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The Relationship Between Active Coping Skills and Self-Reported Knee Function in Individuals With Anterior Cruciate Ligament Reconstruction

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Context: Individuals with anterior cruciate ligament (ACL) injury commonly experience injury-related stressors that can adversely impact subjective knee function after ACL reconstruction (ACLR). Due to the positive effect of active coping skills on perceived stressors, use of such strategies may influence clinical outcomes in individuals with ACLR, such as self-reported knee function. However, it is unknown whether active coping skills are associated with self-reported knee function in this population.

Objective: Examine the relationship between active coping skills and self-reported knee function in individuals with ACLR.

Design: Cross-sectional study.

Setting: Laboratory.

Patients or Other Participants: Forty-five participants (34 females; age = 20.0 [3.3] years) 4 months to 5 years after unilateral ACLR (time since ACLR = 12.0 [16.0] months).

Main Outcome Measure(s): The Athlete Coping Skills Inventory (ACSI) Confidence and Achievement Motivation (ACSI Confid), Goal Setting/Mental Preparation (ACSI Goal/Prep), and Coping with Adversity (ACSI Coping) subscales were used to measure active coping skill facets. The Knee Injury and Osteoarthritis Outcome Score (KOOS) was used to measure self-reported knee function across 5 subscales: pain (KOOS-Pain), symptoms (KOOS-Symptoms), activities of daily living (KOOS-ADL), quality of life (KOOS-QOL), and sports/recreation (KOOS-Sport). Partial Spearman's correlations were used to examine relationships between active coping skills and self-reported knee function after controlling for time since ACLR and age.

Results: Moderate positive correlations were observed between the ACSI Confid and KOOS-Pain ($r = 0.493$, $P = .001$), ACSI Confid and KOOS-QOL ($r = 0.505$, $P < .001$), ACSI Confid and KOOS-Sport ($r = 0.422$, $P = .007$), and ACSI Goal/Prep and KOOS-Pain ($r = 0.441$, $P = .004$). Weak positive correlations were observed between the ACSI Goal/Prep and KOOS-ADL ($r = 0.373$, $P = .018$) and ACSI Goal/Prep and KOOS-QOL ($r = 0.374$, $P = .017$).

Conclusions: Individuals with ACLR who exhibited greater active coping skill facets reported better knee-related function. Assessing active coping skills among individuals with ACLR and poor self-reported knee function may provide clinicians with insight into the role of coping in perceived function and potential treatment approaches.

Key Words: psychological responses, knee injury, coping strategies

Key Points

- Greater active coping skills are associated with better self-reported knee function among individuals with a history of anterior cruciate ligament reconstruction (ACLR).
- Clinicians should assess active coping skills and self-reported knee function among individuals with ACLR.

Individuals who participate in sport have an increased risk of sustaining a musculoskeletal injury, with knee injuries being among the most common.[1] The anterior cruciate ligament (ACL), the primary stabilizing ligament of the knee, is a commonly injured ligament in sports that requires cutting, pivoting, and jumping.[2] Injury to the ACL frequently requires surgical reconstruction to restore knee stability and function, followed by substantial postoperative rehabilitation.[2] Many individuals typically return to sport (RTS) within 9 to 12 months following ACL reconstruction (ACLR); yet as many as 67% of individuals do not return to their preinjury level of sport after ACLR.[3] Although there are a number of nonmodifiable factors that may influence RTS after ACLR (eg, age and sex), modifiable factors, such as psychological responses to injury, may also predict an athlete's ability to recover from ACLR and successfully RTS.[4]

After ACL injury and ACLR, patients frequently exhibit behavioral and affective responses to the injury and rehabilitation process that are dictated by their cognitive appraisal or interpretation of the injury and whether they feel they have

the necessary resources to overcome the demands of the situation.[5,6] Behavioral responses are commonly related to rehabilitation adherence, effort and intensity, risk-taking, malingering, or the use/disuse of social support, whereas affective responses are connected to the individual's moods or emotional responses.[6] Common affective responses may include fear, tension, anger, depression, frustration, boredom, positive attitude, or grief.[6] Together, an individual's cognitive appraisal, as well as their behavioral and emotional responses to the injury and rehabilitation process, affect recovery outcomes.[6] However, recovery outcomes may also be influenced by psychological variables such as coping. Coping is the process of managing stressful situations in an attempt to overcome, lessen, or reduce stress caused by difficult circumstances.[7,8] Two primary forms of coping that may be used in stressful circumstances include active coping, which is characterized by problem-focused coping strategies, and passive coping, which includes emotion-focused coping strategies.[9,10]

