Measurement of Punch Velocity and Strength in Elite Kickboxers with the Help of Sensor Competition Simulation

Selcuk YARALIOGLU
Girne Amerikan University
selcukyaralioglu@gmail.com
https://orcid.org/0000-0001-6481-9494

Mustafa Ferit ACAR
Girne Amerikan University
mustafaferitacar@gmail.com
https://orcid.org/0000-0002-3988-2990

ABSTRACT
This research aimed to measure the fist speed and strength of Elite Kick Boxers from TRNC and the Republic of Turkey, which are the basic techniques of hand smacking. Since measuring with scientific precision technological devices is not suitable due to the dress code in the competitions, punch counts, speeds and strengths were measured by re-creating a similar environment simulation to the competition conditions and wrapping the bandages on the hands through high-precision Corner Boxing Technology sensors under the hand bandages.

The number and speed of direct punches hit by the athletes in the competitions increased compared to other punch types, and then the number and speed of crochet punches also increased. This research has not been done in the TRNC and Turkey before, and it is an authentic study. The results of this research will contribute to both the TRNC and the Turkish national teams in terms of the re-establishment of the training and competition strategies.
Keywords: Kickbox, direct punch, crochet punch, uppercut, striking velocity, striking strength.

1. INTRODUCTION

Sports impact people directly in terms of their physical, psychological, and social development. Especially athletes in close contact sports must explore and acknowledge their skills and what they can achieve and discover themselves before getting to know their opponents.

In martial arts, traditionally, the importance of self-knowledge, self-development and self-control is emphasised. Kickboxing, besides self-defence, is also practising philosophical and moral values that can be put into actual life practice.

There is an intense interest in Far Eastern martial arts globally. In recent years, the professional practice of boxing, kickboxing, and muay Thai, which started professionally in TRNC and the Republic of Turkey as well, has increased the interest in all branches that can be regarded as martial arts all over the world. Although this increasing interest in martial arts positively affects scientific research studies, such studies are very limited in TRNC.

Generally, martial arts are sports branches that aim to develop the skills and characteristics of an athlete in a disciplined way, as well as self-defence. Kickboxing, which is one of these sports branches, is one of the most modern and popular branches of our time. Kickboxing is a type of martial arts, which aims to apply a powerful contact to the counter competitor a by using a punch, kick and tibia as kicking techniques. Kickboxing is known as suitable for all ages nowadays. If monitoring kickboxing is increased, this will positively affect the potential outlook of this sport.

In marital arts, a single performance characteristic of an athlete is not sufficient. In marital arts; power, strength, speed, durability and technique should be consecutive for success. Elite athletes must have a high-performance muscle power and strength to be able to use technique-tactics abilities at competitions. Punching is the main movement of kickboxing and individuals must have speed and power to punch effectively. It is also important that athletes who compete with kickboxers extremity muscle power for their performance. For this reason, all the punching techniques must be applied powerfully, fast and continue to continuity.

1.1 The Aim of the Research

The aim of this research is;
to measure the number of punches, speeds and punch forces in Elite Kick Boxers' hand kicks, which is one of the basic techniques in the competitions. The objective is to sensitively measure their strokes with technological devices and scientific precision by creating a simulation environment similar to the competition conditions. The results will contribute to the redefinition and development of the training and competition strategies of the athletes.

1.2 The Importance of the Research
In line with the data obtained from such a scientific study conducted for the first time on martial arts, it is vital for competitive athletes to see the performance of their ineffective or effective punches that they did not notice during the competition. Moreover, it is important to see the factors that cause them to win or lose the competition from a scientific point of view so that they can continue their strategies and training programmes in this direction. After all these studies, the answers to the questions of which technical-tactical or motor skills are missing or how it has achieved the highest performance efficiency can be found.

1.3 Hypothesis
H0: In Elite Kick Boxers' competition simulation, punch speed and punch strength do not differ between rounds.
H1: In Elite Kick Boxers' competition simulation, punch speed and punch strength differ between rounds.

2. Definitions
Kickboxing is a combat sport that requires strength and effort and has a structure consisting of high-performance, dynamic and static features. In order for the athlete to exhibit performance in the best way and at the highest level, they need to do very serious high-level studies.

