



International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Challenges and strategies in sport-related concussion management: a systematic analysis

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ABSTRACT:

Sport-related concussions (SRCs) present a growing challenge in sports medicine due to their complex pathophysiology, variable symptomatology, and potential for long-term cognitive and psychological effects. This systematic review synthesizes findings from nine recent studies examining concussion knowledge, assessment practices, and management strategies among healthcare professionals. Results reveal significant gaps in concussion education, inconsistent adherence to clinical guidelines, and variability in return-to-play (RTP) protocols. Post-concussion mental health issues, including depression and suicidal tendencies, are significant concerns. These findings underscore the need for standardized concussion protocols, targeted education initiatives, and integration of mental health support into SRC management. Enhanced training and interdisciplinary collaboration are vital for promoting athlete safety and optimizing recovery.

Keywords: Sport-related concussion (SRC), Concussion management, Return-to-play (RTP), Concussion assessment, Mental health.

Introduction

Concussion, a complex and multifaceted form of traumatic brain injury, is a significant concern in sports medicine. Typically resulting from a blow or injury to the head, concussion induces a complex pathophysiological process that affects the brain. The primary mechanism of injury is believed to be shear forces caused by rotational acceleration, which can lead to various short-term and long-term consequences. The incidence of concussion is substantial, particularly in contact sports like rugby. Studies have reported rates of up to 6.9 and 4.9 concussions per 1000 hours played in youth and adult rugby union, respectively. Concussion is now recognized as a public health epidemic, linked to mental health difficulties, increased risk of neurological disorders, and dementia. The symptoms of concussion can be categorized into motor and non-motor deficits, including cognitive, sensory, emotional, autonomic, and sleep problems.¹ Current concussion management involves a structured return-to-play process, with triage assessment and symptom evaluation. However, existing pitch-side assessments, such as the Sport Concussion Assessment Tool (SCAT3), have limitations in detecting subtle dysfunction and monitoring symptoms. This makes return-to-play decisions challenging for clinicians, who must balance the need to ensure athlete safety with the pressure to allow athletes to return to competition.^{1,2} Certified athletic trainers play a pivotal role in concussion management, serving as the primary healthcare providers who assess, diagnose, and guide athletes through the recovery process. Their expertise spans various sports settings, including secondary schools, colleges, and professional teams. To provide optimal care, athletic trainers must remain up-to-date with the latest evidence-based guidelines, assessment techniques, and management strategies.³ The limitations of current concussion assessment tools and management strategies highlight the need for improved approaches to ensure athlete safety and optimal recovery. Ongoing research aims to improve the accuracy of concussion diagnosis and management, including the development of innovative technologies that aid in concussion detection and monitoring. By staying current with the latest research and guidelines, healthcare professionals can provide the best possible care for athletes with concussions, minimizing the risk of further injury and promoting safe return-to-play decisions.

This systematic review aims to synthesize current evidence on sport-related concussion (SRC) management practices, challenges, and areas for improvement among healthcare professionals. By examining the existing literature, we can identify gaps in knowledge and practice, inform the development of evidence-based guidelines, and ultimately improve the care and outcomes for athletes with concussions.

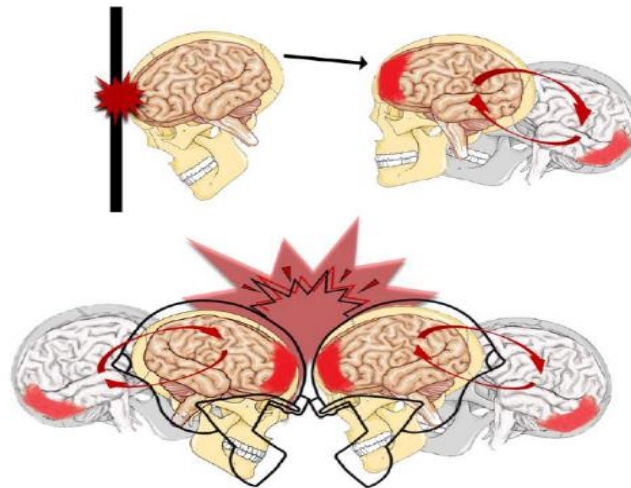


Fig 1:Concussion, also known as traumatic brain injury (TBI), can disrupt normal brain functions. Such injuries may result in bruising and swelling of the brain, as well as damage to blood vessels and nerves, which contribute to the concussion itself. The brain, composed of soft tissue, is safeguarded by blood and cerebrospinal fluid. When the skull undergoes a sudden shock or impact, the brain may shift and strike against the inner surface of the skull. While most concussions are mild and can be effectively managed with proper care, neglecting treatment can lead to severe consequences.⁴

