ORIGINAL ARTICLE

Injuries and overloads in *thai boxing (muay thai)*

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B Data Collection
C Statistical Analysis
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E Funds Collection

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Abstract

Background & Study Aim: *Thai boxing*, or *muay thai*, originates from southern Asia (not only from Thailand, but also from Burma, Cambodia, Vietnam and Malaysia). It was inspired by fighting skills used on battle fields during wars conducted by the Thais in the twelfth and thirteenth century AD. Apart from a fight with use of various weapons, during hand-to-hand fighting warriors used Kaad Chuek [wrappings around hand and forearm] which were hardened and studded with gravel to cause the greatest damage possible. The overall objective of the research is knowledge about injuries and overloads typical for sportsmen who train *thai boxing* as well as about treatment methods and effects.

Material & Methods: The study included 50 athletes training *thai boxing* aged 16 to 26 years (average age 21.9, ±3.1). Training experience amounted to 4.4 ±2.8 years in the case of more experienced athletes; 1.3 years ±0.4 in the case of less experienced ones. They trained on average 4 times a week. The largest group consisted of athletes with secondary education (40%), whereas competitors with higher education constituted 30%. Injuries and overloads in *thai boxing* were evaluated with the use of anonymous questionnaire developed by Bolach et al. (2008). Each examined person could give any number of answers to individual questions (criteria: number and location of injuries on the body, the type of treatment, biological regeneration, etc.).

Results: The injuries most often affected lower extremities (knee joints, ankles, tights, shins), head and shoulders. In contrast, overloads affected knee joints and spine. Injuries and overloads more frequently occurred during trainings than during competitions. They occurred in more experienced athletes more often. Treatment of injuries was more effective (83%) than the one of overloads (74%). Injuries were most often treated pharmacologically and conservatively. The majority of competitors used biological regeneration. The most common was sports massage, sauna and cryotherapy.

Conclusions: Many athletes continued to train or even participated in competitions without uncured sports injury (injury or overload). Coaches should educate players that the overarching mission of sport is to enhance health. Unfortunately, the media pressure for success in all human activities possible distorts the mission of sport. Thus, there is a growing interest in neo-gladiator fights.

Key words: combat sports · hand-to-hand fights · pharmacological treatment · conservative treatment · biological regeneration

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Introduction

Thai boxing, or *muay thai* [1], originates from southern Asia (not only from Thailand, but also from Burma, Cambodia, Vietnam and Malaysia). It was inspired by fighting skills used on battle fields during wars conducted by the Thais in the twelfth and thirteenth century AD. Apart from a fight with use of various weapons, during hand-to-hand fighting warriors used *kaad chuek* (wrappings around hand and forearm) which were hardened and studded with gravel to cause the greatest damage possible.

By using various techniques during fight in direct contact (in which actions are directed directly towards the opponent's body) and throws (in which collision with the ground is an additional factor), *thai boxing* became an art of self-defence based on acute means [2]. The examples include: strikes with elbows, knees and so-called *low kicks* with a shinbone. *Muay thai* is a very offensive combat sport based on strikes made with maximum force and during nearly continuous attack. This martial art (and at the same time a combat sport [3]) popularised in Europe in the mid-nineteenth century and gained multitude of supporters. It was promoted by spectacular fights.

Due to high amount of trauma sustained during fights, at the beginning of the twenties of the last century wrappings and destructive techniques were withdrawn (kicks in the crotch, head-butts, levers and throws). In contrast, at the beginning of the thirties, they began to use groin protectors and boxing gloves. Principles were unified and each fight consisted of 5 rounds, which lasted 3 minutes each. With time, weight categories were distinguished.

Even ordinary observation of *thai boxing* tournaments provides direct evidence that in this combat sport it is possible to hit the opponent's head with nearly all body part. Therefore, it is certain that head and brain injuries cannot be avoided. However, there are few scientific publications that provide reliable data on this phenomenon [4, 5]. Or even less about methods and effects of treatment.

The overall objective of the research is knowledge about injuries and overloads typical for athletes who train *thai boxing* as well as about treatment methods and effects.

