ACTIVE & SAFE

Evidence Summary:
Water Polo

Devon Williams, BSc, MSc

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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.*

Author: Devon Williams

Editors: Sarah A Richmond, Amanda Black

For any questions regarding this report, contact:

BC Injury Research and Prevention Unit
F508 – 4480 Oak Street
Vancouver, BC V6H 3V4
Email: bcinjury1@cw.bc.ca
Phone: (604) 875-3776
Fax: (604) 875-3569
Website: www.injuryresearch.bc.ca

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UBC BC Children's Hospital Research Institute

Evidence synthesis tool

SPORT:	Water Polo	**Target Group:**	Competitive Water Polo players (males and females – teenager and adults)
Injury Mechanisms:	Common injury mechanisms include collisions with other players and being struck by the ball. Common mechanisms for overuse injury (particular in the shoulder includes altered throwing technique, over-training, and rapid rotational movement		

Incidence/Prevalence	**Risk/Protective Factors**	**Interventions**	**Implementation/Evaluation**	**Resources**
There are very few descriptive studies that document the incidence and/or prevalence of injury in water polo. The limited data that we do have available is from Olympic competitions. During the 2012 London Summer Olympic Games, for example, 260 athletes competed in the sport of water polo with 34 sustaining injuries. Of those injuries, 26 were sustained during competition while 7 were sustained during training. None of the injuries resulted in > 7 days of absence (Engebretsen et al., 2013). According to data published from the Rio de Janeiro 2016 Olympic Summer Games, water polo was among the top 5 high injury incidence sports. Water polo injuries accounted for 19% of the 1,101 injuries recorded. Furthermore, the injury incidence was higher in competition than in training (RR= 3.56 (1.70-7.45)(Soligard et al., 2017). **Shoulder Injury** Shoulder injuries account for the largest percentage of injury among elite and sub-elite athletes. The	**<u>Risk Factors</u>** **Sex** A higher percentage of women (43.9% females' 31.26% males) report sustaining a concussion at all levels of play and position. Men, on average, numerically report more concussions (Bluemnfeld et al., 2016). **Over-Training** Ellapen et al. (2012) found that over-training (88.00% [p<0.001]), rapid rotational movement (8.00%) and collision with players (2.66%) are risk factors for musculoskeletal injury among adolescent male water polo players. **Volume of Shooting** Wheeler at al. (2013) found that the volume of goal shooting increased shoulder soreness in high performance women's water polo. Modelling demonstrated that	No high quality intervention studies were identified through this search. Interventions for further exploration: • Protective eyewear • Mouth guards • Tooth rescue boxes	No high quality implementation/evaluation studies were identified through this search. Recommendations: High quality intervention/evaluation studies are needed. Suggestions from articles included: Enhanced concussion data collection (systematically reported) with a focus on exposure risks. Monitoring goal-shooting workloads for each individual athlete to predict injury risk. Headgear for goalies. **Barriers for Mouthguard Use** Athletes feel they are unnecessary (Hershberger 2012)	**Websites** http://www.stopsportsinjuries.org/STOP/STOP/Prevent_Injuries/Water_Polo_Injury_Prevention.aspx https://www.healthychildren.org/English/healthy-living/sports/Pages/Water-Polo.aspx

incidence of shoulder problems ranges from 24 – 80% (Webster et al., 2007). A study by Ellapen et al. (2012), examining the prevalence of water polo related musculoskeletal pain among competitive adolescent male water polo players residing in South Africa, found that the most common anatomical sites that sustained injury were: • shoulder (51.4%), • knees (23.95%) and • vertebral column (17.71%). **Concussion** A recent observational study conducted by Blumenfeld et al. (2016) explored the incidence of head injury and concussion among water polo players. The study found that 36% of all respondents to the survey reported sustaining a concussion while playing the sport, with an average of 2 concussions reported. Interestingly, the prevalence and number of concussions reported varied across genders, age groupings, and field position and competition level. Goalies were found to be at an increased risk for concussion and report a significantly more concussions. **Eye Injury** Eye injury rates are low (Dain, 2016)	shoulder soreness was predicted through the rest time between shots during training sessions (p=0.032) **Position/Level of Play** Blumenfeld et al. (2016) found that field position (goalie status [odds-ratio = 1.12 t(639) = -2.53, p=0.01), length of play (not reported), level of competition (highest competition level [odds-ratio = 1.05, t(639) = -3.95, p = 0.0001] and sex [odds-ratio = 0.91, t(639) = -3.05, p = 0.002] were risk factors for concussion and head injury among elite water polo athletes.			

