



ISSN: 0975-833X

Available online at <http://www.journalcra.com>

International Journal of Current Research
Vol. 10, Issue, 05, pp.69133-69137, May, 2018

INTERNATIONAL JOURNAL
OF CURRENT RESEARCH

RESEARCH ARTICLE

DETERMINING THE RELATIONSHIP BETWEEN ANTHROPOMETRIC, PHYSICAL AND MUSCLE STRENGTH PARAMETRES OF THE AMATEUR BOXING ATHLETES

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ARTICLE INFO

Article History:

Received 17th February, 2018
Received in revised form
26th March, 2018
Accepted 08th April, 2018
Published online 23rd May, 2018

Key words:

Amateur boxing,
Sports injury,
Anthropometry

ABSTRACT

Boxing is one of the most severe branches of contact sports. For this reason, boxing athletes have a very high injury rate. Epidemiologically, they may sustain permanent injuries in their sports lives. In our study, we aimed to find out the anatomical characteristics of amateur boxing athletes, their hand paw muscle strengths, the region and frequency of injuries they encountered during their sports lives. We investigated whether there is a relationship between anatomical region, anthropometric features and muscle strength. The physical characteristics, anthropometric features and hand paw muscle strength of 69 amateur boxing athletes (age: 25.03 ± 10.6) that consist of 15 female and 54 male were measured. In order to determine the injury region and frequency, the data were obtained by a sportsman questionnaire. This study examines the correlation between these data. The most injured regions were the hands and the wrists. We found that boxers were injured during training rather than during competitions ($p < 0.05$). Statistically, we found a positive correlation between extremity length and hand paw muscle strength. We found a significant correlation between injury type, recovery time, right hand strength, and left hand strength with sport age. Knowing the anatomical regions and frequency of injuries will help the boxers to avoid them by taking necessary measures.

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Citation: Ors, A., Colak, T., Bal, E., Colak, S., Sivri, I., Tasdemir, R., Yener, M.D., Guzelordu, D., Aksu, E., Bamac, B. and Medisoglu, S. 2018. "Determining the relationship between anthropometric, physical and muscle strength parametres of the amateur boxing athletes", *International Journal of Current Research*, 10, (05), 69133-69137.

INTRODUCTION

Boxing is the most popular combat sport in the world (Slimani et al., 2017). It is a sports branch which is played between two people in a specific place and in compliance with specific terms and rules by using the punches (Devecioğlu and Pala, 2010). Boxing has two forms, which are amateur and professional. There are some differences between these two forms, such as the duration of the competition, rules, regulatory policies and protective devices. The scores by punching more the opponent or the fact that the fighter cannot finish the competition designate the winner in both forms (Haglund and Eriksson, 1993). Boxing is one of the oldest sports that dates back to the Sumerians in 3000 B.C.

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It was accepted as an Olympic Game in Ancient Greek in 688 B.C. The well-known doctor and philosopher Galen said "...When the athletes grow old, they creep, wrinkle and squint due to the severe blows; their eyes fill with catarrhal liquids, their teeth fall, and their bones become porotic and break easily" referring to the boxing players (Nomikos et al., 2010). The foundation of the modern boxing were laid in Great Britain. The first rules known as the Broughton Rules appeared in 1743 and since then new rules have been established and developed in order to avoid the injuries and deaths. In 1900s, the gloves that are used today came into sight and the nature of the fights started to change (TURKBOKS, 2018). Today, boxing is managed by the International Boxing Association (AIBA) which is in charge of approximately 200 federations. Turkish Boxing Federation is also a member of AIBA and as of 2016 it embodies 94,333 amateur boxing players (SGM, 2018). Sports injuries include deteriorations that emerge in the whole body or some parts of it as a result of an unusual force which exceeds the durability limit of the person (Canbaz et al.,

2007). Although the incidence of injury is higher in skiing, soccer, American football, rugby, ice hockey and motocross, some researchers claim that the combat sports are more dangerous as they include the collision, punching and immobilizing the opponent (Pappas, 2007). Junge *et al.* (2009) stated that the rates of injury in the Olympics as 31.5 % in football, 27% in taekwondo, 20.4% in field hockey, 17.4% in handball, 16.9% in weight lifting, 14.9% in boxing. The research that are conducted in Turkey also designate the rates as 10% in football, 6% in wrestling, 3% in handball, 1% in boxing and 0.5% in skiing (Canbaz *et al.*, 2007). Sports injuries are various and can be seen in any part of the body (Kılıc *et al.*, 2014). When the literature is studied, it can be found out that the most injured anatomical part of the body in boxing is the head. While this statement is true for the professional boxers, it is not true for amateurs (Loosemore *et al.*, 2015).

