Epidemiology of musculoskeletal injuries in combat sports practitioners

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Abstract

Study aim: The purpose of this study was to determine the impact of the type of combat sport and the degree of athletic proficiency on the specificity of musculoskeletal injuries suffered by Muay Thai and Mixed Martial Arts practitioners.

Material and methods: The study involved 64 practitioners of two combat sports, MT (age 26.9 ± 8.1, experience 7.4 ± 5.8 years) or MMA (age 26.2 ± 6.4 years, experience 6.6 ± 4.1 years). The research was conducted using a Google Forms survey.

Results: The groups did not differ significantly (p < 0.05) in terms of risk of injury (average 3.1 in MT, 2.6 in MMA). Injuries (mainly fractures 21% and 7% of practitioners) affected the lower limb (44% and 33% practitioners) and were significantly higher in MT, p < 0.05. There were significant (p < 0.05) correlations between training experience and the number of training hours per week compared to the frequency and severity of injuries in both groups.

Conclusion: Injuries to athletes who mainly use striking techniques are more common in the lower limbs and they are more likely to be fractures. Longer training experience, more training hours and a higher level of athletic proficiency significantly increase the risk of injuries and their severity among people practicing both types of combat sports.

Keywords: Case series report – Injuries – Muay Thai – Mixed Martial Arts – Training

Introduction

The problem of injuries suffered by people training in combat sports still needs deeper analysis, because most scientific publications only describe the risks and specificity of injuries suffered during competitions in these disciplines, ignoring those suffered during training. This applies to both professionals and amateur athletes [16, 35]. There is little research among the studies comparing different combat sports, disciplines such as Muay Thai and Mixed Martial Arts (MMA, which has gained a lot of popularity around the world relatively recently) [5, 33].

The different definitions of injuries in relation to their severity is also problematic. It should be noted that techniques permitted during MMA competitions vary depending on the federation that organizes them, as well as e.g. local state laws [18, 29]. In addition, it has been proven that Muay Thai and MMA contestants often downplay the risk of injury in their sport, which may lead to an increased injury risk [8, 28]. It is worth noting that knowledge of the specifics of injuries in these sports allows for appropriate preventive measures [6, 22].

Therefore, it was decided to examine the specific natures of injuries in two combat sports, Muay Thai and MMA, considering their differences and similarities. It was decided to put these two sports together, because in both one is allowed to use an equally wide range of stand-up techniques, while what clearly distinguishes them from each other is the use of grappling. In Muay Thai elements of grappling only appear while clinching, in a stand-up position, whilst in MMA they are sometimes a basic element of training and combat, used both in stand-up and ground fighting while also using “submission holds” that will cause submaximal tension to a given joint [29, 33]. During a submission hold, the contestant on whom the technique is being used chooses the moment when they signal that they are giving up further combat. If they do it too late, or not at all, the technique may lead to serious injury.

The purpose of this study is to determine the impact of the type of combat sport, and the degree of athletic proficiency, on the specificity of musculoskeletal injuries suffered by Muay Thai and MMA practitioners, to determine the severity of the injuries suffered, their frequency, location, type, and situations in which they occur.

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Material and methods

Participants
Sixty-four athletes who did one of the two combat sports, i.e. Muay Thai and Mixed Martial Arts, were qualified to participate in the survey. All qualified persons completed the questionnaire. The criteria for participation in the study were as follows: being an adult, having done the sport for more than one year, and training frequency of at least one time per week. Athletes who had not trained for more than half a year, and people who practiced sports other than martial arts were excluded from the study. The athletes were divided into two groups depending on their sport. The Muay Thai group (“Muay Thai group”) consisted of 31 people (24 men and 7 women) and the Mixed Martial Arts group (“MMA Group”) consisted of 33 people (29 men and 4 women). In each group contestants and amateurs’ athletes were selected. Anthropometrics characteristics of the groups are presented in Table 1.