Active coping and problem-focused coping strategies consist of cognitive and behavioral efforts used to manage demands that are appraised as taxing or exceeding one's resources.[9] These strategies commonly include defining the problem, generating alternative solutions, determining the costs and benefits of such solutions, and taking action to solve the problem.[10] Active coping strategies allow individuals to effectively manage cognitive, behavioral, and affective stressors associated with sport-related injury and recovery and may be critical for individuals managing setbacks throughout recovery and during RTS.[9,11] By contrast, passive coping and emotion-focused coping strategies involve behavioral responses to regulate the affective consequences of stressful events.[10] Such strategies may include avoidance, minimization, and distancing oneself from the problem.[10] Although individuals may be more likely to use certain coping strategies due to dispositional characteristics such as personality, coping is commonly viewed as a dynamic and fluctuating process dependent on the appraisal of events between an individual and their environment.[10,12,13] As a result, the coping strategies an individual uses in response to specific stressful experiences are flexible and may be influenced by contextual factors.[10,14,15] Evaluating coping skills among athletes with stressors such as injury may help to identify modifiable factors that can be addressed to improve outcomes in this population over time.

Previous research has identified that individuals with ACL injury may use a variety of active and passive coping strategies and skills to try to reduce stress related to their injury and recovery.[9,11,16] Furthermore, it has been found that patients with sport-related knee injuries seek to play an active role in their recovery and specifically exhibit a need for problem-focused or active coping strategies.[9] Active coping strategies commonly used among patients recovering from injury include goal setting, education, and seeking help from appropriate health care providers.[9,11] For individuals with ACLR, use of these strategies may be beneficial for solving problems that could arise during the rehabilitation and RTS periods as well as after. This may include loss of athletic identity, onset of physical impairments, regression in recovery, reinjury, or the development of consequent diseases, such as early-onset posttraumatic osteoarthritis.[9,11,16–18] Additionally, use of active coping strategies across multiple athletic populations has been shown to assist in improving injury acceptance,[18] knee confidence,[19] motivation,[17,20] resiliency,[20] adherence to rehabilitation,[21] and transition to life outside of sport.[22] Therefore, use of active coping strategies after ACLR may improve the recovery process and positively influence pertinent clinical outcomes, such as self-reported knee function.

In addition to psychological responses after ACLR, perceived knee function has been identified as a significant factor in determining readiness to RTS.[23] Furthermore, although many individuals demonstrate adequate physical function to RTS after ACLR, some patient's subjective interpretation of their knee function may not coincide with results of objective assessments.[24] Examples of subjective knee function include perceptions of knee-related pain, stiffness, swelling, joint-locking, and joint instability.[16] Perceived knee function often regulates the rehabilitation and RTS process for athletes after ACLR and is also associated with significant psychological factors examined after ACLR, such as fear of movement or reinjury, task-specific knee confidence, pain, and psychological readiness to RTS.[23] Due to the influence of active coping skills on cognitive, behavioral, and affective stressors, use of such strategies may therefore influence self-reported knee function among individuals with ACLR. However, the relationship between active coping skills and self-reported knee function has yet to be examined in individuals with ACLR. Examination of these factors may support the integration of active coping skills throughout the ACLR rehabilitation process to improve self-reported knee function and RTS after ACLR. Therefore, the purpose of our study was to examine the relationship between active coping skills and self-reported knee function in individuals with ACLR. We hypothesized that individuals with ACLR who exhibit increased levels of active coping skills would demonstrate better self-reported knee function.

METHODS

Study Design

This cross-sectional study involved secondary analysis from an ongoing study examining clinical and psychological outcomes after ACLR. Our variables of interest included sport-related psychological coping skills measured by the Athletic Coping Skills Inventory-28 (ACSI-28) and self-reported knee function measured by the Knee Injury and Osteoarthritis Outcome Score (KOOS). Our study was approved by the Michigan State University Institutional Review Board, and we obtained informed consent ($\geq$18 years) or informed assent ($<$18 years) before participant study enrollment.

