Sex-Specific Concussion Recovery and Reporting Behaviors in Collegiate Athletes: Evaluating an Athlete-Centered Educational Intervention

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Abstract

Sports-related concussions are common in collegiate athletics and can lead to lasting cognitive, emotional, and academic problems, yet female athletes remain underrepresented in concussion research and many athletes still underreport symptoms. Existing educational programs often improve knowledge but have limited impact on reporting behavior, leaving a gap in sex-specific recovery data and effective, behavior-focused interventions. The long-term goal of this project is to improve concussion management and safety in collegiate sports. The central hypothesis is that female collegiate athletes will demonstrate longer recovery times than male athletes and that a tailored, athlete-centered educational workshop will increase concussion knowledge, improve attitudes toward reporting, and enhance self-reported likelihood of disclosing symptoms. Approximately 70–90 collegiate athletes will complete baseline surveys, participate in a 45-minute interactive concussion education workshop, and complete the same surveys post-intervention. Sport-related concussion cases will be followed using standard athletic training protocols to document symptom duration and days to full return-to-learn and return-to-play. Data will be analyzed using group comparisons for sex differences in recovery and pre–post analyses for changes in survey scores. This study is expected to contribute new sex-specific recovery data and provide evidence for a feasible educational approach that directly targets the knowledge–behavior gap, informing concussion education and individualized management in collegiate athletics.

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Project Narrative

The proposed research is relevant to public health because sports-related concussions can lead to persistent cognitive, emotional, and academic difficulties, and underreporting of symptoms increases the risk of repeated injury and long-term harm. By generating sex-specific concussion recovery data and testing an athlete-centered educational intervention designed to improve knowledge and willingness to report symptoms, this project aims to support safer, more individualized concussion management in collegiate sports. The project is relevant to athletic trainers, sports medicine clinicians, coaches, and collegiate athletic programs seeking evidence-based strategies to protect the health and long-term well-being of student-athletes.

Specific Aims

Concussions show a major health concern in collegiate athletics because of their long- and short-term effects on cognition, mental health, and quality of life. Although previous research has examined the biomechanics of concussions (Wilcox et al., 2015), recovery timelines (Anderson et al., 2022), and total outcomes of repeated head injuries (Kuehl et al., 2010; Guskiewicz et al., 2010), gaps remain. Most bigger studies focus on male athletes, specifically football players, leaving female athletes underrepresented despite evidence of sex-specific differences in concussion tolerance and recovery. Additionally, not disclosing concussions is more common due to stigma, lack of awareness, or fear of losing playing time (Kerr et al., 2016; Lininger et al., 2016). While some educational programs improve knowledge, they have limited effectiveness in changing attitudes or increasing reporting symptoms (Bernstein et al., 2019).

Addressing both the biological and behavioral elements of concussion, especially in women, remains a critical unmet need.

The long-term goal of this of research is to advance evidence-based strategies that reduce concussion-related health risks and improve recovery outcomes for collegiate athletes. The specific objective of this proposal is to investigate sex-specific differences in concussion recovery, as well as to evaluate if an adjusted educational intervention could improve knowledge and increase disclosure among athletes. By focusing on both recovery patterns and reporting behavior, this project targets a central problem in concussion management and moves the field toward safer, more effective protocol for return-to-play.

The central hypothesis is that female athletes demonstrate distinct concussion recovery patterns compared to male athletes and that a specific, athlete-centered educational intervention will improve both knowledge and reporting symptoms. This hypothesis is based in prior research suggesting that women sustain concussions at lower impact thresholds (Wilcox et al., 2015) and that nondisclosure remains widespread regardless of baseline education (Kerr et al., 2016; Snyder & McLeod, 2016). To test this hypothesis, the proposed study will pursue three aims:

- **Aim 1:** Compare concussion recovery outcomes, including symptom duration, return-to-learn, and return-to-play, between male and female collegiate athletes.
- **Aim 2:** Assess baseline knowledge, attitudes, and reporting behaviors related to concussions among collegiate athletes.
- **Aim 3:** Evaluate the effectiveness of a specific educational intervention on improving knowledge, shifting attitudes, and increasing self-reported disclosure rates post-concussion.

