

# Assessment of Injuries Sustained in Mixed Martial Arts Competition

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## ABSTRACT

Mixed martial arts (MMA) competitions have gained much popularity, and the sport is watched by many millions annually. Despite ongoing controversy, there have been no objective studies of the injuries sustained in MMA based on on-site evaluation. In the study reported in this article, we attempted to delineate injury patterns for MMA participants.

We conducted an observational cohort study of MMA competitions held in Hawaii between 1999 and 2006. The study included 116 bouts, involving 232 "exposures" and 179 male participants between ages 18 and 40. All the fighters were examined by 1 of 4 physicians, both before and after each bout. Fighters were

referred to an emergency department when necessary, and follow-up was recommended as needed.

Among the 232 exposures were 55 injuries: 28 abrasions and lacerations (6 requiring on-site suturing or referral to an emergency department for suturing), 11 concussions (4 with retrograde amnesia), 5 facial injuries (2 nasal fractures, 1 tympanum rupture, 1 temporomandibular joint sprain, 1 Le Fort fracture), and 11 orthopedic injuries (3 metacarpal

match. Far from the "tough man" competitions that were popular 20 years ago, modern MMA competitions are complex athletic events, often involving elite athletes.

In the events included in this study, competitors included former division I college wrestlers, former college and professional football players, former Olympic medalists in wrestling, and black belts in a variety of martial arts. MMA

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injuries, with 1 confirmed fracture; 1 acromioclavicular separation; 1 traumatic olecranon bursitis; 1 elbow subluxation; 1 midfoot sprain; 1 aggravation of elbow medial collateral ligament sprain; 1 elbow lateral collateral ligament strain; 1 trapezius strain; 1 Achilles tendon contusion).

We describe the injuries sustained in MMA competition to make comparisons with other sports. We discuss distribution and mechanism of injuries as well as injury incidence based on on-site evaluation in MMA.

**M**ixed martial arts (MMA) competitions incorporate elements of boxing, kickboxing, wrestling, jiu-jitsu, and other martial arts in organized events. Athletes are allowed to punch, kick, and use wrestling-style take-downs and jiu-jitsu-style submission holds in an attempt to win bouts by knockout, submission, or judges' decision based on control of the

requires skills in a variety of martial arts and grappling techniques and the highest level of athleticism (Figure 1).

The sport has rapidly grown in popularity. Many millions of fans watch MMA competitions annually on pay-per-view TV in the United States, and the sport has a notable long history of popularity in Brazil and Japan. Controversy with regard to early "open" weight classes and lack of striking rules has followed the sport, particularly in the United States, and a ban of the sport has been attempted in various states. Despite the growing popularity and controversy, there is a paucity of data on the types of injuries that occur in MMA competition.

Bledsoe and colleagues<sup>1</sup> reviewed injury data from the Nevada State Athletic Commission and found an overall rate of 28.6 injuries per 100 fight "participations" (a



Figure 1. Mixed martial arts competition.

“participation” is defined as one competitor in one bout). To our knowledge, studies of prefight and postfight evaluations have not been conducted by on-site physicians. In this article, we describe injuries sustained by professional MMA competitors in Hawaii events during a prospective assessment period (1999–2006). In the study, we attempted to delineate the injury patterns of MMA competitions by analyzing a database compiled by 4 physicians who were ringside physicians at these events.

### MATERIALS AND METHODS

Data were collected for 116 bouts at 12 separate professional MMA events held in Hawaii over 7 years (1999–2006). Competitions were hosted by MMA organizations. Competitors came from Hawaii, the continental United States, Japan, Brazil, and elsewhere.

Each fighter was examined before and after each bout. Ringside care was provided by a team of 4 physicians: emergency department (ED) physician, orthopedic surgeon, ophthalmologist, and anesthesiologist. Data collected included age, past medical and surgical history, current medical problems, and physical examination data. After each fight, each fighter was asked about injuries, and directed examination

of injured areas was performed as indicated. Additional follow-up information was included as appropriate. For this discussion, a bout is defined as an in-the-ring competition between 2 athletes according to the rules of the event. An exposure consists of 1 athlete in 1 bout.

