–0.750	2.352	0.342	0.714
M4–M3	0.592	1.000	0.333	0.995	1.000	–0.286	1.353	0.947	–0.381	0.262	1.000	–0.286	1.176	1.000	0.444
M5–M3	0.740	1.000	0.500	0.199	1.000	0.028	1.534	0.939	–0.467	1.225	1.000	–0.278	1.764	1.000	0.536
M6–M3	0.296	1.000	0.143	1.791	0.410	0.571	0.090	1.000	0.286	3.062	0.055	–0.806	1.323	1.000	0.571
M5–M4	0.148	1.000	0.028	0.796	1.000	0.381	0.180	1.000	0.143	0.962	1.000	–0.167	0.588	1.000	0.476
M6–M4	0.296	1.000	0.000	2.786	0.069	0.889	1.444	0.947	0.444	2.800	0.099	–0.889	0.147	1.000	0.429
M6–M5	0.444	1.000	–0.417	1.990	0.327	1.000	1.624	0.907	0.857	1.837	0.523	–1.000	0.441	1.000	0.143

Note. * $p < 0.05$; M1: time of sports injury; M2: after surgery; M3: 15 days of rehabilitation; M4: 1–3 months of rehabilitation; M5: 3–6 months of rehabilitation; M6: 6 months of rehabilitation–medical clearance.

Table 4. Coefficient of variation for the average Profile of Mood States (POMS) scores

POMS factor	Sex	<i>n</i>	Mean	SD
Tension	Males	3	0.24	0.11
	Females	5	0.32	0.16
	Total	8	0.29	0.14
Depression	Males	3	0.86	0.52
	Females	5	0.80	0.37
	Total	8	0.82	0.40
Anger	Males	3	0.63	0.12
	Females	5	0.49	0.27
	Total	8	0.55	0.22
Vigor	Males	3	0.49	0.21
	Females	5	0.66	0.35
	Total	8	0.60	0.30
Fatigue	Males	3	0.45	0.34
	Females	5	0.60	0.35
	Total	8	0.54	0.33

Table 5. Correlations between psychological questionnaires

	1	2	3	4	5	6	7	8
1. STAI-T	1	0.144	−0.108	0.542	0.537	0.417	0.506	−0.048
2. Magnification (PCS)	–	1	0.392	0.697†	0.736*	0.902**	0.709*	−0.683†
3. Rumination (PCS)	–	–	1	−0.055	−0.012	0.105	0.103	0.084
4. Helplessness (PCS)	–	–	–	1	0.914**	0.758*	0.860**	−0.398
5. Depression (DASS-21)	–	–	–	–	1	0.855**	0.963***	−0.537
6. Anxiety (DASS-21)	–	–	–	–	–	1	0.770*	−0.761*
7. Stress (DASS-21)	–	–	–	–	–	–	1	−0.386
8. PRIA-RS	–	–	–	–	–	–	–	1

Note: † denotes $p < 0.10$; * denotes $p < 0.05$; ** denotes $p < 0.01$, and ***denotes $p < 0.001$.

Abbreviations: DASS-21: 21-item of the Depression, Anxiety, and Stress Scales; PCS: Pain Catastrophizing Scale; PRIA-RS: Postoperative Recovery Inventory–Revised Short version; STAI-T: State–Trait Anxiety Inventory.

