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# Changes in Coping Skills Throughout Concussion Recovery in College-Aged Individuals

**Lilian A. Klein, BS*; Aaron J. Zynda, PhD†; Megan C. Loftin, PhD*; Alyssa M. Pollard-McGrandy, PhD, ATC*; Allie J. Tracey, BA, BS*; Tracey Covassin, PhD, ATC‡**

*Department of Kinesiology, Michigan State University, East Lansing; †Orthopaedic Surgery/UPMC Sports Medicine Concussion Program, University of Pittsburgh Medical Center, PA; ‡Graduate Athletic Training Program, Michigan State University, East Lansing

***Context:*** Psychosocial factors are important to consider throughout concussion recovery. Coping skills may play a role postinjury by influencing the stress response and health-promoting behaviors (eg, rehabilitation adherence). However, limited evidence exists examining coping skills throughout concussion recovery in college-aged individuals.

***Objective:*** To compare (1) changes in coping skills between acute and full medical clearance (FMC) visits in college-aged individuals diagnosed with concussion and healthy controls and (2) determine the association between coping skills and recovery outcomes after concussion.

***Design:*** Prospective cohort study.

***Setting:*** University laboratory.

***Patients or Other Participants:*** Ninety-six college-aged individuals (concussion group: n = 64, age = 21.33 ± 2.37 years; control group: n = 32, age = 21.54 ± 2.54 years) were enrolled.

***Main Outcome Measure(s):*** The Athletic Coping Skills Inventory-28 (ACSI-28) was completed at acute (within 5 days of concussion) and FMC (within 3 days of clearance) visits. A 2 × 2 mixed analysis of variance determined differences in total and subscale scores between groups (concussion vs control) from an acute to FMC visit. Multiple linear regressions determined the association between acute ACSI-28 scores and recovery for the concussion group, with statistical significance set a priori at $P < .05$ for both tests.

***Results:*** Concentration subscale was significantly lower for the concussion group at the initial visit ($F_{1,94} = 7.28$, $P = .01$). The main effect of time showed both groups' ACSI-28 total scores significantly increased from the acute to FMC visit ($F_{1,94} = 22.08$, $P < .001$). There were no significant differences in total scores between groups at either visit ($P > .05$). Additionally, no associations were found between ACSI-28 scores and concussion recovery outcomes when controlling for sex, race, history of depression/anxiety, and acute visit symptom severity (symptom resolution: $B = 0.06$, $P = .62$; FMC: $B = 0.09$, $P = .46$).

***Conclusions:*** Only coping-related concentration skills from the ACSI-28 are impaired during the acute stage of concussion recovery, and these improve by the FMC visit. Other coping skills associated with the ACSI-28 remain unaffected throughout concussion recovery in college-aged individuals.

***Key Words:*** Athletic Coping Skills Inventory-28, recovery outcomes, traumatic brain injury

**Key Points**

- Coping-related concentration scores were significantly lower at the acute visit in concussion participants than in healthy controls; however, scores increased to similar levels to those of healthy controls at the full medical clearance visit.
- Scores on the Athletic Coping Skills Inventory-28 at the acute visit after concussion were not associated with average days to symptom resolution or medical clearance.
- Athlete coping skills in college-aged individuals may not be negatively affected during concussion recovery.

Concussions are common among college-aged individuals, with a recent study's authors estimating an incidence rate of 132.4 concussions per 10 000 students.[1] Effects of concussion are often short-term, with symptoms and impairments typically resolving within 1 month.[2] However, recovery varies and may be prolonged based on preexisting comorbidities.[3,4] Variability in recovery time after concussion can be attributed to several factors, including sex, age, acute symptom severity, and medical history (eg, concussion history, anxiety, depression).[3] Numerous researchers have examined these risk factors related to concussion recovery; however, research examining effects of psychosocial factors on concussion recovery is still evolving.[4–6]

One underexplored psychosocial factor in concussion research is an individual's coping skills. With increasing awareness of athlete mental health in recent years,[7] many clinicians have shifted their treatment focus toward psychology-based interventions[8] and mental practice techniques.[9] These approaches aim to enhance performance, build confidence,[8] and support injury rehabilitation.[9] Psychological skills training (PST) is a psychology-based practice designed to improve sport performance and enjoyment[10] while developing effective