Dental Injury Among the 424 recorded dental injuries during the 2007 Pan American Games, 20 occurred in the sport of water polo (Andrade et al., 2010).				
Works Cited: Andrade, R., Evans, P., Almeida, A., da Silva, J., Guedes, A., Guedes, F., Ranalli, D., Modesto, A. and Tinoco, E. (2010). Prevalence of dental trauma in Pan American Games athletes. *Dental Traumatology*, 26 (3), 248–53. Blumenfeld, R., Winsell, J., Hicks, J. & Small, S. (2016). The epidemiology of sports related head injury and concussion in water polo. *Frontal Neurology*, 7, 98. Dain, Stephen J. (2016). Sports eyewear protective standards. *Clinical & Experimental Optometry*, 99 (1), 4–23. Ellapen, T., Stow, C., Macrar, N., Millne, J. & Hendrick, J. (2012). Prevalence of musculoskeletal pain among competitive high school male water polo players in Kwq Zulu Natal, South Africa. *Postepy Rehabilitacji*, (3), 5-10. Engebretsen, L. Soligard, T., Steffen, K., Alonso, J., Aubry, M., Budgett, R., Dvorak, J., Jegathesan, M., Meeuwisse, W., Mountjoy, M.,	**Works Cited:** Blumenfeld, R., Winsell, J., Hicks, J. & Small, S. (2016). The epidemiology of sports related head injury and concussion in water polo. *Frontal Neurology*, 7, 98. Ellapen, T., Stow, C., Macrar, N., Millne, J. & Hendrick, J. (2012). Prevalence of musculoskeletal pain among competitive high school male water polo players in Kwq Zulu Natal, South Africa. *Postepy Rehabilitacji*, (3), 5-10. Wheeler, K., Kefford, T., Mosler, A., Lebedew, A. & Lyons, K. (2013). The volume of goal shooting during training can predict shoulder soreness in elite female water polo players. *Journal of Science and Medicine in Sport*. 16: 255-258.	**Works Cited:** Andrade, R., Evans, P., Almeida, A., da Silva, J., Guedes, A., Guedes, F., Ranalli, D., Modesto, A. and Tinoco, E. (2010). Prevalence of dental trauma in Pan American Games athletes. *Dental Traumatology*, 26 (3), 248–53. Dain, Stephen J. (2016). Sports eyewear protective standards. *Clinical & Experimental Optometry*, 99 (1), 4–23.	**Works Cited:** Blumenfeld, R., Winsell, J., Hicks, J. & Small, S. (2016). The epidemiology of sports related head injury and concussion in water polo. *Frontal Neurology*, 7, 98. Ellapen, T., Stow, C., Macrar, N., Millne, J. & Hendrick, J. (2012). Prevalence of musculoskeletal pain among competitive high school male water polo players in Kwq Zulu Natal, South Africa. *Postepy Rehabilitacji*, (3), 5-10. Hersberger, S., Krasti, G., Kuhl, S., Filippi, A. (2012). Dental injuries in water polo, a survey of players in Switzerland. *Dental Traumatology*, 28: 287-290;	.

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Review of Sport Injury Burden, Risk Factors and Prevention

Water Polo

Incidence and Prevalence

Water polo is an extremely fast-paced game played over the course of four, eight-minute periods. Each team consists of a goalie and six field players, alternating between defensive and offensive plays. The sport requires a significant amount of endurance as players are required to tread water for several minutes at a time while throwing, defending, wrestling and tackling (Mosley et al., n.d.; Water Polo Canada, 2014). There are very few descriptive studies that document the incidence and/or prevalence of injury in water polo. The limited data that we do have available is from Olympic competitions. During the 2012 London Summer Olympic Games, for example, 260 athletes competed in the sport of water polo with 34 players sustaining injuries. Of those injuries, 26 were sustained during competition while 7 were sustained during training. None of the injuries resulted in > 7 days of absence (Engebretsen et al., 2013). According to data published from the Rio de Janeiro 2016 Olympic Summer Games, water polo was among the top 5 high injury incidence sports. Water polo injuries accounted for 19% of the 1,101 injuries recorded (Soligard et al., 2017).

