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Research Paper

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Injury Profiles and Concerns for Future Martial Artists

Introduction

The world of martial arts has seen increasing popularity especially over the last three decades and has established organizations within many countries. This paper will examine combative martial arts injuries in comparison to popular sports, identify martial arts injury profiles according to style, and offer improvements to increase safety and decrease risk. As many martial arts have a reputation for having high injury rates, organizations have developed rules and regulations to decrease significant risk. Taekwondo and Karate are two of the main styles followed across the world, along with Muay Thai and mixed martial arts, which are also increasing in practice.

Previously, much of the research analyzes specific injuries that have occurred in martial arts and are pilot studies that should be further supported. Additionally, many of the groups studied are of national-level or highly experienced competitors. Though this research yields very important data, it may not be accurate for most people who practice martial arts. In an attempt to better understand this expanding activity, researchers in many different countries have increasingly begun analyzing and publishing papers these last ten years. Nonetheless, studies need to be conducted because the practice of martial arts and competition are evolving and it is important to evaluate injury risk with its current rules. At this point in time, it is better to understand martial arts as it is practiced now, recognize main styles and their injury profiles, and recognize its place among sports and as an art with philosophy and discipline.

Research

Martial Arts in Comparison to Sports

Currently, there are few studies comparing martial arts injuries directly with other sports. One of these includes an analysis of national sports injury insurance data that was taken in Finland during the years of 1987 to 1991 covering 621,691 person-years of sports exposure¹.

(Please refer to file the word document BB Table for the electronic copy of 2 tables)

Researchers compared participants in soccer, ice hockey, volleyball, basketball, Judo, and Karate. They found that each sport has a specific injury profile, with higher injury rates in sports that had more powerful and frequent body contact such as ice hockey and Karate. In soccer, volleyball, and basketball, most injuries were to the lower limb while Judo had more injuries in the upper limbs. In Judo

and Karate, there were more dislocations than in other sports and Judo had more upper limb injuries while Karate had more dental injuries like ice hockey. Across all activities, sprains, strains, and bruises were the most common types of injury. During the course of the study, numerically there were fewer injuries in Judo and Karate; however, Judo and Karate also had fewer exposure-years. Thus, the rate of injury for these martial arts is 23% higher in Judo and 48% in higher Karate than in ice hockey. Mouth guards were recommended for Karate, ice hockey, and basketball due to dental injuries in these sports.

Taekwondo and Related Pediatric Studies

In 1997, a prospective study on athletes (219 males, 99 females) at the Canadian National Taekwondo Championships was directed by Kazemi and Pieter². These injuries were recorded on an injury form to document any injury seen and treatment provided by the health care team.

Table 2: Distribution of injuries by body part per 1,000 athlete-exposures.

Men			Women		
Body part	Number	Rate	Body part	Number	Rate
Head	3	6.9	Hamstrings	1	5.1
Eyes	2	4.6	Ankle	1	5.1
Nose	3	6.9	Foot	3	15.2
Cheek	1	2.3			
Lip	1	2.3			
Jaw	1	2.3			
Neck	1	2.3			
Hands	3	6.9			
Upper back	1	2.3			
Low back	2	4.6			
Pelvis	1	2.3			
Coccyx	2	4.6			
Hamstrings	3	6.9			
Leg	2	4.6			
Ankle	5	11.4			
Foot	2	4.6			
Toes	2	4.6			
Total	35	79.9	Total	5	25.3

The males had 79.0/1,000 injuries/athlete-exposure and sustained significantly more injuries than the females (25.3/1,000 A-E). The lower extremities were the most commonly injured body region in the men, followed by the head and neck; however, all injuries to women occurred in the lower extremities with their most common type of injury being the contusion. In comparison, the men's most common type of injury was the sprain. This difference in injuries may imply differences between male and female competitors and their fighting techniques.

The second paper discussed in this section was published in 1997, and is a prospec-

tive study of injuries sustained during junior Taekwondo (TKD) competitions³. The head researcher, Pieter, used check-off forms that describe the athlete, nature, site, and circumstances of 3,341 boys and 917 girls to collect data. They found that there were no statistical differences boys and girls in total injury rate. Additionally, these tournaments show that there were high injury rates in the lower extremities and unblocked attacks are the major cause of injury in both boys and girls. Thus, the researchers suggest that coaches work on the blocking skills of their junior TKD athletes largely in part to protect the head.