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coping strategies for high-pressure situations.[11] In noninjured athletes, PST combined with mindfulness-based interventions has significantly increased coping skills and decreased competitive anxiety in futsal players.[12] These techniques increase rehabilitation adherence and accelerate injury recovery times.[13] However, there is less understanding of how existing psychological skills evolve naturally throughout injury recovery without intervention or training. Individuals often navigate through challenges psychologically, a process known as coping. Researchers define coping as behavioral efforts that constantly change to manage specific external and internal demands that are considered beyond a person's resources or taxing.[14,15] Thus, coping skills are strategies to handle these stressful conditions.[15] Coping strategies can help manage adverse events like injury[16,17] or general daily stressors (eg, school work, lack of self-competence, relationships with coaches/teammates).[18]

Current researchers examining coping skills during concussion recovery have predominantly focused on coping strategies, both positive and negative, that individuals use during adverse events.[16,17,19] These researchers have used general coping measures (eg, Brief COPE, Coping Strategies Inventory), focusing on navigating a traumatic event or injury rather than existing coping skills.[16,17,19] Covassin and colleagues examined how different coping strategies affect neurocognitive outcomes after concussion, finding that avoidant coping behaviors were associated with greater total concussion symptoms at 3 days postinjury in high school and collegiate athletes.[16] Kontos et al compared coping behaviors among athletes with concussion, athletes with orthopaedic injury, and healthy controls.[17] In this study, athletes with concussion engaged in different coping strategies compared with those with orthopaedic injuries and reported lower coping scores for active coping, instrumental support, and acceptance than the control group. However, the inventories used in these studies examined coping with injury, rather than how general coping skills might be affected after concussion.

Researchers have shown that college students report greater difficulty concentrating after concussion than high school students[20]; however, surveys like the Brief COPE do not assess these issues specifically.[16,17] One inventory, the Athletic Coping Skills Inventory-28 (ACSI-28), is a comprehensive measure of concentration, mental preparation, and other factors relevant to a college student's ability to cope in sport.[12,21,22] Ellis and colleagues found that preoperative coping skills significantly predicted recovery outcomes for anterior cruciate ligament (ACL) reconstruction surgery in adolescent athletes.[21] However, these authors focused on long-term injury recovery outcomes, overlooking the effects of short-term injuries like concussion on these skills.

There remains a gap in the literature regarding how concussions affect existing coping skills and concussion recovery, and whether coping skills are associated with return-to-play and full medical clearance (FMC) outcomes. Therefore, the purpose of this study was 2-fold: (1) to examine changes in ACSI-28 scores between acute and FMC visits in college-aged individuals after concussion compared with healthy matched controls, and (2) to determine associations between ACSI-28 scores at the acute visit and recovery time after concussion. For our primary purpose, we hypothesized that coping skills would significantly improve between acute and FMC visits for the concussion group but would remain similar for the control group at both visits.[21] We also hypothesized that individuals with concussion who had higher (ie, better) scores on the ACSI-28 at the acute visit would have lower average numbers of days to symptom resolution and medical clearance.[13,21]

## METHODS

### Participants

A prospective, repeated-measures–design study of college-aged individuals was conducted. Participants with a medically diagnosed concussion by a medical doctor, doctor of osteopathy, nurse practitioner, or physician assistant and matched controls were recruited from varsity, club, and recreational sports teams at a Division I university. Referrals were made by athletic trainers (ATs), coaches, and sports medicine physicians. Participants aged 18 to 30 years were included in the study if they had sustained their diagnosed concussion within 5 days of enrollment and either currently or recently participated in a varsity, club, or recreational sport. Healthy controls were closely matched to concussed participants based on similar sport and demographic information. Participants were excluded if they presented with a complex case, including hospital admission for over 24 hours, loss of consciousness for over 20 minutes, abnormal neuroimaging, or history of neurological disease. Healthy controls were excluded if they had sustained a concussion within the past 6 months.

### Operational Definitions and Measures

**Concussion.** *Concussion* was defined as a traumatic brain injury from a direct or indirect blow to the head, face, neck, or body, resulting in an array of clinical signs, symptoms, and functional impairments not observed on standard neuroimaging.[2] Concussion diagnoses required the following criteria: (1) presence of 1 or more on-field signs (eg, loss of consciousness, amnesia), and/or (2) 1 or more symptoms (eg, headache, dizziness), and/or (3) any impairment on sideline assessments (eg, balance, vestibular/ocular motor).

**Days to Symptom Resolution.** *Full symptom resolution* was defined as the point in recovery when participants reported no longer experiencing any concussion-related symptoms. Participants self-reported their date of symptom resolution at their FMC visit. This was used to calculate *days to symptom resolution*, which was the number of days between the concussion date and the date participants no longer experienced concussion symptoms.