Procedure
A retrospective cohort study using an online Google Forms (Google LLC) survey was conducted [12]. The research idea was presented to selected martial arts practitioners as well as during a training session in selected martial arts academies. The sample selection was purposive and accounted for meeting the study criteria by respondents. Eligible consenting participants were asked to complete the survey. Invitations to participate in the study were forwarded via private messages on Facebook. The survey consisted of 19 questions, of which the first 9 included various metrics and questions about training details, i.e.: the number of training hours per week, the time spent on practicing ground combat techniques in relation to stand-up combat ones, and the use of submission techniques during training. Further questions related to the specifications of the injuries suffered to the musculoskeletal system. The respondents reported the number of injuries suffered in connection with combat sports, the circumstances in which they occurred (in training, at competitions), location, type, affected body part or anatomical structure. An injury was considered to be a musculoskeletal injury requiring at least one day’s break from training. A severe injury was an injury requiring at least a week’s break from training and/or immobilization of parts of the body, for example in a cast. Suffering 3 or more injuries has been described as “multiple injuries”.

Statistical analysis
Statistica v. 13.3 from Statsoft, and Excel (Office 365) from Microsoft, were used to analyze the results, prepare tables and charts. Quantitative variables included: number of hours training per week, years of training experience, number of injuries, number of severe injuries, body weight, age. Qualitative variables included: e.g. injury occurrence depending on its type and part of the body affected, participating in competitions, injury occurrence during competitions, training and submissions. The Shapiro-Wilk test was used to analyze the normality of distribution. Nonparametric statistical tests where used due to Shapiro-Wilk test result and relatively low sample size of survey respondents. The U Mann-Whitney test (quantitative variables) and the Pearson chi-squared test (qualitative variables) were used to analyze significance between groups. A ϕ factor was used to check the strength of the dependency. Correlations were analyzed with the Spearman test.

Results
There was no significant difference between both contestants’ groups of Muay Thai and MMA in terms of age, body weight, training experience, the number of training hours per week and the number of who took part in competitions. Those who competed, in both combat sports, were characterized by significantly higher (p < 0.05) weight and longer training experience than amateurs. They did more training hours per week and suffered injuries more frequently. Additionally, the injuries they experienced were much more severe.

Table 1. Characteristics of the tested groups

<table>
<thead>
<tr>
<th>Combat Sport</th>
<th>Level of proficiency</th>
<th>Age [yrs]</th>
<th>Experience [yrs]</th>
<th>Body weight [kg]</th>
<th>Training per week [hours]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muay Thai (n = 12)</td>
<td>Contestant</td>
<td>29.42 ± 9.35</td>
<td>11.08 ± 7.13</td>
<td>88.17 ± 14.79</td>
<td>7.58 ± 1.93</td>
</tr>
<tr>
<td>Muay Thai (n = 19)</td>
<td>Amateur</td>
<td>25.32 ± 7.04</td>
<td>5.05* ± 3.26</td>
<td>77.53* ± 16.28</td>
<td>3.79* ± 1.40</td>
</tr>
<tr>
<td>MMA (n = 11)</td>
<td>Contestant</td>
<td>28.1 ± 4.92</td>
<td>10.2 ± 3.76</td>
<td>92 ± 16.96</td>
<td>8.4 ± 2.16</td>
</tr>
<tr>
<td>MMA (n = 22)</td>
<td>Amateur</td>
<td>25.43 ± 7.03</td>
<td>5.09* ± 3.04</td>
<td>79.78* ± 13.32</td>
<td>4.35* ± 0.97</td>
</tr>
</tbody>
</table>

*Significant difference between contestants and amateurs in both groups – p < 0.05.
The Chi-squared ($\chi^2$) test showed no difference between the total number of injuries suffered and the number of people who suffered an injury among those doing both combat sports ($\chi^2 = 0.05$, $p = 0.83$) (Table 2). In the Muay Thai group the median of injuries was 2 ($Q_0 = 0$, $Q_1 = 1$, $Q_3 = 4$, $Q_4 = 10$), the median of severe injuries was 1 ($Q_0 = 0$, $Q_1 = 0$, $Q_3 = 2$, $Q_4 = 4$). In the MMA group the median of injuries was 2 ($Q_0 = 0$, $Q_1 = 1$, $Q_3 = 4$, $Q_4 = 7$), the median of severe injuries was 1 ($Q_0 = 0$, $Q_1 = 0$, $Q_3 = 2$, $Q_4 = 4$). The number of injuries, severe injuries and multiple injuries were similar across all groups, indicating no significant differences ($p < 0.05$).

The next action in the study was analysis of the number and type of injuries between groups: contestants and amateurs (Table 3).

