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

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Context: Psychosocial factors are important to consider throughout concussion recovery. Coping skills may play a role post-injury by influencing the stress response and health-promoting behaviors (e.g., 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 following concussion.

Design: Prospective cohort study

Setting: University laboratory

Patients or Other Participants: 96 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 Measures: The Athletic Coping Skills Inventory (ACSI-28) was completed at acute (within 5 days of concussion) and FMC (within 3 days of clearance) visits. A 2×2 mixed ANOVA determined differences in total and subscale scores between groups (concussion vs. control) from 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 $p<0.05$ for both tests.

Results: The concentration subscale was significantly lower for the concussion group at the initial visit ($F_{(1,94)}=7.28$, $p=0.01$). The main effect of time showed both groups' ACSI-28 total score significantly increased from acute to FMC visit ($F_{(1,94)}=22.08$, $p<0.001$). There were no

significant differences in total scores between groups at either visit (p>0.05). 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=0.62; FMC: B=0.09, p=0.46).

Conclusions: Only coping-related concentration skills from the ACSI-28 are impaired during the acute stage of concussion recovery but 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, Concussion, Recovery Outcomes

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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 as healthy controls at the FMC visit.
- Scores on the ACSI-28 at the acute visit following 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 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 one month.[2] However, recovery varies and may be prolonged based on pre-existing co-morbidities.[3,4] Variability in recovery time following concussion can be attributed to several factors, including sex, age, acute symptom severity, and medical history (e.g., concussion history, anxiety, depression).[3] Numerous studies have examined these risk factors related to concussion recovery[4–6]; however, research examining impacts of psychosocial factors on concussion recovery is still evolving.

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 towards psychological-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 psychological-based practice designed to improve sport performance and enjoyment[10] while developing effective coping strategies for high-pressure situations.[11] In non-injured 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 (e.g., school work, lack of self-competence, relationships with coaches/teammates).[18]

Current research examining coping skills during concussion recovery has predominantly focused on coping strategies, both positive and negative, that individuals use during adverse events.[16,17,19] This research utilizes general coping measures (e.g., Brief COPE, Coping Strategies Inventory), focusing on navigating a traumatic event or injury rather than existing coping skills.[16,17,19] Covassin and colleagues[16] examined how different coping strategies affect neurocognitive outcomes following concussion, finding that avoidant coping behaviors were associated with greater total concussion symptoms at 3 days post-injury in high school and collegiate athletes. Kontos et al.[17] compared coping behaviors among athletes with concussion, orthopedic injury, and healthy controls. In this study, athletes with concussion engaged in different coping strategies compared to those with orthopedic 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 impacted after concussion.

Studies show that college students report greater difficulty concentrating following concussion than high school students[20]; however, surveys like the Brief COPE do not assess these issues specifically. 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] A study by Ellis and colleagues[21] found that preoperative coping skills significantly predicted recovery outcomes for anterior cruciate ligament (ACL) reconstruction surgery in adolescent athletes. However, this study 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 impact 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 twofold: (1) to examine changes in ACSI-28 scores between acute and FMC visits in college-aged individuals following concussion compared to healthy matched controls, and (2) to determine associations between ACSI-28 scores at the acute visit and recovery time following 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 (i.e., better) scores on the ACSI-28 at the acute visit would have a lower average days to symptom resolution and medical clearance.[13,21]

METHODS

Participants

A prospective, repeated-measures design of college-aged individuals was conducted. Participants with a medically diagnosed concussion by a Medical Doctor (MD), Doctor of Osteopathy (DO), Nurse Practitioner (NP), or Physician Assistant (PA) and matched controls were recruited from varsity, club, and recreational sports teams at a Division 1 University. Referrals were made by athletic trainers (ATs), coaches, and sports medicine physicians. Participants aged 18-30 years were included in the study if they 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 their concussed participant