**Days to FMC.** *Days to FMC* refers to the number of days between the concussion date and the date participants were medically cleared to return to full, unrestricted activity by a qualified health care professional (ie, medical doctor, doctor of osteopathy, nurse practitioner, or physician assistant). The following criteria were used to determine FMC by each health care provider: (1) full symptom resolution and a normal vestibular assessment, (2) a return to baseline measures based on the participant's baseline assessment, when applicable, and (3) completion of all 5 stages of the Concussion in Sport return-to-play stepwise protocol.[23] Athletes are typically cleared from a concussion after completing a gradual return-to-play protocol and remaining symptom free for 24 hours. This protocol typically lasts 5 days, but if a participant's symptoms returned at any stage, they remained at that stage until they were

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symptom free. For nonathletes who did not follow a return-to-play protocol, their second visit occurred when they self-reported being symptom free for 24 hours.

**ACSI-28.** The ACSI-28, a 28-item self-report questionnaire, assesses an athlete's ability to cope in sport.[22] Each item is rated from almost never (0) to almost always (3), resulting in a maximum total score of 84, with higher scores equating to better coping skills.[22] The ACSI-28 total score has a high internal consistency ($\alpha = 0.86$).[22] The questionnaire contains 7 subscales (Coachability, Peaking Under Pressure, Freedom From Worry, Goal Setting and Mental Preparation, Confidence and Achievement Motivation, Concentration, and Coping With Adversity), each consisting of 4 questions that measure a specific coping skill, with each subscale scored out of 12. Each subscale has shown moderate to high internal consistency ($\alpha = 0.62$–$0.78$).[22] Examples and further measurement properties of each subscale can be found in Smith et al.[22] In the original validation study of the ACSI-28, the items are interchangeably referred to as psychological skills, psychological coping skills, and coping skills.[22] For the purpose of this paper, we will refer to them as coping skills. Although we aimed to assess athletes and nonathlete college-aged individuals, there are few coping skills inventories for nonsport contexts. Therefore, the current coping skills inventory was used.

### Procedures

This study received approval from the Michigan State University institutional review board of record, and all participants completed informed consent before beginning study procedures. Participants with a concussion were tested within 5 days of injury (acute visit) and at FMC (within 3 days of clearance). Healthy controls followed the same schedule as their matched participant with concussion. At the acute visit, participants completed demographic and medical history information, injury characteristics, the symptom evaluation from the Sport Concussion Assessment Tool-5, and the ACSI-28.[22,24] At the FMC visit, participants reported recovery information, including days to symptom resolution, days to FMC, and the ACSI-28. Participant data were collected and managed through the online database Research Electronic Data Capture.[25]

### Statistical Analyses

Descriptive statistics were used to calculate both groups' demographic and medical history variables. Continuous variables were calculated as means with standard deviations, and categorical variables were calculated as frequencies with percentages. Independent-samples $t$ tests were used to compare continuous data between groups, and $\chi^2$ tests were used to compare categorical data with Fisher exact tests when expected cell counts were less than 5.

To assess our primary purpose, a $2 \times 2$ mixed analysis of variance (ANOVA) was used to investigate differences in coping skills for each group throughout recovery. The within-participants variables were time (acute visit and FMC), and between-participants variables were group (concussion and healthy control). All assumptions of a $2 \times 2$ ANOVA were met. Effect size estimates were determined by partial $\eta$ squared ($\eta_p^2$) and interpreted as small (0.01–0.08), medium (0.09–0.24), and large (>0.25).[26] Follow-up pairwise comparisons using Bonferroni-corrected paired $t$ tests were conducted to examine differences across time points within the same individual. Additionally, post hoc Bonferroni-corrected independent-samples $t$ tests were conducted to examine differences between groups (ie, concussion and control) at each time point. The $\alpha$ level was set at .05.

To assess our secondary purpose, 2 separate multiple linear regressions were run to determine the association between ACSI-28 total score and recovery times (days to symptom resolution and days to FMC) for college-aged individuals with concussion. All assumptions of the multiple regression were met. To determine which covariates were entered into the model, separate univariate linear regressions were performed with known variables that affect recovery outcomes. However, none of these variables were significant. It was determined that sex, race, history of depression and anxiety, and Sport Concussion Assessment Tool-5 symptom severity score at the acute visit would be added as covariates in the multiple regression models, as previous evidence has indicated that these variables are related to recovery outcomes.[4] For the multiple regression models, the overall percentage of explained variance of the model ($R^2$), unstandardized regression coefficient ($B$), standardized coefficient ($\beta$), 95% CI, and $P$ values were calculated with statistical significance set a priori at $P < .05$. All statistical analyses were conducted in SPSS (version 28; SPSS Inc).