Successful completion of these aims is expected to yield evidence that addresses sex-specific vulnerabilities and improve reporting behaviors, ideally contributing to more effective concussion management practices in collegiate athletics.

The expected outcomes of this project are directly aligned with each aim. For Aim 1, it is anticipated that female athletes will show longer recovery periods than their male counterparts, providing important data between sexes to guide individualized management. For Aim 2, baseline assessments are expected to reveal gaps in concussion knowledge and continued underreporting, confirming the need for more effective intervention. For Aim 3, the tailored educational program is expected to significantly improve knowledge scores, positively shift attitudes toward reporting, and increase self-reported disclosure rates compared to baseline. Together these outcomes will deliver new evidence on sex differences in concussion recovery while also offering a practical, expansible educational strategy to address underreporting. The overall impact of this project is that it will advance the field of sports medicine by improving understanding of sex-specific concussion outcomes and by informing policies and educational programs that better protect the health, safety, and long-term well-being of collegiate athletes.

Significance

Concussions are a major concern in collegiate athletics, with an estimated 1.6–3.8 million sports-related concussions occurring each year in the United States (Broglio et al., 2017). These injuries can impact memory, balance, and overall cognitive function, with symptoms sometimes lasting weeks or months. Although concussion awareness has improved, many athletes still fail to report symptoms or return to play prematurely, increasing the risk of long-term complications (Kerr et al., 2016).

Current concussion management includes baseline testing, symptom monitoring, and graded return-to-play protocols. While these strategies are effective for many athletes, recovery times and outcomes vary widely. Anderson et al. (2022) found that most collegiate athletes return to learning in about six days and to full play in about fifteen, though differences exist between men and women. Research suggests female athletes may experience greater symptom severity and longer recovery durations (Wilcox et al., 2015), possibly due to both physiological and behavioral factors.

Despite growing research, key gaps remain. Educational programs have improved knowledge about concussions, but they have not consistently changed reporting behavior (Bernstein et al., 2019). Additionally, many studies focus primarily on male athletes, leaving limited data on sex-specific recovery and reporting patterns.

Understanding these differences is critical for improving athlete safety. This study aims to examine sex-based differences in concussion recovery and evaluate whether an educational intervention can enhance symptom reporting among collegiate athletes. The findings could help athletic trainers and medical staff develop more individualized recovery plans and promote a stronger culture of honesty and safety in sports.

Innovation

Elaborating on the importance of managing concussions in collegiate athletics, the proposed study presents a fairly new and significantly different way of studying two extremely important and poorly researched segments, namely: sex-specific recovery profiles and concussion-reporting behaviors. Most previous research has centered its attention on biomechanics and incidence as well as outcomes of concussions among male athletes,

particularly those who play high-impact sports such as football (Broglio et al., 2017; Guskiewicz et al., 2010). This focus has resulted in women athletes being underrepresented with increasing evidence that women can have more severe symptoms and a longer recovery time (Wilcox et al., 2015). Although some studies have examined why athletes do not report concussions, some of these studies have identified stigma, unawareness, and fear of playing time to be reasons that athletes do not report concussions, yet few studies have been able to alter reporting behaviours (Kerr et al., 2016; Bernstein et al., 2019). This knowledge-behavioral change gap is one of the greatest obstacles to efficient concussion management.

The proposed study is innovative as it fills these two gaps by incorporating biological recovery differences and behavioral reporting patterns into one research design. To start with, the research will directly compare the concussion recovery patterns in male and female collegiate athletes by applying such quantifiable variables as the return-to-learn, the return-to-play, and the duration of symptoms (Anderson et al., 2022). The design offers a deeper insight into sex-specific recovery, more than what had been conducted previously which merely identified the differences but not what they entail. Second, the paper introduces a customized, athlete-focused educational program to enhance knowledge, attitude change, and disclosures of symptoms. In contrast to traditional educational programs that require a standardized lecture or online course, this intervention is based on interactive interaction, peer discussion, and personal reflection to develop behavioral change.