Participants

We recruited a total of 45 participants (34 females and 11 males) with a history of unilateral ACLR from the local university and sports medicine center. Our participants met the following inclusion criteria: (1) aged 14 to 35 years and (2) between 4 months and 5 years postunilateral ACLR. This age range and postsurgical timeframe were selected to allow for a robust sample of individuals that are likely to undergo ACLR and may be engaged in a variety of functional and sport-related activities postsurgery. We excluded individuals from our study if they had a history of bilateral ACLR, if they had a history of secondary ACL injury to

Table 1. Participant Demographics

	Frequency (%) Median [IQR]
Sex	
Females	34 (75.6%)
Males	11 (24.4%)
Age, years	20.0 [3.3]
Height, cm	167.6 [12.7]
Mass, kg	65.8 [13.6]
Time since ACLR, months	12.0 [16.0]

Abbreviations: ACLR, anterior cruciate ligament reconstruction; IQR, interquartile range.

the ipsilateral limb, if they were currently injured, or if they had injured their lower extremity within the last 3 months.

Procedures

Our participants reported to the laboratory for 1 testing session. Participants completed a demographics questionnaire that collected health information, including, age, sex, engagement in physical activity, and lower extremity health history. Participants then completed the ACSI-28 and KOOS measures using Qualtrics (Qualtrics, LLC) survey software.

Instrumentation

Coping Skills Measures. The ACSI-28 is a 28-item questionnaire used to measure an individual's psychological coping skills within a sport context.[25] The questionnaire includes the following 7 subscales, which assess underlying coping skill facets: Coping with Adversity (Coping), Goal Setting/Mental Preparation (Goal/Prep), Confidence and Achievement Motivation (Confid), Peaking Under Pressure (Peaking), Coachability, Concentration, and Freedom from Worry (Worry).[25] Each item is scored on a 4-point Likert scale from 0 (*almost never*) to 3 (*almost always*). Subscale scores range from 0 to 12, with higher scores indicating greater coping in that area. Although the ACSI-28 is considered a multifaceted coping skills construct, our study explored the coping-related subscales Coping, Goal/Prep, and Confid.[25] These subscales were selected in an attempt to identify variables representative of active coping skills that may influence clinical outcomes for individuals with a history of musculoskeletal injury, such as motivation (Confid), resiliency (Coping), and adherence to rehabilitation (Goal/Prep).[25]

Knee Function Measures. The KOOS is a region-specific instrument used to evaluate self-reported knee function using a 42-item questionnaire across 5 separate subscales, including pain (KOOS-Pain), symptoms (KOOS-Symptoms), activities of daily living (KOOS-ADL), sports and recreation (KOOS-Sport), and quality of life (KOOS-QOL).[26] Each item is scored on a 5-point Likert scale from 0 (*no problems*) to 4 (*extreme problems*). Subscale scores are transformed to a 0 to 100 scale, with higher scores indicating better knee-related function. The KOOS subscales have good construct and predictive validity and clinically acceptable test-retest reliability and are responsive to changes in health status.[26]

Table 2. Descriptive Statistics of Explanatory and Response Variables

Variable	Median (IQR)
Explanatory Variables	
ACSI Confid	9.0 (3.0)
ACSI Goal/Prep	7.0 (5.0)
ACSI Coping	8.0 (4.0)
Response Variables	
KOOS-Pain	88.9 (16.7)
KOOS-Symptoms	82.1 (25.0)
KOOS-ADL	98.5 (2.9)
KOOS-QOL	68.8 (18.8)
KOOS-Sport	85.0 (25.0)

Abbreviations: ACSI, Athlete Coping Skills Inventory; ADL, activities of daily living; Confid, Confidence and Achievement Motivation; Coping, Coping with Adversity; Goal/Prep, Goal Setting/Mental Preparation; IQR, interquartile range; KOOS, Knee Injury and Osteoarthritis Outcome Score; QOL, quality of life.