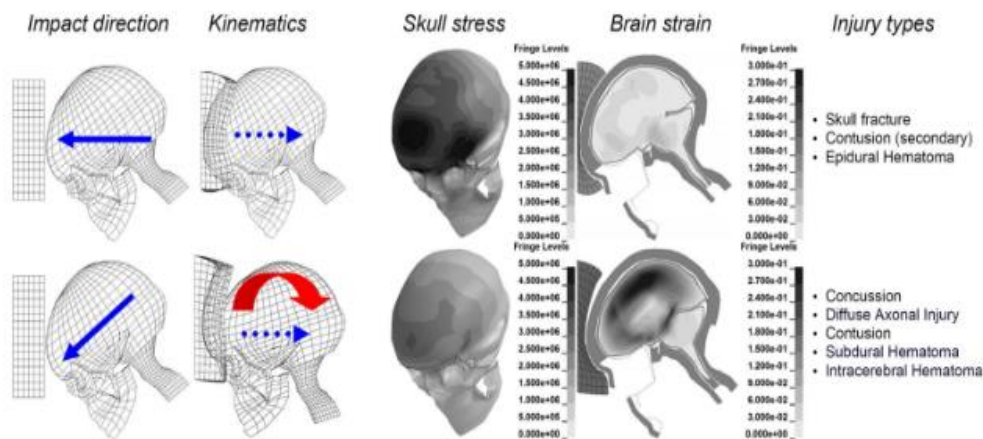


Fig 2:Shows biomechanical comparison of oblique (angled) versus perpendicular (direct) impacts on identical padding at 6.7 m/s velocity.⁵

Method

A thorough search of PubMed, Scopus, and Google Scholar databases was performed to identify relevant literature. The inclusion criteria focused on peer-reviewed studies published between 2016 and 2024 that examined:

- Knowledge and attitudes toward SRC.
- Assessment and management practices.
- Psychological outcomes post-concussion.

Nine studies were selected based on relevance and methodological quality. These included cross-sectional surveys, observational studies, and systematic reviews involving athletic trainers, physicians, physical therapists, and athletes.

SCOPE OF THE STUDY

This study explores the current landscape of sport-related concussion (SRC) management by systematically reviewing existing literature on the knowledge, attitudes, assessment practices, and management strategies employed by healthcare professionals. The scope encompasses:

- Population Focus: Healthcare providers involved in SRC care, including athletic trainers, general practitioners, emergency physicians, and physical therapists across various levels of sport (youth, amateur, and professional).
- Geographic Range: Studies from diverse international settings to capture global practices and regional differences in concussion management.

- Thematic Areas:
 - Awareness and understanding of concussion symptoms and risks.
 - Use and adherence to evidence-based concussion assessment tools and return-to-play (RTP) protocols.
 - The role of professional training and educational background in influencing SRC management.
 - Recognition and integration of mental health concerns, such as depression and suicidality, in concussion care.
- Time Frame: Literature published between 2016 and 2024 to reflect recent advancements and current challenges in SRC management.
- Outcome Objective: To identify critical knowledge gaps, inconsistencies in practice, and opportunities for improvement in SRC care, ultimately guiding the development of standardized, multidisciplinary management strategies.

This study does not focus on the biomechanics of concussion, long-term neurodegenerative outcomes, or pharmacological interventions, as the primary emphasis is on clinical management and professional practices.

NEED FOR THE STUDY

Sport-related concussions are increasingly common, yet their management remains inconsistent across healthcare settings. Many professionals lack formal training and do not consistently follow evidence-based guidelines, leading to risks in diagnosis, treatment, and return-to-play decisions. Additionally, the psychological effects of concussions, such as depression and suicidality, are often underrecognized. This study is needed to highlight existing gaps, promote standardized practices, and support the integration of mental health in concussion care.