The specific objectives regard settling the following issues:

- Can persons who train *thai boxing* be distinguished from those training other combat sports by specific features of injuries and overloads?
- Do the injuries or overloads suffered more often occur during training or competitions and is the experience level in training and sport significant factor in differentiating these phenomena?
- Are there any phenomena which imply the need to modify this system within methods used to treat injuries and overloads which are related to training and participation in *thai boxing* tournaments?

Material and methods

Participants

The study included 50 athletes training *thai boxing* aged 16 to 26 years (average age 21.9, ±3.1). Training experience amounted to 4.4 ±2.8 years in the case of more experienced athletes; 1.3 years ±0.4 in the case of less experienced ones. They trained on average 4 times a week. The largest group consisted of athletes with secondary education (40%), whereas competitors with higher education constituted 30% (Table 1). Local bioethical commission has given consent to the study.

Methods

The method involved indirect observation (based on analysis of the declarations of athletes studied). Injuries and overloads in *thai boxing* were evaluated with the use of anonymous questionnaire (in the annex) developed by Bolach et al. [6] Each examined person could give any number of answers to individual questions (criteria: number and location of injuries on the body, the type of treatment, biological regeneration, etc.).

Statistical analysis

Empirical variables (arithmetic mean, sample standard deviation, range etc.) have been calculated. The hypothesis has been tested with the use of t test for independent samples and significance test: for independent proportion. Sampling distribution of χ^2 [7].

Results

Thai boxing athletes surveyed have various experience in sport. More experienced athletes (n = 34) constituted larger group than less experienced (n = 16). Experience corresponds to age of participants. More experienced athletes were on average older by 3.1 years than less experienced ones (Table 1) and this differences were statistically significant ($p<0.05$).

Training experience of more experienced *thai boxing* athletes was significantly longer in comparison to less experienced group (Table 2).

Cherng muay – basics: These include the rules for using "natural weapons" (fighting techniques) available to a human being in defence or attack. *Cherng muay* techniques were divided into 4 group: *cherng sok* (24 combinations of elbow strikes); *cherng mad* (15 combinations of punches); *cherng thao* (15 combinations of kicks); *cherng khao* (11 combinations of knee strikes);

Counterproductive – from praxiological perspective certain action can be: productive – nonproductive – counterproductive – neutral. The action is **counterproductive** when a doer achieved the opposite of intended goal [42, p. 220].

Extreme sport – "extreme form of physical activity are extreme sports, often classified according to the environment in which they are performed (water, land, air), extreme form of physical recreation as well as gainful activity or voluntary service, and all varieties of physical activity that meet at least one classification criterion of the feature associated either with extreme risk of injury or death, or extreme body burden with high level of effort, or extreme coordination difficulty" [17, p. 19]

Table 1. Age of *thai boxing* athletes in relation to their experience in sport

***Thai boxing* athletes**	**Age [years]**					
	x	**SD**	**Range**		**t-Student**	
			min.	**max.**	**t**	**p**
Experienced (n = 34)	**22.9**	2.6	18	26	3.73	0.0005
Less experienced (n = 16)	**19.8**	3.2	16	26		

Table 2. Training experience years in relation to experience in sport

***Thai boxing* athletes**	**Training duration *thai boxing* [years]**				**t - Student**	
	x	**SD**	**min.**	**max.**	**t**	**p**
Experienced (n = 34)	**4.4**	2.8	2	12	4.37	0.0001
Less experienced (n = 16)	**1.3**	0.4	1	2		

Table 3. Frequency of training conducted by *thai boxing* athletes per week in relation to experience in sport

Number of trainings per week	***Thai boxing* athletes**	
	Experienced (n = 34)	**Less experienced (n = 16)**
1	0	1
2	3	2
3	**10**	**6**
4	**11**	**4**
5	7	3
6	3	0

Table 4. The number of training units performed in the observation period, duration of training unit (minutes) and number of training units per week in relation to experience in sport of *thai boxing* athletes

Duration of training unit [minutes]	***Thai boxing* athletes**	
	Experienced (n = 34)	**Less experienced (n = 16)**
60	2	1
90	**18**	**10**
120	9	4
150	3	0
240	2	1