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 sustained a concussion within the past six 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 at least one or more on-field signs (e.g., loss of consciousness, amnesia), and/or 2) one or more symptoms (e.g., headache, dizziness), and/or 3) any impairment on sideline assessments (e.g., 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 Full Medical Clearance: Days to FMC refers to the number of days between the concussion date to the date participants were medically cleared. FMC was determined by a qualified healthcare professional (i.e., MD, DO, NP, PA) when the participant was cleared to return to full, unrestricted activity. The following criteria were used to determine FMC by each healthcare provider: a) full symptom resolution and a normal vestibular assessment, b) a return to baseline measures based on the participant's baseline assessment, when applicable, and c) completion of all 5 stages of the Concussion in Sport return to play stepwise protocol.[22] Athletes

are typically cleared from a concussion after completing a gradual RTP 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 symptom-free. For non-athletes who did not follow an RTP protocol, their second visit occurred when they self-reported being symptom-free for 24 hours.

Athletic Coping Skills Inventory-28 (ACSI-28): The ACSI-28, a 28-item self-report questionnaire, assesses an athlete's ability to cope in sport.[23] 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.[23] The ACSI-28 total score has a high internal consistency (α= 0.86).[23] The questionnaire can be divided into 7 subscales (Coachability, Peaking Under Pressure, Freedom from Worry, Goal Setting and Mental Preparation, Confidence and Achievement Motivation, Concentration, and Coping with Adversity) 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 (α=0.62-0.78).[23] Examples and further measurement properties of each subscale can be found in Smith et.al.[23] In the original validation study of the ACSI-28, the items are interchangeably referred to as psychological skills, psychological coping skills, and coping skills.[23] For the purpose of this paper, we will refer to them as coping skills. Although this study aims to assess athletes and non-athlete college-aged individuals, there are few coping skills inventories for non-sport contexts. Therefore, the current coping skills inventory was used.

Procedures

This study received approval from the 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 (SCAT5),[24] and the ACSI-28. At the FMC visit, participants reported recovery information, including days to symptom resolution, days to FMC, and the ACSI-28. Participant data was collected and managed through the online database Research Electronic Data Capture (REDCap).[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, while chi-square tests were used to compare categorical data with Fisher's exact tests when expected cell counts were less than 5.

To assess our primary purpose, a 2×2 mixed analysis of variance (ANOVA) was used to investigate differences in coping skills for each group throughout recovery. The within-subject variables were time (acute visit, and FMC), and between-subjects variables were group (concussion and healthy control). All assumptions of a 2x2 ANOVA were met. Effect size estimates were determined by partial eta squared (η_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 (i.e., concussion and control) at each time point. Alpha level was set at 0.05.

To assess our secondary purpose, two 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 SCAT5 symptom severity score at the acute visit would be added as covariates in the multiple regression models, as previous evidence has indicated these variables are related to recovery outcomes.[4] For the multiple regression models, the overall percent of explained variance of the model (R^2), unstandardized regression coefficient (*B)*, standardized coefficient (β), 95% Confidence interval (95% CI), and *p* values were calculated with statistical significance set a priori at $p<0.05$. All statistical analyses were conducted in SPSS version 28 (SPSS Inc, Chicago, Illinois).

Power Analysis

To achieve an acceptable power of 0.80 in a 2x2 mixed ANOVA using a small effect size of 0.15 and alpha set at 0.05, an estimated 90 participants (i.e., 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 0.05, an estimated 55 participants were needed. To ensure 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;control:n=32,46.9%,female,age=21.94±2.84) were included in this study. Table 1 provides demographic and medical history information. A significantly greater number of participants in our concussion group reported having a history of concussion than our control group (p=0.04); however, no other significant differences were noted between groups. For the concussion group, 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, 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=0.53, d=-0.14).