The punching action, which is one of the hand-hitting methods of kickboxing sport, must be performed in the fastest, strongest and most powerful way. Because punching is a very fast and short movement, the energy system used is the high-energy phosphate system.

Kickboxing is one of the motor skills that affects performance and determines competence in sports. Speed has a property that is directly related to force. It is the most intense application of motor actions in the shortest time interval under certain factors depending on the movement basis.

In kickboxing, which is one of the combat sports, the speed of the movement to be made against the opponent during the attack or defence depends on joint mobility and reaction speed.

Flexibility, which is a major factor in the high performance of athletes during competition in martial arts, is important in terms of getting rid of the contra strikes that may come from the opponent and then making moves against the opponent. It also reduces the risk of injury to the lowest level.

3. Research Model
In this research, an experimental study was carried out by collecting data such as the number, speed and power of the punching techniques from participating elite national athletes who are interested in Kick Boxing in TRNC and Turkey, which is one of the kickbox kicking techniques, by using technological sensors.

3.1 Sampling Method
The sample of the study consists of national athletes who do kickboxing at the elite level in TRNC and Turkey. The sample group is composed of 8 athletes from TRNC and 18 athletes from Turkey who are national or international degrees, are aged between 18-25 and weighted about 71-75 kg. Measurements were done on a voluntary basis by going to the athlete's clubs and accompanied by their trainers. Studies were done in 2 different groups.
- The first group is composed of 8 TRNC National team athletes, where studies were done at SBOX Athletic Clubs, located in Nicosia.
- The second group is composed of 18 TR National elite kickboxes. Studies were done at Selahattin AYDIN FIGHT ACADEMY in Istanbul.

3.2 Punching Simulation
A punching simulation can be educational and beneficial for athletes in several ways:
- Technical Development: Athletes can practice proper punching techniques, improving their form and skills. Simulations help them identify and correct mistakes in real-time.
- Reaction Time: Simulations can be designed to enhance quick decision-making and reaction times, providing an advantage in real fight situations.
- Situational Awareness: Athletes can encounter different scenarios, enhancing their strategic thinking abilities. This helps them learn how to respond to their opponent's movements.
- Strength and Endurance Analysis: Simulations allow athletes to test their strength and endurance levels, aiding in the optimization of their training programs.

- Psychological Preparation: Competing in a virtual environment can help athletes develop psychological skills like stress management and mental resilience.
- Reduced Injury Risk: By practicing in a simulated environment, athletes can minimize the injury risks associated with real sparring sessions, allowing for safer practice.
- Feedback and Analysis: Simulations can be used to analyze performance and provide feedback, helping athletes understand which areas need improvement.

3.3 Tools and Methods

In this research, the contestant Kickboxers acted within the framework of professional contest rules and were dressed with a formal dress code. This research was done with simulation characters because it is not allowed to have extra equipment at the formal competition. Punching techniques, numbers of punches, punch speed and punch strength, were measured with sensors which was placed under hand bandages in kickboxing gloves by kickboxing's most common K-1 form in 3 minutes long 3 rounds.

