



Evidence Summary: Martial Arts

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Evidence synthesis tool

SPORT:	Martial Arts	Target Group:	Participants of Martial Arts		
Injury Mechanisms:	The primary mechanisms of injury in Martial Arts are contacts typically with an opponent resulting from the practices of combat sports.				
Incidence/Prevalence	Risk/Protective Factors	Interventions	Implementation/Evaluation	Resources	
<p>Mixed Martial Arts Injury rates of Mixed Martial Artists (MMA) have been reported in different ways. A study by Karpman, et al. (2016) suggested that 59.4% of MMA sustained injuries.¹ An injury incidence rate is estimated at 228.7 injuries per 1000 athlete-exposures (95%CI: 110.4-473.5).²</p> <p>The prevalence of injury across injury types in MMA fighters is reported as: contusions/bruising ranging from 16.5% to 56% of injuries,^{1,3} concussions ranging from 8.3% to 20.8%,^{1,3} lacerations ranging from 8% to 37.3%,^{1,3} fractures 5% to 6.2%.^{1,3}</p> <p>The primary injury locations in MMA are reported as: hand/arm ranging from 38.9% to 49.2%,^{1,3} face 32.2%,¹ neck 17.6%,³ and head 14.2%.³</p> <p>Martial Arts Pappas, (2007) reported that 30% of combat injuries seen in emergency departments which required hospitalization were related to martial arts (MA).⁴ Of these injuries, young athletes (<13 years of age) accounted for 22.7%</p>	<p>Mixed Martial Arts In mixed martial artists, sex, older age, being in a heavier weight category, being in a title fight, being the loser of a match, or being knocked out (KO) or technically knocked out (TKO) were factors associated with higher risk of injury.^{2,13}</p> <p><u>Age</u> Being 35 years or older puts male mixed martial artists at greater risk of a KO (OR=1.94, 95%CI: 1.03-3.61) and TKO (OR=1.96, 95%CI: 1.18-3.22).¹³</p> <p><u>Weight</u> The heavy weight category increases the risk of TKO from repetitive strikes (OR=2.12, 95%CI: 1.16-3.98).¹³ The middle weight category reduces the athletes risk of KO (OR=0.44, 95%CI: 0.20-0.97).¹³ Lystad, et al. (2014) also reported a higher risk of injury for those in the heavy weight category (OR=1.57, 95%CI: 1.14-2.16).²</p> <p><u>Match characteristics</u> Title fights are associated with a higher risk of injury (OR=2.01,</p>	<p>Rule changes Implementation of rule changes such that referee/judge training is updated, enforcement of rules, and has been shown to reduce the risk of injury.^{15,16} Importantly; however, the rule change must be in favour of injury prevention and not for point rewards or for spectator enjoyment.¹⁷ Providing athletes with both the tools and knowledge seem to encourage higher rates of compliance with rules.¹⁸</p> <p>Macan, et al. (2006) reported that following a rule change (regarding equipment) the relative risk of injury decreased for female competitors under the age of 18 years (RR=2.08, 95% CI: 1.24-3.49).¹⁵ In terms of male Karate participants the risk decreased; however, it was not a statistically significant reduction, the same was true for women over 18 years of age.¹⁵</p> <p>Jae-Ok and Voaklander (2016) reported that the number of head kicks increased following a</p>	<p>There is a lack of literature that examines the implementation and/or evaluation of interventions to reduce the risk of injury in MA.</p> <p>A study by Lee, et al. (2013) found that only 29.8% of participants agreed that mouthguards were useful in terms of their ability to protect the teeth.¹⁶</p>	<p>Websites</p> <p>Stop Sport Injuries: Martial Arts Injuries http://www.stopsportsinjuries.org/STOP/STOP/Prevent_Injuries/Martial_Arts_Injury_Prevention.aspx</p>	