Table 5. Frequency of injuries and overloads sustained in relation to experience in sport of *thai boxing* athletes

***Thai boxing* athletes**	**Injury type**			
	Injuries		**Overloads**	
	n	**%**	**n**	**%**
Experienced (n = 34)	25	74	31	91
Less experienced (n = 16)	10	63	8	50
χ^2	1.34		**16.97**	
p	0.5106		**0.0002**	

Table 6. Frequency of injuries and overloads sustained during trainings and competitions by *thai boxing* athletes

Injury type	**Training**		**Competition**	
	n	**%**	**n**	**%**
Injuries	27	59	19	41
Overloads	36	69	16	31

They trained on average 4 times per week. The regimen of 4-3 trainings per week was predominant among more experienced athletes, whereas less experienced ones trained 3-4 times per week (Table 3).

Similarly, the level of experience in sport did not coincided with duration of training units (minutes of exercises during each training unit). Usually, training lasted 90 or 120 minutes (Table 4).

Injuries occurred relatively often among *thai boxing* athletes: 70% (35 athletes) of them declared injuries. The incidence of overloads was even higher. It amounted to 76% (39 persons).

More experienced competitors suffered from injuries slightly more often than less experienced ones. The difference in incidence of injuries among these groups was not statistically significant. On the other hand,

Table 7. Location of injuries and overloads sustained by *thai boxing* athletes (ordinal variable – body parts from head to toes)

Location of injury or overload	Number of injuries	
	Injuries	Overloads
Feet	12	9
Ankle joints	11	11
Shank	12	7
Knee joints	**16**	**23**
Tights	12	13
Hip joints	8	6
Hands	8	9
Forearms	7	5
Elbows	8	11
Arms	4	7
Shoulders	10	8
Spine	7	**18**
Head	**15**	2

Table 8. Distribution of time, in which *thai boxing* athletes undertake treatment of injuries

Time until start of treatment [days]	N
0 (directly)	**27**
1	1
2	5
3	2
4	1
7	1
21	1

Table 9. Distribution of time, in which *thai boxing* athletes undertake treatment of overloads

Time until start of treatment [days]	N
0 (directly)	**25**
2	6
3	2
4	1
5	2
9	1
14	1
28	2

Table 10. Distribution of treatment duration of injuries undertaken by *thai boxing* athletes

Duration of treatment (days)	N
4	1
7	2
9	1
14	**6**
21	**4**
28	2
30	1
35	1
56	1
60	**4**
90	**6**
120	2
126	1
150	2
180	1
210	1
360	1

more experienced athletes more frequently suffered from overloads and in this case the difference in percentage of athletes who sustained overloads in both groups was statistically significant ($p>0.05$) (Table 5). Overloads occurred more often during trainings, whereas injuries during tournaments (Table 6).

The injuries most often affected lower extremities (mainly knee joints) and head. In contrast, overloads affected spinal joints (Table 7).

An injury was treated directly after it happened (Table 8). In 85% of cases (33 cases out of 39), treatment was started on average 2 days after its occurrence. Only in one case, treatment was initiated after a week and in another one after three weeks.

Overloads were treated by the athletes directly after they happened. In 78% of cases (31 cases out of 40), treatment was started on average 2 days after its occurrence (Table 9).

Table 11. Distribution of treatment duration of overloads undertaken by *thai boxing* athletes

Duration of overloads' treatment (days)	N
3	2
4	5
5	4
6	3
7	5
10	3
14	5
20	1
21	5
28	1
30	1
42	2
45	1
60	1

Table 12. Frequency of applying different types of treatment for injuries and overloads undertaken by *thai boxing* athletes

Treatment type	Injuries	Overloads
Pharmacological	23	31
Conservative	19	18
Surgical	6	0
Treatment was not undertaken	4	5

Table 13. Effectiveness of treatment for injuries and overloads undertaken by *thai boxing* athletes

Treatment effects	Injury type			
	Injury		Overload	
	n	%	n	%
No	6	17	10	26
Yes	29	83	29	74