Measurement Tools

Photo.1: Corner boxing training technology

Measurement: Below data has been measured by the measurement device.
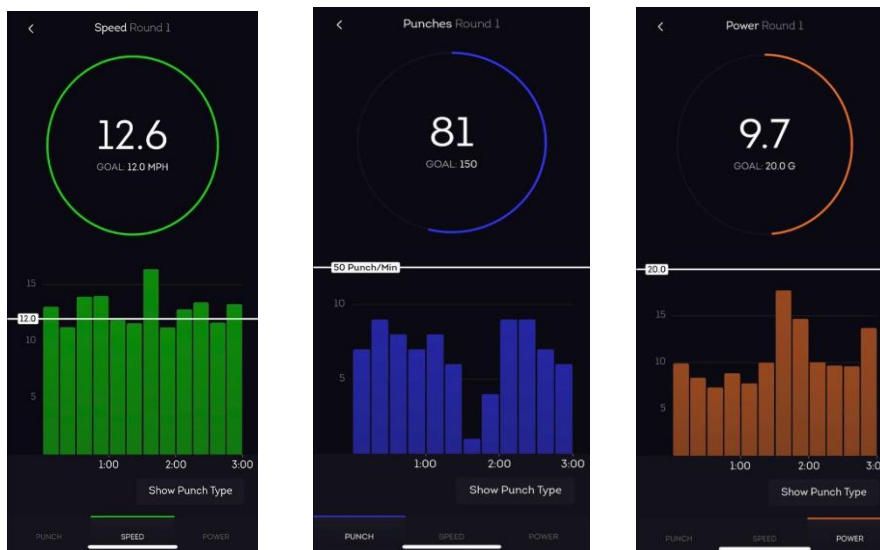
Mold 1. Number of punch Graph   Mold 2. Punch Speed graph   Mold 3. Punch Strength graph

Place of Measurements

Photo 2. The moment of placing the sensors inside the hand bandages before the test at Nicosia region.

Photo 3. Contest simulation test at Nicosia Region

Photo 4. Athletes traning moments before contest simulation at Istanbul Region

4. Results

Direct, hook and uppercut hitting styles were studied in three different rounds depending on the number, speed and power relations. Pearson and Spearman's Rho analysis was used in Correlation analysis by using the obtained results. A positive correlation was seen in every round if it was analysed in number, speed and power relation. Assets were found initiated in $P<0.05$ and $P<0.01$ limit. When this relation was tried to make sense, it was understood that false results were depending on 5% and 1 % chance. Regarding the result of the power analysis, crochet and uppercut were increased and it was determined that participants spend a lot more power on these types of hits. Direct hit number analysis increased up to $P<0.01$ and especially some relations were shown a negative correlation in 3rd round. Regarding the previous explanation, power and speed increased or decreased depending on the hit number from time to time. Considering the crochet punch, the power correlation showed a significant correlation. This correlation level changes as positive and negative in different rounds. When the uppercut is considered, the power analysis mostly has a negative relationship at $P<0.05$ and $P<0.01$ levels according to number and speed. When the number and speed increased the power decreased or when the number and speed decreased power increased has been seen.

Table 1. Direct punch analysis of participants on rounds 1-2-3.

	N(number)	Total	Arithmetic average	St. Deviation
round1 number	26	1134	43.62	9.575
round1power	26	346.4	13.323	2.9195
round1 strength	26	313.1	12.042	2.0098
round2 number	26	998	38.38	11.053
round2 power	26	329.8	12.685	2.2103
round2 strength	26	316.9	12.188	2.0393
round3 number	26	994	38.23	10.199
round3 power	26	327.3	12.588	2.2290
round3 strength	26	303.1	11.658	2.1094
Valid N (listwise)	26			

Table 2. Crochet hit analysis of participants on rounds 1-2-3

	N(number)	Total	Arithmetic average	St. Deviation
round1number	26	804	30.92	8.333
round1speed	26	302.1	11.619	1.9428
round1power	26	341.8	13.146	2.4902
round2number	26	819	31.50	9.301
round2speed	26	302.9	11.650	1.9148
round2power	26	350.4	13.477	2.3323
round3number	26	743	28.58	7.506
round3speed	26	299.4	11.515	1.7169
round3power	26	346.5	13.327	2.3028
Valid N (listwise)	26			

Table 3. Uppercut analysis of participants on rounds 1-2-3

	N(number)	Total	Arithmatic Average	St. Deviation
round1numbet	26	467	17.96	5.032
round1speed	26	310.5	11.942	2.0644
round1power	26	351.4	13.515	2.1782
round2number	26	488	18.77	5.935
round2speed	26	291.8	11.223	1.7542
round2 power	26	424.1	16.312	15.2158

round3number	26	443	17.04	5.032
round3speed	26	292.7	11.258	1.5667
round3power	26	350.9	13.496	2.3751
Valid N (listwise)	26			