### Power Analysis

To achieve an acceptable power of 0.80 in a $2 \times 2$ mixed ANOVA using a small effect size of 0.15 and $\alpha$ set at .05, an estimated 90 participants (ie, 45 participants per group) were needed. A separate a priori power analysis was conducted to determine the minimum power needed for a multiple regression analysis on the concussion group. To achieve an acceptable power of 0.80 using a small effect size of 0.15 and $\alpha$ set at .05, an estimated 55 participants were needed. To ensure that the estimated sample size was met for both purposes, we enrolled a total of 96 participants, with 64 in the concussion group and 32 in the control group.

## RESULTS

### Demographic and Medical History Information

A total of 96 college-aged individuals (concussion n = 64, 53.1% female, age = 21.28 ± 2.36 years; control n = 32, 46.9%, female, age = 21.94 ± 2.84 years) were included in this study.

Table 1 provides demographic and medical history information. A significantly greater number of participants in our concussion group than in our control group reported having a history of concussion ($P = .04$); however, no other significant differences were noted between groups. For the concussion group, the average time from injury to acute visit was 3.38 ± 1.6 days, and time from acute visit to FMC visit was 14.92 ± 12.4 days. For the control group, the average time from acute visit to FMC visit was 13.41 ± 7.9 days. There was no difference in time between visits for the groups ($t_{95} = -0.63$, $P = .53$, $d = -0.14$).

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**Table 1. Descriptive Data for Participants With Concussion and Controls**

| Variable | Concussion (n = 64) | Control (n = 32) | Total (N = 96) | *P* Value[a] |
|---|---|---|---|---|
| Age, mean ± SD, y | 21.33 ± 2.37 | 21.94 ± 2.84 | 21.54 ± 2.54 | .27 |
| Sex, No. (%) | | | | |
| Female | 34 (53.1) | 15 (46.9) | 49 (51.0) | .56 |
| Male | 30 (46.9) | 17 (53.1) | 47 (49.0) | |
| Race, No. (%) | | | | |
| White/Caucasian | 43 (67.2) | 24 (75.0) | 67 (69.8) | .42 |
| Black or African American | 13 (20.3) | 3 (9.4) | 16 (16.7) | |
| Other, unknown, or not reported | 8 (12.5) | 5 (15.5) | 13 (13.5) | |
| Sport participation, No. (%) | | | | |
| Yes | 58 (90.6) | 29 (90.6) | 87 (90.6) | .99 |
| No | 6 (9.4) | 3 (9.4) | 9 (9.4) | |
| History of sport, No. (%) | | | | |
| Yes | 60 (93.8) | 30 (93.8) | 90 (93.8) | .99 |
| No | 4 (6.2) | 2 (6.2) | 6 (6.2) | |
| Depression/anxiety, No. (%) | | | | |
| Yes | 15 (23.4) | 6 (18.8) | 21 (21.9) | .60 |
| No | 49 (76.6) | 26 (81.2) | 75 (78.1) | |
| ADD/ADHD, No. (%) | | | | |
| Yes | 13 (20.3) | 7 (21.9) | 20 (20.8) | .86 |
| No | 51 (79.7) | 25 (78.1) | 76 (79.2) | |
| Learning disorder/dyslexia, No. (%) | | | | |
| Yes | 4 (6.2) | 4 (12.5) | 8 (8.3) | .43 |
| No | 60 (93.8) | 28 (87.5) | 88 (91.7) | |
| Headache or migraine disorder, No. (%) | | | | |
| Yes | 5 (7.8) | 1 (3.1) | 6 (6.2) | .66 |
| No | 59 (92.2) | 31 (96.9) | 90 (93.8) | |
| Motion sickness, No. (%)[b] | | | | |
| Yes | 3 (6.2) | 2 (6.2) | 5 (5.2) | .99 |
| No | 60 (93.8) | 30 (93.8) | 90 (93.8) | |
| History of concussion, No. (%) | | | | |
| Yes | 32 (50.0) | 9 (28.1) | 41 (42.7) | .04[c] |
| No | 32 (50.0) | 23 (71.9) | 55 (57.3) | |

Abbreviations: ADD, attention-deficit disorder; ADHD, attention-deficit/hyperactivity disorder.
[a] Independent-samples *t* test; Pearson $\chi^2$ test; Fisher exact test.
[b] One participant in the concussion group did not respond to this item; therefore, data for this variable were calculated out of 95.
[c] Denotes significance based on an $\alpha$ of $P \leq .05$.