Statistical Analyses

We calculated descriptive statistics for participant demographics and KOOS, ACSI Confid, ACSI Coping, and ACSI Goal/Prep scores. Partial Spearman correlation coefficients were used to assess the relationship between active coping skills (ACSI Confid, ACSI Coping, and ACSI Goal/Prep) and self-reported knee function (KOOS-Pain, KOOS-Symptoms, KOOS-ADL, KOOS-Sport, and KOOS-QOL). Given the large distribution in age and surgical time points within our sample, age and time since ACLR were included as covariates in our analysis to limit their potential effect on the relationship between active coping skills and perceived knee function in this population. The correlation coefficients were interpreted as follows: 0.00 to 0.19 = *very weak*, 0.20 to 0.39 = *weak*, 0.40 to 0.59 = *moderate*, 0.60 to 0.79 = *strong*, and 0.80 to 1.0 = *very strong*.[27] The Benjamini-Hochberg procedure, a statistical method that controls the false discovery rate across multiple comparisons by ranking P values and applying a threshold to determine statistical significance, was applied to the partial Spearman's correlation analyses to control the study-wide false discovery rate at .05.[28] Our statistical analyses were completed using Stata (StataCorp, LLC) statistical software.

RESULTS

Participant demographics are presented in Table 1. The median and interquartile range values for the ACSI Confid, Goal/Prep, and Coping subscales and KOOS measures are presented in Table 2. The largest P value after the Benjamini-Hochberg procedure was 0.020 for statistical significance. There was a moderate positive correlation between the ACSI Confid and KOOS-Pain ($r = 0.493$, $P = .001$), ACSI Confid and KOOS-QOL ($r = 0.505$, $P < .001$), ACSI Confid and KOOS-Sport ($r = 0.422$, $P = .007$), and ACSI Goal/Prep and KOOS-Pain ($r = 0.441$, $P = .004$). There was a weak positive correlation between the ACSI Goal/Prep and KOOS-ADL ($r = 0.373$, $P = .018$) and ACSI Goal/Prep and KOOS-QOL ($r = 0.374$, $P = .017$). Remaining correlations between the ACSI subscales and KOOS were considered weak or very weak ($r = 0.078$–0.366) and not statistically significant. All correlations between the ACSI Confid,

Table 3. Partial Spearman's Correlations Between Active Coping Skills and Self-Reported Knee Function When Controlling for Age and Time Since ACL Reconstruction

	KOOS-Pain	KOOS-Symptoms	KOOS-ADL	KOOS-QOL	KOOS-Sport
ACSI Confid	0.493 ($P = .001$[a])	0.329 ($P = .038$)	0.262 ($P = .103$)	0.505 ($P < .001$[a])	0.422 ($P = .007$[a])
ACSI Goal/Prep	0.441 ($P = .004$[a])	0.331 ($P = .370$)	0.373 ($P = .018$[a])	0.374 ($P = .017$[a])	0.366 ($P = .200$)
ACSI Coping	0.146 ($P = .370$)	0.214 ($P = .185$)	0.078 ($P = .960$)	0.239 ($P = .137$)	0.116 ($P = .475$)

Abbreviations: ACSI, Athlete Coping Skills Inventory; ADL, activities of daily living; Confid, Confidence and Achievement Motivation; Coping, Coping with Adversity; Goal/Prep, Goal Setting/Mental Preparation; KOOS, Knee Injury and Osteoarthritis Outcome Score; QOL, quality of life.

[a] Denotes statistical significance based on analyses adjusted via the Benjamini-Hochberg procedure.

Goal/Prep, and Coping subscales and KOOS are presented in Table 3.

DISCUSSION

The purpose of our study was to examine the relationship between active coping skills and self-reported knee function in individuals with a history of ACLR. We hypothesized that individuals with greater levels of active coping skills would demonstrate better self-reported knee function. Our results partially supported our hypothesis, as we observed moderate positive relationships between confidence and achievement motivation and knee pain, knee-related quality of life, and sport-related knee function as well as between goal setting/mental preparation and knee pain. We also observed weak positive relationships between goal setting/mental preparation and knee-related activities of daily living and knee-related quality of life.