Table 4. Direct hit correlation analysis

		round1adet	round1hız	round1guc	round2adet	round2hız	round2guc	round3adet	round3hız	round3guc
round1adet	Pearson Correlation	1	.102	.310	.566**	.144	.370	-.058	-.050	.128
	Sig. (2-tailed)		.620	.123	.003	.484	.063	.777	.807	.532
	N	26	26	26	26	26	26	26	26	26
round1hız	Pearson Correlation	.102	1	.646**	.349	.739**	.577**	.359	.701**	.517**
	Sig. (2-tailed)	.620		.000	.081	.000	.002	.072	.000	.007
	N	26	26	26	26	26	26	26	26	26
round1guc	Pearson Correlation	.310	.646**	1	.407*	.715**	.831**	.341	.635**	.757**
	Sig. (2-tailed)	.123	.000		.039	.000	.000	.089	.000	.000
	N	26	26	26	26	26	26	26	26	26
round2adet	Pearson Correlation	.566**	.349	.407*	1	.399*	.639**	.509**	.308	.570**
	Sig. (2-tailed)	.003	.081	.039		.043	.000	.008	.126	.002
	N	26	26	26	26	26	26	26	26	26
round2hız	Pearson Correlation	.144	.739**	.715**	.399*	1	.613**	.448*	.879**	.585**
	Sig. (2-tailed)	.484	.000	.000	.043		.001	.022	.000	.002
	N	26	26	26	26	26	26	26	26	26
round2guc	Pearson Correlation	.370	.577**	.831**	.639**	.613**	1	.512**	.603**	.888**
	Sig. (2-tailed)	.063	.002	.000	.000	.001		.007	.001	.000
	N	26	26	26	26	26	26	26	26	26
round3adet	Pearson Correlation	-.058	.359	.341	.509**	.448*	.512**	1	.533**	.622**
	Sig. (2-tailed)	.777	.072	.089	.008	.022	.007		.005	.001
	N	26	26	26	26	26	26	26	26	26
round3hız	Pearson Correlation	-.050	.701**	.635**	.308	.879**	.603**	.533**	1	.602**
	Sig. (2-tailed)	.807	.000	.000	.126	.000	.001	.005		.001
	N	26	26	26	26	26	26	26	26	26
round3guc	Pearson Correlation	.128	.517**	.757**	.570**	.585**	.888**	.622**	.602**	1
	Sig. (2-tailed)	.532	.007	.000	.002	.002	.000	.001	.001	
	N	26	26	26	26	26	26	26	26	26

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5. Crochet hits correlation analysis

		round1adet	round1hız	round2adet	round1guc	round2hız	round2guc	round3adet	round3hız	round3guc
round1adet	Pearson Correlation	1	-.215	.758**	.501**	-.147	.489*	.429*	-.032	.091
	Sig. (2-tailed)		.291	.000	.009	.475	.011	.029	.879	.658
	N	26	26	26	26	26	26	26	26	26
round1hız	Pearson Correlation	-.215	1	.083	.452*	.625**	.346	.147	.664**	.328
	Sig. (2-tailed)	.291		.688	.020	.001	.084	.474	.000	.102
	N	26	26	26	26	26	26	26	26	26
round2adet	Pearson Correlation	.758**	.083	1	.578**	.030	.464*	.710**	.122	.098
	Sig. (2-tailed)	.000	.688		.002	.886	.017	.000	.551	.633
	N	26	26	26	26	26	26	26	26	26
round1guc	Pearson Correlation	.501**	.452*	.578**	1	.296	.822**	.406*	.302	.530**
	Sig. (2-tailed)	.009	.020	.002		.142	.000	.040	.133	.005
	N	26	26	26	26	26	26	26	26	26
round2hız	Pearson Correlation	-.147	.625**	.030	.296	1	.321	.315	.779**	.344
	Sig. (2-tailed)	.475	.001	.886	.142		.109	.117	.000	.085
	N	26	26	26	26	26	26	26	26	26
round2guc	Pearson Correlation	.489*	.346	.464*	.822**	.321	1	.349	.464*	.763**
	Sig. (2-tailed)	.011	.084	.017	.000	.109		.080	.017	.000
	N	26	26	26	26	26	26	26	26	26
round3adet	Pearson Correlation	.429*	.147	.710**	.406*	.315	.349	1	.441*	.358
	Sig. (2-tailed)	.029	.474	.000	.040	.117	.080		.024	.073
	N	26	26	26	26	26	26	26	26	26
round3hız	Pearson Correlation	-.032	.664**	.122	.302	.779**	.464*	.441*	1	.502**
	Sig. (2-tailed)	.879	.000	.551	.133	.000	.017	.024		.009
	N	26	26	26	26	26	26	26	26	26
round3guc	Pearson Correlation	.091	.328	.098	.530**	.344	.763**	.358	.502**	1
	Sig. (2-tailed)	.658	.102	.633	.005	.085	.000	.073	.009	
	N	26	26	26	26	26	26	26	26	26