The fighters were male, medically fit professional athletes, ages 18 to 40, with experience in various martial arts and/or wrestling.

### RESULTS

The study included 116 bouts (232 exposures) at professional MMA events held in Hawaii over 7 years (1999–2006). The 49 fighters who participated in the 116 bouts

sustained 55 injuries. Each bout involved 2 fighters, though some fighters competed in more than 1 bout per event.

The 55 injuries were classified as abrasions and lacerations ( $n = 28$ ), concussions ( $n = 11$ ), facial injuries ( $n = 5$ ), or orthopedic injuries ( $n = 11$ ). Minor contusions and superficial hematomas in the absence of other injuries were not included in this study.

The largest injury group, abrasions and lacerations, consisted of 1 deep tongue laceration (required suturing in the ED); 6 forehead lacerations (1 required suturing); 11 lacerations to eyebrows or eyelids and 1 corneal abrasion; 4 lacerations to the nasal bridge; and 6 lacerations to the knees, scalp, or chest or superficial abrasions that did not require formal medical care. Six of the fighters were sent to the ED for suturing or wound care.

Of the 11 concussions, 7 caused brief (<15 seconds) loss of consciousness; the other 4 were characterized by retrograde amnesia. In 4 cases, computed tomography (CT) of the head was performed after the fight. All CT scans were negative for cerebral hemorrhage, per the radiologist’s report.

The facial injury group consisted of 2 nasal fractures, 1 tympanic membrane rupture, 1 Le Fort fracture, and 1 temporomandibular joint sprain.



Figure 2. Jiu-jitsu arm bar.

**Table. Comparative Injuries per Exposure in Martial Arts Competitions**

| Sport                      | Injuries Per Exposure <sup>a</sup> |
|----------------------------|------------------------------------|
| Mixed martial arts         |                                    |
| Present study              | 0.237                              |
| Bledsoe et al <sup>1</sup> | 0.286                              |
| Karate <sup>7</sup>        | 0.31                               |
| Karate <sup>8</sup>        | 0.29                               |
| Karate <sup>9</sup>        | 0.214                              |
| Boxing <sup>4</sup>        | 0.25                               |
| Taekwondo <sup>6</sup>     | 0.0629                             |

<sup>a</sup>Exposure = single participation in a bout.

All orthopedic injuries were evaluated, after the competition, by a board-certified orthopedic surgeon, with recommendations for follow-up as appropriate. The most common orthopedic injuries were to the metacarpals, with 1 fracture requiring closed reduction and casting. The other 2 athletes with metacarpal injuries were referred for follow-up with their primary care physician and were lost to follow-up. The most common mechanism of metacarpal injury was a punch or strike to the other fighter.

There was 1 elbow lateral collateral ligament sprain and 1 elbow medial collateral ligament sprain. The latter was in an athlete with a prior injury to the same elbow. His mechanism of injury, a jiu-jitsu arm bar, resulted in a hyperextension injury to the elbow (see example of a jiu-jitsu arm bar in Figure 2).

There was 1 case of traumatic elbow subluxation with spontaneous reduction that occurred from a jiu-jitsu arm bar. The other orthopedic injuries were 1 acromioclavicular separation, 1 midfoot sprain, and 1 traumatic olecranon bursitis with negative radiographs. There was 1 trapezius strain and 1 Achilles tendon contusion without rupture.

The midfoot sprain resulted from delivering a kick. The traumatic olecranon bursitis resulted from an elbow strike superimposed on trauma from a prefight fall. The Achilles contusion was from a jiu-jitsu ankle lock (this lock is shown in Figure 3).

Considering the statistical methods used in comparable studies

in other sports, and counting each bout as a single exposure, we found 232 exposures among 179 male competitors. There were 55 injuries in 49 fighters during the 116 recorded bouts. Of these injuries, 28 were abrasions or lacerations, 11 were concussions, 5 were facial injuries, and 11 were orthopedic injuries. In summary, the injury-per-exposure rate was 0.237, and the risk for injury was 0.27 per athlete. This risk for injury per exposure was compared with those reported in other studies documenting injury frequency in karate, boxing, and taekwondo (Table).

