Epidemiology of injuries in full-contact combat sports

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Abstract

As in any sport, there is an inherent risk of injury to practitioners of combative martial arts. Notwithstanding the potential for injury, there has not been a concerted effort to clearly elucidate the injury problem in full-contact combat sports. The purpose of this review is to provide an overview of the injury incidence, injury pattern, and injury severity in six popular and commonly practiced full-contact combat sports. Data from a total of 47 observational studies suggest that there is a significant injury problem in full-contact combat sports generally. However, the injury incidence rates and injury patterns vary considerably across different styles, which most likely is a reflection of differences in competition rules. Very little is known about the actual severity of injuries in combat sports. Future studies are strongly encouraged to adopt stronger study methodologies.

Introduction

The term combat sports can be used to refer to the subset of martial arts that are practiced for the purpose of competition. Combat sports typically involve one-on-one combat, either unarmed or with the use of various weapons such as sticks (e.g. arnis, kali, eskrima), wooden swords (e.g. kendo), small swords (e.g. modern fencing), or even lances (e.g. jousting). Unarmed combat sports can be further subdivided into striking styles (e.g. boxing, kickboxing, karate, taekwondo), grappling styles (e.g. wrestling, judo, Brazilian jiu-jitsu), or hybrid styles combining striking and grappling (e.g. mixed martial arts). Naturally, there is a wide range of rulesets across the combat sports. These rulesets regulate various aspects of the contests, for instance: which techniques and targets are permissible, what protective gear (if any) the contestants must wear, and whether contests are won by scoring more points or by disabling an opponent. Reflecting the amount of force that can be used on an opponent, combat sports can be divided into light-contact, medium-contact, and full-contact variants.

Although both karate and taekwondo each boast having almost 100 million practitioners worldwide, it is difficult to estimate exactly how many people participate in combat sports worldwide, and, moreover, to ascertain which of them are the most popular or commonly practised. The official program for the Rio 2016 Olympic Games includes three unarmed combat sports, namely boxing, judo, and taekwondo. Noteworthy among the non-Olympic combat sports is mixed martial arts. Promoters and organisers of mixed martial arts contests have enjoyed a surging popularity and widespread coverage in mainstream media since the early 2000s, but the sport has also attracted rebuke from both politicians and medical associations that wish to see it banned.[1]

The health benefits of regular physical activity are undisputed, and the specific health benefits of martial arts practice have been reviewed elsewhere.[2-4] However, participation in sport and active recreation are not without risk, and injuries can be an adverse outcome. Indeed, sport injury is identified as a major public health problem,[5-7] and approximately 8% of youths discontinue sporting activities annually because of injury.[8] As in any sport, there is an inherent risk of injury to practitioners of combative martial arts, in particular in full-contact combat sports. The aim of any sport, therefore, should be to keep the risk of injury at an acceptable level, and to ensure that the benefits of participation outweighs the potential adverse events.

It is been claimed that all styles of martial arts are safe and that practitioners are seldom severely injured.[9] However, good quality evidence to support such claims are often wanting. Moreover, there are good reasons to suspect that the injury problem varies significantly between different combat sports. Unlike in many other major sports such as football, rugby, and basketball (to name but a few), there has not been a long-standing, concerted effort to clearly elucidate the injury problem in popular combat sports. It is therefore difficult to ascertain the true injury risk in these sports, which in turn precludes athletes from making truly informed choices. The lack of good quality epidemiological investigations also precludes the identification of risk factors that could become targets for injury prevention efforts, thereby improving the safety for combat sport athletes.

Fortunately, prospective epidemiological investigations of injuries in combat sports have started to emerge in the literature. It may therefore be useful to athletes and sport governing bodies, as well as to sports injury prevention

scientists, if the available data were synthesised in a way that allowed for meaningful comparisons to be made. Thus, the main objective of this review is to provide an overview of the injury incidence, injury pattern, and injury severity in six popular and commonly practised full-contact combat sports (i.e. boxing, kickboxing, judo, karate, taekwondo, and mixed martial arts).