Common Injury Types

<u>Shoulder Injury</u>

Proper swimming technique in water polo requires the head to be up out of the water for prolonged periods of time, either while in possession of the ball or monitoring the game play (Mosely et al., n.d.). Swimming with the head out of the water puts the elbows at a higher position relative to the body, involving extension of the neck and shorter arm strokes (Mosley et al., n.d.). This technique places stress on the cervical spine and shoulders (Mosley et al., n.d.). A recent systematic review found that shoulder injuries account for the largest percentage of injury among elite and sub-elite water polo players with the incidence of shoulder problems ranging from 24 to 80% (Webster et al., 2007). The review included articles involving both male and female water polo players between the ages of (~16 years and 33 years). Additional literature not included in the review supports the finding that the most common injury among high school water polo players is to the shoulder (Ellapen et al., 2012).

Several mechanisms of shoulder injury have been identified including: muscle strength imbalance (caused by improper training) (Moseley et al., n.d.; Webster et al., 2007), hypermobility (Webster et al., 2007, altered throwing techniques (Webster et al., 2007), over-training/overuse (Mosley et al., n.d.; Webster et al., 2007; Ellapen et al., 2012) and rapid rotational movements (caused by throwing, catching and defending) (Ellapen et al., 2012). Rapid rotational movement of the shoulder joint accounts for 8.00% of reported pain and injury in water polo. While less common, collisions with other players account for 2.66% of all reports of shoulder injury. While not all collisions can be avoided, policies can be explored, similar to the body checking policies introduced in the sport of hockey, to decrease the amount of contact

between players (Macpherson et al., 2006). Future studies should explore shoulder mobility, strength, throwing action, swimming drills and sports specific strength programs using evidence-based measurement tools to decrease the impact of rapid rotational movement.

Knee Injury

The eggbeater kick is commonly used in the sport of water polo to elevate athlete's bodies for prolonged periods before firing the player out of the water for defending, tackling, passing or shooting purposes (Mosely et al., n.d.). This type of kick produces stress on the medial aspect of the knee. While limited high quality evidence exists, literature (based on self-reported data) has been published citing the knee as the body site with the second highest degree of musculoskeletal pain among High School aged male water polo athletes.The challenge is that although self-reported data provide investigators with the respondents' views directly, validity problems, deception (of self or others), lack of conscious awareness and attribution biases can occur. High quality studies of knee injury among water polo players are needed. Several mechanisms of knee injury have been identified including: over-training/overuse (Ellapen et al., 2012) and blows to the knee (most commonly caused collisions with other players) (Ellapen et al., 2012).

Head Injury/Concussion

Water polo is a contact sport and thus head injury and concussion risk is of significant concern and are not an uncommon injury type (Bluemfeld et al., 2016). Sex, field position, and level of play are all critical factors in determining the risk of injury. Overall, it is reported that approximately 36% of water polo players have sustained a concussion while playing the sport. According to the data, females are at an increased risk of sustaining a concussion (43.5% versus 30.8% in their male counterparts), although this may be a reflection of underreporting in the male population. Goalies are also identified as being at an increased risk for concussion (approximately 47%). As suspected, athletes playing at an elite level too were at an increased risk (with 43.1% reporting sustaining at least one concussion). This data is based on one self-reported survey of 1485 athletes (Blumenfeld et al., 2016). These data provide an important and necessary first step in understanding the risks of concussion and head injury in the sport of water polo. It is recommended that concussion data in water polo be systematically reported, and that particular attention be paid to the exposure risks of goalies during practice.

Several mechanisms of head injury have been identified including: blows to the head (caused by coming in contact with an inanimate object), collisions with other players, and being struck with the ball (Blumenfeld at al., 2016) Being struck with a ball accounts for 1.33% of all reports of injury. Protective gear to prevent the impact of being struck with the ball should be explored further.

Eye Injury

Dain (2016) identified water polo as a sport where participation may increase the risk for ocular injury as it involves the rapid movement of a ball and close aggressive play with opponents. Eye injuries can include lacerations and corneal abrasions, though rates of ocular injury are low (Youn et al., 2008). Mechanisms of eye injury include collisions with other players and blows to the head (caused by coming in contact with an inanimate object) (Dain 2016; Youn et al., 2008). While the effectiveness of protective eyewear during play has not been systematically evaluated in the sport of water polo, current evidence recommends the use of glasses/goggles. Discussions with athletes should take into consideration past ocular history (Youn et al., 2008).

