Injuries in Competitive Boxing. A Prospective Study

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Key words
- injury rate
- box fight
- sparring

Abstract

Boxing remains a subject of controversy and is often classified as dangerous. But the discussion is based mostly on retrospective studies. This survey was conducted as a prospective study. From October 2012 to September 2013, 44 competitive boxers were asked to report their injuries once a month. The questionnaire collected general information (training, competition) and recorded the number of bouts fought, injuries and resulting lost days. A total of 192 injuries were recorded, 133 of which resulted in interruption of training or competition. Each boxer sustained 3 injuries per year on average. The injury rate was 12.8 injuries per 1 000 h of training. Boxers fighting more than 3 bouts per year sustain more injuries ($p = 0.0075$). The injury rate does is not a function of age (age ≤ 19 vs. > 19a, $p = 0.53$). Injuries to the head and the upper limbs occur most frequently. The most common injuries are soft tissue lacerations and contusions. Head injuries with neurological symptoms rarely occur (4.2 %). Boxing has a high injury rate that is comparable with other contact sports, but most injuries are minor. Injury frequency is not a function of whether the boxer competes in the junior or adult category. Athletes fighting many bouts per year have a greater risk of injury.

Introduction

Boxing is an Olympic sport, but its abolition continues to be the subject of debate [39,41]. It is classified as a dangerous sporting activity, with the serious neurological complications of head injuries especially being discussed in the literature [20,22]. In particular, injuries from boxing in children and adolescents have attracted great attention [41,46]. Several deaths from craniocerebral trauma have been reported. In these cases, a laceration of the vertebral artery in addition to intracranial injuries was also suspected as the cause of death [3,13,15,34]. Furthermore, the long-term consequences, such as neurodegenerative diseases, are being discussed [18,30,38].

In addition to intracranial injuries, superficial facial lacerations, eye injuries, damage to teeth, nose injuries, cervical spinal column injuries and even a bilateral mandibular fracture have been described [1,8–10,12–14,29,33,37]. Injuries to the upper limbs in particular (e.g. hand, scapula fracture, rupture of the subscapular tendon) have also been reported [27,32,35,37,44,45,50].

However, despite the heated debate on this sport, accurate injury rates from reliable epidemiological studies and characterisation of injuries from prospective studies are available only for individual cases. In a retrospective data analysis from U.S. emergency rooms from the period from 1990 to 2008, an annual average of 8 716 boxing injuries warranting medical treatment was recorded [37]. During the 2008 Summer Olympics, boxing was the sport with the highest risk of injury together with soccer, taekwondo, hockey, handball and weight lifting [26]. An injury rate of 17.1–25 per 100 professional fights (male) was reported [8,52,53]. Compared to men's boxing, women's boxing is seen as a safe discipline, rarely requiring hospitalisation [6,8].

In general, research in this field is hampered by the lack of high-quality epidemiological studies of injuries in boxing, and the predominance of retrospective surveys and case studies [27,35,44,50,53]. Among existing literature, only 2 prospective studies with a 5- and 12-month follow-up deal with injuries in boxing [36,51]. 3 studies on this subject have determined an injury rate per 1 000 h of participation [36,48,51]. But it is

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essential for the physicians in charge of boxers to have knowledge about the injuries to be expected and their frequency, thus highlighting the need for high-quality studies [15,40].
The current study was designed as a prospective (12 months) epidemiological survey of competitive boxers. The aim of the study was to assess as accurately as possible the actual injury rate in boxing. Knowledge of the injury patterns should allow medical staff and ringside physicians to better prevent and treat injuries.

Materials and Methods

Study design

This survey was conducted as a prospective epidemiological study. Data was collected by questionnaire once a month for one year. Participation in the study was voluntary. From October 2012 to September 2013, 44 boxers (42 male, 2 female) were asked to report their injuries. Only active, competitive boxers were recruited.
The study participants gave their written consent prior to data-recording and were provided with detailed study participant information. Parental consent was obtained for underage participants. At the beginning of the study, the participants filled out an admission questionnaire. Then data were collected monthly using a second questionnaire. This study was performed in accordance with the ethical standards of the IJSM [19].