## Changes in Coping Skills

Statistical outcomes of the mixed ANOVA are summarized in Table 2, with means and SDs for the ACSI-28 listed in Table 3. The group × time interaction for Concentration ($F_{1,94} = 7.28$, $P = .01$, $\eta_p^2 = 0.07$) was significant. Post hoc comparisons with Bonferroni-corrected independent-samples *t* tests revealed that Concentration scores were significantly lower for the concussion group than the control group at the acute visit (mean = −1.41, SE = 0.53, $P = .01$), but were not different at the FMC visit (mean = −0.33, SE = 0.54, $P = .54$). Post hoc comparisons with Bonferroni-corrected paired-samples *t* tests revealed that Concentration scores improved from the acute to FMC visit for the concussion group (mean = 0.95, SE = 0.23, $P < .001$), but Concentration scores were not different between visits for the control group (mean = −0.13, SE = 0.33, $P = .70$). There were no additional significant group × time interactions for any other ACSI-28 scores ($P > .05$). The mixed ANOVA revealed significant main effects for time for the ACSI-28 total score ($F_{1,94} = 22.08$, $P < .001$, $\eta_p^2 = 0.19$), Coping With Adversity ($F_{1,94} = 4.53$, $P = .04$, $\eta_p^2 = 0.05$), Confidence and Achievement Motivation ($F_{1,94} = 8.71$, $P = .004$, $\eta_p^2 = 0.09$), Goal Setting and Mental Preparation ($F_{1,94} = 6.53$, $P = .01$, $\eta_p^2 = 0.07$), and Freedom From Worry ($F_{1,94} = 10.25$, $P = .002$, $\eta_p^2 = 0.10$). Finally, we did not find any significant main effects of group for any ACSI-28 scores ($P > .05$).

## Relationship Between Coping Skills and Recovery Outcomes

The multiple regression model results, examining the relationship between the ACSI-28 total score and days to symptom resolution while controlling for sex, race, history of depression/anxiety, and acute visit symptom severity, was not significant ($F_{5,63} = 1.39$, $P = .24$, adjusted $R^2 = 0.03$), and the ACSI-28 total score did not significantly add to the model ($B = 0.06$, $P = .62$). The results for this multiple regression are presented in Table 4. Additionally, the multiple regression model results examining the relationship between ACSI-28 total score and days to FMC while controlling for sex, race, history of depression/anxiety, and acute visit symptom severity was not significant ($F_{5,63} = 1.54$, $P = .19$, adjusted $R^2 = 0.04$), and the ACSI-28 total score did not significantly add to the model ($B = 0.089$, $P = .46$). The results of this multiple regression are presented in Table 5. Additionally, exploratory regressions were run with and without covariates between our independent variable (ACSI-28 total score) and dependent

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**Table 2. Results of the 2 × 2 Mixed ANOVAs Used to Analyze Variables From the ACSI-28**

| Variables | Comparison | *F* Value | df | *P* Value | $\eta_p^2$ |
|---|---|---|---|---|---|
| ACSI-28 total score | Time[a] | 22.08 | 1, 94 | <.001[b] | 0.19 |
| | Group[c] | 0.86 | 1, 94 | .36 | 0.01 |
| | Interaction | 2.94 | 1, 94 | .09 | 0.03 |
| ACSI-28 subscale | | | | | |
| Coping with adversity | Time | 4.53 | 1, 94 | .04[b] | 0.05 |
| | Group | 0.40 | 1, 94 | .53 | 0.004 |
| | Interaction | 0.37 | 1, 94 | .54 | 0.004 |
| Coachability | Time | 2.56 | 1, 94 | .11 | 0.03 |
| | Group | 0.04 | 1, 94 | .84 | 0.00 |
| | Interaction | 2.06 | 1, 94 | .15 | 0.02 |
| Concentration | Time | 4.29 | 1, 94 | .04[b] | 0.04 |
| | Group | 3.07 | 1, 94 | .08 | 0.03 |
| | Interaction | 7.28 | 1, 94 | .01[b] | 0.07 |
| Confidence and achievement motivation | Time | 8.71 | 1, 94 | .004[b] | 0.09 |
| | Group | 0.07 | 1, 94 | .80 | 0.001 |
| | Interaction | 0.00 | 1, 94 | <.99 | 0.00 |
| Goal setting and mental preparation | Time | 6.53 | 1, 94 | .01[b] | 0.07 |
| | Group | 1.00 | 1, 94 | .32 | 0.01 |
| | Interaction | 0.20 | 1, 94 | .65 | 0.002 |
| Peaking under pressure | Time | 3.32 | 1, 94 | .07 | 0.03 |
| | Group | 0.63 | 1, 94 | .43 | 0.01 |
| | Interaction | 0.002 | 1, 94 | .97 | 0.00 |
| Freedom from worry | Time | 10.25 | 1, 94 | .002[b] | 0.10 |
| | Group | 0.08 | 1, 94 | .78 | 0.001 |
| | Interaction | 3.64 | 1, 94 | .06 | 0.04 |