Our results from this study are consistent with prior literature demonstrating an association between coping strategies and outcomes following knee surgery in athletes.[29] Previously, Everhart et al found the use of problem-focused coping strategies, specifically pain reduction attempts, relaxation, and distraction, to be associated with improved postoperative outcomes for athletes undergoing knee surgeries such as ACLR.[29] The positive relationship we identified between active coping strategies and knee pain among individuals with ACLR is also supported by previous research identifying an association between the use of active coping strategies and greater perceived pain control, which predicts lower levels of pain and disability.[30] It is therefore possible that individuals with ACLR who engage in active coping strategies could believe to have greater control of their knee pain, thus reporting improved knee-related pain and function; however, future research is needed to determine the impact of active coping strategies on perceived pain control in this population.

The relationships we identified between confidence and achievement motivation, sport-related knee function, and knee-related quality of life as well as between goal setting/mental preparation and knee-related activities of daily living and quality of life may be attributed to the specific components of the ACSI Confid and ACSI Goal/Prep. The ACSI-Confid measures if an athlete is confident and positively motivated, consistently gives 100%, and works hard to improve.[25] The ACSI-Goal/Prep assesses whether an athlete sets and works toward specific performance goals, plans and mentally prepares, and has a plan for performing well.[25] Therefore, it is possible that after ACLR, individuals who are more likely to set goals, have higher levels of confidence, and have greater motivation to achieve their goals may be less likely to modify their lifestyle due to their injury and be more confident in their ability to safely engage in sport-related or daily activities post-ACLR. Continued engagement in activities of daily living and sport may subsequently improve perceived knee function in these activities and overall knee-related quality of life. This idea is supported by previous research demonstrating that active coping skills such as goal setting and motivation assist in injury acceptance, greater knee confidence, resiliency, and adherence to rehabilitation in other athletic populations.[9,16–21] Therefore, assessment of confidence and achievement motivation, as well as goal setting and mental preparation, may be warranted for individuals with ACLR.

Other factors that could potentially influence the relationship between coping skills and self-reported knee function in individuals with ACLR may include nonmodifiable factors, such as age and sex, as well as modifiable factors that were not measured in our study, including life stress and social support.[4,9–11] Previous studies have found differences in coping skills between sexes, as women tend to use coping skills aimed at changing their emotional responses to stressful situations, whereas men are more likely to use problem-focused skills, therefore potentially influencing self-reported knee function.[31] Previous research has also suggested differences in coping skills and cognitive and behavioral responses to ACLR recovery and life stress between adolescent and adult athletes due to personal factors such as sexual maturity, musculoskeletal status, and neurocognitive development.[32] Compared with adults, adolescent coping skills may be influenced by the high level of cognitive, emotional, social, and physical growth occurring simultaneously over the same time period, which may result in potential differences in their psychological responses to ACLR recovery and life stress.[32]

Additionally, time since ACLR may influence the relationship between coping skills and knee function. The first 12 months following ACLR is a significant time period for recovery and RTS.[16] During this period, musculoskeletal tissues are progressing through different phases of the healing process, while at the same time the athlete is influenced by continuously changing cognitive, affective, and behavioral responses to their ACLR recovery, which in turn may affect rehabilitation outcomes and self-reported knee function.[16] Given that participants in our sample ranged from 4 months to 5 years post-ACLR and were a median of 12 months post-surgery, we included time since ACLR as a covariate in our analysis to limit its potential effect on the relationship between coping skills and knee function in this population. However, Williams et al identified that coping influences perceived knee function via better rehabilitation adherence throughout various time points in the ACLR rehabilitation

process.[16] Furthermore, previous research exploring changes in coping among patients with extremity injuries found an increase in the use of adaptive coping strategies, as well as a decrease in the use of maladaptive coping strategies, between the onset of injury and 3 months postinjury.[33] These findings suggest a need for future studies to assess coping skills at multiple time points post-ACLR to better understand the relationship and effects of active coping skills on self-reported knee function among individuals actively recovering from ACLR.