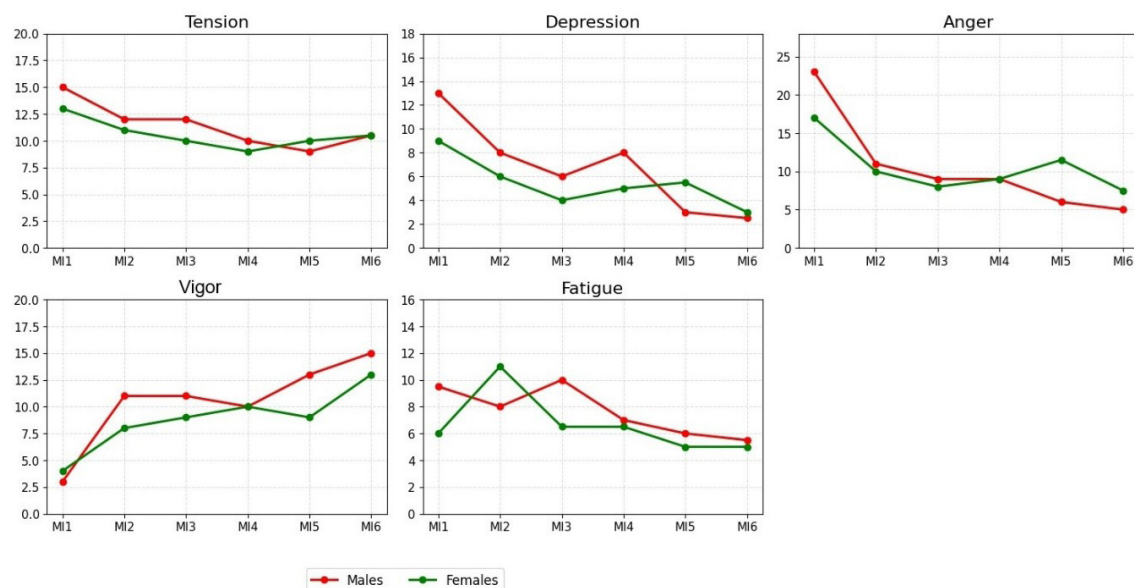


Figure 1. POMS scores according to sex across the six evaluation moments: M1, time of sports injury; M2, after surgery; M3, 15 days of rehabilitation; M4, 1–3 months of rehabilitation; M5, 3–6 months of rehabilitation; and M6, 6 months of rehabilitation–medical clearance

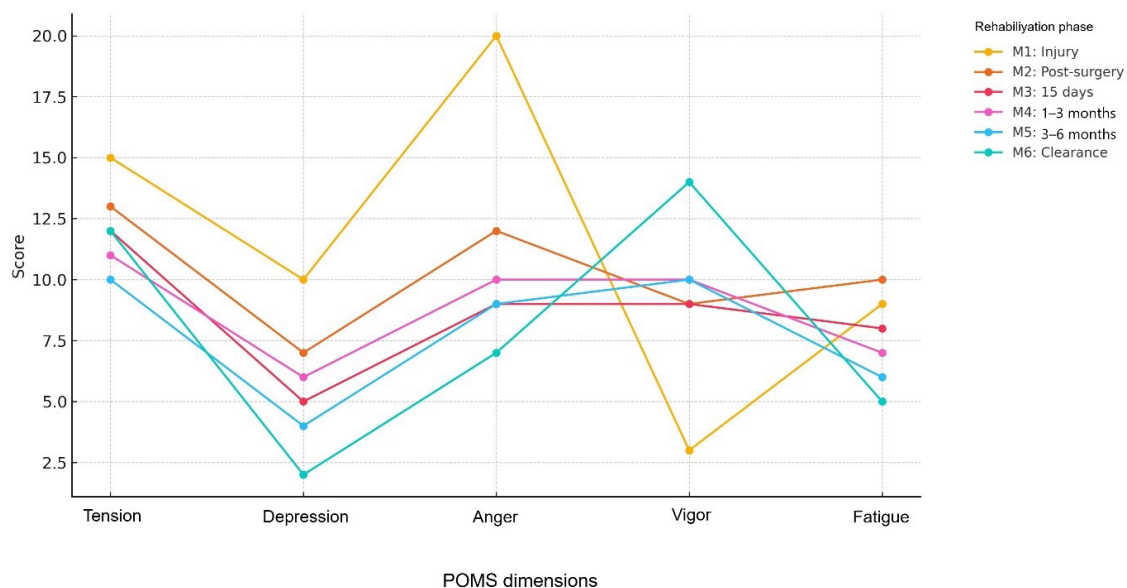


Figure 2. Visual representation of POMS mood dimensions across rehabilitation phases
Abbreviation: POMS: Profile of Mood States.

lower anxiety was associated with greater psychological readiness for return to play.