Abbreviations: ACSI-28, Athletic Coping Skills Inventory-28; ANOVA, analysis of variance; $\eta_p^2$, partial $\eta^2$.
[a] Denotes comparison of time from the acute visit to full medical clearance visit.
[b] Denotes significance based on an $\alpha$ of $P \leq .05$.
[c] Denotes comparison of concussion group to healthy control group.

variables (days to symptom resolution and days to FMC). These resulting models were still insignificant.

## DISCUSSION

The purpose of this study was to compare changes in coping skills between acute and FMC visits in college-aged individuals diagnosed with concussion and healthy controls and determine the association between coping skills and recovery outcomes after concussion. Regarding the primary purpose, the Concentration subscale showed the only statistically significant interaction between groups over time; no other statistically significant interactions from the ACSI-28 total score or subscales were identified. This contradicts our initial hypothesis that there would be a significant interaction between the concussion and control groups over time on coping skills. The main effect of time showed a significant increase in coping skills from the acute to the FMC visit for both groups; however, there were no significant differences between groups at either time point. Regarding the secondary purpose, the ACSI-28 total score was not significantly associated with average days to symptom resolution or days to FMC for college-aged individuals with concussion.

### Changes in Coping Skills

Previous researchers have investigated the influence of coping strategies on postinjury and neurocognitive outcomes after

**Table 3. ACSI-28 Total and Subscale Scores at the Acute and FMC Visits for the Concussion and Control Groups**

| | Acute Visit, Mean ± SD[a] | | FMC Visit, Mean ± SD[b] | |
|---|---|---|---|---|
| Outcome measures | Concussion (n = 64) | Control (n = 32) | Concussion (n = 64) | Control (n = 32) |
| ACSI-28 total score | 52.98 ± 13.8 | 56.81 ± 12.2 | 57.75 ± 12.7 | 59.03 ± 13.5 |
| ACSI-28 subscale | | | | |
| Coping with adversity | 7.19 ± 2.7 | 7.66 ± 2.4 | 7.75 ± 2.8 | 7.97 ± 2.7 |
| Coachability | 9.86 ± 2.3 | 10.22 ± 2.1 | 10.44 ± 2.2 | 10.25 ± 2.1 |
| Concentration | 7.09 ± 2.5 | 8.50 ± 2.5 | 8.05 ± 2.4 | 8.38 ± 2.7 |
| Confidence and achievement motivation | 8.86 ± 2.1 | 8.75 ± 2.4 | 9.39 ± 2.0 | 9.28 ± 2.2 |
| Goal setting and mental preparation | 6.75 ± 3.3 | 7.31 ± 3.5 | 7.30 ± 3.2 | 8.09 ± 3.7 |
| Peaking under pressure | 7.39 ± 3.3 | 7.91 ± 2.9 | 7.75 ± 3.1 | 8.28 ± 3.4 |
| Freedom from worry | 5.84 ± 3.3 | 6.47 ± 2.9 | 7.08 ± 2.9 | 6.78 ± 2.6 |

Abbreviations: ACSI-28, Athletic Coping Skills Inventory-28; FMC, full medical clearance.
[a] Acute visit occurred within 5 days of concussion.
[b] FMC visit occurred within 3 days of medical clearance by a medical doctor, doctor of osteopathy, nurse practitioner, or physician assistant.

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**Table 4. Multiple Regression Results for Days to Symptom Resolution With the ACSI-28 Total Score as the Independent Variable[a]**

| | *B* | 95% CI for *B* | β | *P* Value |
|---|---|---|---|---|
| (Constant) | 3.20 | −12.81, 19.21 | — | .69 |
| Sex | −2.30 | −8.90, 4.31 | −0.09 | .49 |
| Race | | | | |
| Black | 2.31 | −6.85, 11.46 | 0.08 | .62 |
| Other | 9.42 | −0.61, 19.44 | 0.25 | .07 |
| Depression/anxiety | 4.03 | −3.72, 11.77 | 0.14 | .30 |
| Symptom severity score | 0.03 | −0.12, 0.18 | 0.05 | .70 |
| ACSI-28 total score | 0.06 | −0.18, 0.31 | 0.07 | .62 |

Abbreviations: ACSI-28, Athletic Coping Skills Inventory-28; B, unstandardized regression coefficient; β, standardized coefficient.
[a] Reference groups: gender, male; race, White; depression/anxiety, yes.