Questionnaire

Admission questionnaire

The admission questionnaire collected the following general information: age, gender, weight, weight class, professional or amateur status, boxing years. Data specifically related to training were also collected: average number of training hours per week, allocation of training times (in hours) to strength training, endurance training or boxing training. Any chronic diseases were recorded, along with the current injury status. In addition, the participants were asked about past injuries from boxing, as residual damage may influence the findings in the study period.

Monthly questionnaire

The monthly questionnaire first collected general information about training and competition in the previous month: total training time, proportion of endurance training (e.g. jogging, jumping rope), strength training (e.g. weight training), boxing without partner (e.g. sand bag, shadow boxing) and boxing with a partner (e.g. box training, sparring). The number of bouts fought in the previous month was also recorded.
In the second part, all injuries sustained during the month were recorded, including location (e.g. eye, arm) and type (e.g. laceration, contusion). Then the participants specified whether the injury had occurred during training or competition and who treated the injury (e.g. coach, physician). Finally, they indicated whether the injury had resulted in an interruption in training and, if so, how long.

Statistical analysis

The descriptive statistics include mean, range, median, and standard deviation (S.D.). Values of $p < 0.05$ were considered significant. The chi-square test was used to analyse differences in the study cohort. Overall injury rates were estimated as the number of injuries per athlete per year and the number of injuries per 1000 h of exercise. Injury was defined as an event causing interruption in training or competition. Beside these results ("time loss" definition) we provided data based on the "physical complaint" definition of injury and the "medical attention" definition of injury [16,47].

Results

Subjects

The participants' average age was 20.2 ± 7.86 (median: 17; range 10–40) years, with an average weight of 76.2 ± 18.75 kg (median: 76.5; range 29–126 kg). **Table 1** gives an overview of competition class (weight) and age of the athletes. The response rate of the questionnaire was 100% (monthly survey by personal contact).

Training information of the participants

The study participants trained 21.5 h per month in average (S.D. ± 12.35; median: 21; range 0–60) or 257.5 h per year (S.D. ± 90.1; median: 245; range 74–608). In total, the 44 athletes reported 11 330 training hours in the study period of which, per month on average, 6.15 h were dedicated to endurance training (S.D. ± 4.6; median: 5; range 0–28), 4.4 h to strength training (S.D. ± 4.7; median: 3; range 0–32), 6.74 h to training without partner (S.D. ± 5.4; median: 6; range 0–45) and 3.96 h to training with a partner.

Competitive box fights

In total, the participants competed in 121 boxing matches in 12 months (average of 2.75 bouts per boxer/year). The number of bouts per boxer and year is shown in **Fig. 1**. Bouts were performed with head and mouth protection in all cases.

Injuries

During the study period, the 44 boxers reported 192 injuries in total. Of these, 67 occurred during a bout and 125 during training. In 133 cases, it resulted in lost days of training or competition. These 133 cases constitute the basis for the calculation of the injury rates shown below. In total, 1125 days were lost, i.e., in average, 10.51 days per injury (S.D. ± 9.43 d; range 1–150). Every boxer sustained 3.02 injuries on average (S.D. ± 2.3, median: 3, range: 0–9). Only 5 (11.4%) boxers had no injury leading to an interruption of training or competition. The injury rate was 12.8 injuries per 1000 h of training.

Table 1 Weight categories and age of participating boxers.

Weight category	n = 44	age
pin	2	U13(2)
light fly	1	U15(1)
feather	1	U13(1)
light	1	E(1)
light welter	4	U13(1); U15(2); E(1)
welter	2	U17(2)
light middle	2	U17(2)
middle	6	U13(1); U15(1); U17(1); U19(2); E(1)
light heavy	7	U15(1); U17(2); U19(1); E(3)
heavy	5	U17(1); U19(1); E(3)
super heavy	13	U13(1); U17(5); U19(1); E(6)

Age and weight categories (International Boxing Association)
n = number of athletes (in parentheses); U = under; Elite (E) ≥ 19 years

