Evidence Summary:
Rugby

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BC INJURY research and prevention unit

The British Columbia Injury Research and Prevention Unit (BCIRPU) was established by the Ministry of Health and the Minister's Injury Prevention Advisory Committee in August 1997. BCIRPU is housed within the Evidence to Innovation research theme at BC Children's Hospital (BCCH) and supported by the Provincial Health Services Authority (PHSA) and the University of British Columbia (UBC). BCIRPU's vision is *to be a leader in the production and transfer of injury prevention knowledge and the integration of evidence-based injury prevention practices into the daily lives of those at risk, those who care for them, and those with a mandate for public health and safety in British Columbia.*

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Evidence synthesis tool

SPORT:	Rugby	**Target Group:**	Amateur/recreational to international/professional; pediatric to adult
Injury Mechanisms:	Tackling [being tackled or tackling] is the predominant injury mechanism, followed by ruck/maul. Injury Types: ligament injuries (sprains and strains), haematoma, contusions and lacerations, and concussions		

Incidence/Prevalence	**Risk/Protective Factors**	**Interventions**	**Implementation/Evaluation**	**Resources**
Professional/ International Level Overall injury rates professional and/or international level rugby range were reported in Williams et al.'s (2013) systematic review and meta-analysis on injuries in men's professional rugby, and a prospective cohort study from the 2015 Rugby World Cup (Fuller et al. 2016a). The injury rate ranged from 35 match injuries /1000 player hours in level one club rugby, to 123 injuries/1000 player hours in international match play. **Rugby Sevens** In a prospective cohort study of international rugby sevens tournaments from 2008-2009 to 2014-2015 by Fuller et al (2016), the match injury rate was found to be 108.3 injuries/1000 match player hours. The concussion rate in this level of competition (as reported in the systematic review and meta-analysis of concussions in Rugby Union) by Gardner et al (2014) has been found to range from 0.40/1000 player hours	**Mouthguards** Tanaka et al. (2015) conducted a retrospective cohort study of high school and competitive recreational rugby players to evaluate history of orofacial injury and history of mouthguard use. The authors found that high school rugby players who reported a one year history of using a personal mouthguard in the 3rd quartile (OR: 0.19 95%CI: 0.04-0.93, p=0.04) and 4th quartile (OR: 0.11, 95%CI:0.02-0.66, p=0.02) had significant decreased probability of reporting an one year history of orofacial injury. Competitive recreational rugby players who reported a one year history of usin- a personal mouthguard in the 4th quartile (OR: 0.27 95%CI: 0.12-0.61, p=0.002) had significant decreased probability of reporting an one year history of orofacial injury. **Training Load** Cross et al. (2016) conducted a	**Rule Changes** Fraas et al. (2016) conducted a systematic review of education interventions to reduce the risk of concussion. There was no evidence to support coach and referee education programmes in reducing concussion rates. There was minimal evidence that education and rule changes resulted in reduced catastrophic injuries. **Exercise Program** Hislop et al. (2017) conducted a cluster randomized controlled trial evaluating the efficacy of a 20-minute exercise program in reducing injuries amongst rugby players, ages 14-28 years old. Hislop et al. (2017) reported reduced head/neck injuries (incidence RR=0.72, 95%CI: 0.51-1.01), upper limb injuries (burden RR=0.66, 95%CI: 0.40-1.10) and concussion (incidence RR=0.71, 95%CI: 0.48-1.05) in those assigned to the intervention group. There were no studies	**Injury Prevention Attitudes** Brown et al (2016) utilized semi-structured interviews with referees and coaches to evaluate perceptions of the BokSmart injury prevention program using the RE-AIM framework. While there was consensus amongst participants that the BokSmart program was capable of reducing injuries and taught them about correct techniques, the barriers differed between roles as well as socioeconomic status (SES). High SES coaches feel like there is a low likelihood of catastrophic injuries, combined with a paradoxical fear of touching injured player secondary to lack of knowledge and fear of litigation, therefore has more negative feelings about the program. Low SES coaches overestimated the impact of the course on their injury prevention capacity. There was also a perception amongst high SES coaches and referees that referees were not able/willing to reinforce BokSmart regulations.	W**ebsites** (http://boksmart.sarugby.co.za) contains links to their concussion medical protocol, "Safe Six" neuromuscular injury prevention program, health and safety policies and procedures, research, training and education, and injury statistics. **The RugbySmart Concussion Toolkit from New Zealand Rugby** (http://nzrugby.co.nz/rugbysmart/concussion) provides education, on the recognition, removal, recovery and return process associated with a suspected concussion. It includes scenarios, checklists, education on correct tackle technique, and information on APPLAUD, a set a guidelines to encourage positive sideline behaviour amongst school and club rugby participants, and spectators. **The international rugby federation, WorldRugby**, has a Player Welfare section on their website (http://playerwelfare.worldrugby.org). Here there is information on concussion, catastrophic injuries,