Review of literature

Mental Health Impact of Sport-Related Concussions

Fogarty K.et al (2024), did a study to examine the relationship between sports-related concussions (SRC) and internalizing problems (depression, self-harm, and suicidality) in a representative sample of 4,668 youth, with 547 reporting SRC experiences. Significant associations were found between SRC and depression (AOR = 1.32), suicidality (AOR = 2.68), and self-harm (AOR = 1.97). Notably, African American students with SRC were at increased risk, while Latinx youth showed mental health resilience post-concussion. The findings advocate for population-specific health promotion measures, SRC education, and timely psychological evaluation and support.⁶

Andersson J M.et al (2024), did a cross-sectional study to examine the relationship between concussion history, psychological distress, and hazardous gambling in 459 high school students (ages 16-18). The findings showed that the students with 3+ concussions were more likely to experience moderate-severe psychological distress (OR = 2.71) & concussion history was not associated with hazardous gambling. The study suggests that adolescents with multiple concussions should undergo mental health evaluations beyond the acute phase of injury to identify and treat psychological distress.⁷

Knowledge and Awareness among Healthcare Providers

Oxford W S.et al (2023), did a cross-sectional study to assess knowledge and attitudes towards sport-related concussion (SRC) among 141 key stakeholders in touch rugby. Results showed high to very high concussion knowledge (median CKI score: 21 ± 2.0) and safe attitudes (median CAI score: 67 ± 6.3). However, only 32% were aware of concussion guidelines and 39% reported previous SRC. The study suggests targeted education by individual associations and the governing body to further improve knowledge and attitudes.⁸

Thomas E. et al (2021), did a cross-sectional study to explore Western Australian General Practitioners (GPs) exposure, knowledge, confidence, and management of concussion, revealing varied knowledge surrounding concussion guidelines, diagnosis, and management among 66 respondent GPs. Notably, familiarity with concussion guidelines was significantly associated with correctly identifying concussion symptoms (84% of those unfamiliar with guidelines answered incorrectly, $p = 0.039$) and confidence in diagnosis (78% of confident GPs had heard of guidelines, $p = 0.029$). However, guideline familiarity didn't impact confidence in managing concussion, highlighting a need for additional education and support. Surprisingly, none of the respondents correctly identified all signs of concussion and excluded distractors, underscoring the importance of promoting concussion guidelines and targeted education.⁹

Sirisena D.et al (2018), did a study to assess emergency physicians understanding and management of sports concussion in Singapore. Out of 65 emergency physicians, 52 (80%) responded, with 48.1% being medical officers. The results showed significant knowledge gaps: 90% had not received formal training in concussion management, 76.9% recognized that loss of consciousness was not essential for diagnosis, but only 46.2% knew the most common symptom. Furthermore, 50% incorrectly reported that they would perform brain imaging, and 55.8% would refer concussed patients to neurosurgery. These findings highlight the need for targeted education programs to improve emergency physicians' knowledge and management of concussion.¹⁰

Assessment and Management Practices

Almansour. et al (2024), did a cross-sectional study to evaluate the knowledge, attitude, and practice of 83 sports physical therapists in Riyadh, Saudi Arabia, regarding sport-related concussion (SRC) management, revealing that they demonstrated good understanding and knowledge of concussions with a score of 3.91 ± 0.98 on a 5-point Likert scale. While they correctly recognized concussion signs and symptoms, they lacked confidence in making return-to-play decisions. Notably, the study identified knowledge gaps in specific areas, including the utilization of concussion severity scales, management of youth concussion, and the use of neurological imaging modalities for diagnosing concussion cases, highlighting the need for targeted education and training to improve SRC management among physical therapists.¹¹

Lempke B L et al (2020), did a cross-sectional study to examine concussion assessment and management practices among 1307 athletic trainers (ATs), revealing that they reported assessing a median of 12 concussions per year. The most common assessment tools used were clinical examination (95.3%) and symptom assessment (86.7%), with 52.7% of ATs using a 3-domain minimum multidimensional concussion-assessment battery. Notably, ATs with master's degrees were 1.36 times more likely to use a 3-domain battery than those with bachelor's degrees, and collegiate ATs were 2.12 and 1.63 times more likely to use a 3-domain battery than high school and clinic-based ATs, respectively. Published return-to-participation (RTP) guidelines (91%) and clinical examination (88.2%) were the most common RTP decision-making tools. Despite progress, nearly half of ATs didn't use a 3-domain assessment battery, highlighting the need for multidimensional assessments to ensure optimal diagnosis and management.³