The athletes who are interested in the same sports constantly may experience some morphological changes in their bones, muscles, nerves and joints as a result of over usage (Pirnay *et al.*, 1987; Colak, 2001; Aksu, 2015). The anatomic structures that are used constantly may encounter fast and more degenerative changes. These changes may lead to positive states such as hypertrophy in muscles or strengthening or to negative states such as injuries (Savas and Ugras, 2008; Zazryn *et al.*, 2009). Preventing these changes depends on the physical capacities of the athletes. One of the important aspects of efficiency in sports is that the increase in muscular force of an athlete may change pursuant to the increase in flexibility and endurance (Muratlı, 1997). It is obvious that there may be some changes in the anthropometric aspects and muscular force of the athletes who deal with boxing amateurishly based on the exercise they perform. Besides, they will encounter with different injuries with different intervals. In this study, we tried to designate the anthropometric aspects of the amateur boxers, their hand paw muscle strength, the injury types and intervals they experience throughout their sports career and the relations among all these.

METHODS

The population of the research composes of the athletes over 18-year-old who are interested in boxing amateurishly. The sample group, on the other hand, includes 69 (age: 25.03 ± 10.61) athletes who participated in the amateur boxing competitions in Kocaeli, Turkey. The survey questions were addressed to the athletes and the anthropometric measurements were made. Data collection: The prepared survey is given to the athletes. The survey includes the following information: demographical information such as age, height, weight, sports age; the injuries they experienced before, the parts of the body that are injured and the reasons why they injured, their warm-up periods, their healing processes, whether they experienced the injury during a competition or a training and the first-aid they received. Anthropometric measurements: The upper extremity length is measured with a non-elastic tape from the same sides. The distance between the acromion and the longest finger of the hand is measured after the athlete positioned in a proper anatomic posture.

Lower extremity length; the distance between superior anterior iliac spine and the medial malleolus is measured. The wideness of the wrist is measured with caliper from the widest part of the wrist hand paw muscle strength is measured with Baseline Digital Hand Dynamometer 3001. In order to

designate the maximal claw force of both hands, three different measurements with 60-seconds intervals were conducted with a position of 10-15 degree angle from the arms and shoulders of the athletes. The highest result is taken into consideration (Savas and Ugras, 2008).

Statistical analysis: The data were analysed using the SPSS package (SPSS for Windows v 15.0, SPSS, Chicago, IL, USA). The means and standard deviations of all the measurements were calculated. The differences between group means were determined using a non-parametric test for independent samples (Mann-Whitney U test). A p value of 0.05 was considered statistically significant (Colak, 2010).

RESULTS

Firstly, the demographic characteristics of the boxers (age, weight, height, sport age) were learned with survey (Table 1).

Table 1. Means and Standard deviations of the boxers' demographic characteristics

	Mean (n=69)	Std. deviation
Age	25.03	± 10.61
Weight (kg)	67.36	± 12.84
Height (cm)	173.94	± 8.21
Sport Age	9.25	± 6.91

The right upper extremity length was 71.88±4.91cm. The left upper extremity length was 72.41±5.32cm. The right lower extremity length was 90.22±6.57cm. The left lower extremity length was 90.05±6.66 (Table 2).

Table 2. Mean and Standard deviations of the boxers' anthropometric measurements

	Mean (cm)	Std. deviation
Right upper extremity length (cm)	71.88	± 4.91
Left upper extremity length (cm)	72.41	± 5.32
Right lower extremity length (cm)	90.22	± 6.57
Left lower extremity length (cm)	90.05	± 6.66
Right wrist diameter (mm)	56.75	± 10.58
Left wrist diameter (mm)	57.04	± 11
Right hand paw muscle strength (kg)	47.62	± 10.76
Left hand paw muscle strength (kg)	45.04	± 9.95

When the regions of the injuries of the boxers are investigated, the most injuries are found in hand and wrist with 18 boxers (Table 3).