Such a strategy is a stark contrast to the status quo. Past studies have tended to divide concussion recovery research into studies on education and reporting, which has led to lack of understanding of interaction between biological and behavioral factors. This study uses a

combination of these dimensions and the targeting of female athletes to challenge the traditional one-size-fits-all model of concussion management. It presents a model holistic from the impact of physiological results and the behavioral context of recovery.

This new design will allow the reach new horizons, as it can promote the knowledge of sex-specific concussion recovery and develop a more efficient, evidence-based teaching plan. The results may assist athletic trainers, coaches, and medical workers to develop personalized recovery and communication standards that should focus on the safety and well-being of athletes. In the end, the proposed research will provide the background to the future interdisciplinary studies connecting the data of physical recovery with the outcome of behavior and educational outcomes, establishing a new oriental point of interdisciplinary concussion management in intercollegiate sport.

Approach

Research Design and Intervention

This study will use a quantitative, quasi-experimental pre–post design to (1) compare concussion recovery outcomes between male and female collegiate athletes and (2) evaluate a tailored educational intervention aimed at improving concussion knowledge, attitudes, and reporting intentions.

All participating athletes will complete a baseline online survey assessing concussion knowledge, attitudes toward reporting, and likelihood of disclosing symptoms. Over the academic year, sport-related concussions will be tracked through the athletic training staff, and recovery outcomes symptom duration, return-to-learn, return-to-play will be recorded using standard clinical protocols.

Separately, all participants will attend a single 45-minute concussion education workshop. The session will be delivered in team-based groups by a trained facilitator using a standardized slide deck and script. The workshop will include: (1) brief didactic content on concussion signs, risks, and sex-based recovery differences; (2) discussion of case scenarios involving nondisclosure; and (3) a short reflection activity on personal barriers to reporting. The same survey battery will be completed immediately after the workshop to assess changes in knowledge, attitudes, and reporting intentions. A fidelity checklist will be used in a subset of sessions to ensure consistent delivery.

Participants and Settings

The study will take place within a university athletic department, using athletic training facilities and team meeting rooms for data collection.

Inclusion Criteria

•Collegiate athletes aged 18–25

•Currently rostered on an NCAA or competitive club team

•Able to provide informed consent

All participants will be included in survey and intervention analyses. For recovery comparisons (Aim 1), a subset of these athletes who sustain a diagnosed sport-related concussion and have complete RTL and RTP documentation will be included.

Exclusion Criteria

•Non-sport concussions (e.g., car accidents)

•Known neurological disorders unrelated to concussion

•Medical disqualification from sport at baseline

•Incomplete or inaccessible concussion records

Recruitment and Grouping

Athletes will be recruited through coach-approved team meetings, department emails, and flyers. Interested athletes will complete an online consent form and baseline survey. Sex (male/female) will be used as a grouping variable for recovery and baseline comparisons; athletes are not randomized by sex. For the educational intervention, all athletes receive the same workshop, and within-subject pre–post changes will be examined.

