



Evidence Summary: Wakeboarding

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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:	Wakeboarding	Target Group:	Elite/Professional and recreational wakeboarders	
Injury Mechanisms:	<p>Common Injuries: Lower extremity injury [anterior cruciate ligament (ACL) rupture], shoulder dislocations, fractures, and ankle sprains Common Mechanisms: Noncontact axial compression, direct or twisting contact made with the water, falling, flips and tricks, 180-degree spin, hard landing after jumping in the air, hold onto the rope while falling.</p>			
Incidence/Prevalence	Risk/Protective Factors	Interventions	Implementation/Evaluation	Resources
<p>Overall Injury Rates</p> <p>In 2004, Carson et al., examined injuries sustained in wakeboarders using a cross-sectional questionnaire sent to orthopaedic surgeons in Florida. A total of 156 surveys were returned with 57 (36%) of the orthopaedic surgeons reporting treating a wakeboarding injury, with a total of 122 injuries.</p> <p>In 2005, Hostetler et al. studied the characteristics of wakeboarding-related injuries treated in emergency departments in the United States from 2000-2003. The National Electronic Injury Surveillance System (NEISS) collected data and 95 individuals sustained wakeboarding-related injury between January 1, 2001 and December 31, 2003 with a National Estimate of 4806 injuries (95% CI 4150-5470).</p> <p>In 2010, Baker et al., studied wakeboarding injuries with the use of NEISS data for individuals seeking care at an emergency</p>	<p>No studies were found that examined specific factors associated with wakeboarding and injury outcomes. The primary studies reviewed speculate potential risk factors for injury in wakeboarding (Starr et al., 2012; Hostetler et al., 2005; Carson et al., 2004; Baker et al., 2010):</p> <ol style="list-style-type: none"> 1. Combination of high kinetic energy, fixed bindings and a large board surface area. 2. The flat position on the board lateral to the direction of motion; especially when landing on the water. 3. Rapid acceleration up to 35 mph, lack of protective gear, and waterway obstacles such as towlines, and boat propellers. 4. Attempting tricks. 5. Feet being securely attached to the board – especially during a fall. 6. Being male: injury rates were higher for males compared to females (1.29 per 10,000 and 0.35 per 100,000 respectively) (Baker 	<p>There are currently no evidence-based injury prevention strategies to reduce the burden of injury in wakeboarding; however, there are opportunities for prevention based on the type and mechanism of injury occurring in wakeboarders (Hostetler et al., 2005; Carson et al., 2004):</p> <ol style="list-style-type: none"> 1. Wearing helmets and other protective head gear. 2. Plastic or foam coating for tow ropes to decrease likelihood of injury during falls and tricks. 3. Attentive boat operators (knowledge of acceleration and top speeds, focused observers in the boat to monitor and communicate between the rider and the boat operator. 4. Bindings on the board (improved or mechanically sound bindings, or possibly using a different release system). 5. Strength training to improve 	<p>No studies were found that evaluated implementation/evaluation strategies in this sport.</p>	

<p>department due to a wakeboarding-related injury. Between 2000-2007 18,967 wakeboarding-related injuries occurred in the US; while injury rates increased from 2000 (0.60 per 100,000) to 2007 (1.33 per 10,000).</p> <p>Professional & Amateur</p> <p>In 2012, Starr et al., studied the ACL injuries in professional and amateur wakeboarders, and the prevalence of ACL injuries in 123 (102 males and 21 females) returned surveys were 42.3% (52); of these 14 (26.9%) were classified as pro/advanced, 35 (67.3%) as intermediate, and 3 (5.8%) as beginner. There was no reported statistically significant difference in skill level and ACL injury ($p=0.25$).</p> <p>Common Types of Injuries</p> <p>Carson et al. (2004) reported that 31% of wakeboard injuries were ACL tears, 15% shoulder dislocations, and 21% were reported as some type of fracture. Thus, 68% of all the injuries were either ACL tears, shoulder dislocations or fractures.</p> <p>Hostetler et al. (2005) reported the most common injury type for wakeboarders were lacerations to the face; and other injuries</p>	<p>et al., 2010).</p> <p>7. Injury rates were seen to peak between ages 20-29; 2.62 per 100,000 (Baker et al., 2010).</p>	<p>upper and lower body strength and posture to manage the demands of the sport.</p> <p>6. Wakeboarding instruction/education.</p>		
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included contusions/abrasions, fractures, strains or sprains and traumatic brain injuries.