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 6. Uppercut hit correlation analysis (Spearman's Rho)

APARKART YUMRUK KORELASYON ANALİZİ (Spearman's Rho)

Correlations

			round1adet	round1hız	round1guc	round2adet	round2hız	round2guc	round3adet	round3hız	round3guc
Spearman's rho	round1adet	Correlation Coefficient	1.000	.093	.381	.672**	.357	.235	.537**	.243	.033
		Sig. (2-tailed)	.	.650	.055	.000	.074	.247	.005	.232	.871
		N	26	26	26	26	26	26	26	26	26
	round1hız	Correlation Coefficient	.093	1.000	.123	-.054	.544**	-.031	-.236	.381	-.413*
		Sig. (2-tailed)	.650	.	.551	.793	.004	.881	.246	.055	.036
		N	26	26	26	26	26	26	26	26	26
	round1guc	Correlation Coefficient	.381	.123	1.000	.199	.093	.399*	.359	.004	.384
		Sig. (2-tailed)	.055	.551	.	.331	.652	.044	.072	.983	.053
		N	26	26	26	26	26	26	26	26	26
	round2adet	Correlation Coefficient	.672**	-.054	.199	1.000	.349	.258	.710**	.195	.076
		Sig. (2-tailed)	.000	.793	.331	.	.081	.204	.000	.341	.711
		N	26	26	26	26	26	26	26	26	26
	round2hız	Correlation Coefficient	.357	.544**	.093	.349	1.000	-.011	.356	.884**	-.189
		Sig. (2-tailed)	.074	.004	.652	.081	.	.957	.074	.000	.355
		N	26	26	26	26	26	26	26	26	26
	round2guc	Correlation Coefficient	.235	-.031	.399*	.258	-.011	1.000	.331	-.013	.592**
		Sig. (2-tailed)	.247	.881	.044	.204	.957	.	.098	.952	.001
		N	26	26	26	26	26	26	26	26	26
	round3adet	Correlation Coefficient	.537**	-.236	.359	.710**	.356	.331	1.000	.362	.356
		Sig. (2-tailed)	.005	.246	.072	.000	.074	.098	.	.069	.075
		N	26	26	26	26	26	26	26	26	26
	round3hız	Correlation Coefficient	.243	.381	.004	.195	.884**	-.013	.362	1.000	.001
		Sig. (2-tailed)	.232	.055	.983	.341	.000	.952	.069	.	.997
		N	26	26	26	26	26	26	26	26	26
	round3guc	Correlation Coefficient	.033	-.413*	.384	.076	-.189	.592**	.356	.001	1.000
		Sig. (2-tailed)	.871	.036	.053	.711	.355	.001	.075	.997	.
		N	26	26	26	26	26	26	26	26	26

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

5. Discussion

The number and speed of direct punches hit by the athletes in the competitions showed an increase compared to other punch types, and then the number and speed of crochet punches also increased. In power evaluations, the uppercut punch type showed a significant increase especially in rounds 2 and 3. Generally, in round 1, the first rounds are more controlled because the opponents try to get to know each other and apply their own combination strategies. However, in some cases, if the contestants discover each other's open and weak points in round 1, they may try to knock out by making faster and stronger hits. Three different punch number analyses used in the study were evaluated according to 26 participants in three different rounds. The arithmetic of the number of direct punches in round 1 (x=43.62) showed the highest number of punches compared to other punch analyses. In round