Table 3. The distribution of percentage of the injury regions of the boxers'

	Frequency	Percent (%)
Head-neck	3	6.97
Shoulder	1	2.32
Upper Arm-Forearm	4	9.30
Elbow	4	9.30
Hand- Wrist	18	41.8
Chest	1	2.32
Beck	2	4.64
Thigh-Lower leg	1	2.32
Knee	2	4.64
Foot-Ankle	3	6.97
Total	43	100

When we explore the sorts of injuries, tendon-ligament injuries are the most with 12 boxers, the fractures are the second injuries with 8 boxers (Table 4).

Table 4. The percentage distribution of the sorts of the boxers' injuries

	Frequency	Percent (%)
Contusion	3	7.89
Sprain	4	10.52
Laceration	2	5.26
Abrasion	4	10.52
Hematoma	2	5.26
Fracture	8	21.05
Muscle injury	1	2.63
Tendon-ligament injury	12	31.57
Other	2	5.26
Total	38	100

When the moments of the boxers' injuries were evaluated, 65 percent of these injuries happened in the training period (Table 5).

Table 5. The percentage distribution of the moments of the boxers' injuries

	Frequency	Percent (%)
Training	25	65.78
Competition	8	21.05
Other	5	13.15

Statistically, the strength of right and left hand are corelated with the length of right and left upper extremity, the length of right and left lower extremity and the diameters of the right and left wrist ($p < 0.05$).

Table 6. The relationship between hand power and the length of extremities and diameters of the wrist. (n=67)

	Right hand paw muscle strength	Left hand paw muscle strength
The right upper extremity length	r: 0.506 p: 0.000	r: 0.518 p: 0.000
The left upper extremity length	r: 0.447 p: 0.000	r: 0.495 p: 0.000
The right lower extremity length	r: 0.283 p: 0.021	r: 0.375 p: 0.002
The left lower extremity length	r: 0.329 p: 0.007	r: 0.432 p: 0.000
Right wrist diameter	r: 0.317 p: 0.008	r: 0.372 p: 0.002
Left wrist diameter	r: 0.335 p: 0.005	r: 0.405 p: 0.001

When we study the missing time about these injuries, 79 percent of them are more than 21 days (Table 7).

Table 7. The missing time of the boxers

	Frequency	Percent (%)
1-7 days	4	10.52
8-21 days	4	10.52
More than 21 days	30	78.94

DISCUSSION AND CONCLUSION

The common injuries in people who are interested in boxing are head, upper extremity, lower extremity and thorax injuries (Pappas, 2007; Zazryn *et al.*, 2006; Siewe *et al.*, 2015; Loosemore *et al.*, 2016). One of the fundamental reasons of these injuries is that boxing is a contact sport which bases on speed, force and strength. For all these reasons, the athletes should have a durable muscular strength and physical conditions. Boxing is one of the fighting sports that requires higher physical capacity and talent (Pala, 2011). Each athlete

spends 1000-times more time in trainings than in competition (Siewe *et al.*, 2015). When we check the literature, we can see that there are different results about the times of the injuries. As a result of a study conducted with 33-amateur and 14-professional boxers by Zazryn *et al.* (2006), the rates of injuries were higher while in competition. On the other hand, Loosemore *et al.* (2015), found out that the injuries are more common in amateur boxers during training sessions. Siewe *et al.* (2014) performed a study with 44-amateur athletes and claimed that 65% of the injuries occur during trainings. We also found out that 65.78% of the injuries occur during the trainings, as a result of our study (Table 5). We assume that factors such as inadequate preparation before the training, incorrect training methods, inappropriate training places and incorrect sports equipment may be the reason of this result. The injuries in sports should be taken into good consideration for both the future of the athlete and in medical terms. The risk of injuries can be minimized by making the athlete having the appropriate form and condition, and with the preventive approach applied before, after and during the season (Kılıç *et al.*, 2015). In the literature, it can be seen that there is a wide difference among the intervals of injured parts. According to Loosemore *et al.* (2015), the reason lies behind that difference can be the contradiction in the definition of injury, the conditions of boxing and whether the boxer is professional or amateur. In conformity with the study conducted with 33-amateur and 14-professional boxers, the head-injuries are the most common ones with a rate of 71% (Zazryn *et al.*, 2006). In another study that is conducted with professional boxers within a period of 8-months, it is found out that the most common injuries are head related injuries with a rate of 86.2%, and it is followed by upper extremity injuries with a rate of 8% (Zazryn *et al.*, 2009). In a prospective study conducted in 2015, 44 active boxers were required to report their injuries on a monthly basis and it is found out that 45.8% of these injuries are head-related, 25% upper extremity, 14.6% chest and back, 15.63% lower extremity (Siewe *et al.*, 2015).