The third paper discussed in this section was published in 2005, and is a retrospective study using a precompetition habits and training survey for Canadian Taekwondo athletes competing in a national tournament⁴. In Kazemi's pilot study, questionnaires were distributed to 60 athletes of whom 28 replied. This study looked at dieting and weight cycling in addition to training, injury profiles, and social support. The injury and training aspects are examined here; however only 24 competitors' surveys were used in the injury statistics and inform descriptively more than numerically.

Table 6: Injury rates and location of injuries in Taekwondo athletes (n = 24)

Number of Injury	Lower Limb Injury (%)	Upper Limb Injury (%)	Back Injury (%)	Other Injury (%)
1 st	13 (46.5)	5 (17.9)	3 (10.8)	1 (3.6)
2 nd	8 (28.5)	3 (10.8)	2 (7.2)	0
3 rd	2 (7.2)	1 (3.6)	1 (3.6)	0
4 th	4 (14.4)	0	0	0
5 th	2 (7.2)	0	0	0

Lower limb injuries were the most common (46.5%), followed by upper extremity (18%), back (10%), and head (3.6%)—similar to the injuries found in the junior competitors of Pieter's study. Most of the injuries consisted of sprains/strains, followed by contusions, fractures, and concussions—similar to Kazemi and Pieter's study. Another important aspect is that injury did not have an association with fight outcome, likely because those with severe injuries did not compete or minor injuries were not severe enough to affect performance.

Karate and Muay Thai

Karate is often thought of a sport with higher risk of sports injury, similar to Taekwondo⁵. In order to decrease injury rates, the World Karate Federation in 2000 has changed safety, equipment, and scoring rules. In Macan's study published 2006, researchers compare the incidence and distribution of injuries in noncontact Karate in 1997 and 2002 to observe the effects of the new rules in Croatia⁶. These rules prohibit excessive force used in dealing blows, blows to the face with open hand techniques, dangerous or prohibited throwing techniques, and redistribute more points to kicking techniques. This study used a questionnaire to evaluate a total of 2023.5 and 2584 minutes of active fighting (exposure time) for 1997 and 2002 competitors, respectively. After the new rules, the

overall relative risk of injury has decreased in competitors under 18 years old. Additionally, there are fewer injuries to the head and more injuries to the legs, in part due to the redistribution of scored points. This study concluded that the new rules are very important in the distribution and prevention of injuries in martial arts. These Karate competitions were specifically for noncontact/light contact fighting and thus, strict judging and heavy penalties for uncontrolled (excessive) blows have significantly decreased the risk of injury.

In 2001, Gartland published his study conducted on Muay Thai kick boxing in order to compare the type and number of injuries that occur during the training and practice of Muay Thai to the data obtained with those from previous studies of Karate and Taekwondo⁷. They collected data by conducting one to one interviews using a standard questionnaire on injuries during training and practice of Muay Thai at various gyms and competitions in the United Kingdom and a Muay Thai gala in Holland. They studied 132 men and 20 women of whom 19 were beginners, 82 amateurs, and 51 professionals.

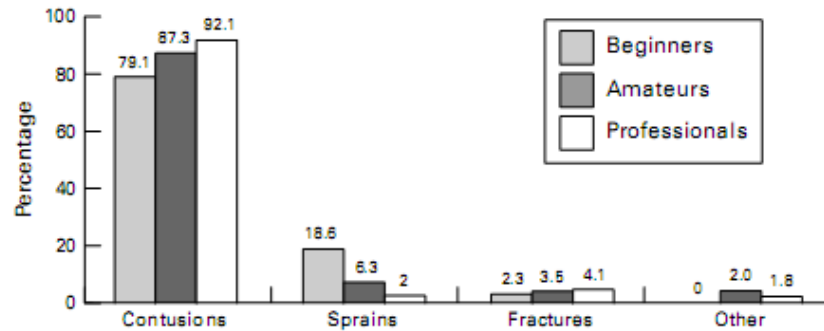


Figure 2 Percentage distribution of injuries by generic type.