**Table 5. Multiple Regression Results for Days to FMC With the ACSI-28 Total Score as the Independent Variable[a]**

| | *B* | 95% CI for *B* | β | *P* Value |
|---|---|---|---|---|
| (Constant) | 6.21 | −9.35, 21.76 | — | .43 |
| Sex | −3.01 | −9.42, 3.41 | −0.12 | .35 |
| Race | | | | |
| Black | 3.41 | −5.50, 12.31 | 0.11 | .45 |
| Other | 9.38 | −0.37, 19.13 | 0.26 | .06 |
| Depression/anxiety | 3.69 | −3.84, 11.21 | 0.13 | .33 |
| Symptom severity score | −0.004 | −0.15, 0.144 | −0.01 | .96 |
| ACSI-28 total score | 0.09 | −0.15, 0.33 | 0.10 | .46 |

Abbreviations: ACSI-28, Athletic Coping Skills Inventory-28; B, unstandardized regression coefficient; β, standardized coefficient; FMC, full medical clearance.
[a] Reference groups: gender, male; race, White; depression/anxiety, yes.

concussion,[16] and differences in coping among athletes with concussion, athletes with orthopaedic injury, and healthy controls.[17] Furthermore, researchers examining coping skills using the ACSI-28 have predominantly focused on recovery time and return to activity after long-term musculoskeletal injuries.[21] This study expands on existing literature by observing changes in existing coping skills in college-aged individuals after concussion while including a healthy control group for comparison. No significant interaction was observed between group and time for the ACSI-28 total score and most subscales, except Concentration. The lack of interaction between groups at both time points suggests that existing coping skills may not be affected by concussion and do not play a role in concussion recovery.

Most ACSI-28 scores were not significantly different at either time point between groups, except for one group × time interaction. The Concentration subscale was significantly lower for the concussion group than the healthy control group at the acute visit. Experiencing difficulty with concentration is common after concussion and can be exacerbated by the severity of concurrent symptoms (eg, headache, dizziness) and impairments (eg, migraine, vestibular).[27,28] Therefore, it is logical that individuals with concussion would exhibit reduced concentration skills and face more significant challenges with concentration compared with the control group. Notably, the Concentration score for the concussion group was not different than the control group at the FMC visit. This suggests that, although individuals with concussion might struggle initially with concentrating on tasks, these issues should be less prominent and return to preinjury levels by the time they are cleared for full activity. This likely coincides with the resolution of other concussion-related symptoms and impairments with rehabilitation.

The lack of interaction between groups for the ACSI-28 total score and additional subscales could be due to several factors. It is important to note that most participants in our study were collegiate athletes. These athletes were likely placed into a stepwise progression protocol after concussion, as is recommended by several consensus statements for concussion in sport.[2,23,29] Consequently, many athletes in our sample could have been recovering with their ATs or physicians before their return-to-play visits and possibly even before their initial visit. Because many ATs use PST during injury recovery, athletes working with ATs may use these skills throughout recovery.[13] This exposure could mitigate the negative psychological effects of a concussion during recovery. Additionally, an active plan for recovery might have improved their cognitive appraisal of their injury, leading to better sport-related coping skills.[30] However, interventions and treatments were not noted for participants, so we cannot make conclusions from this information. Moreover, individuals dealing with shorter injuries like concussion may not have sufficient time to process their injury within the context of their sport before returning to play. This shorter recovery period might not be enough time to negatively affect their preexisting coping skills. Other studies whose authors found significant changes in total scores over time using the ACSI-28 involved long-term (>6 months) musculoskeletal injuries (eg, ACL reconstruction surgeries).[21] The average time to recovery for individuals in our sample was 16.69 ± 12.19 days, which is much shorter than the year after surgery in the study by Ellis et al.[21]

The main effect of time showed similar increases for both groups in the ACSI-28 total score and subscales including Coping With Adversity, Confidence and Achievement Motivation, Goal Setting and Mental Preparation, and Freedom From Worry. Finding increases in total ACSI-28 scores from the acute to the FMC visit was expected for participants with concussion; however, it was not expected that matched controls would also increase in total ACSI-28 scores over time. This finding could be attributed to the large number of athletes in the current study. Previous researchers have noted that many collegiate athletes rely on the social support of their teammates to help them cope with stressors related to sport.[18] This existing social support and reliance on teammates may lead to a preexisting ability to cope with general stressors that all college students face independent of injury, like school, which may extend to injury-related stressors like concussion.[18] Approximately 90% of controls were athletes, often referred from the same team or by the injured athlete. This shared social support may have been used by uninjured teammates during injury recovery, leading to similar coping skills between groups. Regardless of injury, reliance on one's teammates and shared support of injured teammates might help improve coping skills between visits for injured and noninjured athletes.