In a research conducted with the boxers who went to the emergency services in the USA between 2002-2005, it is determined that 63.7% of these injuries are upper extremity, 4.5% lower extremity, 8.2% chest and 23.3% head related (Pappas, 2007). Loosemore *et al.* (2015), found that hand related injuries are more common than the other anatomic parts of the body for amateur boxing team of Great Britain from 2005 to 2012. We also did find out that the hand and wrist are the most injured parts of the body with a rate of 41.8%. It is followed by arm and fore arm with 9.30% and elbow with 9.3%. The head related injuries compose of the 6.97% of all the injuries (table 4). The head and neck related injuries compose of the 6.97% of all the injuries (table 7). As for the types of injuries, tendon-ligament injuries are the most common ones with a rate of 31,57%, and it is followed by fractures with 21.05%, sprains with 10,52% and contusions with 7.89% (table 4). The healing process of 78.9% of illnesses is more than 21 days (table 7). While it is expected that the head related injuries are more common as it is more open to punches, it is injured less among the amateur boxers. One of the reasons why hand and wrist injuries are more common among the amateur boxers may be that when the boxer is tired his/her wrist is flexed. The burden laid on the wrist flexion cause tension in the back of carpometacarpal joint (Morgan and Carrier, 2013). The complaints about elbows are traumas occurred in posterolateral elbow as a result of hyperextension took place during the punches that are not addressed to the

opponent. During this hyperextension, olecranon enters into fossa olecranon rapidly. This clash results in osteophyte formation on the tip of the olecranon (Valkering et al., 2008). Anthropometric is a method that classifies the objective aspects of the human body in regard to the sizes and shapes via specific measurement techniques. The anthropometric aspects of the athletes are prerequisites that affect his/her performance and make him/her perform better (Temur, 2017). Anthropometric and physiological aspects are regarded as the important determinants of the performance in boxing (Gabriel and Andy, 2001).

Hand paw muscle strength is considered as an objective measurement in the evaluation of upper extremity performance (Johanson et al., 1998). Other studies show that it is related with the body's muscular force. In order to have the Hand paw muscle strength, it is necessary that wrist extensors and the flexor muscles of the fingers coordinate together. In the EMG studies it is observed that while the higher activity of the long flexor muscles of the fingers are recorded, the extensors of the wrist are active in order to stabilize the carpal, midcarpal and metacarpophalangeal joints (Narin, 2009; Stegink et al., 2003). A positive correlation found between hand paw muscle strength and arm and fore arm measurements (Temur, 2017, Inskip et al., 2007) and length in the research conducted (Temur, 2017). We also determined a positive correlation between upper extremity length and Hand paw muscle strength in our study (table 6) ($p < 0,05$). Epidemiologically, it is necessary for the athletes who are interested in boxing to have a good cardiovascular system and a locomotor system functions. However, because of the specific aspects of boxing, they experience permanent injuries during their sports career and after that. Knowing the anthropometric aspects of the athletes is important in increasing the efficiency, taking preventive measures for the athlete's well-being, providing suitability with the sports branch and increasing the performance. Knowing the injury intervals and the injured anatomic parts of the athletes during his/her career will make them to take some precautions in order to lead a healthy and smooth life in their later years. Hand and wrist injuries in amateur boxers and the fact that they occur more frequently during the trainings should be taken into consideration and the necessary precautions should be taken.

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