Changes in Coping Skills

Statistical outcomes of the mixed ANOVA are summarized in Table 2, with means and standard deviations for the ACSI-28 listed in Table 3. The group x time interaction for concentration ($F_{(1,94)}$=7.28, p=0.01, η_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 (M=-1.41, SE=0.53, p=0.01), but were not different at the FMC visit (M=-0.33, SE=0.54, p=0.54). Post-hoc comparisons with Bonferroni corrected paired samples t-tests revealed that concentration scores improved from acute to FMC visit for the concussion group (M=0.95, SE=0.23, p<0.001), but concentration scores were not different between visits for the control group (M=-0.13, SE=0.33, p=0.70). There were no additional significant group x time interactions for any other ACSI-28 scores (p>0.05). The mixed ANOVA revealed significant main effects for time for the ACSI-28

total score ($F_{(1,94)}$=22.08, p<0.001, η_p^2=0.19), coping with adversity ($F_{(1,94)}$=4.53, p=0.04, η_p^2=0.05), confidence and achievement motivation ($F_{(1,94)}$=8.71, p=0.004, η_p^2=0.09), goal setting and mental preparation ($F_{(1,94)}$=6.53, p=0.01, η_p^2=0.07), and freedom from worry ($F_{(1,94)}$=10.25, p=0.002, η_p^2=0.10). Finally, we did not find any significant main effects of group for any ACSI-28 scores (p>0.05).

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=0.24, Adj.R^2=0.03), and the ACSI-28 total score did not significantly add to the model (B=0.06, p=0.62). 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=0.19, Adj.R^2=0.04), and the ACSI-28 total score did not significantly add to the model (B=0.089, p=0.46). 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 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 following concussion.

Regarding the primary purpose, our findings concluded that the concentration subscale was the only statistically significant interaction between groups over time, and 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 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 studies have investigated the influence of coping strategies on post-injury and neurocognitive outcomes following concussion,[16] and differences in coping between athletes with concussion, athletes with orthopedic injury, and healthy controls.[17] Furthermore, research examining coping skills using the ACSI-28 has 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 following concussion, while including a healthy control group for comparison. No significant interaction was observed between groups 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 timepoint between groups, except for one group x 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 following concussion and can be exacerbated by the severity of concurrent symptoms (e.g., headache, dizziness) and impairments (e.g., 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 to 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 pre-injury 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 reasons. It is important to note that most participants in our study were collegiate athletes. These athletes were likely placed into a stepwise progression protocol following concussion, as is recommended by several consensus statements for concussion in sport.[2,22,29] Consequently, many athletes in our sample could have been recovering with their athletic trainers or physicians before their return-to-play visits and possibly even before their initial visit. Since many athletic trainers utilize PST during injury recovery, athletes working with athletic trainers 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,[30] leading to better sport-related coping skills. 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 pre-existing coping skills. Other studies that found significant changes in total scores over time using the ACSI-28 involved long-term (>6 months) musculoskeletal injuries (e.g., 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 a year after surgery in the Ellis study.[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 research has 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,[18] which may extend to injury-related stressors like concussion. Approximately 90% of controls were athletes, often referred from the same team or by the injured athlete. This shared social support may have been utilized 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 non-injured 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 recovery outcomes. The ACSI-28 was not significantly associated with any

recovery outcomes (i.e., average days to symptom resolution and average days to FMC). Previous research using the ACSI-28 to predict recovery outcomes for athletes with ACL injuries found that lower scores preoperatively on the ACSI-28 predict a significantly greater number of days to recovery.[21] This finding, and other findings noting the importance of coping on injury recovery outcomes,[16,31] 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. The study by Covassin and colleagues[16] assessed their populations at two specific time points: 3 days and 8 days post-injury. In contrast, our study 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 Covassin et al. Future studies might consider adding an additional timepoint between the acute phase and full recovery to determine if there are any associations between coping mechanisms and recovery outcomes. Furthermore, the Covassin study used the Brief COPE, which evaluates general coping strategies throughout injury. This study used the ACSI-28, which focuses on how existing coping skills, such as peaking under pressure and confidence and achievement motivation, impact 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 may have increased the likelihood of detecting a significant difference between groups for the total scores and subscales. Future studies should focus on recruiting larger and more balanced sample sizes for concussion and control groups to further assess the impact of coping on recovery outcomes. Additionally, our sample consisted of athletes and non-athletes 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. However, no interventions or protocols that the concussion group participated in throughout recovery were noted, which could have impacted 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 impact on our results. Lastly, our sample consisted of college-aged individuals, mostly managed by team athletic trainers 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, while 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 acute to FMC visit. For the concussion group, 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 studies should examine relationships between coping skills and concussion in a more diverse sample, including a greater variety of age, race, and sociocultural backgrounds. Previous research examining coping throughout injury found that coping strategies impact athletes' neurocognitive performance post-concussion,[16] so future research should expand on specific coping strategies and styles and their role in concussion recovery.

