



Evidence Summary: Waterskiing

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Evidence synthesis tool

SPORT:	Waterskiing	Target Group:	Recreational: young adulthood and middle age male and females (predominantly male); level of experience novice to expert	
Injury Mechanisms:	<p>Common Injuries: strains and sprains to the lower extremities (knees and upper leg), douche and enema injuries, contusions, abrasions, lacerations, fractures, ruptured tympanic membranes, vaginal lacerations, enema, and spinal cord damage</p> <p>Common Mechanisms: exertion for takeoff, cuts across the wake, sharp turns, and maintaining balance through choppy water, falling</p>			
Incidence/Prevalence	Risk/Protective Factors	Interventions	Implementation/Evaluation	Resources
<p>Overall Injury Rates In 2005, Hostetler et al., studied the characteristics of water skiing-related injuries treated in 98 emergency departments (ED) in the United States from January 1, 2001- December 31, 2003, and data were extracted through the National Electronic Injury Surveillance System (NEISS). Data were collected for 517 individuals with water-skiing related injuries. Based on these data, an estimated 23, 460 (95% CI 20, 240 – 26,680) individuals with water skiing related injuries were treated in the US EDs in 2001 to 2003. Men accounted for most injuries (72.2%).</p> <p>In 2010, Baker et al., studied water-skiing related injuries in the United States for individuals seeking care at an emergency department from 2000-2007 and collected data from the NEISS. During this time 52,399 water skiing-related injuries occurred in the U.S and were shown to decrease over time from 3.32 per 100,000 in 2000 to 1.51</p>	<p>No studies were found that examined specific risk factors associated with waterskiing and injury outcomes. The primary studies reviewed speculate potential risk factors for injury in waterskiing (Hostetler et al., 2005):</p> <ol style="list-style-type: none"> 1. Lack of protective gear. 2. Level of experience; novice skiers are injured most frequently while submerged during takeoff with douche and enema injures, while experts most commonly injury their knees, backs or shoulders while falling. 3. Lack of proper equipment. 4. Number of exposure hours. 5. Lack of boat user knowledge; or involvement of alcohol. 6. Age: young adulthood (20s) and middle age (early 40s) at higher risk of injury; injury rates seemed to peak between ages 20-29 (4.59 per 100,000). 7. Males – higher risk; males tended to have higher injury 	<p>There are currently no evidence-based injury prevention strategies to reduce to burden of injury in waterskiing; however, there are opportunities for prevention based on the type and mechanism of injury occurring in water-skiers.</p> <p>Studies for this report suggest:</p> <ol style="list-style-type: none"> 1. Physical conditioning and education (Hostetler et al., 2005; Loughlin 2013). 2. Education regarding techniques for getting up out of the water (Hostetler et al., 2005) 3. Strategies to minimize the force exerted by the towrope (avoid pulling the rope in toward the body, keeping the rope taut when outside the wake) (Hostetler et al., 2005) 4. Education of the importance of letting go of the rope when falling (Hostetler et al., 2005). 5. Attentive boat operators, knowledgeable of the acceleration and top speeds 	<p>No studies were found that have evaluated implementation/evaluation strategies in this sport.</p>	