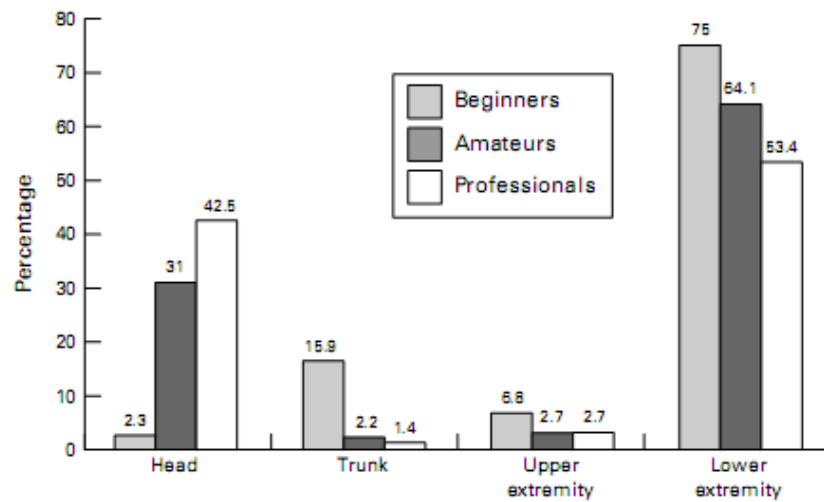


Figure 3 Anatomical distribution of injuries.

Injuries to the lower extremities were the most common in all groups and head injuries were the second most common in professionals and amateurs; beginners are not allowed contact in sparring. Soft tissue trauma was the most common type of injury in the three groups. Injury rates were higher in beginners—13.5/1000 participants, amateurs had a rate of 2.43/1000 participants and professionals, 2.79/1000 participants. They concluded that Muay Thai injury rates are similar to those found for Karate and Taekwondo although they also found a lower percentage of injuries resulting in time off training for Muay Thai.

Mixed Martial Arts Injuries

Mixed martial arts (MMA) competitions began 1993 with combatants trained in diverse martial arts and competitions with virtually no protective gear, weight classes, time limits, or other regulatory standards⁸. This was known as “no holds barred sports fighting.” Though no deaths or permanently disabling injuries have been reported in the US, the criticism and concerns have led to rules

and regulations that were instated in 2000--the same year as new regulations in Karate and three years before TKD point redistribution⁹. In 2005, Buse published his study on MMA to identify the medical issues that may be associated with mixed martial arts competition by reviewing public videos footage of 1,284 men competing in 642 televised matches from 1993 to 2003¹⁰.

Table 3 Types and proportions of match stoppages because of head impact

Mechanism of match stoppage	Percentage of matches ± 95% CI (n = 642 matches)
Punch	16.8 ± 2.9
Various strikes*	5.9 ± 1.8
Knee strike	2.2 ± 1.1
Elbow strike	1.6 ± 1.0
Kick	0.9 ± 0.7
Slam to ground	0.6 ± 0.6
Head stomp	0.3 ± 0.4

*Any assorted barrage of strikes to opponent's head.
CI, Confidence interval.

He found that of the 642 matches, 182 were stopped due to head impact, 106 because of musculoskeletal stress, 91 because of neck choke, and 173 because of expiration of match time. This study showed that most of the matches ended with blunt forces to the head and he suggests further research is needed to find how morbidity is associated with participation in mixed martial arts.

In Ngai's study, they conducted a retrospective cohort study to examine mixed martial arts injuries during March 2002 to September 2007, involving 1,270 fight participants and 635 professional MMA matches¹¹. Take note that Buse's study largely takes part before regulations were instated and Ngai's study slightly overlaps in time with Buse's study when additional safety rules have been implemented. Their results show increasing numbers of participants since 2002 and with the losers sustaining 2.53 times as many injuries than the winners. They found that most of the common reported injuries were lacerations (17.3%) and upper extremity injuries (ocular, facial, and upper: 26.1%) that were mainly from striking. This paper documented 23.5 injuries per 100 fight participants and a concussion rate of 15.4 per 1,000 athlete exposures or 3% of all matches, which they noted is similar to risk of concussion in the world class international men's Taekwondo competition. Their conclusion is that injury rates in the

regulated professional MMA competitions are similar to other combat sports and the overall risk of critical injury appears low. They noted that the age, weight, and fight experience of the martial artists did not significantly increase the likelihood of injuries when they controlled for other covariates—though they do not mention what those covariates are.