Methods

Selection criteria

Reports from observational studies published in peer-reviewed literature were eligible for inclusion in this review. Eligible study designs included prospective or retrospective cohort studies based on on-site competition injury surveillance data, and meta-analyses of similar data. On the other hand, cross-sectional surveys, case-control studies, case series and reports, commentaries, editorials, and letters to the editor were excluded from this review. Language restrictions were applied such that only English, German, French, and Spanish language articles were included. Eligible studies had to report epidemiological data such as incidence, distribution, or severity of injuries in either boxing, judo, karate, kickboxing, mixed martial arts, or taekwondo. No studies were excluded based on sex, age, or any other characteristics of the study population.

Search strategy

This review used a quasi-systematic approach to identify relevant studies. This entailed using the results from previously conducted, sport-specific systematic literature searches. Although there are minor differences between the original search strategies (e.g. which databases were utilised, when the searches were conducted, and which sport-specific keywords were used), they all included at a minimum electronic searching of PubMed and SPORTDiscus databases from inception to 2013. Moreover, snowballing strategies were used to identify additional studies not captured by the original electronic searches.

Data extraction and analysis

Data from included studies were extracted and tabulated in an electronic spreadsheet. The data of interest were as follows: (i) injury incidence rate per 1,000 athlete-exposures, (ii) distribution of injuries by anatomical region and by type of injury, and (iii) injury severity. One athlete-exposure was defined as one athlete being exposed to the possibility of incurring an injury while participating in a single contest (fight or bout). If the included studies did not specifically report injury incidence rates per 1,000 athletes-exposures, they were, if possible, calculated from the available data.

The number of injuries by anatomical region and by type of injury from individual studies were pooled for each combat sport and presented as proportions of the total number of injuries. In an attempt to increase the comparability across the included studies, injuries were categorised according to the Orchard Sports Injury Classification System, version 10[10], while unspecified injuries were omitted from the pooled injury proportion calculations.

Similarly, the number of injuries by injury severity were presented as proportions of the total number of injuries. Injury severity was defined in accordance with previous recommendations,[11] that is, as the number of days elapsed from the date of injury to the date of the athlete's return to full participation in training and match play. Injury severity was categorised as follows: slight (0–1 days), minimal (2–3 days), mild (4–7 days), moderate (8–28 days), severe (>28 days).

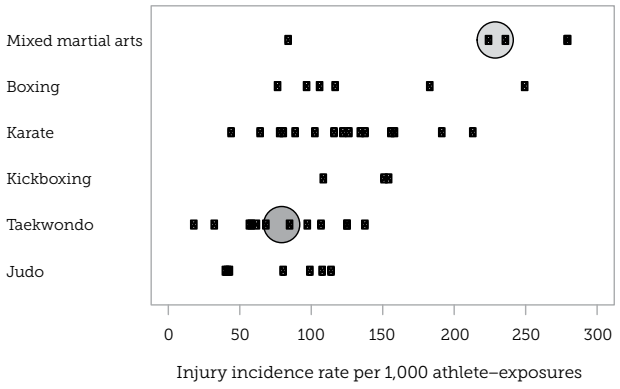
Results

A total of 47 observational studies were included in this review. Two studies reported on injuries in both taekwondo and judo. Thus, the total number of injury reports for each combat sport were as follows: 13 for taekwondo[12-24], 3 for kickboxing[25-27], 5 for mixed martial arts[28-32], 6 for boxing[33-38], 13 for karate[39-51], and 7 for judo.[24, 51-56] In addition, two meta-analyses (one for mixed martial arts[1] and one for taekwondo[11]) were identified and included in this review.

Injury incidence rates

Figure 1 shows the injury incidence rates per 1,000 athlete-exposures as reported by the included studies. The small circles represents point estimates from individual observational studies, while the large circles represent pooled estimates from published meta-analyses. The data suggest that, among the popular full-contact combat sports, the risk of injury is lowest in grappling styles such as judo (range: 41.2–115.1); greater in striking styles such as taekwondo (range: 19.1–138.8), karate (range: 45.2–214.3), kickboxing (range: 109.7–155.4), and boxing (range: 77.7–250.6); and greatest in hybrid styles such as mixed martial arts (range: 85.1–280.7).

