Sport-related concussions in athletes with disabilities: A review and synthesis of the literature

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1 Introduction

Sport-related concussions (SRC) are a concern for athletes with disabilities. SRCs are of particular concern when those athletes participate in high-speed and high-contact sports such as para alpine skiing and para ice hockey (Weiler et al., 2021). There's limited research studying SRC in athletes with disabilities (Fudge, 2020; Kissick & Webborn, 2018). However, due to the potential short-term and long-term implications of an SRC on an athlete's health and well-being, it's essential that individuals involved in sport for persons with disabilities (para sport) are familiar with the current best practices around SRC assessment, management and prevention. To ensure that athletes with disabilities have safe sport experiences, health practitioners, sport organizations and sport participants can use this review's information to inform their decisions around SRC in para sport (for example, rule changes).

2 Purpose

This review's purpose was to explore the research focused on SRC assessment, management and prevention strategies in para sport. Specifically, this review identified how SRC strategies may be adapted to be more inclusive of athletes with diverse abilities.

3 Search strategy

To explore the literature looking at SRC in para sport, we searched 4 databases (PubMed, DOAJ, Elsevier Science Direct, and Google Scholar) between January and March 2021, using the terms “concussion” and “para sport” or “athletes with disabilities” and “management” or “assessment” or “prevention.” We limited searches to articles published in English from the years 2014 to 2021. We identified additional articles to include through our manual search of reference lists in key articles included in the initial review. In total, we identified 19 articles to include in this review.

4 Summary of findings

4.1 SRC assessment

The Concussion in Para Sport (CIPS) group, a multidisciplinary group of experts in SRC, suggests that on-field and off-field SRC assessment should be performed using the Sport Concussion Assessment Tool 5th Edition[1] (SCAT-5: Weiler et al., 2021). The SCAT-5 is currently the most well-established test for sideline SRC assessment (Fudge, 2020; Kissick & Webborn, 2018). However, while the SCAT-5 has been well established for use in the able-

[1] SRC diagnosis should not be based solely on the results of the SCAT-5 (Weiler et al., 2021).

bodied population (Kissick & Webborn, 2018), this tool hasn't been as well validated for assessing SRC in athletes with disabilities (Weiler et al., 2021).

In particular, researchers have noted that some elements of the SCAT-5 may not be inclusive for athletes with diverse abilities (Kissick & Webborn, 2018; Weiler et al., 2021). The reason is that various elements of the SCAT-5 require athletes to stand, read and communicate verbally. For example, the Balance Error Scoring System portion of the SCAT-5 can't be performed by athletes who use wheelchairs (Kissick & Webborn, 2018). Thus, researchers have suggested an alternative test for postural stability, called the Wheelchair Error Scoring System (WESS: Moran et al., 2020). The WESS requires athletes to perform several seated postural stability tasks with their eyes open and closed (Moran et al., 2020; Kissick & Webborn, 2018), such as performing a wheelie (that is., bringing the front wheels of their wheelchair off the ground). While the WESS requires further validation (Kissick & Webborn, 2018; Weiler et al., 2021), it's a promising adaptation for the SCAT-5.

Adaptations to the SCAT-5 may also be required for athletes with other impairments (Kissick & Webborn, 2018; Webborn et al., 2018; Weiler et al., 2021), including those that affect speech and cognition. Boccia Canada, the boccia delivery arm of the Canadian Cerebral Palsy Sports Association, has suggested that communication boards may be used when assessing memory and concentration in athletes with verbal impairments. An extensive list of considerations for using the SCAT-5 in assessing SRC in athletes with disabilities can be found in the Concussion in para sport consensus statement (Weiler et al., 2021).

It may be important to have baseline measures for athletes with disabilities. In a study exploring baseline SRC assessment in adapted athletes, Moran and colleagues (2020) noted that 81% of adapted athletes had higher baseline symptom severity scores than able-bodied athletes. These findings are consistent with those found by Weiler and colleagues in 2016. In their study, Weiler et al. (2016) found that soccer players who had a disability (for example, cerebral palsy) had higher baseline symptom scores than those without a disability. Sport organizations may not be able to make SCAT-5 baseline testing mandatory, because the tool hasn't been well validated for use with athletes with disabilities (Weiler et al., 2021). However, they may consider encouraging baseline testing as it can help identify individual differences, which may support SRC assessment (Peltonen et al., 2018).