Comparisons within Martial Arts Styles and other Implications

Currently, there are few studies that compare multiple martial arts. In 2005, Zetaruk published his study comparing five martial arts with respect to injury outcomes with a one year retrospective cohort using an injury survey¹². They studied 263 martial artists: 114 in Shotokan Karate, 47 in aikido, 49 in tae kwon do, 39 in kung fu, and 14 in tai chi.

Table 1 Injury rates by style

Style	No	Injury	Major injury	Multiple injuries
Karate	114	34 (29.8)	19 (16.7)	21 (18.4)
TKD	49	29 (59.2)*	13 (26.5)	22 (44.9)*
Aikido	47	24 (51.1)	13 (27.7)	15 (31.9)
Kung fu	39	15 (38.5)	7 (17.9)	9 (23.1)
Tai chi	14	2 (14.3)	1 (7.1)	0 (0.0)
Total	263	104 (39.5)	53 (20.2)	67 (25.5)

Values are number of participants with outcome (%).

*p<0.001 compared with Shotokan karate.

TKD, tae kwon do

They found the rate of injuries varied according to style: 59% Taekwondo, 51% Aikido, 38% Kung fu, 30% Karate, and 14% Tai chi and that Taekwondo had a threefold increased risk of injury and multiple injuries than Karate.

Table 2 Region of injury

Style	No	Upper extremity	Lower extremity	Groin	Trunk	Head/neck
Karate	114	19 (16.7)	26 (22.8)	1 (0.9)	17 (14.9)	11 (9.6)
TKD	49	20 (40.8)*	28 (57.1)*	9 (18.4)*	12 (24.5)	15 (30.6)*
Aikido	47	20 (42.6)*	16 (34.0)	3 (6.4)	12 (25.5)	15 (31.9)*
Kung fu	39	8 (20.5)	14 (35.9)	2 (5.1)	5 (12.8)	4 (10.3)
Tai chi	14	1 (7.1)	1 (7.1)	0 (0.0)	1 (7.1)	1 (7.1)
Total	263	68 (25.9)	85 (32.3)	15 (5.7)	47 (17.9)	46 (17.5)

Values are number of participants with outcome (%).

*p<0.001 compared with Shotokan karate.

TKD, tae kwon do.

Compared with Karate, the risks of head/neck injury, upper extremity injury, and soft tissue injury were all relatively higher in Aikido, and the risks of

head/neck, groin, and upper and lower extremity injuries were higher in Taekwondo. Thus, those in Taekwondo have higher relative injury risk than those in Shotokan Karate and different martial arts have significantly different types and distribution of injuries.

Along with pediatric studies involving martial arts, more studies have been done involving the elderly and how martial arts may benefit this age group as well. In 2007, van Swigchem, Groen, Weerdesteyn, and Duysens published a paper on how falling techniques may decrease impact upon the hip and whether people can apply these techniques in real life¹³. Because it is unethical to push subjects such as an elderly woman and time her fall, they have used five seasoned Judokas and nine non-Judokas to perform voluntary falls. They find that voluntary motor control is possible within a specific time window (about 145-155ms from a kneeling height) in the fall, even in inexperienced fallers. This is important because falling is the leading cause of injury-related death in adulthood¹⁴. More studies should be done to expand the knowledge due to: the lack of the “startle-adrenaline” effect, error due to the subjects being young women, and small sample size.

Discussion

While analyzing these studies, it became clear that many studies agree upon certain aspects and some studies do not show similar results. An important concern of all the studies involves underreporting injuries which leads to underestimates of injury rate. This may be due to participants’ uncertainty about what constitutes an injury, low recall on past injury, unreported injuries to trainers in order to compete, or self-treated injuries. Some of the important issues include gender differences in injury profiles, age of participants, and equipment. In the Taekwondo studies, the junior competitions¹⁵ showed no statistical differences between males and females while the study with Canadian nationalists¹⁶ show an obvious difference in injury profile. It is possible that for younger Taekwondoists, their training and body strength do not differ as greatly between genders as in older competitors. This may reflect upon the trainers and training methods, though the studies do not record how many trainers a competitor usually has. Additionally, the studies stated that many of the Taekwondo blows to the head were unblocked and even though helmets are worn, concussions still are a concern. Many groups suggest that no head contact should occur in competition and blocking skills be implemented. In the new Karate regulations, the number of head injuries decreased due to enforcement of stricter rules and point system. Perhaps this idea should be instated for younger Taekwondo competitors as well.