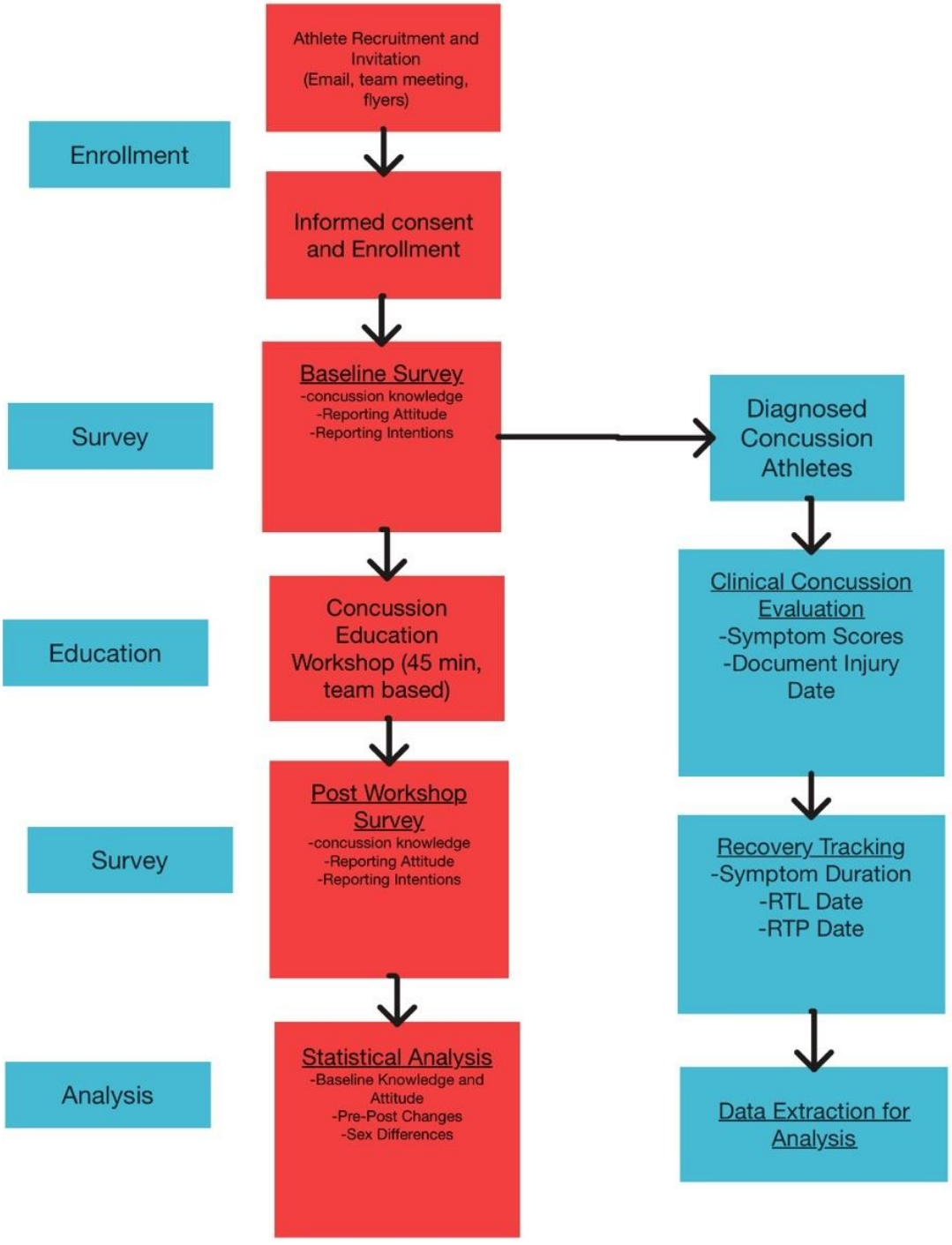
Sample Size

This study is designed primarily to evaluate pre–post changes in concussion knowledge, attitudes, and reporting intentions following the educational intervention (Aim 3). Assuming a medium effect size (Cohen's d = 0.50), an alpha level of .05, and desired power of .80 for a paired-samples comparison, a total sample of approximately 34 athletes is sufficient for detecting significant pre–post differences. To allow for incomplete data and variability across teams, we plan to recruit approximately 70–90 collegiate athletes.

For Aim 1, the number of athletes who sustain a sport-related concussion during the study period will be limited by real-world incidence. We anticipate obtaining recovery data for roughly 20–30 concussed athletes. As a result, analyses of sex differences in recovery will be considered preliminary and may be underpowered to detect small effects, but they will still provide useful exploratory data to guide future, larger studies.