(overall elite) to 3.9/1000 playing hours (professional rugby). The rate of shoulder injuries ranges from 1.8/1000 playing hours at the semi-professional level to 2.8/1000 playing hours at the professional level. **Community/Amateur Level** The Gardner et al. (2014) systematic review/meta-analysis reported the average concussion rate in amateur rugby ranged from 0.62 concussions/1000 player hours for school boy (ages 14-18 years old) rugby to 2.08/1000 player hours for community level rugby. A prospective cohort of shoulder injuries in community rugby by Singh et al. (2016) reported a rate of shoulder injuries of 1.8 injuries/1000 player hours. **Under-21/Pediatric Population** The Gardner et al. (2014) systematic review/meta-analysis reported the average concussion rate amateur rugby ranged from 0.62 concussions/1000 player hours for school boy rugby. A systematic review and meta-analysis of rugby injuries in players under 21 years old was conducted by Freitag et al in 2015. The overall injury rate was reported as 26.7 injuries/1000	prospective cohort study evaluating the influence of in-season load on injury risk during one season of profession English Premiership Rugby. During the in-season phase, injury risk in the subsequent week increase linearly with an increase of 2 standard deviations (SD) in 1-week loads [1245 arbitrary units (AU) i.e., exposure x sessional rating of perceived exertion] and absolute change in loads (1069 AU) being associated with an increased odds of injury [OR=1.68 (95%CI: 1.05-2.68), OR=1.58 (95%CI: 0.98-2.54), respectively.] Hulin et al (2016) conducted a prospective cohort study in Australian professional rugby league players over two years. The risk of injury with a very high acute chronic workload ratio of >=2.11 was reported to be 6.9 (90%CI: +/-1.7; 98% likelihood, very likely) times greater than very low ratio of <=0.30, 3.4 (90%CI: +/-2.0, 97% likelihood, very likely) times greater than low acute: chronic workload ratio of 0.31-0.66, 2.3 (90%CI:3.4, 91% likelihood, likely) greater than a moderate ratio of 1.03-1.38, and 2 (90%CI:17.2, 77% likely, likely) greater than a high ratio of 1.75-2.10.	evaluating the cost-effectiveness of the interventions conducted in rugby.	**Opportunities and Partnerships** Comprehensive injury surveillance systems would be needed to run these studies. All of the studies that reported rates estimated denominators based on the product of the number of players allowed on the field at a time and the length of a regular game. The education intervention like the ones in Fraas et al (2016) and Brown et al (2016) require collaborative effort of the league, the coaches, the referees and the trainers to implement. Hislop et al (2017) conducted an intervention that requires the development and dissemination of workshops and materials related to the exercise intervention (e.g., DVD of filmed exercises), as well as the participation of coaches for data collection during the season.	injury surveillance, the WorldRugby research programs, and the Rugby Science Network, by way of guidelines, online education videos, research, and expert papers.

player hours. In rugby union the match injury rate ranged from 3.7 injuries greater than 7 days/1000 player hours in U10-U13 age groups, to 129.8 injuries (irrespective of time loss)/1000 player hours in 14-18 year olds. The match injury rate for studies that reported on rugby league ranged from 56.8 injuries with at least 24 hours time loss/1000 player hours in 17-19 year olds, to 217.9 match injuries that required medical advice/attention/1000 player hours in U16 to U18 age groups. The specific injury type rate ranges from included studies are as follows: Ligament/sprain/strain: 3.9-69.2/1000 player hours. Dislocation and subluxation: 0.4-1.3/1000 players hours. Lacerations/contusion and haematoma: 0.4-31.9/1000 players hours. Concussion: 0.8-11.8/1000 players hours. **Women's Rugby** A meta analyses of concussion in rugby (Gardner et al, 2014) reported a mean rate of 0.55 concussions/1000 playing hours in women's 15s rugby. **Wheelchair** A prospective cohort study of	Fuller et al. conducted two prospective cohort studies in international rugby sevens players to evaluate fatigue (2016b) and air travel (2015) as injury risk factors for rugby. The proportion of injuries sustained in the second half of the match in international rugby sevens players was significantly higher than the proportion of injuries sustained in the first half. Extensive travel and/or crossing multiple time zones did not have appear to influence injury risk in the Rugby Sevens World Series.			