Baker et al., 2010 reported common injury types by region with lacerations being the most common diagnosis for the head and neck (51.3%). The hip and lower extremity was injured in 26.5% of injuries with strains and sprains being the most common diagnosis. Injuries to the shoulder/upper extremity were 14.8% and to the trunk 10.6%. Dislocations were the most common diagnosis for shoulder and upper extremity injuries (33.7%), followed by contusions or abrasions (25.4%) and strains or sprains (20.8%).

In 2012, Starr et al., studied ACL injuries in professional and amateur wakeboarders. Of the 123 wakeboarders that returned surveys, 42.3% had reported having a previous ACL tear. This survey also captured other injuries these wakeboarders sustained while wakeboarding in which the majority included: concussion, MCL injury, meniscus tear, fracture of the lower extremity, ankle sprain, and shoulder injury.

Common Injury Regions

Carson et al. (2004) examined

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<p>wakeboarding injuries and reported that 68% of the injuries were to the lower extremity, 28% to the upper extremity, and 4% involving the head, back or ribs. Of these injuries 44% involves the knee, 21% to the shoulder, and 10% to the ankle.</p> <p>Hostetler et al. (2005) reported the head (28.8%) and face (28.4%) had the highest percentage of injuries; while the lower extremity had 25.6%, the trunk 14.4% and the upper extremity having 2.9%.</p> <p>In 2010, Baker et al. noted the head and neck to be the most common body region injured (47.9%), the hip and lower extremity 26.5% of injuries, the shoulder/upper extremity were 14.8% and to the trunk 10.6%.</p>				
<p>Works Cited: Carson et al. (2004). Wakeboarding injuries. <i>American Journal of Sports Medicine</i>, 32(1).</p> <p>Hostetler et al. (2005). Characteristics of water skiing-related and wakeboarding-related injuries treated in emergency departments in the United States, 2001-2003. <i>American Journal of Sports Medicine</i>, 33(7) 1065-1070..</p> <p>Starr et al. (2012). Anterior</p>	<p>Works Cited: Carson et al. (2004). Wakeboarding injuries. <i>American Journal of Sports Medicine</i>, 32(1).</p> <p>Hostetler et al. (2005). Characteristics of water skiing-related and wakeboarding-related injuries treated in emergency departments in the United States, 2001-2003. <i>American Journal of Sports Medicine</i>, 33(7) 1065-1070.</p> <p>Baker, J. I., Griffin, R., Brauneis, P. F., Rue, L. W., & McGwin, G. (2010). A</p>	<p>Works Cited: Carson et al. (2004). Wakeboarding injuries. <i>American Journal of Sports Medicine</i>, 32(1).</p> <p>Hostetler et al. (2005). Characteristics of water skiing-related and wakeboarding-related injuries treated in emergency departments in the United States, 2001-2003. <i>American Journal of Sports Medicine</i>, 33(7) 1065-1070.</p>		

<p>cruciate ligament injuries in wakeboarding: prevalence and observations on injury mechanism. <i>Sports Health</i>, 4(4), 328–332.</p> <p>Baker, J. I., Griffin, R., Brauneis, P. F., Rue, L. W., & McGwin, G. (2010). A comparison of wakeboard, water skiing and tubing-related Injuries in the United States, 2000-2007. <i>Journal of Sports Science & Medicine</i>, 9(1), 92–97.</p>	<p>comparison of wakeboard, water skiing and tubing-related Injuries in the United States, 2000-2007. <i>Journal of Sports Science & Medicine</i>, 9(1), 92–97.</p> <p>Starr et al. (2012). Anterior cruciate ligament injuries in wakeboarding: prevalence and observations on injury mechanism. <i>Sports Health</i>, 4(4), 328–332.</p>			
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Review of Sport Injury Burden, Risk Factors and Prevention

Wakeboarding

The popularity of wakeboarding has markedly increased over the years, and an estimated 3.4 million people are now participating in the sport (Starr et al., 2012). Wakeboarding is an individual “extreme” sport that is performed on numerous rivers, lakes, and/or bays (Carson et al., 2004). Despite the increase in popularity of the sport there is a significant lack of information on the incidence, risk factors and interventions to reduce the impact of injury in wakeboarding.

Incidence and Prevalence

There is a paucity of literature examining the incidence rates in wakeboarding. Furthermore, the studies that have examined injury rates in wakeboarding have used different methodology, which makes it challenging to synthesize injury rates. In 2004, Carson et al., examined injuries sustained in wakeboarders through using a questionnaire sent to orthopedic surgeons in Florida. A total of 156 surveys were returned with 57 (36%) of the orthopedic surgeons reporting treating a wakeboarding injury. A total of 122 wake boarding injuries were seen; however, this study did not capture the number of exposure hours for both injured and uninjured wakeboarders. This study reported that there is a risk of sustaining a serious injury in wakeboarding, particularly when attempting new tricks and risky behavior (Carson et al., 2004).