Finally, Table 6 summarizes the correlations between mood states (POMS) and the remaining psychological variables. Exploratory analyses suggested potential relationships between the STAI-T and depression ($\rho = 0.755, p < 0.05$) and anger ($\rho = 0.738, p < 0.05$) dimensions.

Vigor showed very strong negative correlations with helplessness ($\rho = -0.868, p < 0.01$) and depression (DASS-21; $\rho = -0.854, p < 0.01$). Anxiety (DASS-21) was strongly and positively correlated with depression (POMS; $\rho = 0.716, p < 0.05$), while stress correlated negatively with vigor ($\rho = -0.807, p < 0.05$). No significant correlations were found between psychological readiness (PRIA-RS) and any POMS factor.

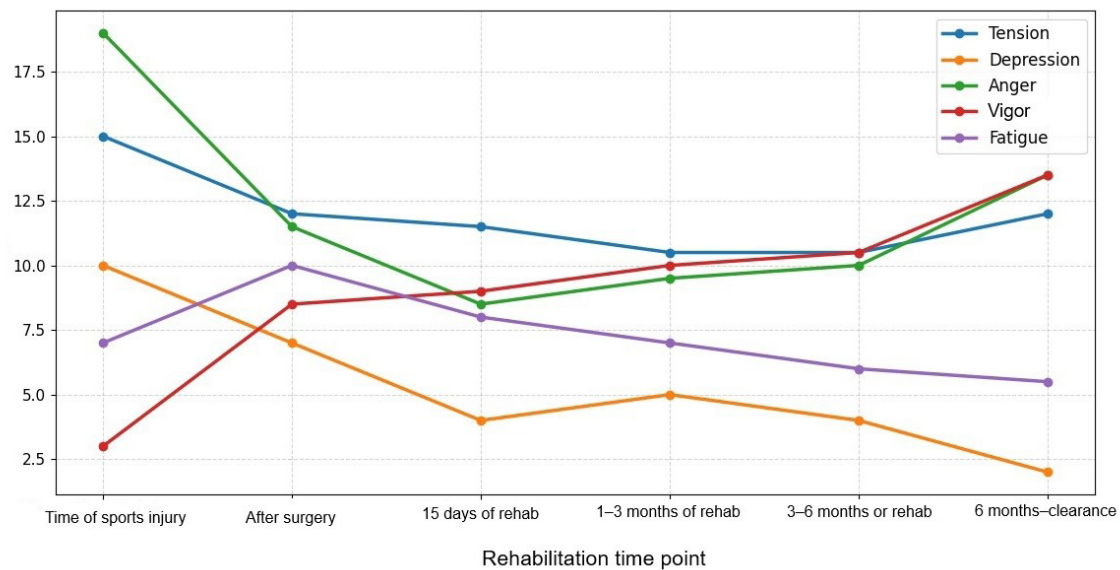


Figure 3. Visual representation of mood state changes (POMS dimensions) across rehabilitation phases
Abbreviation: POMS: Profile of Mood States.

Table 6. Correlations between mood states (POMS) and other psychological questionnaires

Other psychological questionnaires	Tension (POMS)	Depression (POMS)	Anger (POMS)	Vigor (POMS)	Fatigue (POMS)
STAI-T	0.611	0.755*	0.738*	-0.452	0.667†
Magnification (PCS)	0.518	0.627†	0.359	-0.407	0.371
Rumination (PCS)	0.241	0.205	-0.036	0.407	-0.048
Helplessness (PCS)	0.515	0.685†	0.410	-0.868**	0.542
Depression (DASS-21)	0.540	0.663†	0.512	-0.854**	0.366
Anxiety (DASS-21)	0.531	0.716*	0.577	-0.577	0.454
Stress (DASS-21)	0.552	0.600	0.422	-0.807*	0.265
PRIA-RS	-0.467	-0.515	-0.595	0.262	-0.381

Note: † denotes $p < 0.10$; *denotes $p < 0.05$; ** denotes $p < 0.01$, ***denotes $p < 0.001$.