Dental Injury

Andrade et al. (2010) assessed, using a cross-sectional epidemiological survey, the prevalence of dental trauma among athletes at the 2007 Pan American Games in Rio de Janeiro. Among the 424 recorded dental injuries, 20 were among water polo athletes. Water polo is a moderate-high risk sport, which does not require the use of a mouth guard (Andrade et al., 2010). Mechanisms of dental injury include collisions with other players and blows to the head (caused by coming in contact with an inanimate object) (Andrade et al., 2010). While the effectiveness of mouth guards during play has not been systematically evaluated in the sport of water polo, current evidence suggests that properly fitted mouth guards can reduce dental trauma among athletes (Andrade et al., 2010). While data on the use of mouth guards is minimal, a survey conducted in 2012 found that only 7.7% of water polo players wear mouth guards. The most common reason for not wearing the protective device was that it was seen to be unnecessary (40.7%) (Hersberger et al., 2012). Tooth rescue boxes are also important in preserving teeth for up to 24 hours after trauma. Ensuring that these boxes are available at water polo training facilities and competitions can reduce the effects of dental trauma (Hersberger et al., 2012).

Risk and Protective Factors

There are few studies that specifically examine factors associated with increased or decreased risk of injury in water polo. The following are suggestions of possible risk factors from the review of literature.

Modifiable Risk Factors

Overtraining (Wheeler at al., 2013; Ellapen et al., 2012)

The volume of shots taken accounts for 74% of the variance in shoulder soreness among water polo players (Wheeler et al., 2013). This finding, while based only on a study among high performance water polo players, suggests the possibility of predicting shoulder soreness based on the volume of goal shooting. Among adolescent males, the majority of players attribute musculoskeletal pain to overtraining (88.0%) (Ellapen et al., 2012). This data is important for coaches as it emphasizes the need to monitor goal-shooting workloads. The literature importance of setting threshold limits individually rather than as a group to account for possible

individual differences. Monitoring the number of shots a player takes during training may provide valuable insight into players at higher risk for shoulder soreness and offer an alternative to self-rating surveys.

Level of play (Blumenfeld et al., 2016)

Athletes performing at elite levels (i.e., professional and college) report the highest percentage of concussions. Future studies are needed to more closely examine risk factors among differing levels of play.

Non-Modifiable Risk Factors

Sex (Blumenfeld et al., 2016)

While a higher percentage of women (43.49% females; 31.26% males) report sustaining a concussion at all levels of play and positions, men, on average, report more concussions across levels and positions compared to women (2.0 $\pm$ 0.1 females; 2.8 $\pm$ -0.3 males). This data is based on one self-reported survey of 1485 athletes (Blumenfeld et al., 2016).

Field position (Blumenfeld et al.. 2016)

Playing the position of goalie in water polo significantly increases an athlete's risk of sustaining a concussion. Goalies are the last line of defense in a match and since most of their bodies are submerged, goalies heads are at a disproportionate risk of being impacted.

Competition vs. Training

Water polo players may be at an increased risk of injury in games when compared to practice. According to data collected at the 2016 Summer Olympic games, injury incidence was higher in competition than in training (RR= 3.56, 95%CI: 1.70-7.45) (Soligard et al., 2017).

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

High quality intervention, implementation/evaluation studies are needed in the sport of water polo. However, recommendations include enhancing concussion data collection with a focus on exposure risks (Blumenfield et al., 2013); monitoring goal-shooting workloads for each individual athlete to predict injury risk (Ellapen et al., 2012); examining the effects of head protection among goalies as a way of mitigating concussion risk (Blumenfield et al., 2013); determining whether previous injury, differences in pain perception, athlete conditioning and training age are considered to be risk or protective factors (Wheeler et al., 2013); introducing the use of protective eyewear and/or mouthguards (Dain, 2016; Andrade, et al., 2010); implementing mandatory tooth rescue boxes (Andrade et al., 2010) and exploring the possibility of introducing a policy to decrease the severity of contact between players. This may include penalizing certain types of contact (i.e., purposeful blows to the head). It is suggested that future studies target

shoulder mobility, strength, throwing action, swimming drills and sports specific strength programs using evidence-based measurement tools. More rigorous study designs are required to confirm injury mechanisms and methods to mitigate the risk of injury.

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