<p>of MA injuries and the older athletes (>31 years of age) accounted for 33.6% of injuries.⁴</p> <p>The primary injury diagnoses for MA were strains/sprains (31%), fractures (24.3%), contusions/abrasions (23.2%), with lacerations (4.5%), dislocations (4%), and concussions (1.2%).⁴</p> <p>Taekwondo A review of the taekwondo literature found one article on concussion in youth (athletes 18 years or younger).⁵ This study reported that of the sports reviewed taekwondo had the highest incidence of concussion with a rate of 5.0 (95%CI: 3.6-6.8)/1000 athlete exposures (AE).⁵</p> <p>In taekwondo athletes the most common injury diagnoses were contusions ranging from 36.25%-48.4% of injuries, strains (13.5%-14.66%), sprains (11.4%-18.86%), fractures (7.7%-7.84%), concussions (5.9%-7.6%), and joint dysfunction (7.1%-7.27%).^{6,7}</p> <p>The primary injury locations in Taekwondo athletes were the foot ranging from 16% to 16.16% of injuries, knee (8.42%-14.8%), ankle (7.97%-13.8%), thigh (9.43%-11.1%), head (10.5%-18.86%), and leg (6.17%-8.3%).^{6,7}</p>	<p>95%CI: 1.51-2.69).² Uncarded matches have a reduced risk of injury (OR=0.51, 95%CI: 0.32-0.81).¹³</p> <p><u>Match outcome</u> Lystad, et al. (2014) reported a greater risk of injury to the loser of a match compared to the winner [OR (range)=2.32, 95%CI: 1.36-3.98] to OR=5.05, 95%CI: 2.01-12.67].²</p> <p>Matches which ended in either a KO/TKO were also associated with higher risks of injury (OR=3.72 [95%CI: 2.98-4.65]).²</p> <p>Taekwondo In elite male and female taekwondo athletes chronological age, weight category, and annual quarter can be considered risk factors for sustaining injuries based on location and diagnosis.⁸</p> <p>Covarrubias, et al. (2015) considered stretching, warming-up, and cooling-down to be protective factors against injury.¹⁴</p> <p><u>Sex</u> Males 23-24 years old and females 17-18 years of age are reported to have a greater risk of injury).⁸</p> <p>Males sustained equal total injuries compared to females;</p>	<p>rule change which awarded additional points for the technique.¹⁷</p> <p>Equipment Zadik and Levin (2009) reported half the number of oro-facial injuries were sustained by martial arts participants who used a mouthguard.¹⁸</p> <p>Additionally (though not martial arts specific) Zadik and Levin (2009) reported that increased use of mouthguards following an injury was only seen in 16% of their participants.¹⁸</p>		
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<p>Professional (Olympic Level Taekwondo athletes) Based on two Olympic periods, in elite taekwondo athletes (males and females) knee (21.3%), foot (17.0%), ankle (12.2%), thigh (11.4%), and lower leg (8.8%) were the most common body parts to be injured.⁸</p> <p>Contusions (29.3%), cartilage (17.6%), and joint (15.7%) injuries were the most common injury diagnoses during the same two Olympic periods.⁸</p> <p>Judo Pocecco, et al. (2013)⁹ reported an average injury proportion of 11.2-12.3% for over 380 judo athlete per summer Olympic games. Furthermore, they noted the highest incidence rate was reported to be 1.18 injuries/athlete-year by Souza, et al. (2006).¹⁰</p> <p>Pocecco, et al. (2013) reported frequency ranges for common injury types in judo. Sprains accounted for 5.6%-59.8% of injuries, strains 7.0%-33.8% of injuries, and contusions at 5.6%-56.0% of injuries.⁹</p> <p>Additionally, the prevalence of injury in different anatomical</p>	<p>however, males were more likely to be injured when on the receiving end of a kick, whereas females had an equal risk of injury whether they delivered or received the kick.⁷</p> <p><u>Weight</u> Males in the <58kg weight class and females in the 49-57kg weight category are reported to have a higher risk of injury.⁸</p> <p><u>Annual season</u> Most injuries in both males and females occurred during the first annual quarter.⁸</p> <p><u>Experience</u> Covarrubias, et al. (2015) reported that athletes with less than 3 years of tournament experience were at a lower risk of injury (OR=0.198, 95%CI: 0.05-0.76).¹⁴ However, they also reported more experienced individuals (with a black belt) the less likely they are to experience an injury.¹⁴</p> <p><u>Training habits</u> Four or more hours of practice per week is associated with increased risk of injury (OR=4.5, 95%CI: 1.6-12.8).¹⁴ Sparring for more than two hours increased risk of injury (OR=8.7, 95%CI: 2.0-36.6).¹⁴</p>			
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locations was reported to vary. Up to 28% of injuries were knee-related injuries, up to 22% involved the shoulder, and up to 30% were hand/finger injuries.⁹