Polish wheelchair rugby players by Bauerfeind et al (2015) found that injuries that do not require medical intervention (n=102) were more common in wheelchair rugby than injuries requiring medical attention (n=4). Shoulder girdle and arm muscles were the most common injury locations, and were typically overuse.				
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Review of Sport Injury Burden, Risk Factors and Prevention

Rugby

Incidence and Prevalence

Overall match injury rates in rugby union at the professional and/or high performance level ranged from 35 injuries/1000 player-hours in level one club rugby (Williams, Trewartha, Kemp, & Stokes, 2013) to 123/1000 player-hours in international match play (Fuller, Taylor, Kemp, & Raftery, 2016). Gardner, Iverson, Williams, Baker, & Stanwell (2014) reported match concussion rate ranges from 0.40/1000 player-hours (overall elite level) to 3.9/1000 player-hours in professional rugby. Singh, Trewartha, Roberts, England, & Stokes (2016) reported shoulder injuries in rugby union ranged from 2.8/1000 player-hours at the semi-professional level to 2.8/1000 playing hours at the professional level. Fuller et al. (2016) reported match injury rates in rugby sevens were reported as 108.3/1000 player-hours. Concussion rates amongst women's 15s players have been reported by Gardner et al. (2014) at 0.55 concussions/1000 player-hours. The sole wheelchair rugby study by Bauerfeind, Koper, Wieczorek, Urbański, & Tasiemski (2015) found injuries that required medical attention in wheelchair rugby (n=4) were less common than injuries that did not require medical attention (n=102).

Studies involving community level rugby union have reported concussion rates of 2.08/1000 player-hours (Gardner et al., 2014) and shoulder injuries: 1.8 injuries/1000 player-hours (Singh et al., 2016). Overall match injuries in rugby union players under 21 years of age was reported by Freitag, Kirkwood, & Scharer, (2016) to be 26.7/1000 player-hours. Freitag et al. (2016) reported schoolboy rugby (i.e., ages 14 to 18 years old) match injury rates of 129.8/1000 player-hours, while Gardner et al. (2014) reported schoolboy rugby concussion rates of 0.62/1000 player-hours. Injury rate for injuries with greater than 7 days time loss of 3.7/1000 player-hours in U10 to U13 players (Freitag, 2016). Freitag et al. (2016) also reported match injury rates amongst community/amateur level rugby league players ranged from 56.8 injuries with at least 24 hours time loss/1000 player-hours in 17-19 year olds, to 217.9 match injuries that required medical attention/1000 player-hours in U16 to U18 players.

Tackling (i.e., being tackled or tackling) has been associated with 34%-99% of rugby injuries (Freitag et al, 2016; Gardner et al., 2014; Singh et al., 2016). Ruck/maul injuries and scrum injuries were the other common injury mechanisms.

In rugby union players, ligament injuries, sprains and strains have reported a rate range from 3.9-69.2/1000 player-hours, and prevalence range from 15.7% to 47.2% (Freitag et al., 2016; Williams et al, 2013). Concussions have reported a rate range from 0.6-11.8/1000 players-hours, and prevalence range from 2.2% to 24.6% (Freitag et al., 2016; Williams et al, 2013). The rate of dislocations and subluxations ranges from 0.4-1.3/1000 player-hours, and prevalence ranges from 0.5% to 10.8% (Freitag et al., 2016; Williams et al, 2013). The rate of lacerations/contusion and hematoma ranged from 0.4-31.9/1000 players hours, with prevalence ranges from 2.7%-46% (Freitag et al., 2016; Williams et al, 2013). The fracture rate ranges from 0.8-11.3/1000 player-hours (Williams et al, 2013). Bauerfeind et al. (2015) reported that overuse injuries dominated in

wheelchair rugby, with shoulder girdle and arm muscles being the most common injury location.