In 2005, Hostetler et al. studied the characteristics of wakeboarding-related injuries treated in emergency departments in the United States from 2000-2003. The National Electronic Injury Surveillance System (NEISS) collected injury data between January 1, 2001 and December 31, 2003 and reported 95 individuals sustaining a wakeboarding-related injury. Injury rates could not be calculated due to the lack of accurate national estimates of the number of participants or sport-specific exposure times (Hostetler et al., 2005). In 2010, Baker et al., studied wakeboarding injuries with the use of NEISS data for individuals seeking care at an emergency department due to a wakeboarding-related injury. Between 2000-2007 18,967 wakeboarding-related injuries occurred in the US; with injury rates increasing from 2000 (0.60 per 100,000) to 2007 (1.33 per 10,000). It is important to note that the increase over time for these injury rates could be attributed to the increase in participation.

In 2012, Starr et al., studied ACL injuries in professional and amateur wakeboarders. Of the 123 wakeboarders that returned surveys, 42.3% had reported having a previous ACL tear. This survey also captured other injuries these wakeboarders sustained while wakeboarding in which the majority included: concussion, MCL injury, meniscus tear, fracture of the lower extremity, ankle sprain, and shoulder injury.

In 2004, Carson et al. examined wakeboarding injuries and reported that 68% of the injuries were to the lower extremity, 28% to the upper extremity, and 4% involving the head, back or ribs. Of these injuries, 44% involved the knee, 21% involved the shoulder, and 10% to the ankle. Both Hostetler et al. (2005) and Baker et al. (2010) found the head and face/neck to be the most

common body region affected (28.8% and 47.9% respectively). Moreover, Hostetler et al. (2005) reported the lower extremity being 25.6% affected, the trunk 14.4% and the upper extremity 2.9%. Whereas Baker et al. (2010) reported the hip and lower extremity accounting for 26.5% injuries, the shoulder/upper extremity 14.8% and the trunk 10.6%.

Common injury types in wakeboarding include ACL tears (Carson et al., 2004; Starr et al., 2012) and lacerations to the face (Baker et al., 2010; Hostetler et al., 2005). Other common types of injuries reported include dislocations, fractures, contusions/abrasions, strains/sprains, traumatic brain injuries, MCL injury, meniscus tear, ankle sprain and shoulder injury (Carson et al., 2004; Hostetler et al., 2005; Baker et al., 2010; Starr et al., 2012).

Risk and Protective Factors

No studies were found that examined specific factors associated with wakeboarding and injury outcomes. The primary studies (Starr et al., 2012; Hostetler et al., 2005; Carson et al., 2004; Baker et al., 2010) reviewed that reported the incidence of injury and common mechanisms of injury in wakeboarding, speculate potential risk factors for injury in wakeboarding including:

1. Combination of high kinetic energy, fixed bindings and a large board surface area.
2. The flat position on the board lateral to the direction of motion; especially when landing on the water.
3. Rapid acceleration up to 35 mph,
4. Lack of protective gear.
5. Waterway obstacles such as towlines and boat propellers.
6. Attempting tricks/maneuvers.
7. Feet being securely attached to the board with unforgiving release technique – particularly during a fall.
8. Being male: Injury rates were higher for males compared to females (1.29 per 10,000 and 0.35 per 100,000 respectively, Baker et al., 2010)
9. Age: Injury rates were seen to peak between ages 20-29 (Baker et al., 2010).

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

There are currently no evidence-based injury prevention strategies published in the literature; however, there are opportunities for prevention regarding the type and mechanisms of injuries occurring in wakeboarding. Studies reviewed for this report suggest wearing helmets and other protective head gear, plastic or foam coating for tow ropes to decrease the likelihood of injury during falls and tricks, and bindings with a different release technique (Hostetler et al., 2005; Carson et al., 2004; Starr et al., 2012). It was also noted that attentive boat operators are key for the prevention of injury. Operators need to be knowledgeable of the acceleration and top speeds appropriate for wakeboarding, and ensure that there is a focused observer in the boat to monitor and communicate between the rider and the boat operator (Hostetler et al., 2005). Finally, it was recommended to participate in professional and formal wakeboarding instruction,

as well as to include strength training for the rider to improve upper and lower body strength and body posture to manage the demands of the sport (Carson et al., 2004).

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