Mechanisms of injury

A review of injury causes by Pocecco, et al. (2013) suggested that close to 85% of injuries in judo occurred during standing fighting.⁹ Pocecco, et al. (2013) suggests that the most common cause of injuries in judo is being thrown, resulting in 42%-90% of injuries.⁹ Although Pocecco, et al. (2013) did not find a sex-related difference in injury causes they did report that women seem to be more likely to be injured during ground fighting or due to loss of balance.⁹

Low Back Pain

A study by Noormohammadpour, et al (2016) examined the prevalence of low back pain in female university athletes who participated in a variety of sports.¹¹ Of the sports, Karate was reported to have the highest point prevalence of low back pain (24.8%).¹¹ The Karate athletes also reported the highest consumption of medication and the most sick leave, in addition to more frequent care seeking behaviours.¹¹

Reis, et al. (2015) reported a

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<p>prevalence of chronic low back pain in adult (>18 years of age) male Brazilian jiu-jitsu athletes as 80.6%.¹² This study reported the prevalence in both recreational (72.2%) and professional (88.9%) of jiu-jitsu athletes.¹²</p>				
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Review of Sport Injury Burden, Risk Factors and Prevention

Martial Arts

Martial arts is a sport that encompasses a number of different styles and techniques of fighting. Mixed martial arts is a form of martial arts that allows the use of techniques from a number of other forms of martial arts such that both striking and grappling are allowed and combat can occur in both standing and ground positions. Karate is a form of martial arts which employs strike techniques, specifically punching. Although taekwondo is also a strike based martial art, the specific technique used is kicking. Judo is categorized as a grappling form of martial arts in which throwing and pinning techniques are practiced and while Brazilian jiu-jitsu is also a grappling form of martial arts where techniques such as joint locks, chokeholds, and submission holds are used.

Due to the technical differences in the various forms of martial arts, this synthesis reports the incidence/prevalence, risk factors, and interventions by sport.

Incidence and Prevalence

Mixed Martial Arts

Injury rates of Mixed Martial Artists (MMA) have been reported in different ways by different authors. A study by Karpman, et al. (2016) suggests that 59.4% of MMA participants sustained injuries. An injury incidence rate of 228.7 per 1000 athlete-exposures (95%CI: 110.4-473.5) was reported by Lystad, Gregory, & Wilson (2014). The prevalence of the most common injury types MMA fighters varies: contusions/bruising ranging from 16.5% to 56% of injuries (Ji, 2016; Karpman, et al., 2016), concussions ranging from 8.3% to 20.8% (Ji, 2016; Karpman et al., 2016), lacerations ranging from 8% to 37.3% (Ji, 2016; Karpman, et al., 2016), fractures 5% to 6.2% (Ji, 2016; Karpman, et al., 2016). The primary injury locations in MMA were reported as being the hand/arm ranging from 38.9% to 49.2% (Ji, 2016; Karpman et al., 2016), face 32.2% (Karpman et al., 2016), neck 17.6% (Ji, 2016) and head 14.2% (Ji, 2016). The types and locations of injuries that occur in mixed martial arts are likely influenced by the techniques and practices of the sport.

Martial Arts

Pappas (2007), reported that of combat injuries seen in emergency departments which required hospitalization, 29.9% were related to martial arts (MA). Of these injuries, young MA (<13 years of age) accounted for 22.7% of MA injuries and the older MAs (>31 years of age) accounted for 33.6% of injuries (Pappas, 2007). The primary injury diagnoses for martial artists is reported as strains/sprains (31%), followed by fractures (24.3%), contusions/abrasions (23.2%), lacerations (4.5%), dislocations (4%), and concussions (1.2%).