4.2 Management

There's limited research exploring SRC management for athletes with disabilities (Kissick & Webborn, 2018). However, like in the able-bodied population, the 4 Rs (recognize, remove, refer, return) of SRC management[2] can be used to guide an athlete's recovery. Depending on an athlete's impairment, special consideration may be required during the SRC management process (Kissick & Webborn, 2018; Weiler et al., 2021). For example, wheelchair users may

[2] To learn more about the 4Rs of SRC, please see SIRC's literature review on SRC management and prevention.

require additional assistance in the early stage of recovery (that is, 24 to 48 hours post-injury) to avoid the exertion that can come with activities like wheelchair transfers (Weiler et al., 2021).

To help athletes safely return to sport, organizations working with athletes with disabilities may consider creating sport and impairment-specific, return-to-sport protocols. For example, organizations may recommend activities like light hand-pedalling rather than cycling for athletes who use wheelchairs or mobility aids (Weiler et al., 2021). In general, an individualized approach to SRC management is needed to ensure an athlete's safe re-entry to sport.

4.3 Prevention

Identifying and implementing strategies for change within sport is essential for SRC prevention. This review identified 3 strategies for improving SRC prevention in para sport: 1) education, 2) better enforcement of rules and inclusion of new rules, and 3) neck strengthening.

4.3.1 Education

Improving SRC education may contribute to injury prevention. When athletes understand why they should do something (for example, wear protective equipment or follow the rules), they may be more inclined to do so (Kissick & Webborn, 2018). In their literature review, Enniss and colleagues (2018) noted that educational initiatives targeted at coaches and athletes could reduce the number of high-risk activities in sport (for example, aggressive play). While the studies evaluated by Ennis et al. (2018) were all carried out in able-bodied sports, educational programs in para sport may have similar benefits. With that in mind, organizations should continue to promote SRC education.

Educational initiatives may also improve knowledge around SRC assessment, recognition and management. This is crucial in para sport as there appear to be persistent knowledge gaps around these topics (Derman et al., 2017; Kissick & Webborn, 2018; Webborn et al., 2018; Weiler et al., 2021). The importance of improving SRC education was highlighted in a study by Derman and colleagues (2017), which explored injury rates during the 2016 Paralympic Games. In that study, researchers found that despite several cases of athletes sustaining a hit to the head and appearing unsteady after the impact, no SRCs were reported (Derman et al., 2017). While it isn't known if these athletes sustained an SRC, this study emphasizes the need for improved education around SRC recognition, management and assessment (Derman et al., 2017).

Educational initiatives should target all individuals involved in para sport (for example, coaches, trainers, athletes), because everyone plays a role in SRC recognition and management

(Derman et al., 2017; Kissick & Webborn, 2018; Webborn et al., 2018; Weiler et al., 2021). Additionally, tools that can assist with SRC recognition and management (for example, respectively, the Concussion Recognition Tool 5 and Parachute Canada's Return-to-Sport Strategy) should be shared with all individuals involved in para sport. Organizations may consider adapting these tools to make them more accessible for sport participants (Weiler et al., 2021). For example, by offering the braille or large-text versions of resources (Weiler et al., 2021).

Improving SRC education may be particularly important for athletes with disabilities, due to low SRC reporting by this population (Kissick & Webborn, 2018; Webborn et al., 2018; Wessels, 2014). For example, a study of SRC incidence in wheelchair basketball players found that 50% of athletes didn't report their SRC, because at the time of injury, they didn't recognize that what they had sustained was an SRC (Wessels, 2014). Additionally, it's concerning that even when athletes recognize they've suffered from an SRC, they may not report it. In that same wheelchair basketball study, the researcher noted that some athletes may not report an SRC because they feel an SRC isn't a big deal relative to other health issues they've faced (Wessels, 2014). Therefore, educational initiatives must emphasize the importance of brain safety (Kissick & Webborn, 2018). However, education alone doesnt appear to effectively improve SRC reporting behaviours in athletes (Pennock et al., 2020). As such, efforts should also be made to reduce risk-taking behaviours, which may be prevalent in some para sports (Kissick & Webborn, 2018).