Baugh M C et al (2016), did a cross-sectional survey to examine concussion diagnosis and management practices among 527 NCAA member colleges, revealing that while 95% of schools administered pre-participation baseline examinations, most (87.5%) only did so for high-risk athletes. Computerized neurocognitive testing and balance assessments were commonly used, but multi-modal examinations, as recommended by guidelines, were underutilized. The majority of clinicians adhered to NCAA concussion guidelines during the initial 24-hour post-injury period. Notably, Division I schools had shorter return-to-play times (9.13 days) compared to Division III schools (10.31 days), and more frequently referred athletes to physicians within 24 hours, highlighting some variation in management patterns across divisions. Overall, while concussion management incorporates some guideline-recommended elements, there is room for improvement, particularly in increasing the use of multi-modal baseline and post-injury examinations.¹²

Limitations in Balance and Symptom Assessment

Sweeny M et al (2020), did a cross-sectional observational study to characterize balance deficits in 100 community-dwelling adults with acute concussion and 20 healthy controls, revealing significant group differences in BESS scores (concussion: 16.0 ± 6.0 , control: 12.6 ± 3.8 , $p = .017$) and anteroposterior and mediolateral high-frequency power ($p < .001$ and $p = .002$). Notably, participants with concussion reporting balance and dizziness symptoms and those without symptoms showed less stability than controls in mediolateral high-frequency power, highlighting that clinical and posturographic measures didn't align with self-reported balance symptoms. These findings emphasize the need for careful selection of optimized balance assessments in research and clinical practice to accurately capture balance deficits in individuals with concussion.¹³

Result

The review revealed several key findings:

4.1 Knowledge Gaps among Stakeholders

Across multiple studies, a consistent theme is the lack of formal training and knowledge about concussion guidelines. For example, Sirisena et al. reported that 90% of emergency physicians in Singapore had never received formal SRC training. Similarly, Oxford et al. found that less than one-third of rugby stakeholders were familiar with concussion guidelines despite high overall knowledge scores.

Implication:

Without guideline awareness, healthcare professionals may misdiagnose or improperly manage SRC, leading to increased risk for long-term complications.

4.2 Inconsistent Assessment and Management Practices

Studies by Baugh and Lempke show that although most institutions use some form of baseline or post-injury testing, only half employed comprehensive multi-domain assessment batteries (including cognition, balance, and symptom checklists). Moreover, RTP decisions varied widely, especially between high-level and lower-tier sports programs.

Implication:

Lack of standardization in assessment tools creates variability in diagnosis and RTP clearance, potentially jeopardizing athlete safety.

4.3 Return-to-Play (RTP) and Confidence

Almansour et al. revealed that even knowledgeable physical therapists lacked confidence in making RTP decisions, especially when working with youth athletes or interpreting neuroimaging. Lempke et al. noted that more educated and collegiate-level trainers were more likely to use comprehensive assessments.

Implication:

Confidence and correct application of RTP protocols are linked to educational background and experience. More structured training could improve consistency.

4.4 Mental Health Considerations

Several studies, including Fogarty and Andersson, emphasized the psychological impact of SRC. Youth with multiple concussions were significantly more likely to report depression and suicidality, underscoring the long-term risks of unmanaged concussion effects.

Implication:

Psychological screening should be a routine part of post-concussion care. Ignoring these issues can exacerbate long-term mental health consequences.

4.5 Deficiencies in Balance Testing

Sweeny et al. found that individuals with concussion showed quantifiable balance impairments, even when they didn't self-report symptoms. This discrepancy highlights the limitations of relying solely on subjective reports or basic clinical tools.

Implication:

Incorporating objective, technology-supported balance assessments could improve diagnosis and tracking of concussion recovery.