Figure 1. Injury incidence rates per 1,000 athlete-exposures in full-contact combat sports. Small squares represent point estimates from individual observational studies. Large circles represent pooled estimates from published meta-analyses

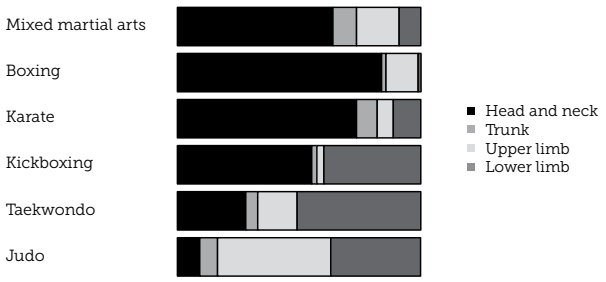


Injury patterns

Figure 2 shows the proportions of the total number of injuries by anatomical region across the included combat sports. The head and neck was the most frequently injured anatomical region in boxing (84%), karate (74%), mixed martial arts (64%), and kickboxing (55%); whereas the lower limb and upper limb were the most frequently anatomical regions in

taekwondo (51%) and judo (47%), respectively. The proportion of trunk injuries was relatively small across all combat sports (2–10%).

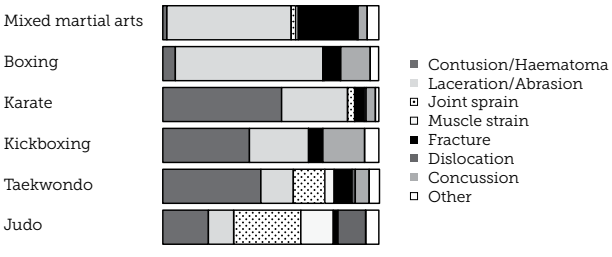
Figure 2. Proportions of total number of injuries by anatomical region in full-contact combat sports



Proportion (%) of total number of injuries by anatomical region

Figure 3 shows the proportions of the total number of injuries by type of injury across the included combat sports. Contusion (which includes bruising and haematoma) was found to be the most common type of injury in karate (55%), taekwondo (45%), and kickboxing (40%); while laceration (which includes abrasion) was the most common type of injury in boxing (68%) and mixed martial arts (58%). Compared to other combat sports, judo was found to have a greater variety of injury diagnoses, with joint sprain (31%) being the most common type of injury. Concussion comprised a greater proportion of the total number of injuries in kickboxing (19%) and boxing (14%) compared to taekwondo (6%), MMA (4%), and karate (4%). The proportion of fractures, however, was greater in mixed martial arts (27%) than in taekwondo (8%), boxing (7%), kickboxing (7%), karate (4%), and judo (2%).

Figure 3. Proportions of total number of injuries by type of injury in full-contact combat sports

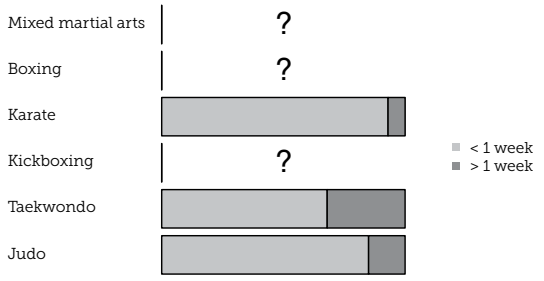


Proportion (%) of total number of injuries by type of injury

Injury severity

Figure 4 shows the proportions of the total number of injuries by injury severity across the included combat sports. Although several of the included studies mentioned injury severity, only three of these measured injury severity in terms of actual, as opposed to estimated, time-loss from participation. The proportion of moderate to severe injuries (i.e. injuries resulting in more than one week of time lost from play) was 32% in taekwondo[22], 15% in karate[50], and 7% in judo.[53] There were no studies reporting on the severity of injuries in boxing, kickboxing, or mixed martial arts.

Figure 4. Proportions of total number of injuries by injury severity in full-contact combat sports



Proportion (%) of total number of injuries by injury severity

Discussion

This review highlights that there is a significant injury problem in full-contact combat sports generally, that both injury incidence rates and injury patterns vary considerably across different styles, and that very little is known about the actual severity of injuries in combat sports.

Among full-contact combat sports, the risk of injury appears to be greater in hybrid styles (e.g. mixed martial arts), intermediate in striking styles (e.g. boxing, kickboxing, karate, and taekwondo), and lower in grappling styles (e.g. judo), with injury incidence rates of around 230, 120, and 80 injuries per 1,000 athlete-exposures, respectively. However, there is considerable heterogeneity in study methodologies among the included studies. For instance, the included studies varied in terms of operational injury and exposure definitions, data collection methods, setting, and study population characteristics. Consequently, there may have been significant underreporting of injuries in some of the included studies. It is therefore prudent to be cautious when interpreting the injury incidence rates reported herein.