The Chi-squared ($\chi^2$) test shows no difference between the total number of injuries suffered and the number of people who suffered an injury while doing both combat sports ($\chi^2 = 0.05$, $p = 0.83$). There is a significant relationship ($p < 0.05$) between participation in competitions and the occurrence of injuries ($\phi = 0.4$ in MMA contestants), severe injuries ($\phi = 0.41$ in Muay Thai contestants, 0.43 in MMA contestants) and multiple injuries ($\phi = 0.69$ in Muay Thai contestants, 0.52 in MMA contestants).

Injuries sustained while defending against a submission hold and while competing in a given combat sport were shown in Table 4. There was no significant link between sustaining an injury and the occurrence of injuries during competitions among the Muay Thai and MMA contestants. Similarly, sustaining an injury and the occurrence of injuries during a submission hold in the MMA group do not show a significant relationship.

Table 5 below shows the results of the Spearman test, which analyzed the correlations between selected quantitative variables divided into groups of people practicing the relevant combat sports. An increase in the number of training hours per week increased the number of injuries suffered in both groups. The more time spent on ground combat training, the fewer injuries in the MMA group were observed, but not at a significant level.

Table 2. Number of people practicing combat sport and total number of injuries suffered

<table>
<thead>
<tr>
<th>Combat sport contestants and amateurs</th>
<th>Nº of people injured</th>
<th>Total Nº of injuries suffered</th>
<th>Nº of people who suffered severe injuries</th>
<th>Nº of more serious injuries suffered</th>
<th>Nº of people who suffered multiple injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muay Thai (n = 31)</td>
<td>27 (87%)</td>
<td>96</td>
<td>18 (58%)</td>
<td>37</td>
<td>15 (48%)</td>
</tr>
<tr>
<td>MMA (n = 33)</td>
<td>25 (76%)</td>
<td>85</td>
<td>17 (51%)</td>
<td>30</td>
<td>15 (45%)</td>
</tr>
</tbody>
</table>

Table 3. Number of contestants and amateurs practicing combat sport and total number of injuries suffered

<table>
<thead>
<tr>
<th>Combat Sport</th>
<th>Level of proficiency</th>
<th>Nº of people injured</th>
<th>Nº of injuries</th>
<th>Nº of people suffered a severe injury</th>
<th>Nº of severe injuries</th>
<th>Nº of people suffered multiple injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muay Thai (n = 12)</td>
<td>Contestant</td>
<td>12 (100%)</td>
<td>64</td>
<td>10 (83%)</td>
<td>24</td>
<td>11 (92%)</td>
</tr>
<tr>
<td>Muay Thai (n = 19)</td>
<td>Amateur</td>
<td>15 (79%)</td>
<td>32*</td>
<td>8 (42%)*</td>
<td>13*</td>
<td>4 (21%)*</td>
</tr>
<tr>
<td>MMA (n = 11)</td>
<td>Contestant</td>
<td>11 (100%)</td>
<td>50</td>
<td>9 (81%)</td>
<td>17</td>
<td>9 (81%)</td>
</tr>
<tr>
<td>MMA (n = 22)</td>
<td>Amateur</td>
<td>14 (64%)*</td>
<td>35*</td>
<td>8 (36%)*</td>
<td>13*</td>
<td>6 (27%)*</td>
</tr>
</tbody>
</table>

*Significant difference between contestants and amateurs in both groups – $p < 0.05$.

Table 4. A number of persons injured during competitions and during submission holds

<table>
<thead>
<tr>
<th>Combat Sport</th>
<th>Nº of contestants injured</th>
<th>Nº of contestants injured during competition*</th>
<th>Nº of people who were injured during submission holds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muay Thai (n = 31)</td>
<td>12</td>
<td>8 (67%)</td>
<td>0*</td>
</tr>
<tr>
<td>MMA (n = 33)</td>
<td>11</td>
<td>5 (45%)</td>
<td>6 (24%)</td>
</tr>
</tbody>
</table>

*Note. In Muay Thai, submission techniques are not used.
Table 6 shows the distribution of injuries in both groups in terms of their location, type and body structure. In the Muay Thai group, more people suffered lower limb injuries (p < 0.05, φ = 0.37) and fractures (p < 0.05, φi = 0.31). In both combat sports, a similar number of upper and lower limb injuries and torso and neck injuries is observed in the Chi-squared (χ²) test.