There are more studies in this area of rugby injury prevention than any other, but they are not distributed in such a way that they are representative of all rugby players. For example, more work is needed to understand the injury burden amongst wheelchair rugby and young female rugby players.

Risk and Protective Factors

Risk and protective factors examined in rugby include: mouthguard use, training loads, fatigue, and air travel prior to tournaments.

Mouthguard Use

Tanaka, Maeda, Yang, Ando, Tauchi, & Miyanaga, (2015) reported that high school rugby players with the highest and second highest self-reported mouthguard use over one year had odds of sustaining an orofacial injury in that same year of 0.11 (95%CI:0.02-0.66), and 0.19 (95%CI: 0.04-0.93), respectively. Tanaka et al. (2015) also reported that competitive recreational rugby players who reported a one year history of using a personal mouthguard in the 4th quartile (OR: 0.27 95%CI: 0.12-0.61) had significant decreased probability of reporting an one year history of orofacial injury.

Training Load

The odds of injury increased with linearly with weekly load increases [OR 1.68(95%CI:1.05-2.68)] and load increases greater than 2 standard deviations [OR 1.58 (95%CI:0.98-2.54] in professional rugby union by Cross, Williams, Trewartha, Kemp, & Stokes (2016). Hulin, Gabbett, Caputi, Lawson, & Sampson (2016) reported the risk of injury in professional Australian league players with a very high acute: chronic workload ratio of >=2.11 was reported to be 6.9 (90%CI: +/-1.7; 98% likelihood, very likely) times greater than very low ratio of <=0.30. The risk of injury was 3.4 (90%CI: +/-2.0, 97% likelihood, very likely) times greater than low acute: chronic workload ratio of 0.31-0.66, and 2.3 (90%CI: 3.4, 91% likelihood, likely) greater than a moderate ratio of 1.03-1.38, and 2 (90%CI:17.2, 77% likely, likely) greater than a high ratio of 1.75-2.10 (Hulin et al., 2016).

Fatigue

Fuller, Taylor, & Raftery (2016) reported that the proportion of injuries sustained in the second half of the match in international rugby sevens players was significantly higher than the proportion of injuries sustained in the first half.

Air Travel

Fuller, Taylor, & Raftery (2015) reported no significant difference in injury risk in international rugby sevens players exposed to extensive air travel and/or multiple time zones prior to tournaments in the Sevens World Series.

There is an overall paucity of studies of intervention studies. Other limitations include limited generalizability, particularly to female rugby players, community level rugby league

players and wheelchair rugby players. There was also significant heterogeneity across studies, so even when systematic reviews or meta-analyses were attempted, the pooled data may not have reflected all available studies retrieved. There is a lack of multivariable analyses/accounting for known risk factors like history of injury/concussion.

Opportunities for Prevention: Effective Interventions, Cost-Effectiveness, Implementation and Evaluation

Fraas & Burchiel (2016) reported that coach and referee education programmes did not significantly impact concussion rates, and found minimal evidence that education and rule changes resulted in reduced catastrophic injuries. A recently published cluster RCT by Hislop, Stokes, Williams, McKay, England, Kemp & Trewartha (2017 reported that a 20-minute warm up program in schoolboy rugby players resulted in reduced head/neck injury incidence rate (RR=0.72, 0.51 to 1.01), upper limb injury severity (RR=0.66, 0.40 to 1.10) and concussion incidence rate (RR=0.71, 0.48 to 1.05) 14-18 (all with >95% likelihood).

Implementation and Evaluation

The one study evaluating implementation was conducted by Brown, Verhagen, van Mechelen, Lambert, & Draper (2016) amongst South African referees and coaches regarding their perceptions of the BokSmart injury prevention education program. While coaches and referees believe the program could help prevent injuries and taught them proper technique, the barriers to using the program varied by socioeconomic status (Brown et al., 2016). High SES coaches felt like there was a low likelihood of catastrophic injuries, and had fear of touching injured player secondary to lack of knowledge and fear of litigation, resulting in more negative feelings about the program (Brown et al., 2016). Low SES coaches overestimated the impact of the course on their injury prevention capacity (Brown et al., 2016). High SES coaches as well as referees felt that referees were not able/willing to reinforce BokSmart regulations (Brown et al., 2016).

Similar to intervention studies, there is a paucity of literature with respect to injury prevention effectiveness, implementation and evaluation in rugby.

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