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Table 1. Descriptive Data for Participants with Concussion and Controls

Variable[a]		Concussion (N=64)	Control (N=32)	Total (N = 96)	P value[c]
Age in years		21.33 (2.37)	21.94 (2.84)	21.54 (2.54)	0.27
Sex	Female	34 (53.1%)	15 (46.9%)	49 (51.0%)	0.56
	Male	30 (46.9%)	17 (53.1%)	47 (49.0%)	
Race	White/Caucasian	43 (67.2%)	24 (75.0%)	67 (69.8%)	0.42
	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	Yes	58 (90.6%)	29 (90.6%)	87 (90.6%)	0.99
	No	6 (9.4%)	3 (9.4%)	9 (9.4%)	
History of Sport	Yes	60 (93.8%)	30 (93.8%)	90 (93.8%)	0.99
	No	4 (6.2%)	2 (6.2%)	6 (6.2%)	
Depression/Anxiety	Yes	15 (23.4%)	6 (18.8%)	21 (21.9%)	0.60
	No	49 (76.6%)	26 (81.2%)	75 (78.1%)	
ADD/ADHD	Yes	13 (20.3%)	7 (21.9%)	20 (20.8%)	0.86
	No	51 (79.7%)	25 (78.1%)	76 (79.2%)	
Learning Disorder/Dyslexia	Yes	4 (6.2%)	4 (12.5%)	8 (8.3%)	0.43
	No	60 (93.8%)	28 (87.5%)	88 (91.7%)	
Headache or Migraine Disorder	Yes	5 (7.8%)	1 (3.1%)	6 (6.2%)	0.66
	No	59 (92.2%)	31 (96.9%)	90 (93.8%)	
Motion Sickness[d]	Yes	3 (6.2%)	2 (6.2%)	5 (5.2%)	0.99
	No	60 (93.8%)	30 (93.8%)	90 (93.8%)	
History of Concussion	Yes	32 (50.0%)	9 (28.1%)	41 (42.7%)	0.04[b]
	No	32 (50.0%)	23 (71.9%)	55 (57.3%)	

Abbreviations: ADD, attention-deficit disorder; ADHD, attention-deficit hyperactivity disorder.

[a] Categorical variables are reported as frequencies (percent) continuous variables are reported as means (SD).

[b] Denotes significance based on an alpha of $p \leq 0.05$.

[c] Independent samples t-test; Pearson x^2 test; Fisher exact test.

[d] One participant in the concussion group did not respond to this item, therefore data for this variable was calculated out of 95.