Furthermore, all exposures are not equal. For instance, the typical length of an exposure in most combat sports is somewhere between 5 and 25 minutes, whereas matches in team sports such as rugby and soccer may last an hour or more. Thus, it becomes difficult compare the risk of injury in combat sports to other sports without first factoring in the actual exposure time. Unfortunately, few studies on combat sports report exposure time-adjusted injury incidence rates. However, if we assume an average exposure time of 15 minutes, then we can estimate the time-adjusted injury incidence rates for hybrid, striking, and grappling styles to be approximately 920, 480, and 320 injuries per 1,000 contest-hours, respectively. By this measure, the injury risk in full-contact combat sports is far greater than in popular sports such as rugby (80 per 1,000 match-hours)[57], soccer (20–25 per 1,000 match-hours)[58], and running (8–18 per 1,000 hours).[59] Although this measure provides a more direct comparison, caution must nevertheless still be exercised

because there may be significant differences in the total time of competition exposure (e.g. annually or lifetime) that is typical for combat sports and other sports such as rugby, soccer, and running.

The included combat sports appear to have unique injury patterns, and differences in competition rules undoubtedly explain much of these observed variations in injury patterns. For instance, lower limb injuries are very uncommon in boxing, but very common in taekwondo. Although it is not permissible to strike the lower limb in either sport, taekwondo allows using the feet to kick the opponent's trunk or head. Another example is that head injuries are uncommon in judo (which disallows strikes to the head), but exceedingly common in boxing, kickboxing, mixed martial arts and, to lesser extent, karate where strikes to the bare head are allowed. The high proportion of head injuries in some of these combat sports is a cause for concern, especially considering that continued repetitive head trauma (not necessarily limited to clinically observable concussions) is associated with degeneration in brain structures such as thalamus, basal ganglia, and hippocampus, with measurable decline in cognitive function.[60]

In regard to injury severity, only three of the included studies measured actual, as opposed to estimated, time lost to participation in training or competition. With such scarcity of data it becomes very difficult to both assess the actual burden injuries in combat sports, and, subsequently, to know where to direct efforts to prevent or mitigate the risk of injury. Thus, it is strongly recommended that future studies investigate the severity of injuries in combat sports using objective measurements of actual time lost to participation.

It is important to emphasise that this review has concerned itself with competition injuries only. The injury problem is expected, as is the case in many other sports, to be very different in the training context, not only in terms of incidence, but also in regard to injury pattern and severity. This disparity in injury risk between training and competition should be kept in mind when considering the costs and benefits of participating in combat sports. It is, for instance, both possible and reasonable to choose to train in combat sports without ever participating in contests or tournaments.

This review is limited by the paucity of available injury data in some of the combat sports, as well as the methodological quality of the included studies. It is possible the literature searches failed to identify all relevant studies, while the exclusion of articles in languages other than English, German, Spanish, and Italian may have introduced language bias. However, reviews of the potential impact of language bias have concluded that language restrictions has generally little effect on summary on the overall findings.[61, 62] Lastly, the included studies were not subjected to a formal risk of bias assessment, which could, in turn, have been used to provide preferential weighting when synthesising the data presented in this review. The findings herein should be interpreted in light of these limitations. To facilitate cross-study comparisons, future studies are strongly encouraged to adhere to the (STrengthening the Reporting of Observational studies in Epidemiology (STROBE) Statement guidelines[63], adopt standard injury definitions, and employ standardised sports injury classification systems.

Conclusion

There is a significant injury problem in full-contact combat sports. The risk of injury appears to be greatest in hybrid styles (e.g. mixed martial arts), intermediate in striking styles (e.g. boxing, kickboxing, karate, and taekwondo), and lowest in grappling styles (e.g. judo), with injury incidence rates around 230, 120, and 80 injuries per 1,000 athlete-exposures, respectively. The injury patterns vary considerably across different styles, which most likely is a reflection of differences in competition rules. Unfortunately, very little is known about the actual severity of injuries in combat sports. Future studies are strongly encouraged to adopt stronger study methodologies.

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