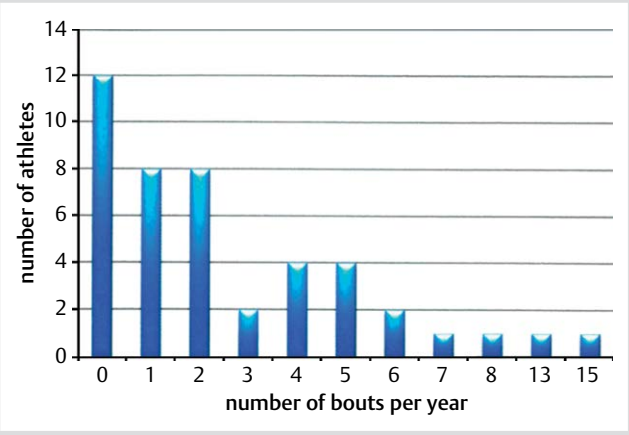

Fig. 1 Number of bouts fought by the participants per year.

Analysis of data revealed no significant difference in injury frequency between the boxers who were younger than 19 years (n = 29) and the older athletes (n = 15, p = 0.53). However, injury frequency was very significantly correlated with the number of bouts per year. Boxers who had more than 3 bouts per year (n = 14) sustained more injuries than those with less (n = 30; p = 0.0075).

The specific injury types are listed in **Table 2**. Among the injuries, 71 (36 %) were contusions and 42 (21.9 %) were classified as soft tissue lacerations. A total of 25 (13 %) athletes had pulled or injured muscles, and 16 (8.3 %) complained about low back pain or disc herniation during training or competition. Only 3 fractures (1.6 %) were recorded. Cerebral concussion and neurological symptoms such as dizziness following a blow to the head occurred in only 8 cases (4.2 %).

A total of 106 injuries were treated by the boxers themselves, 66 injuries by a physician and 19 by the coach.

Table 2 Specific diagnosis and symptoms of injuries.

Diagnosis/symptom	n = 192	%
Head	**88**	**45.8**
eyebrow laceration, contusion (cut)	20	10.4
nosebleed	12	6.25
nasal bone contusion	9	4.69
periorbital hematoma	8	4.17
cerebral concussion	8	4.17
periorbital contusion	6	3.13
cheek bone contusion	5	2.6
lip laceration, contusion	5	2.6
lower jaw contusion	4	2.08
maxillary tooth contusion	3	1.56
ear drum rupture	2	1.04
gingival bleeding	2	1.04
nasal bone fracture	1	0.52
tooth subluxation	1	0.52
hyposphagma	1	0.52
forehead contusion	1	0.52
Upper extremities	**47**	**24.48**
wrist contusion	23	11.98
shoulder contusion	3	1.56
shoulder strain	3	1.56
biceps tendon tear – upper arm	3	1.56
forearm contusion	2	1.04
metacarpophalangeal joint DII bruise	2	1.04
capsule rupture – middle phalanx DI	2	1.04
shoulder impingement syndrome	2	1.04
shoulder laceration, contusion	1	0.52
biceps muscle tear	1	0.52
metacarpus contusion	1	0.52
metacarpophalangeal DI fracture	1	0.52
elbow capsule rupture	1	0.52
upper arm triceps contusion	1	0.52
hand laceration, contusion	1	0.52
Thorax and back	**27**	**14.06**
low back pain	15	7.81
rib contusion	10	5.21
nucleus pulposus prolapse	1	0.52
hernia	1	0.52
Lower extremities	**30**	**15.63**
thigh muscle tear	8	4.17
calf muscle tear	6	3.13
higher ankle sprain	5	2.6
adductor tear	5	2.6
tibia contusion	2	1.04
tibia greenstick fracture	1	0.52
thigh muscle rupture	1	0.52
calf cramp	1	0.52
lower leg laceration, contusion	1	0.52

Specific diagnosis and symptoms of injuries
(n = absolute number of injuries/ % of 192 injuries)

Discussion

Reliable epidemiological studies on injury patterns and frequencies are essential for preventing injuries and also providing adequate care to the athletes [47]. The Olympic sport of boxing is considered to be dangerous and injury-prone, and particularly for adolescents, is a subject of controversy [41]. Even public funding of this sport has been criticized for this reason by medical associations [21].