Taekwondo

A review of the taekwondo literature found one article on concussion in youth (athletes 18 years or younger) (Pfister, et al., 2016). This study reported that of the sports reviewed, taekwondo had the highest incidence of concussion with a rate of 5.0 (95%CI: 3.6-6.8)/1000 athlete exposures (AE) (Pfister et al., 2016). In taekwondo athletes the most common injury diagnoses were contusions ranging from 36.25%-48.4% of injuries, strains (13.5%-14.66%), sprains (11.4%-18.86%), fractures (7.7%-7.84%), concussions (5.9%-7.6%), and joint dysfunction (7.1%-7.27%) (Ji, 2016a; Kazemi et al., 2009). The primary injury locations were also reported in these studies for taekwondo athletes with ranges for foot injuries from 16% to 16.16%, knee (8.42%-14.8%), ankle (7.97%-13.8%), thigh (9.43%-11.1%), head (10.5%-18.86%), and leg (6.17%-8.3%) (Ji, 2016; Kazemi et al., 2009).

Professional (Olympic Level Taekwondo athletes)

Based on two Olympic periods, elite taekwondo athletes (males and females) reported the knee (21.3%), foot (17.0%), ankle (12.2%), thigh (11.4%), and the lower leg (8.8%) as the most common body parts to be injured (Altarriba-Bartes et al., 2014). Contusions (29.3%), cartilage (17.6%), and joint (15.7%) injuries were the most common injury diagnoses during the same two Olympic periods (Altarriba-Bartes et al., 2014).

Judo

Pocecco et al. (2013) reported an average injury rate of 11.2-12.3% for over 380 judo athletes in the summer Olympic games. Furthermore, they noted the highest incidence rate was reported to be 1.18 injuries/athlete-year by Souza, et al. (2006). Pocecco, et al. (2013) reported common injury types in judo as sprains, accounting for 5.6%-59.8% of injuries, strains being 7.0%-33.8% of injuries, and contusions being 5.6%-56.0% of injuries. Additionally, the prevalence of injury to different anatomical locations varies; 28% of injuries were knee-related injuries, 22% involved the shoulder, and up to 30% were hand/finger injuries (Pocecco et al., 2013).

A review of the mechanisms of injury in judo by Pocecco, et al. (2013) suggested that close to 85% of injuries in judo occurred during standing fighting. Pocecco, et al. (2013) also suggested that the most common cause of injuries in judo is being thrown, which resulted in 42%-90% of injuries (Pocecco et al., 2013). Although Pocecco, et al. (2013) did not find a sex-related difference in injury causes they did report that women seem to be more likely to be injured during ground fighting or due to loss of balance (Pocecco et al., 2013).

Low Back Pain

A study by Noormohammadpour et al. (2016) examined the prevalence of low back pain in female university athletes who participated in a variety of university sports, one of which was karate. Of the sports examined in this study, Karate was reported to have the highest point prevalence of low back pain (24.8%) (Noormohammadpour et al., 2016). The Karate athletes also reported the highest consumption of medication and the most sick leave, in addition to more frequent care seeking behaviours (Noormohammadpour et al., 2016). Reis, et al. (2015) reported a prevalence of chronic low back pain in adult (>18 years of age) male Brazilian jiu-jitsu athletes

as 80.6%. This study reported the prevalence in both recreational (72.2%) and professional (88.9%) of jiu-jitsu athletes (Reis, et al., 2015).

Risk and Protective Factors

Mixed Martial Arts

In mixed martial artists sex, older age, being in a heavier weight category, being in a title fight, being the loser of a match, or being knocked out (KO) or technically knocked out (TKO) were factors associated with higher risk of injury (Hutchison, et al., 2014; Lystad, Gregory, & Wilson, 2014). Those who were 35 years or older and participated in mixed martial arts were at greater risk of a KO (OR=1.94, 95%CI: 1.03-3.61) or TKO (OR=1.96, 95%CI: 1.18-3.22) (Hutchison et al., 2014). MMA participants in the heavy weight category were at greater risk of TKO from repetitive strikes (OR=2.12, 95%CI: 1.16-3.98) (Hutchison et al., 2014). Lystad, et al. (2014) also reported a higher risk of injury for those in the heavy weight category (OR=1.57, 95%CI: 1.14-2.16). Those in the middle weight category had a reduced risk of KO (OR=0.44, 95%CI: 0.20-0.97) (Hutchison et al., 2014). Mixed martial arts title fights were associated with a higher risk of injury OR=2.01, 95%CI: 1.51-2.69) (Lystad et al., 2014). Matches which were classified as uncarded had a reduced risk of injury (OR=0.51, 95%CI: 0.32-0.81) (Hutchison et al., 2014). Lystad, et al. (2014) reported a greater risk of injury to the loser of a match compared to the winner (OR=2.32, 95%CI: 1.36-3.98 – OR=5.05, 95%CI: 2.01-12.67). Matches which ended in either a KO/TKO were also associated with higher risks of injury (OR=3.72, 95%CI: 2.98-4.65) (Lystad et al., 2014).