4.3.2 Better enforcement of rules and the inclusion of new rules

Adding new rules may be a way to reduce SRC incidence in para sport. In particular, rules that work to decrease player-to-player contact may reduce the number of SRCs caused by collisions (Halstead et al., 2018). For example, researchers have noted that removing body checking in able-bodied youth ice hockey resulted in nearly a three-fold reduction in SRC occurrence (Black et al., 2016). Similar rule changes in para sport may have similar protective effects.

Additionally, including new rules that allow for SRC assessment without placing an athlete or their team at a disadvantage may help promote more SRC assessment (Weiler et al., 2021). For example, in December 2019, the International Federation of Cerebral Palsy Football (IFCPF) announced a "Temporary Concussion Substitution" rule change (for details, see Ahmed et al., 2020). This rule allows teams to remove a potentially concussed athlete and replace them with a substitute player. A sideline assessor then has a 10-minute window to evaluate the injured athlete. If the athlete is cleared to return to play, they may be substituted back into the game without using up one of the teams' substitutions. Sport organizations should continue to work to identify sport-specific ways to promote SRC assessment and reduce SRC incidence.

As organizations find new ways to encourage safe play, it becomes even more critical for officials to enforce the rules of play. Officials may help discourage dangerous and aggressive playing behaviour by improving rule enforcement and penalizing players for not following the rules (Kissick & Webborn, 2018). For example, researchers have found that better enforcement

of the voy rule in football 5-a-side (soccer for athletes with visual impairments) may decrease SRC incidence (Kissick & Webborn, 2018). The voy rule requires athletes to say “voy” when approaching the ball, which allows the ball carrier to anticipate and avoid collisions (Kissick & Webborn, 2018). Improving enforcement of this rule may reduce player-to-player contact (Kissick & Webborn, 2018), which is known to contribute to this sport’s high incidence of SRC (Webborn et al., 2018).

4.3.3 Neck strengthening

Incorporating neck strength training into an athlete's routine may be a feasible way to reduce injury risk (Hrysomallis, 2016). Researchers have found that individuals with greater neck strength may experience less head movement following an impact (Collins et al., 2014; Honda et al., 2018; Hrysomallis, 2016; Peek at al., 2020), which may reduce SRC risk. The relationship between neck strength and SRC risk reduction in athletes with disabilities requires further investigation. However, an initial study performed by Fitzpatrick and colleagues (2021) noted that blind football (soccer) players who had increased neck strength experienced less linear head acceleration than those with weaker neck muscles, which may contribute to a lower risk of SRC. More research is needed to explore the link between neck strength and SRC risk in para sport, but the initial evidence is promising.

5 Conclusion

This review provides individuals involved in para sport with information to help them understand and adapt SRC assessment, management and prevention strategies. By adapting their strategies accordingly, they can be more inclusive of athletes with all abilities. For example, when it comes to SRC assessment, adaptations to the SCAT-5 may be needed to accurately evaluate if an athlete sustained an SRC. Baseline testing can help identify individual differences and may support SRC assessment. An individualized approach to SRC management should be taken to ensure that an athlete with disabilities doesn't return to sport too soon after an injury. To reduce SRC incidence, organizations should continue to identify new rules. Meanwhile officials should continue enforcing existing rules of play along with any new rules once adopted. Lastly, a critical next step for ensuring athlete’s safety is to improve education around SRC assessment, management and prevention strategies in para sport.

Takeaway points
• Athletes with disabilities may need to be assessed with an adapted version of the SCAT-5. • Baseline testing can support SRC assessment, by identifying individual differences. • There's a need for educational initiatives targeted directly at para sport. • Better enforcement of the rules and the creation of new rules may help reduce SRC incidence.

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