Table 14. Perception of the effects of an injury sustained by *thai boxing* athletes

Perception of injury effects	Injury type			
	Injury		overload	
	n	%	n	%
No	15	43	23	59
Yes	20	57	16	41

Table 15. Types of biological regeneration procedures used by *thai boxing* athletes and their frequency

Biological regeneration	N	%
Sauna	25	78
Sports massage	23	72
Cryotherapy	13	41
Underwater massage	6	19
Whirl massage	5	16
Swimming pool	4	13
Ultrasound	1	3

Duration of treatment was very varied – from 4 days to 1 year (Table 10). Similarly, treatment of overloads also lasted for various time, but in general it was shorter and lasted from 3 days to 2 months (Table 11).

Pharmacological and conservative treatment were most commonly used in the case of injuries and overloads (Table 12).

Some *thai boxing* athletes did not undergo treatment of injury or overloads sustained during a fight. Treatment of injuries was more effective than of overloads. Injury was cured by 83% of respondents, whereas overloads were cured in slightly less cases, i.e. in 74% of cases (Table 13).

More than half of *thai boxing* athletes (54%) declared that they felt the effects of sustained injury, whereas 41% of them experienced the effects of an overload (Table 14).

Only 32 athletes admitted that they used biological regeneration. They used sauna (78%), sports massage (72%), cryotherapy (41%) (Table 15). Two or three procedures were most often used (Table 16).

Discussion

There are few publications related to *thai boxing* and devoted to injuries [4, 5]. This results from the fact that *thai boxing* is not an Olympic sport.

Gartland et al. [5] concluded that 64% of all injuries sustained by *thai boxing* athletes constituted injuries to lower extremities and head (31%). The authors claimed that during training competitors did not use their entire force while striking the opponent. Additional protection to the athlete being stricken was provided by protectors and helmets.

Our study confirmed the tendency disclosed in the

Table 16. Distribution of parallely used biological regeneration procedures

Number of biological regeneration procedures	Number of indications
None	18
1	5
2	**14**
3	**10**
4	1
5	2

observations made by Gartland et al. [5], but it revealed two new and significant information – description of the overloads' structure and treatment methods undertaken both in the case of injuries and overloads as well as their consequences. Some *thai boxing* athletes did not undergo treatment of injury or overloads sustained during a fight or training. This applies both to injuries and overloads. This proves recklessness and lack of responsibility for their own health. Given that many of them participated in training or competitions with untreated injury (57%) or overload (90%), this proves that majority of athletes lost the sense of health mission of sport.

Such situation should not be surprising to experts and to all people who have the sense of responsibility for the education of youth and the promotion of health in its all dimensions – somatic, mental, social [2, 8-11]. Success at all costs and no matter in what sphere of human activity is everyday narration provided by the media. Thus, it is not surprising that we are witnessing an unprecedented expansion of the neo-gladiatorships [2, 12-15]. In accordance with media message, MMA (*mixed martial arts*) and other forms of gladiators' fights contrary to the *Olympic Charter* [16] are considered by media as a sport (!).

During those bloody fights, body parts most crucial to proper functioning of the body (head and thus brain, heart and other internal organs) become damaged. External injuries provide only the topography of actual injuries sustained inside the body, which are disproportionately more dangerous to life and health of neo-gladiators. Mostly athletes from combat sports based on acute means get to gladiatorial cages (*boxing, karate, taekwondo, muay thai etc.*). These are one of the most extreme forms of human physical activity [17]. But media do not refer to victims who lost their health or life.

A 16-year study of injuries sustained by professional kickboxers in the state of Victoria, Australia – Zazryn et al. based on 382 injuries were recorded from 3481 fight participations, at an injury rate of 109.7 injuries per 1000 fight participations [18] – that is the most common body region injured was the head/neck/face (52.5%), followed by lower extremities (39.8%). Specifically, injuries to the lower leg amounted to 23.3% and the ones to the face to 19.4%. Intracranial injuries (17.2%) were the most common. Over 64% of the injuries included superficial bruising or lacerations.