When comparing fractures and dislocations, a significantly more varied number of cases occurs in the Muay Thai group (χ² = 4.15, p = 0.04). The frequency of sprains and bruises is the same in both sports – with Chi-squared (χ²) at the level of p = 0.74. Bone and muscle injuries occur in the same proportion in the observed combat sports (χ² = 2.83, p = 0.09) and the proportions of ligament and joint capsule injuries are similarly insignificant (χ² = 0.09, p = 0.77). Compared to amateurs, those who compete in both combat sports were significantly (p < 0.05) more likely to suffer head and neck injuries (φ 0.55 in the Muay Thai group, φ 0.52 in the MMA group).

**Discussion**

One of the problems when comparing the results of studies by different authors on combat sports is the different definitions of injury in relation to its severity. Some studies lack any indicator that would allow one to determine how severe the injuries considered in this study are, or the injuries in the statistical analysis available below. After all, cuts or bruises are sometimes not very distressing and one can continue training despite the injury suffered. Other authors [25], for the purpose of their studies, only consider injuries “requiring treatment” and consultation with a specialist, and so the studies are usually carried out in agreement with, and with the help of, medical personnel. It is worth noting that the most studies found in the literature concern those who compete and the risk of injury during competitions, understood as the number of injuries suffered during fights divided by the number of...
Musculoskeletal injuries in combat sports

...In this study, 26.5% of practitioners suffered an injury, 26.5% severe injuries, and 44.9% of three or more injuries. The safest to practice was Tai Chi, where 14.3% of those who did it suffered injuries, 7.1% severe injuries, and 0% three or more injuries. In the Bolach et al. study [1], about 40% of Muay Thai practitioners surveyed suffered long-term effects from previous injuries. However, a relatively high risk of injury can also be observed in non-contact sports. In the Sheer and Krak study [23] musculoskeletal injuries suffered by long-distance runners are common, mostly affecting lower limb and are of overuse in nature. In the Cabak and Cichocki study [3], 65% of non-professional long-distance runners suffered injuries. Nevertheless, almost all the subjects recommended this form of exercise.

The athletes’ degree of athletic proficiency had a major impact on the occurrence of injury in both studied groups. A higher risk of injury was associated with longer training experience and more hours per week devoted to training, and this was seen in those who competed. This is also evident in other sports, even those of a completely different nature, such as badminton [4, 20]. The risk of injury correlated with body weight, but it is difficult to tell whether this is a significant risk factor, since the tested contestants had a significantly higher body weight than amateurs, so the dependence may be more due to the fact that the examined persons with a higher body weight were at the same time competitors.

Of those who suffered an injury in the MMA group, 24% of people suffered at least one injury during a submission hold, but this was not a significant dependency. There was also no differences in terms of injury risk between Muay Thai and MMA participants. However, there are other studies [24] showing significantly lower injury rate of 9.2 per 1000 Brazilian Jiu Jitsu (BJJ) match participations in comparison with 236 per 1000 MMA match exposures, which may prove that in sports focused on grappling only, the risk of injuries occurrence during combat sport competition is lower in comparison to sports that allow striking techniques. Worth mentioning is that Stephenson and Rosschein [26] study found striking to be a leading cause of injury for both the striking-allowed sport – MMA, and non-striking sports, BJJ and Judo, despite the rules prohibiting striking in the latter sports.

Among those who competed in both combat sports there were significantly more frequent injuries during competitions compared to training. It should be noted, however, that a fight during a competition lasts a maximum of 25 minutes, while the contestant spends many hours per week training and sparring. Therefore, the risk of injury during these two activities is balanced out. However, this also confirms the need to conduct studies on amateurs and injuries suffered in training, and not only during competitions, as also stated by Zetaruk et al. [35].

As for the location of injuries, in both groups they were most common in the limbs, with lower limb injuries...
more common in the Muay Thai group. This may be due to Muay Thai’s total focus on stand-up combat — the exchange of low kicks during fights and sparring lasts longer in this sport than in MMA. In both groups, bruises were the most common type of injury, while fractures were more common in the Muay Thai group. This may be due to a greater emphasis on punching techniques in Muay Thai. Compared to amateurs, those who entered competitions in both combat sports were more likely to suffer head and neck injuries. Muay Thai contestants were more likely to experience fractures. The above results coincide with those reported in the literature, where most of the injuries in both Muay Thai and MMA were muscle injuries in the lower limb — most commonly bruises [1, 11, 27, 32]. Similar results were also presented by Del Vecchio et al. [6], where combat sports using striking techniques had an increased risk of lower limb injuries compared to grappling sports, and those who competed had more frequent head and neck injuries, while amateurs had torso injuries, and the most common types of injuries were bruises, then sprains and fractures.