Measurement Procedures

Timing



1. Baseline (T1): Before the workshop – knowledge, attitudes, reporting intentions

2. Post-intervention (T2): Immediately after the workshop – same measures

3. Concussion Event / Recovery: As concussions occur – symptom scores, RTL, RTP from existing records

Measures

Concussion Knowledge

A validated concussion knowledge questionnaire (e.g., adapted Rosenbaum index) will be used. It consists of multiple-choice/true–false items about symptoms, risks, and management. Total correct responses will form a knowledge score.

Attitudes Toward Reporting

A Likert-scale attitude measure adapted from prior concussion-reporting research will assess beliefs about the importance and consequences of symptom disclosure. Higher scores reflect more positive attitudes toward reporting.

Reporting Intentions

Scenario-based items will ask athletes how likely they are to report symptoms in different situations (e.g., before a big game). Higher scores indicate stronger intentions to report.

Recovery Outcomes

For athletes with a diagnosed concussion, the athletic training staff will document:

•Symptom duration: days from injury until symptom resolution

•RTL: days from injury until full academic participation

•RTP: days from injury until full sport clearance

These values will be extracted from standard clinical documentation using a structured data form.

Standardization and Quality Control

All surveys will be administered via a secure online platform using participant ID codes. Athletes will be encouraged to complete surveys in a quiet environment. Medical data will be extracted by trained research personnel, and a subset of entries will be double-checked to ensure accuracy. A fidelity checklist will be used to monitor adherence to the intervention script and structure.

Statistical Analysis Plan

Data will be analyzed using SPSS and/or R. Descriptive statistics will be calculated for all major variables. Normality will be assessed via Shapiro–Wilk tests and visual inspection, outliers (>3 SD) will be examined and, if necessary, winsorized. Missing survey data may be handled with multiple imputation when appropriate.

Aim 1 (Recovery Differences by Sex):

•Independent-samples t-tests (or nonparametric equivalents) will compare male and female athletes on symptom duration, RTL, and RTP.

•ANCOVA will be used to control for covariates such as sport type and prior concussion history.

•Effect sizes (Cohen's d, partial η^2) and 95% confidence intervals will be reported.

Aim 2 (Baseline Knowledge, Attitudes, Reporting):

•Descriptive statistics will summarize overall levels.

•Sex differences will be tested with t-tests.

•Multiple regression may be used to explore predictors of lower reporting intention (e.g., sex, prior concussion, knowledge scores).

Aim 3 (Intervention Effects):

•Paired-samples t-tests will compare pre–post scores for knowledge, attitudes, and reporting intentions.

•Repeated-measures ANOVA may be used to examine changes while controlling for sex and other covariates.

•Effect sizes (Cohen's d, partial η^2) will indicate magnitude of change.

Methodological Considerations

Limitations

The study does not include a no-intervention control group, which limits causal conclusions about the educational component. Recovery data are observational and may be influenced by unmeasured factors such as playing position or injury severity. Self-reported intentions may not perfectly predict actual reporting behavior. Additionally, the single-institution sample may limit generalizability.

Controls and Mitigation

To address these issues, the study uses standardized intervention materials, validated survey instruments, and statistical control of key covariates. Clear documentation procedures will help ensure consistency in how recovery outcomes are recorded.

Contingency Plans

If concussion incidence is lower than expected, the data collection period may be extended. If workshop attendance is low, additional sessions will be offered at more flexible times. Sensitivity analyses (e.g., comparing complete case vs. imputed data) will be used if missing data become a concern.

Future Directions

Findings from this study can inform more individualized concussion management strategies, particularly regarding sex-based recovery differences, and support the development of more effective, athlete-centered concussion education. Future work could expand the

intervention to multiple campuses, track actual reporting behaviors longitudinally, and test sport-specific or sex-specific educational modules.

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