However, the studies and case descriptions of this sport are almost exclusively retrospective, thus subject to the severe limitations inherent to such studies, particularly in the epidemiology of sports injuries [47]. In addition, the present literature on boxing focuses primarily on the analysis of head injuries. For this reason, there is a need for prospective data collection that also records the other injury patterns below the neck and provides hard data for further discussion.

Injury rates in contact sports such as ice hockey, professional rugby, handball or soccer range between 13.5 and 83 injuries per 1 000 training hours [4,7,17,28,42]. Sports without contact such as powerlifting, dancing, beach volleyball or rowing show clearly lower injury rates (0.24–4 injuries/1 000 h of training) [2,11,43,49]. Previous prospective studies on boxing also showed low injury rates with 0.69 injuries per boxer per year and 2.0 injuries per 1 000 h of training [36,51]. The findings in these studies contrast sharply with our own that show a significantly higher injury rate. The 2 publications use a definition of injury that corresponds to our own [36,51]. However, the study by Zazryn et al. had a poor response rate of less than 25 % of the study participants that may have caused a selection bias and explain its differences to our study. The frequency of bouts is probably another difference of greater importance. In the aforementioned study, only 56 bouts were recorded over 12 months. During the study period, most boxers (n = 29) among the 47 participants did not fight in a bout [51]. Our own results indicate a significantly higher injury rate for higher frequency of bouts, i. e., active boxers have a significantly higher injury rate. In the study

by Porter and O'Brien, injuries incurred in competition or in training were evaluated separately. In both cases, there were low injury rates per year [36]. The study on the bouts lasted only 4 months, and on injuries in training only 5 months. It is not clear whether the study involved the same or different subjects. Additionally, the low competition activity would explain the low injury rate in this study [36]. In contrast, a study by Welch et al. found a significantly higher injury rate of 22.1/1 000 h of training that is more in line with our own findings [48]. However, these studies did not record any possible individual differences in training styles (e.g. positive vs. negative reinforcement) that might contribute to different injury rates. Furthermore, the boxer's experience before the first bout might affect the risk of injury.

In the present study, the athletes sustained injuries mostly to the head and to the upper limbs. Overall, the injuries resulted in an average of 10.5 lost days. In the vast majority of cases, injuries were treated by the athletes themselves or by the coaches, and were thus mainly minor injuries such as soft tissue lacerations or contusions. In addition, injuries to the head and to the upper limbs were reported for the most part in other collectives [36,45,51,52]. Studies collecting data from amateur boxers report mostly less serious injuries [45,52]. Based on the current literature, 27.1–93.4% of injuries from boxing involve the head, but for the most part insignificant lacerations and contusions [24,25,36,48,51,52]. In our study, head injuries that caused neurological symptoms occurred only in 4.2% of the cases. Porter et al. reported that cerebral injuries with neurological symptoms accounted for over 50% of the injuries sustained in competition, but documented no cerebral injuries in training. In this study, cerebral injury was documented in 12% of the bouts (281 bouts, 33 cerebral injuries). Our own data show a rate of 7% and are therefore consistent with this prospective study [36]. Whether the rate observed in our study with predominantly young athletes is acceptable warrants further discussion. Currently there is no strong evidence to associate chronic traumatic brain injury with amateur boxing [31]. Among elite athletes, the life expectancy of boxers is not shorter compared to that of athletes of other sports such as football, basketball, wrestling, swimming or ice hockey [5].

In the past, the duration of exposure was often seen as a risk factor for an injury in boxing [23,51]. Zazryn et al. demonstrated, however, that exposure especially to competition increases the risk of injury, as only 42.9% of injuries were sustained in training (99.9% of participation time) [51]. In our study, 65% of injuries occurred in training. In 11 330 h of training compared to 121 bouts, exposure to competition was the largest risk factor for injury in boxing.

Conclusion

Boxing shows a high injury rate that is comparable with other contact sports. However, the injuries are generally not serious. Injury frequency is not a function of age or whether the boxer is active in the junior or adult category. Athletes competing frequently have a significantly greater risk of injury and should receive intensive medical care.

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