As seen by Kujala’s study¹⁷, injury rates are low in younger athletes and highest in young adults. Many of the other studies have shown this difference in injury rate among ages as well, though they differ in their age categories such as 18 or older¹⁸ or 20 to 24¹⁹. Some studies instead choose to view experience differences by categorizing them into beginners or years of experience. Overall, it is shown that younger athletes have lower injury rates, probably due to regulations that promote safety and careful training received as well as smaller

body sizes that may not achieve the strength threshold to injure their opponents. Body factor may also have a role in the gender difference. However, in Muay Thai²⁰, beginners suffered more injuries, though these were more likely to be contusions followed by sprain/strain as compared to fractures in professionals. It is seen that different training methods/regulations are often given according to age, rank, and experience and that these play an important role in relative injury risk. Additionally, in mixed martial arts²¹, many of the competitors have multiple years in experience in different styles which may decrease the risk factors mentioned such as age and weight. While some of the studies are of a certain set of competitors such as Taekwondo nationalists or experienced mixed martial artists, these injury profiles are indicative of the extreme end of participation. Some studies took note that with lower hours trained per week²² and differing competition style^{23,24}, there were statistically lower injury rates—this may be in part due to exposure and type of competition, but also has a confounding factor of personality. If a person enjoys and finds excitement in training/sparring, it is likely he/she will train more hours with enthusiasm—which may lead to larger risk of injury. As seen with the national Taekwondoists²⁵, some athletes continue to train despite injury and may exacerbate them and leads to higher risk of subsequent injuries.

Overall, injury rates are higher in combative martial arts due to the nature of the sport that involves body contact with the opponents. Thus, many studies expressed concern with preventative measures such as teaching Taekwondoists to block^{26,27,28} and instate changes in protective gear^{29,30}. They remarked that for much of the gear it was more protective for the attacker than the defender, such as instep guards and gloves that do not slow down the acceleration of the punch or decrease force. In the pediatrics study³¹, weight has a positive correlation with injury and helmets were more beneficial to prevent injuries if the competitor hit the ground. From personal martial arts experience, it is hard to tell whether heavier padding is favorable due to increased protection or if believing there is increased protection leads to harder strikes. Though many competitions have regulations on equipment, it would be beneficial to design gear specific to martial arts style to decrease injury rates.

Conclusion

Martial arts involving contact competition have higher injury rates than other sports involving body contact. Additionally, competitions are held between pairs and during the match, the attacker may be injured as well as the defender—as seen by the lower limb injuries in Taekwondo though no strikes directed below the waist are legal. Although martial arts are not team competitions in the ring, Kazemi³² studied the psychological effect of social support that should be studied in further research to observe its effects upon athletes. Martial arts uniquely has many styles that leads to different injury profiles such as lower limb and head injuries for TKD and Muay Thai, lacerations in mixed martial arts, and upper extremities in Karate, MMA, Aikido, and Judo.

Some martial arts are largely popular in certain age groups. Mixed martial

arts and Muay Thai participants are likely to be in the 20-29 years old age group while Tai Chi usually references to older adults. Additionally, Judo falls have been taught to the elderly in attempts to decrease falling injuries and van Swigchem's focus on falls should be further investigated if we are to apply them in the future. Thus, martial arts are not solely for the young, they may be applied to many age groups with factors varying upon style and training regime. Other considerations (not studied in this paper) are teaching discipline, effects of meditation on stress reduction, and increasing strength that are important factors when considering upon joining martial arts.

In conclusion, martial arts are developing and undergoing changes in public opinion, popularity, rules and regulations, equipment, and training styles. Though increasing attention is given to martial arts, there are still relatively few articles studying this activity and its many nuances such as styles, training methods, injury prevention, and competition. While it is likely that those who practice martial arts are likely to sustain injuries, like in sports, injury also depends on frequency of participation and the level of athletes. Since rules, regulations, and equipment are still evolving, it is essential to identify the effects on injury rates and determine whether these regulations and equipment can collectively provide a safer environment. Additionally, it is not uncommon for martial arts schools to have multiple or intermixed styles—this makes it possible for future participants to have more access to styles that are appropriate for their age, body, and goals. Goals of competition, personal growth, discipline, honor, and self defense are only a few of the reasons why a person may join martial arts, but its integral philosophy plays a role in separating it from pure sport.

Notes

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