Taekwondo

In elite male and female taekwondo athletes chronological age, weight category, and annual quarter can be considered risk factors for sustaining injuries based on location and diagnosis (Altarriba-Bartes et al., 2014). Covarrubias, et al. (2015) considered stretching, warming-up, and cooling-down to be protective factors against injury. Males who were in the 23 to 24 year age range and females in the 17 to 18 year age range had the greatest number of injury episodes (Altarriba-Bartes et al., 2014). Kazemi et al. (2009) reported that males sustained equal total injuries compared to females. Additionally, males were more likely to be injured when on the receiving end of a kick, whereas females had an equal risk of injury whether they delivered or received the kick (Kazemi et al., 2009). Altarriba-Bartes et al. (2014) reported that males in the <58kg weight class and females in the 49-57kg weight category had higher risk of injury. Additionally Altarriba-Bartes et al. (2014) reported that most injuries in both males and females occurred during the first annual quarter. Level of experience was also determined to be an injury risk factor for taekwondo participants. Covarrubias, et al. (2015) reported that athletes with less than 3 years of tournament experience were at lower risk of injury (OR=0.198, 95%CI: 0.05-0.76); however, they also reported, more experienced individuals (with a black belt) the less likely they are to experience an injury (Covarrubias, et al., 2015). Lastly, Covarrubias, et al. (2015) reported that training habits influenced risk of injury. They report that four or more hours of practice per week is associated with increased risk of injury (OR=4.5, 95%CI: 1.6-12.8) (Covarrubias et al., 2015). Sparring for more than two hours increased the risk of injury (OR=8.7, 95%CI: 2.0-36.6) (Covarrubias et al., 2015).

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

Rule changes related to scoring (Jae-Ok & Voaklander, 2016; Macan, Bundalo-Vrbanac, & Romić, 2006), the standardized use of mouthguards (Lee, Heo, Kim, Kim, & Lee, 2013; Zadik & Levin, 2009), and standardized rules about style and use of protective gloves (Bartsch, Benzel, Miele, Morr, & Prakash, 2012) have been shown to be effective in reducing some types of injuries in MA.

Jae-ok & Voaklander (2016) and Macan (2006) examined the scoring rule change found that by increasing the number of points awarded to head kicks, the number of torso and back injuries decreased. However, they also noted that this put athletes at greater risk of head injuries and suggested that combative sports organizations would either need to change the rule back to what it was previously or provide their athletes with greater training to defend against tactics such as head kicks. Additionally, the authors reported that this rule change made it easier for referees and judges of this sport to make the right call, and be stricter about the enforcement of illegal moves. Although a few studies have examined mouthguard usage (Lee et al., 2013; Tulunoglu & Özbek, 2006), these studies have focused on the athletes' awareness regarding the protective effect of mouthguards, which has in part been influenced by previous experience with either dental or facial injuries. The study by Bartsch et al. (2012) examined the effect of gloves and padded head gear on linear and angular velocity, acceleration, and momentum resulting from contact. They reported that mixed martial arts gloves against a bare head (no padded head gear) resulted in a significant increase in both the angular velocity and momentum. Other injury prevention strategies such as shoes (Alvarez, 2011), mats (McCann, 2016), taping/bracing (Wang, 2011), and strength training/training programs (Bingham, 2010; Malliaropoulos, 2014; Ratamess, 2011) have been published in magazines or the scientific literature; however, the research is limited to draw a conclusion. Little is known about the implementation or the effectiveness of these policies because the research is preliminary. Studies suggest that sports organizations need to promote the use of injury prevention strategies.

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