It should be noted that the conducted survey carries a risk of error depending on the memory and reliability of the respondents. Some subjects who had been training for a long time responded regarding injuries sustained over a dozen or so years. The author is also aware that wounds are missing as one of the types of injury, even though post-traumatic musculoskeletal damage is divided into bruises, dislocations, sprains, fractures and wounds. Wounds were omitted due to the fact that they, in the colloquial sense, mainly concern skin damage. This could interfere with the results of the study because it was decided to focus mainly on injuries to the passive and active musculoskeletal system, i.e. the bone, joint-ligament, and muscular systems.

In Muay Thai, boxing gloves are used during training and competitions, while in MMA gloves are much smaller; they protect the heads of the metacarpal bones but the athlete’s fingers are exposed. However, boxing gloves [33] are also used during MMA training. Depending on the rank of the competition, contestants of both disciplines may also have leg and face protectors during competition, though these are not used during fights at a higher level [25]. Even the type of protector matters, for example, a regular tooth protector typically used will not provide the same protection as a protector specially prepared with a plaster model. These factors may have influenced the results of the study, such as the frequency of upper and lower limb injuries. In order to dispel doubts relating to this, in future studies it will also be necessary to divide the subjects based on the gloves and protectors used during training and competitions.

As mentioned, combat sports whose main purpose is to neutralize the opponent, whether by means of striking techniques or by grappling and putting pressure on a joint, are associated with a higher risk of injury [25], as this study also proves. Therefore, it is extremely important for the training staff to minimize said risk, so that nothing stands in the way of the sporting success of their charges. This is also important for combat sports enthusiasts. It is widely accepted that motor preparation and physiotherapy contribute greatly to the prevention of sports injuries [2, 9, 10, 21, 22, 34].

This study, conducted on people who practice combat sports, indicates a high risk of injury to the musculoskeletal system, especially the limbs. Such injuries are often caused by the asymmetry of antagonistic muscle forces, i.e. flexors and extensors of the knee joint [7]. The increased risk of fractures in the Muay Thai group is probably due to the nature of the sport since it is based mainly on striking techniques. Nevertheless, as mentioned in the introduction, in Muay Thai, for fear of losing flexibility and gaining weight, elements of typical strength training are still avoided [31]. Meanwhile, properly planned resistance training developed by a specialist can lead not just to an increase in muscle strength without a pronounced increase in body weight, but also positively affect bone density [13].

In conclusion, it should be stated that epidemiological studies of sports injuries make it possible to determine whether practicing a particular sport is or is not a risk factor for injuries, as well as the nature of injuries suffered by practitioners. This allows specialists to plan appropriate musculoskeletal-enhancing preventive exercises, for example, to achieve an adequate balance of antagonistic muscle forces or exercises aimed at improving flexibility, central stabilization of the body, and the quality of fundamental movement patterns [2, 7]. Appropriate comprehensive exercise programs are successfully used in football, for example, where research indicates that the use of the FIFA 11+ injury prevention program is related to a 39% reduction in injuries suffered by footballers, resulting in a 40% reduction in injury-related costs [30]. It should be noted, however, that knowledge of the specific nature of injuries in a given discipline should be considered only as an addition to an appropriate functional examination of the musculoskeletal system, carried out individually in order to find weak links requiring therapeutic measures [14]. Due to the relatively small amount of research comparing Muay Thai and MMA practitioners, different definitions of injury (which makes it even more difficult to compare the results of the studies), different rules for sports competitions held for the same combat sport, and not considering factors such as gloves and protectors used during training and competitions, further research is needed to confirm the obtained results.

To sum up the information gathered in this study using the survey method, it can be concluded that the Muay Thai practitioners, who mainly use stand-up striking techniques, do not differ in terms of their risk of injuries and...
their severity, from people who do MMA and prefer striking as well as grappling techniques in stand-up and ground combat. Compared to MMA fighters, injuries suffered by Muay Thai practitioners are more likely to affect the lower limbs and are more likely to be fractures. Longer training experience and more training hours and a higher level of athletic proficiency significantly increase the risk of injuries and their severity among people practicing both types of combat sports.

Conflict of interest: Authors state no conflict of interest.

References


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