Abbreviations: DASS-21: 21-item of the Depression, Anxiety, and Stress Scales; PCS: Pain Catastrophizing Scale; POMS: Profile of Mood States; PRIA-RS: Postoperative Recovery Inventory-Revised Short version; STAI-T: State-Trait Anxiety Inventory.

Overall, these findings should be interpreted as exploratory and hypothesis-generating, and not as evidence of stable or causal relationships.

4. Discussion

The aim of this exploratory retrospective study was to examine the associations between mental health variables and psychological responses during ACL rehabilitation in male and female futsal players, and to explore their relationship with psychological readiness for return to sport.

In the present sample, higher levels of trait anxiety appeared to be associated with more negative emotional states, including depression, anger, and fatigue during rehabilitation. The demanding and uncertain nature of ACL recovery may contribute to emotional distress in some athletes; however, causal inferences cannot be drawn given the retrospective design of the study. Previous research has linked trait anxiety and negative psychological responses with poorer rehabilitation adherence and delayed return to sport,¹⁰ underscoring the potential relevance of monitoring athletes' cognitive appraisals during recovery.

Similarly, higher levels of catastrophizing appeared to be associated with lower vigor and greater depressive, anxious, and stressful states. Baranoff *et al.*⁶ reported that catastrophizing in ACL-injured athletes was linked to increased pain and postoperative depression. Recurrent pain experiences may contribute to heightened psychological distress and movement avoidance behaviors, such as kinesiphobia, which have been described as barriers during rehabilitation and predictors of reinjury risk.^{7,17}

From a theoretical perspective, these findings may be interpreted within Wiese-Bjornstal's integrated model of response to sport injury,⁴ which proposes that personal and situational factors influence cognitive appraisals, emotional responses, and behavioral outcomes during rehabilitation. Athletes with higher trait anxiety or catastrophizing tendencies may be more likely to appraise injury-related challenges as threatening, potentially intensifying emotional distress and influencing perceived readiness to return to sport. Although appraisal mechanisms were not directly measured in the present study, the observed associations are consistent with this theoretical pathway.

Exploratory analyses suggested differences across retrospectively reported rehabilitation stages for depression, anger, and vigor, but not for tension or fatigue. These findings should be understood as subjective reconstructions rather than objective longitudinal measurements. Descriptive patterns suggested a decrease

in negative mood states and an increase in vigor across rehabilitation stages. Similar fluctuations in mood and cognitive evaluation have been described in previous studies examining psychological adjustment during ACL rehabilitation.^{30,31} However, given the small sample size and retrospective data collection, these temporal patterns must be interpreted with caution.

It is important to distinguish psychological readiness for return to sport from actual return-to-play outcomes. Psychological readiness reflects perceived confidence, emotional stability, and fear of reinjury,¹² whereas actual return to sport depends on multiple physical, contextual, and performance-related factors.³² Therefore, the present findings should not be interpreted as indicators of successful or unsuccessful return to sport, but rather as preliminary evidence suggesting that psychological disposition may be associated with perceived readiness during rehabilitation. Previous research has shown that higher psychological readiness is related to improved functional outcomes and lower reinjury risk,^{12,33} supporting the relevance of examining psychological dimensions within rehabilitation contexts.

Regarding sex differences, male participants in the present sample reported higher scores in trait anxiety, catastrophizing, and several mood dimensions, whereas female participants reported higher stress and psychological readiness for return to sport. As noted above, previous literature has shown sex differences following ACL injury. Some studies have reported that women experience almost twice as many depressive or anxious symptoms after surgery as men,¹⁹ as well as lower psychological readiness.²⁰ On the other hand, during rehabilitation, discomfort in men is mainly associated with physical limitations, although they tend to show greater self-efficacy.²¹ In contrast, in women, discomfort fluctuates more depending on progress in rehabilitation and social support. These findings suggest that contextual and individual factors, such as injury history, competitive level, and perceived performance expectations, may influence emotional responses to rehabilitation.