The significant moderate positive relationships we identified between aspects of the ACSI-28 and KOOS measures suggest that individuals who set goals and are intrinsically motivated demonstrate better perceived knee function. Such active coping skill facets can be improved using a variety of intervention strategies throughout the ACLR rehabilitation process, which may also enhance clinical outcomes in this population. Previous research has indicated that patients recovering from a sport-related knee injury could experience psychological and behavioral benefits, such as increased confidence, motivation, resiliency, and rehabilitation adherence, by using active coping strategies, including education, goal setting, mindfulness, and relaxation training.[9,11,16–18,34] Specifically, educational strategies may be beneficial at earlier time points postinjury and could be used to explain the nature of injury, likely course of progression, prescribed rehabilitation activities, and justification for therapeutic intervention.[9,18] Additionally, goal setting may be used to focus on processes or controllable actions to execute or improve throughout rehabilitation. This may include performance objectives to achieve certain standards when completing rehabilitation progressions, such as number of repetitions or time to complete a task as well as long-term outcomes including RTS.[9,11,16,17] Mindfulness and relaxation training may also be used to help reduce stress and provide emotion-oriented coping skills throughout the rehabilitation process.[9,11,34] Previous studies have shown that using these active coping strategies may aid in injury acceptance, improved knee confidence, motivation, resiliency, and rehabilitation adherence.[17–21] Implementation of active coping strategies into the ACLR rehabilitation process could therefore provide greater motivation, more resilient behavior, and better adherence to the rehabilitation process, which may ultimately lead to increased knee function and improved clinical outcomes for patients after ACLR.[16]

Limitations and Future Research

Our study is not without limitations. First, although both the ACSI-28 and KOOS questionnaires are reliable tools for measuring coping skills and self-reported knee function, respectively, the ACSI-28 has yet to be validated for the ACLR population and has only been validated among athletes. Although all participants included in this study participated in sport, the level of sport (eg, recreational, competitive) varied among participants, which could have influenced their coping skills within a sport context. Second, participants included in our study ranged from 4 months to 5 years post-ACLR and from ages 14 to 35, which may limit the generalizability of our findings to specific subgroups within this population. However, we included time since ACLR and age as covariates in our analysis to limit the potential effect they may have on the relationship between coping skills and knee function in this population. Third, some ACSI-28 questions may be more appropriate for measuring coping skills that pertain to athletic performance stress than injury-related stress, which may influence the relationship between coping and knee function. Additionally, ACSI-28 questions pertaining to athletic performance stress may have been interpreted differently between participants given that our sample ranged from 4 months to 5 years post-ACLR and that some participants had returned to sport whereas others were still completing rehabilitation. It is possible that individuals not yet cleared for RTS may have found questions regarding athletic performance less applicable to their current postsurgical stage than individuals actively engaging in sport. Therefore, future research exploring specific injury-related coping strategies may be warranted for individuals with ACLR who have not yet returned to sport. Finally, we do not have information regarding participant perception or use of active coping strategies throughout their rehabilitation process. Additional coping-related information, such as whether participants used specific types of active coping strategies throughout ACLR recovery, may provide further insight into our results and would be beneficial to explore in future research. Based on the limitations of our study, future studies should explore the potential relationship between these variables at earlier time points post-ACLR and throughout the rehabilitation process to better understand the effects of active coping skills on self-reported knee function among individuals recovering from ACLR. Additional studies should also investigate potential differences in coping skills between males and females with ACLR as well as between adults and adolescents with ACLR, at various sport levels, after primary versus secondary ACL injury, and after ACLR failure.

CONCLUSIONS

There are significant weak and moderate positive correlations between active coping skill facets and self-reported knee function in individuals with ACLR. These relationships suggest that individuals with ACLR who report increased levels of active coping skills demonstrate better self-reported knee function and highlight the importance for clinicians to assess psychological factors, such as active coping skills, in individuals with ACLR. Specifically, clinicians who encounter patients with poor self-reported knee function after ACLR may benefit from evaluating active coping skills related to confidence and achievement motivation as well as goal setting and mental preparation. Better understanding these psychological factors among individuals with ACLR and poor self-reported knee function could provide additional insight to help guide treatment approaches for this population. Future research should investigate these relationships at earlier and more frequent time points post-ACLR among individuals who are actively undergoing rehabilitation to better understand the role coping skills may play on recovery and RTS post-ACLR.

FINANCIAL DISCLOSURE

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