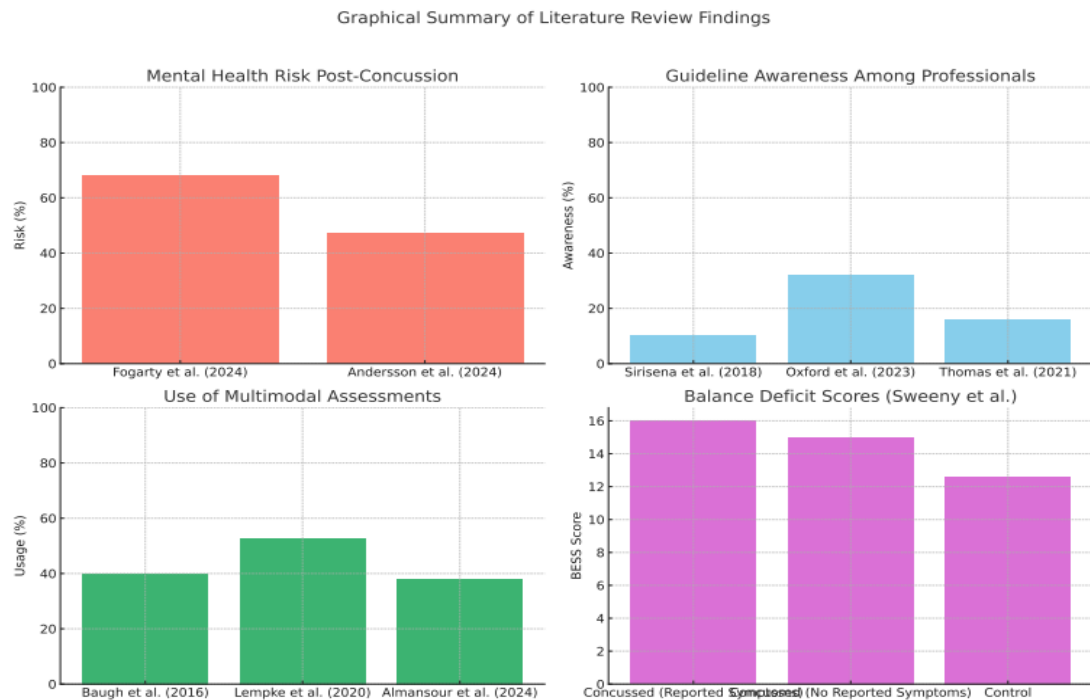


Fig 3:Shows graphical representation of the literature review findings

Discussion

This review illustrates systemic deficiencies in how SRC is assessed and managed. Despite growing awareness, concussion care remains inconsistent across healthcare settings. A lack of formal training, poor guideline adherence, and inadequate assessment tools all contribute to this problem.

Strategies for Improvement:

- **Standardized Education Programs:** Targeted training modules for athletic trainers, general practitioners, emergency physicians, and therapists.
- **Protocol Enforcement:** Institutions and sports organizations must ensure that evidence-based RTP guidelines are implemented and audited.
- **Mental Health Integration:** Post-concussion care should include mandatory psychological evaluation and follow-up.
- **Advanced Diagnostic Tools:** Expand the use of balance and cognitive technologies (e.g., force plates, computerized neurocognitive tests).
- **Youth-Specific Management:** Develop protocols tailored to pediatric and adolescent athletes.

FUTURE SUGGESTIONS:

- Further research is needed to examine the effectiveness of different concussion management strategies and protocols.
- Studies should investigate the impact of targeted education and training programs on healthcare professionals' knowledge, attitudes, and practices in concussion management.
- Research should focus on developing standardized guidelines and protocols for concussion management that can be applied across different healthcare settings.

Conclusion

Sport-related concussion is a complex injury with significant physical and psychological implications. While awareness has improved, this review identifies critical weaknesses in education, assessment, and management across various healthcare settings. To ensure athlete safety and optimal recovery, it is imperative to implement standardized guidelines, provide interdisciplinary training, and adopt comprehensive assessment strategies. A multifaceted approach will help close the gap between current practices and best-practice concussion care.

Acknowledgements

We would like to extend our gratitude to the authors of previous studies on sport-related concussion management, whose work has laid the foundation for our research. Specifically, we acknowledge the contributions of Stuart et al., Hunt and Asplund, Lempke et al., and others who have advanced our understanding of concussion diagnosis, assessment, and management. We also wish to thank my co-author for his invaluable collaboration, expertise, and dedication to this project. This study would not have been possible without the collective efforts of researchers in this field, and we are grateful for their contributions to the advancement of concussion management.

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