## DISCUSSION

As in other contact sports (eg, boxing, judo, kickboxing, rugby, football), in MMA there is the potential for significant injury. According to

our review, the most common injuries, in decreasing order, are abrasions and lacerations (51% of injuries), concussion (20%), orthopedic injuries (20%), and facial injuries (9%). There were no deaths. There was no severe trauma requiring immediate resuscitative measures. To our knowledge, there were no injuries that precluded eventual return to competition.

In addition to the 4 categories of injuries already described, there were superficial contusions and ecchymoses. Because contusions and ecchymosis are usually considered minor injuries not requiring follow-up, we did not include them in this study, which is consistent with studies of other contact sports.

All data were gathered by ringside physicians with experience in the unique medical aspects of MMA competition. After each fight, each fighter was reevaluated in the locker room with directed examination of any suspected injured areas. In addition, the physicians were available in each case until the end of each night's matches. The physicians were available to any fighter who subsequently developed pain or wished to have an injury evaluated at any time until the final event of the evening was over.

This study had some limitations owing to the nature of the sport.



**Figure 3.** Jiu-jitsu ankle lock used in mixed martial arts. Practitioner on left plantarflexes ankle joint with own wrist and forearm used as fulcrum.

Some athletes may have developed pain or symptoms of injury during the days after a given competition. Because many of the competitors were from other states or countries, and most returned home 1 or 2 days after the event, it is possible that injuries with delayed onset of symptoms could have been missed and not included in this study. Also, some athletes, for personal or professional reasons, may have wished to conceal an injury. The logistics

injuries). The authors documented a 6.4% knockout rate and a 39.8% technical knockout rate. It is not clear how many of the knockouts represented actual concussions, as no physician diagnosis was documented in these categories.

In our study, the overall rate of injury per exposure was 0.237 or 23.7 injuries per 100 fight participations. The rate of lacerations (12 per 100 fight participations) was higher than that of other injuries.

recorded, for a rate of 1.18 injuries per competitor and 0.43 injuries per bout,<sup>7</sup> considerably more than our rate of 0.28 injuries per competitor. Of the 168 injuries, 141 were minor contusions, 12 were facial lacerations, 3 were knockouts (mild brain injuries), 3 were thoracic contusions, 1 was a mid-foot fracture, and 9 were other blunt injuries.

A similar study,<sup>8</sup> of Danish karate championships from 1983

**“...our study indicated that injury rates in MMA competitions are comparable to those in boxing and karate.”**

of the sport, then, and the fact that its athletes converged on the event from a variety of distant locations, made long-term follow-up difficult and may have unintentionally skewed the results.

Several epidemiologic studies have attempted to outline the frequency and types of injuries most common in certain sports. The inconsistency of data recording, as well as different injury criteria, has complicated comparison with our study. We know of only 2 other reviews of MMA competitions. In the first, Buse<sup>2</sup> delineated the medical reasons for fight stoppage in 642 televised matches. Of the stoppages, 28.3% were because of concussions. The most common reason for stoppage was periocular lacerations. In addition, punches caused more stoppages than did all other mechanisms of injury. A study limitation was lack of physical examination of fighters and reliance on televised images to draw medical conclusions.

In the other review of MMA competitions, using the Nevada Athletic Commission database, Bledsoe and colleagues<sup>1</sup> found an overall injury rate of 28.6 per 100 fight participations, with facial lacerations comprising the most abundant category (47.9% of all

Most injuries in the first 3 groups (abrasions and lacerations, concussions, facial injuries) were from receiving punches, kicks, or strikes from a knee or elbow. The rate of concussions was 4.7 per 100 fight participations.