<p>per 100,000 in 2007.</p> <p>Common Injury Types Most injury diagnoses in the study for Hostetler et al. (2005) were strains or sprains (36.3%), lacerations and/or contusions/abrasions (17.1%), fractures (9.0%) and traumatic brain injury (2.4%). Overall the most common injuries seen in skiers were strains and sprains to the lower extremity, specifically the knee or upper leg, and were seen to peak during young adulthood and middle age; showed a bimodal distribution of early 20s and early 40s. The mechanism of injury described here was the exertion required for takeoff, cuts across the wake, sharp turns, and maintaining balance through choppy water.</p> <p>In the study by Baker et al. (2010), overall the most common water skiing-related injuries were strains and sprains to the lower extremity. Other types of injuries sustained include: concussion, contusion/abrasion, fracture, laceration, and dislocation; depending on the region of the body, the percent affected differed.</p> <p>In a study by Loughlin (2013), the most common type of injury for competitive water-skiers was</p>	<p>rates than females; 3.39 per 100,000 and 1.13 per 100,000 respectively (Baker et al., 2010).</p> <p>8. Water and/or weather conditions.</p> <p>In a study by Loughlin (2013) examining competitive water-skiing injuries various potential risk factors were identified:</p> <ol style="list-style-type: none"> 1. No increased risk of injury by gender. 2. Lack of education on physical conditioning prior to engaging in water-skiing. 3. Performing tricks. 4. Type of water skiing: slalom or jump 5. Participating in more than one event in a day. 6. Increased speeds. 	<p>appropriate, as well as a focused observer in the boat to monitor the skier and communicate between the skier and the boat operator (Hostetler et al., 2005)</p> <p>6. Need to evaluate the plastic and/or foam coating for the towropes to decrease the likelihood of injury during falls (Hostetler et al., 2005).</p> <p>Competitive Water-Skiers</p> <p>In a study by Loughlin (2013), examining competitive water skiing injuries, various opportunities for prevention were discussed:</p> <ol style="list-style-type: none"> 1. Conditioning exercises to improve hip and trunk musculature and improve stabilization of posture. 2. Exercises in tandem stance; narrow the base of support during training to improve balance. 3. Strengthening exercises such as supine and prone planks to increase the muscular endurance of the trunk extensors. 4. Pre-season training <p>A study by Mullins et al., (2007) has outlined a strength and conditioning program for slalom water skiers which includes tandem squats, tandem deadlifts, supine plank, prone plank, side bridge, torso</p>		
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<p>strain/sprain (64.6%), the second most common type of injury was contusions/lacerations (15.4%), and broken bone (12.3%). However, based on gender, males reported the most common type of injury being strain/sprains (75%), followed by broken bone (10.4%), and contusion/laceration (6.3%); whereas females reported the most common type of injury being contusion/laceration (41.2%), followed by strain/sprain (35.3%), and broken bone (5.9%).</p> <p>Common Injury Regions In a study by Hostetler et al. (2005), the lower extremity was the most frequently injured body region (34% of all injuries); among these injuries the knees (30.8%) and legs (25.7%) were most frequently injured. Moreover, body regions injured for water skiers included the trunk (27.1%), the face (20.8%), the upper extremity (13.0%), and the head (4.3%) (Hostetler et al., 2005).</p> <p>Along with the findings from Hostetler et al. (2005), in 2010, Baker et al. noted that the hip and lower extremity was the most common region of the body affected among water skiers (35.9%), while the head and neck was the second most common body part injured (24.6%). The</p>		<p>rotations, wall slides/dock slides, seated rows and pull-ups. Also it is stressed in incorporate a warm-up prior to engaging in water-skiing and/or dryland training.</p>		
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<p>trunk accounted for 21.3% of injuries. The shoulder and upper extremity injuries accounted for 18.3% of injuries in water skiers</p> <p>In a study by Loughlin (2013), the most common body part that was injured for competitive water-skiers was the back/trunk (38.8%); while the lower limb was the second most injured area (31.3%) and then the upper limb (24.4%). However, when looking at gender, males affected the back/trunk the most (39.2%), whereas females affected the lower limb the most (43.8%).</p>				
<p>Works Cited: 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 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>Loughlin, Sarah L. (2013) Investigation of injuries occurring within competitive waterskiing in</p>	<p>Works Cited: 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 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>Loughlin, Sarah L. (2013) Investigation of injuries occurring</p>	<p>Works Cited: 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>Loughlin, Sarah L. (2013) Investigation of injuries occurring within competitive waterskiing in the UK. <i>International Journal of Exercise Science</i>, 6(1): 29-42.</p> <p>Mullins, Nicole M. (2007) Slalom water skiing: physiological considerations and specific conditioning. <i>Strength and</i></p>		

the UK. <i>International Journal of Exercise Science</i> , 6(1): 29-42.	within competitive waterskiing in the UK. <i>International Journal of Exercise Science</i> , 6(1): 29-42.	<i>Conditioning Journal</i> , 29 (4), 42-54.		
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Review of Sport Injury Burden, Risk Factors and Prevention

Waterskiing

Waterskiing is a sport of established popularity with an estimated 8.4 million participants. However, waterskiing has a high potential for injury due to rapid boat acceleration, lack of protective gear, and waterway obstacles such as towlines, boat propellers, and other skiers (Hostetler et al., 2005). Despite the popularity of this sport, there is a significant lack of information on the incidence, risk factors and intervention to reduce the impact of injury in waterskiing.

Incidence and Prevalence

To date there is a paucity of literature examining the incidence rates in waterskiing. In 2005, Hostetler et al., studied the characteristics of water skiing-related injuries treated in 98 emergency departments (ED) in the United States from January 1, 2001- December 31, 2003. Data were collected for 517 individuals with water-skiing related injuries. Based on these data, an estimated 23,460 (95% CI: 20, 240 – 26,680) individuals with water skiing related injuries were treated in the US EDs from 2001 to 2003. Injury rates could not be calculated from the lack of accurate national estimates of the number of participants or their sport-specific exposure times (Hostetler et al., 2005). In 2010, Baker et al., studied water-skiing related injuries in the United States for individuals seeking care at an ED from 2000-2007. During this time 52,399 water skiing-related injuries occurred in the U.S and were shown to decrease over time from 3.32 per 100,000 in 2000 to 1.51 per 100,000 in 2007 (Baker et al. 2010).