When examining retrospectively reported mood patterns across rehabilitation stages, descriptive differences between men and women were observed. However, given the very small and unequal sample sizes, these patterns cannot be generalized. Possible explanations remain speculative and warrant examination in future prospective studies with larger and balanced samples.

From a practical perspective, these findings suggest that incorporating brief psychological screening during ACL rehabilitation may help identify athletes who experience greater emotional vulnerability. Early identification of

elevated anxiety or catastrophizing tendencies could support more individualized rehabilitation planning. In this context, interdisciplinary collaboration between physiotherapists, strength and conditioning professionals, and sport psychologists may contribute to a more holistic rehabilitation approach, as suggested in previous psychosocial intervention research.³⁴ Structured psychosocial interventions have demonstrated benefits in rehabilitation adherence and emotional adjustment.³⁵ However, such recommendations should be considered cautiously and confirmed in larger prospective studies.

While the retrospective design represents a methodological limitation, it also offers insight into how athletes reconstruct and interpret their injury experiences over time. Memory-based reconstructions may reflect the way individuals integrate injury into their athletic identity and recovery narrative. Narrative reconstruction of injury experiences has been described as part of athletes' identity reorganization during recovery.^{30,34} Future prospective designs incorporating repeated real-time assessments would allow comparison between immediate psychological responses and retrospective accounts, thereby improving understanding of emotional adjustment throughout rehabilitation.

4.1. Limitations and future directions

This study presents several important limitations that must be considered when interpreting the findings. First, the small and unequal sample size ($n = 8$; three males and five females) substantially limits statistical power and generalizability. In particular, sex-based comparisons should be interpreted cautiously, given the very small number of male participants.

A major limitation of this study is the retrospective reconstruction of psychological states across rehabilitation stages. Participants were required to recall emotional experiences that, in some cases, occurred several years prior (particularly among male participants, with a mean of 7.64 years since injury). This may have introduced recall bias and memory reconstruction effects, potentially limiting the accuracy of stage-specific psychological estimates. Therefore, the reported temporal patterns should be interpreted as subjective retrospective perceptions rather than objective longitudinal measurements.

In addition, although stage-based analyses were conducted, the data were collected in a single session rather than through prospective repeated measures. Consequently, the design does not allow causal inference or precise examination of psychological trajectories over time. The use of multiple statistical analyses in a very small sample further requires cautious interpretation, as

estimates may be unstable.

Future research should adopt prospective longitudinal designs with larger and more balanced samples to examine real-time psychological responses throughout rehabilitation. Such studies should include objective return-to-play outcomes alongside psychological readiness measures, allowing clearer differentiation between perceived and actual recovery. It would also be valuable to control for pre-existing psychological conditions and explore potential moderating variables such as level of competition, injury mechanism (contact versus non-contact), injury history (first versus recurrent ACL injury), social support, personality traits, and coping strategies. Integrating qualitative approaches may also provide richer insight into athletes' lived experiences during rehabilitation.

Therefore, the statistical results should be interpreted cautiously and primarily as hypothesis-generating findings, which should be confirmed in future studies with larger, prospectively collected samples.

5. Conclusion

This exploratory retrospective study highlights the potential relevance of psychological variables during ACL rehabilitation. Retrospectively reported mood patterns suggested that higher levels of anxiety and catastrophizing were associated with more negative emotional states and lower psychological readiness for return to sport. Although descriptive differences were observed between men and women, these findings should be interpreted with caution due to the small sample size and retrospective design. Overall, the results suggest that psychological factors may represent important considerations during rehabilitation and warrant further prospective research with larger samples.

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Conflict of interest

The authors declare no conflicts of interest.

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Ethics approval and consent to participate

The study was approved by the Ethics Committee of the University of Murcia (Spain), reference CEI-4734-2023. All subjects received detailed written and oral information about the study and provided electronic informed consent.

Consent for publication

All participants provided informed consent for the use and publication of their anonymised data in accordance with ethical guidelines.

Availability of data

The data presented in this study are available from the corresponding author upon reasonable request, subject to ethical and privacy restrictions.

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