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

Variables	Comparison	*F*	df	P value	partial η^2 (η_p^2)
ACSI-28 Total Score	Time[b]	22.08	1, 94	<0.001[a]	0.19
	Group[c]	0.86	1, 94	0.36	0.01
	Interaction	2.94	1, 94	0.09	0.03
Coping with Adversity	Time	4.53	1, 94	0.04[a]	0.05
	Group	0.40	1, 94	0.53	0.004
	Interaction	0.37	1, 94	0.54	0.004
Coachability	Time	2.56	1, 94	0.11	0.03
	Group	0.04	1, 94	0.84	0.00
	Interaction	2.06	1, 94	0.15	0.02
Concentration	Time	4.29	1, 94	0.04[a]	0.04
	Group	3.07	1, 94	0.08	0.03
	Interaction	7.28	1, 94	0.01[a]	0.07
Confidence and Achievement Motivation	Time	8.71	1, 94	0.004[a]	0.09
	Group	0.07	1, 94	0.80	0.001
	Interaction	0.00	1, 94	<0.99	0.00
Goal Setting and Mental Preparation	Time	6.53	1, 94	0.01[a]	0.07
	Group	1.00	1, 94	0.32	0.01
	Interaction	0.20	1, 94	0.65	0.002
Peaking Under Pressure	Time	3.32	1, 94	0.07	0.03
	Group	0.63	1, 94	0.43	0.01
	Interaction	0.002	1, 94	0.97	0.00
Freedom From Worry	Time	10.25	1, 94	0.002[a]	0.10
	Group	0.08	1, 94	0.78	0.001
	Interaction	3.64	1, 94	0.06	0.04

Abbreviation: ACSI-28, Athletic Coping Skills Inventory-28

[a] Denotes significance based on an alpha of $p \leq 0.05$.

[b] Denotes comparison of time from acute visit to Full Medical Clearance (FMC) visit

[c] Denotes comparison of concussion group to healthy control group

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

Outcome measures	Acute Visit[b]		FMC Visit[c]	
	Concussion (n=64)[a]	Control (n=32)[a]	Concussion (n=64)[a]	Control (n=32)[a]
ACSI-28 Total Score	52.98 ± 13.8	56.81 ± 12.2	57.75 ± 12.7	59.03 ± 13.5
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] Values are mean ± SD.

[b] Acute visit occurred within 5 days of concussion.

[c] FMC visit occurred within 3 days of medical clearance by a Medical Doctor (MD), Doctor of Osteopathy (DO), Nurse Practitioner (NP), or Physician Assistant (PA).

Table 4. Multiple Regression Results for Days to Symptom Resolution with ACSI-28 Total Score as the Independent Variable.

	B[a]	95% CI for *B*[a]	β[a]	P value
(Constant)	3.20	-12.81 – 19.21	-	0.69
Sex	-2.30	-8.90 – 4.31	-0.09	0.49
Race				
Black	2.31	-6.85 – 11.46	0.08	0.62
Other	9.42	-0.61 - 19.44	0.25	0.07
Depression/Anxiety	4.03	-3.72 – 11.77	0.14	0.30
Symptom Severity Score	0.03	-0.12 – 0.18	0.05	0.70
ACSI-28 Total Score	0.06	-0.18 – 0.31	0.07	0.62

Abbreviation: ACSI-28, Athletic Coping Skills Inventory-28.
Reference Groups: Gender: Male, Race: White, Depression/Anxiety: Yes
[a] B = Unstandardized regression coefficient; 95% CI = 95% Confidence interval; β = Standardized coefficient.

Table 5. Multiple Regression Results for Days to FMC with ACSI-28 Total Score as the Independent Variable.

	B[a]	95% CI for *B*[a]	β[a]	P value
(Constant)	6.21	-9.35 – 21.76	-	0.43
Sex	-3.01	-9.42 – 3.41	-0.12	0.35
Race				
Black	3.41	-5.50 – 12.31	0.11	0.45
Other	9.38	-0.37 - 19.13	0.26	0.06
Depression/Anxiety	3.69	-3.84 – 11.21	0.13	0.33
Symptom Severity Score	-0.004	-0.15 – 0.144	-0.01	0.96
ACSI-28 Total Score	0.09	-0.15 – 0.33	0.10	0.46

Abbreviations: ACSI-28, Athletic Coping Skills Inventory-28; FMC, Full Medical Clearance.
Reference Groups: Gender: Male, Race: White, Depression/Anxiety: Yes
[a] *B* = Unstandardized regression coefficient; 95% CI = 95% Confidence interval; β = Standardized coefficient.