It is logical that the majority of scientific papers on injuries in combat sports are devoted to judo. Since its promotion was initiated by Jigoro Kano already at the turn of 19 and 20 century [19-21], martial arts became very popular on the entire world. However, media do not recognise the idea of judo which ultimately leads to harmonious human development – in physical and ethical (spiritual) sense.

Media above all love to dazzle the audience with sensation, thus bloody combat sports – apart from neo-gladiators fights in cages – such as *boxing, kickboxing, muay thai etc.*, fill the programmes lasting for many hours under the name of "sport". In media, there is no place to promote health aspects of martial arts. Therefore, it is not surprising that *Częstochowa Declarations of 2015: HMA against MMA* is currently known almost only by participants of the *1st World Congress on Health and Martial Arts in Interdisciplinary Approach* (17–19 September 2015, Czestochowa, Poland) under the patronage of Lech Wałęsa, the Nobel Peace Prize winner [22].

Based on analysis of 100 publications, Elena Pocecco et al. [23] determined that judo injuries mostly affect body extremities, especially the knee (up to 28%), shoulder (up to 22%) and hand/fingers (up to 30%), as shown in online supplementary. No difference in the location of injuries has been reported between male and female judokas. In children (12.6±2.8 years,

range 5–17 years), the shoulder/ upper arm (19%), foot/ankle (16%) and elbow/lower arm (15%) were the most common injury locations [23].

Nevertheless, Kamitani et al. [24] analysed head and neck injuries in Japanese judo players sustained between 2003 to 2010 (15 judokas died). There are many important studies on body injuries of judo athletes from various countries [25-29]. Treatment effects are analysed less frequently. Studies more often provide recommendations for the prevention and therapy and athletes' opinion on warm-up, etc. [2, 30, 31].

According to most recent research of Witkowski et al. [31] on female judo injuries were most frequent during intensive training. They studied 30 female athletes with high sports competencies who belonged to various weight categories. Female competitors with severe injuries could not participate in trainings for a period longer than 6 weeks. Light injuries occurred less frequently than moderate ones. The authors concluded that such injuries resulted from aggressive tournament or training fight.

Based on previous studies, Witkowski et al. [27] state that injuries in judo mainly affect lower extremities (38.06%) and upper extremities (27.27%), followed by head and chest injuries. On the other hand, kickboxers suffer from head injuries (39.02%) and injuries of lower extremities (33.33%), followed by injuries of upper extremities and chest (this resembles the observations made by Zazryn et al [18]). According to Polish scientists and judo experts [26, 30] sports training appropriately conducted plays a significant role in preventing injuries in judo.

Bujak [32] noticed that up to 60% of injuries sustained by kickboxers occurred during competitions. He believes that this resulted from poorly conducted warm up. In this sports discipline, loss of consciousness due to a strike (made with arm or leg) in the head took place frequently. Thus, here is another confirmation that training of each combat sport based on acute means is associated with high risk of loss of health or even life.

Many injuries or overloads occurred during training. It mainly stems from poor warm up or lack of focus on training tasks. This happens not only among thai boxing athletes and other athletes training combat sports, but also in other disciplines, such as football, volleyball, basketball, etc. Kuźma et al. [33] report that in 24% of cases injuries of boxers were caused by insufficient warm up and in 19.4% too large training load which could not be tolerated by athletes' organisms.

However, it would be irrational to totally deny combat sports based on acute means. Such skills are necessary for officers of anti-terrorist groups, police officers, security personnel, etc. [34-39]. The use of acute means during rational exercise of self-defence is the last resort. Therefore, rational training of self-defence cannot be excluded [38, 40, 41]. There is sufficient scientific argumentation based on reliable empirical data that learning of self-defence arts solely on the basis of acute means and the idea of constant aggressive counterattack is counterproductive [42].