## Relationship Between Coping Skills and Recovery Outcomes

Further analyses were conducted on the concussion group to determine if ACSI-28 scores were associated with

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recovery outcomes. The ACSI-28 was not significantly associated with any recovery outcomes (ie, average days to symptom resolution and average days to FMC). Previous researchers using the ACSI-28 to predict recovery outcomes for athletes with ACL injuries found that lower scores preoperatively on the ACSI-28 predicted a significantly greater number of days to recovery.[21] This finding, and other findings noting the importance of coping to injury recovery outcomes, contradicts the current study, which did not find a significant association in average days to recovery, specifically days to symptom resolution and days to FMC.[16,31] Covassin and colleagues assessed their populations at 2 specific time points: 3 and 8 days postinjury.[16] In contrast, we waited until full recovery to assess the groups, with the mean days to recovery being 16.69 ± 12.19. Our second visit occurred more than 8 days later than the second visit in the study by Covassin et al.[16] Future researchers might consider adding an additional time point between the acute phase and full recovery to determine if there are any associations between coping mechanisms and recovery outcomes. Furthermore, the study by Covassin et al used the Brief COPE, which evaluates general coping strategies throughout injury.[16] This study used the ACSI-28, which focuses on how existing coping skills, such as peaking under pressure and confidence and achievement motivation, affect recovery outcomes.

### Limitations

This study is not without limitations. First, the ACSI-28 is a self-report survey, which may be subject to recall or response bias by participants. The concussion and control group sizes were also unequal, which may have introduced error in our statistical analyses. Our control group sample size was also below the sample estimate to reach minimum statistical power, which may have contributed to insignificant results between groups. This limitation adds several constraints to the generalizability of our findings. In this study, we did not find any significant differences between groups for total score or any subscales of the ACSI-28, except for the Concentration subscale, at either initial or recovery visits. A more balanced sample size for each group might have increased the likelihood of detecting a significant difference between groups for the total scores and subscales. Future researchers should focus on recruiting larger and more balanced sample sizes for concussion and control groups to further assess the effect of coping on recovery outcomes. Additionally, our sample consisted of athletes and nonathletes sustaining sport-related and non–sport-related injuries. Due to the nature of some of the athlete-focused questions in the ACSI-28, not being an athlete might limit the ability to provide accurate and meaningful responses to specific questions relating to coachability or feeling pressure to return to sport. Additionally, some athletes likely followed a structured protocol per the consensus statement guidelines. No interventions or protocols that the concussion group participated in throughout recovery were noted, which could have affected their coping skills related to activity; however, most participants in our sample with concussion were athletes (n = 58, 90.6%), so this likely had no meaningful effect on our results. Lastly, our sample consisted of college-aged individuals, mostly managed by team ATs in a university setting, which limits the generalizability of our findings to other populations and different clinical settings.

### Conclusions

This study examined differences in coping skills assessed via the ACSI-28 from acute to FMC visits between participants with concussion and healthy matched controls. A significant interaction between groups from the acute to FMC visit was observed for the Concentration subscale, whereas results for all other subscales and the total ACSI-28 score were insignificant. The Concentration score for participants with concussion was significantly worse acutely but normalized to the level of controls by the FMC visit. The ACSI-28 total score, Coping With Adversity, Confidence and Achievement Motivation, Goal Setting and Mental Preparation, and Freedom From Worry significantly increased from the acute to FMC visit. For the concussion group, the ACSI-28 total score was not significantly associated with recovery outcomes, including average days to symptom resolution and days to FMC. These results suggest that coping skills may not be an important factor for clinicians to consider in short-term injury recovery like concussion. Future researchers should examine relationships between coping skills and concussion in a more diverse sample, including a greater variety of age, race, and sociocultural backgrounds. Previous researchers examining coping throughout injury found that coping strategies affect athletes' neurocognitive performance postconcussion,[16] so future researchers should expand on specific coping strategies and styles and their role in concussion recovery.

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*Address correspondence to Lilian A. Klein, BS, 308 W Circle Drive, East Lansing, MI 48823. Address email to kleinli3@msu.edu.*

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