Garland and colleagues<sup>3</sup> reported a 7.7% rate of fight stoppage because of head injury in 46 kickboxing matches. In another review of kickboxing, Zazryn and colleagues<sup>4</sup> found a rate of 19.2 concussions per 1000 fights over 16 years. A study of mild traumatic brain injury in professional taekwondo fighters revealed an incidence of 365 head blows per 1000 athlete exposures.<sup>5</sup>

A Canadian study<sup>6</sup> of professional taekwondo competitions revealed an overall rate of 62.9 injuries per 1000 exposures (0.0629), lower than the rate in our study, and a rate of 6.9 concussions per 1000 exposures. In addition, an Australian study<sup>4</sup> of professional boxers revealed an injury rate of 0.25 per fight participation, just 0.02 lower than our finding, and injury rates of 89.9% (head, face, neck), 7.4% (upper extremities), and 45.8% (eye region).

During the 1999 World Karate Confederation championship event in Germany (392 bouts, 142 competitors), 168 injuries were

to 1986, revealed an injury rate of 0.29 per match when knuckle protection was used and 0.25 when knuckle protection was prohibited. With use of gloves, injury rates were 92% for head, neck, and face, 4% for extremities, and 4% for trunk; without gloves, injury rates were 78% for head, neck, and face, 18% for extremities, and 4% for trunk. Our study revealed a comparable distribution of 75% head, neck, and face injuries, 19% extremity injuries, and 21% trunk injuries (some injuries fit multiple criteria). Another study<sup>9</sup> of karate competitions revealed an injury rate of 0.3 per match, compared with our rate of 0.23.

## CONCLUSIONS

Despite our difficulties in comparing various studies because of different methods used, our study indicated that injury rates in MMA competitions are comparable to those in boxing and karate. We emphasize that we attempted to list injuries that occur in MMA and to determine injury rates based on on-site evaluation. Long-term studies have not been conducted, and any determination of long-term medical sequelae in MMA athletes is beyond the scope of this study. The largest group of inju-

ries was abrasions and lacerations, which occurred in 12% of exposures. Most of these were superficial, with only 2.6% of the exposures resulting in laceration requiring suturing or ED care. The second largest group of injuries was orthopedic injuries, which occurred in 4.7% of exposures. Concussions and facial injuries rounded out the injury distribution and occurred in 4.7% and 2.2% of exposures, respectively. The incidence of injuries in MMA competitions documented in our study is comparable to that found by other investigators in MMA, boxing, and kickboxing.

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### REFERENCES

1. Bledsoe GH, Hsu EB, Grabowski JG, et al. Incidence of injuries in professional mixed martial arts competitions. *J Sports Sci Med.* 2006;5(CSSI-1):136-142.
2. Buse GJ. No holds barred sport fighting: a 10-year review of mixed martial arts competition. *Br J Sports Med.* 2006;40(2):169-172.
3. Gartland S, Malik MH, Lovell M. A prospective study of injuries sustained during competitive

Muay Thai kickboxing. *Clin J Sports Med.* 2005;15(1):34-36.

4. Zazryn TR, Finch CF, McCrory P. A 16-year study of injuries to professional kickboxers in the state of Victoria, Australia. *Br J Sports Med.* 2003;37(5):448-451.
5. Roh JO, Watkinson EJ. Video analysis of blows to the head and face at the 1999 world taekwondo championships. *J Sports Med Phys Fitness.* 2002;42(3):348-353.
6. Kazemi M, Pieter W. Injuries at the Canadian National Taekwondo Championships: a prospective study. *BMC Musculoskeletal Disord.* 2004;5(22):1-8. doi:10.1186/1471-2474-5-22.
7. Muller-Rath R, Bolte S, Peterson P, et al. Injury profile in modern competitive karate—analysis of 1999 WKC-karate world championship games in Bochum. *Sportverletzung Sportschaden.* 2000;14(1):20-24.
8. Johannsen HV, Noerregaard FOH. Prevention of injury in karate. *Br J Sports Med.* 1988;22(3):113-115.
9. Stricevic M, Mukund RP, Okazaki T. Karate: historical perspective and injuries sustained in national and international tournament competitions. *Am J Sports Med.* 1983;11(5):320-324.

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