All studies identified in this review reported strains/sprains to be the most common injury type (Hostetler et al., 2005; Baker et al., 2010; Loughlin 2013). In the study by Hostetler (2005), strains/sprains accounted for 36.3% of injuries and 64.6% of injuries in Loughlin et al. (2013). Other injuries include lacerations and/or contusions/abrasions (17.1%), fractures (9.0%) and traumatic brain injuries (2.4%) (Hostetler et al., 2005). Baker et al. (2010) identified concussions, contusions/abrasions, fractures, lacerations, and dislocations as common injury types. While Loughlin et al. (2013) report contusions/lacerations (15.4%), and broken bones (12.3%) as common injury types experience by water-skiers.

Hostetler et al. (2005) and Baker et al. (2010) report the lower extremity to be the most commonly affected body region. While Loughlin et al. (2013) report the back/trunk (38.8%) as the most commonly affected region of the body. The differences reported here could be due to the level of skill of the water-skier, as Loughlin specifically examined injury in competitive water-skiers. Hostetler et al. (2005) identified other regions that can be affected including the trunk (27.1%), the face (20.8%), the upper extremity (13.0%), and the head (4.3%). Baker et al. (2010) report the head and neck to be the second most common body part injured (24.6%), the trunk 21.3%, and the shoulder and upper extremity injuries accounting for 18.3% of injuries in water skiers.

Risk and Protective Factors

No studies were found that examined specific factors associated with water-skiing and injury outcomes. The primary studies (Hostetler et al., 2005; Loughlin et al., 2013) reviewed that reported the incidence of injury and common mechanisms of injury in water-skiing, speculate the following as potential risk factors for injury in water-skiing:

1. Lack of protective gear.
2. Level of experience: Novice skiers are injured most frequently while submerged during takeoff with douche and enema injures, while experts most commonly injury their knees, backs or shoulders while falling.
3. Lack of proper equipment.
4. Number of exposure hours.
5. Lack of boat user knowledge or involvement of alcohol.
6. Age: Young adulthood (20s) and middle age (early 40s) are reported at a higher risk of injury; injury rates seemed to peak between ages 20-29 (4.59 per 100,000).
7. Males are reported to be at increased risk of injury compared to females. Baker et al. identified that males tended to have higher injury rates than females; 3.39 per 100,000 and 1.13 per 100,000 respectively; however, Loughlin et al., 2013 report no gender differences.
8. Water and/or weather conditions.
9. Lack of education on physical conditioning prior to engaging in water-skiing.
10. Certain tricks or manouvers.
11. Type of water skiing: Slalom or jump.
12. Participating in more than one event in a day.
13. Increased speeds.

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

A strength and conditioning program designed for slalom (predominantly competitive) water-skiing (Mullins et al., 2007) may prevent the risk of injury. Mullins et al. (2007) report that sport-specific exercises to reduce the risk of injury for water-skiers can include: tandem squats and tandem deadlifts to support during training to improve balance (Loughlin 2013); supine plank, prone plank, and side bridge to increase the muscular endurance of the trunk extensors (Loughlin 2013; Mullins et al., 2007). Additional exercises outlined by Mullins et al. (2007) include torso rotations, wall slides/dock slides, seated rows, and pull-ups. Mullins et al. (2007) also stressed the use of a proper warm-up to increase blood flow to working muscles, which in turn enhances nutrient supply, tissue oxygenation, waste removal, and facilitates motor unit recruitment which directly affects the rate and force of muscle contractions and may prolong fatigue. Additionally, a warm-up assists in raising the muscle and core body temperature, promoting oxygen-hemoglobin dissociation at the tissues, faster nerve impulse conduction, and

increased joint range of motion (Mullins et al., 2007). Warm-up is also believed to help athletes mentally prepare for their events, possibly influencing arousal and focusing attention (Mullins et al., 2007). Unfortunately, many water skiers move from sedentary roles as spotters and boat drivers to intense sport activity without warming up at all (Mullins et al., 2007). Overall, slalom water skiing is an extremely demanding technical event, requiring a unique blend of strength, power endurance, timing, coordination, and balance (Mullins et al., 2007). For individuals seeking to reach their skiing potential, dryland conditioning must be considered essential, as attempting to ski “into” shape can both slow progress and increase susceptibility to injury (Mullins et al., 2007). Dryland training should be used to prehabilitate injury-prone muscles and joints, to enhance on-the-water training to correct muscular imbalances arising from skiing, and to minimize losses of neuromuscular adaptations during the off-season (Mullins et al., 2007).

Additionally, various opportunities for prevention based on the type and mechanism of injury occurring in water-skiers have been proposed in the literature. Educational programs regarding techniques for getting up out of the water, strategies to minimize the force exerted by the towrope (ex. avoid pulling the rope toward the body, keeping the rope taut when outside the wake) and the importance of letting go of the rope when one falls (Baker et al., 2010), could decrease the risk of injury. The development of safer towropes to decrease the incidence of lacerations to the riders should be considered; plastic and/or foam coating for the towrope (Hostetler et al., 2005). Finally, attentive boat operators, knowledgeable of the acceleration and top speeds appropriate, as well as a focused observer in the boat to monitor the skier and communicate between the skier and the boat operator (Hostetler et al., 2005).

References

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