Health mission of combat sports and martial arts is obvious for experts of new subdiscipline recognised in global science – *science of martial arts* [12]. In three main products of *Archives of Budo* – that is from 2005 when the journal was established in the global science – many empirical evidence and recommendations have been published. They apply mainly to:

- health aspects of martial arts [43-48];
- protecting of own body due to fall and collision [49-52];
- diagnosing susceptibility to a loss of balance and fall [53-57];
- personal safety and decent actions as well as principles for learning decent self-defence for all [40, 58-66];
- diagnosing and reducing human aggressiveness [13, 67, 68];
- *martial arts bibliotherapy* (as a new trend in therapy of aggressiveness, reduction of fear and strengthening personality) [69, 70].

Conclusions

The results of our study confirm the trend that the structure of injuries sustained by *thai boxing* athletes is consistent with the general trend that combat sports based on acute means is characterised by similar location of injuries. Head injuries are most common, followed by ankle joints.

Overloads due to long-term training of *thai boxing* are only partially similar with features of the same indicators used to describe injuries. The same conclusion applies to treatment effects. Experience in sport is a factor having impact on these features.

In our opinion, the greatest value of this research is general estimation of both causes of injuries and

overloads sustained by *thai boxing* athletes during training (the most general characteristics of the training indicators: number of training sessions per week, duration of training units, etc.) as well as their consequences in two aspects. The first one includes information about qualitative and quantitative injuries and overloads as well as their location within the body of *thai boxing* athletes. The second one involves the types and effects of treatment.

Coaches should educate athletes that the overarching mission of sport is to enhance health. Unfortunately, the media pressure for success in all human activities possible distorts the mission of sport. Thus, there is a growing interest in neo-gladiator fights.

Competing interests

Authors declare that he does not have any financial or personal interests.

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Annex

Bolach et al. questionnaire

Personal data:

Initials .....

Age.....

Education: - elementary □, - secondary □, - vocational □, - higher □

Occupation learned .....

Current place of residence: - city □, - village □

How long do you practice *thai boxing*? .....

How many times a week do you train and how many hours do you devote for it?
.....

Questionnaire questions:

Have you sustained any injuries or overloads during your sporting career?

injuries – yes □, no □ overloads – yes □, no □

If the answer was „yes", these injuries or overloads were sustained during:

injuries:

a) training □

b) competition □

overloads:

a) training □

b) competition □

What body part was injured or overloaded?

Injuries:

(1) feet □
(2) ankle joints □
(3) shank □
(4) knee joints □
(5) tights □
(6) hip joints □
(7) hands □
(8) forearms □
(9) elbows □
(10) arms □
(11) shoulders □
(12) spine □
(13) head □

Overloads:

(1) feet □
(2) ankle joints □
(3) shank □
(4) knee joints □
(5) tights □
(6) hip joints □
(7) hands □
(8) forearms □
(9) elbows □
(10) arms □
(11) shoulders □
(12) spine □
(13) head □

In what time the treatment was undertaken since the injury or overload took place?

Injuries:

a) Directly □

b) Later:

- after …… days,
- after …… weeks,
- after …… months,

Overloads:

a) Directly □

b) Later:

- after …… days,
- after …… weeks,
- after …… months,

What type of treatment of injuries or overloads was used?

Injuries:

a) Pharmacological (analgesics, anti-inflammatory drugs) □

b) Conservative (plaster dressing, rehabilitation Exercises, massage, physical therapy) □

c) Surgical □

d) Treatment was not undertaken □

Overloads:

a) Pharmacological (analgesics, anti-inflammatory drugs) □

b) Conservative (plaster dressing, rehabilitation Exercises, massage, physical therapy) □

c) Surgical □

d) Treatment was not undertaken □

How long did treatment of injuries or overloads last?

Injuries:

……. days,

……. weeks,

……. months

Overloads:

……. days,

……. weeks,

……. months

Has the injury or overloads been cured?

injuries – yes □, no □ overloads – yes □, no □

Do you still feel the effects of sustained injuries or overloads?

injuries – yes □, no □ overloads – yes □, no □

Did you happen to participate in training or competitions with untreated injury or overload?

injuries – yes □, no □ overloads – yes □, no □

Do you use biological regeneration?

yes □ no □

Please list biological regeneration procedures, in which you have participated:

- sports massage □, - sauna □, - cryotherapy □, - whirl massage □, - underwater massage □,

- other .....