1, the contestants preferred to use a direct punch in a fast and rapid manner, as they used their energy in a mobile and controlled way. The most common punch number detected was 39. Considering the number analysis, it was observed that the uppercut hit had the least arithmetic mean (x= 17.96). The athletes used the uppercut punch technique less in terms of their combination styles and the caught in the competition. In round 2, values similar to those observed in round 1 were determined. Straight punch (a=38.38), Crochet punch (x=18.77) and uppercut punch (x=18.77) have an average arithmetic list. As determined in the first round, the most common number of punches was 30 in the direct punch. Direct punch standard deviation (SD=10.2) showed parallel standard deviation with normal values. Due to the fact that the competitions started to get tougher in round 2, the athletes started to create pressure and damage on their competitors by using more crochet punch techniques. More power has been used due to the crochet punch technique being performed using the whole body strength. In round 3, the direct punch arithmetic average was higher than the other punch number (x=38.23) But it decreased in round 3. In the last round, the number and frequency of uppercut punches were 16 compared to the rounds and were increased. Although signs of fatigue started in both competitors in round 3, they tried to use guard defending position by evaluating their competitor's tiredness; in punch combinations generally used powerful crochet and uppercut hits instead of being in large quantities or fast.

Considering three types of punching analyzes (m/p), direct punch (x=13.32) has a higher arithmetic average compared to the others. Crochet punch (x=11.62) and Uppercut punch (x=11.94) do not have much difference in correlation average. Uppercut punch speed frequency and punch speed are shown not much difference. The uppercut punch and crochet punch's arithmetic average speed difference is quite less in round 2. ($\underline{x}$= 11.65; $\underline{x}$= 11.22). When three types of punches considered uppercut punch arithmetic average in rounds 1,2, and 3 respectively (x=13.51; x=16.31; x=15.50), it has the highest arithmetic average and standard deviation. Direct punch's arithmetic average speed (x=12.64) and standard deviation (SD=2.21) are increased parallel by the other's numbers.

Direct punch power has the lowest arithmetic average difference than the others in rounds 1,2 and 3 (x=12.04; x=12.19; x=11.66).

Suggestions
Generally, contestants should pay attention to their endurance training programme to minimise fatigue during the contest, also, doing more training contests will develop their physical condition and experience. This study has been made about kickboxers. It can be used in other martial arts. If the study is done during the contest, the result will be better. The research was done on elite kickboxers. However, if similar work is done at younger ages, new training programmes can be created for the insufficient carrying plans of the athletes.

BIBLIOGRAPHY
The role of simulation in Sports Training, *Journal of Sports Sciences*
Effects of Virtual Reality Training on Performance in Combar Sports, Journal of Sports Medicine
Understanding Motor Learning in Boxing: The role of Practice and Feedback, *International Journal of Sports Psychology*
Improving Reactıın Time in Athlete Through Simulation Training, *Sports Science Review*
The Use of Simulators in Skill Acquistion for Combat Sports, *European Journal of Sport Science*
The Technology in Sports Training The Future of Coaching, *International Journal of Sports Coaching*
Physical and Psychological Benefits of Simulation Training in Sports, Journal of Applied Sport Psychology
Simulation-Based Training for Combat Sports: Enhancing Performance Through Technology"
        Journal of Sports Technology
Virtual Reality as a Tool for Training in Martial Arts, International Journal of Martial Arts Science
The Science of Boxing: A Comprehensive Guide to the Art of Boxing" - A. N. Cramer
Sports Training Principles - Thomas R. Baechle, Roger W. Earle
Boxing: The Complete Guide to Training and Fitness - John McCallum
Principles of Sports Training- John E. McGuigan
Virtual Reality in Sport and Exercise - Andrew M. Williams
The Art of Boxing: A Self-Instruction Manual - S. S. Timmons
Boxing Fitness: A Guide to Your Ultimate Workout - Nick Kearney
Alibaz, ve ark, (2006). Türkiye' de üst düzey Taekwondo, Karate ve Kick Boks sporcularının bu spor branşına yönelmelerine teşvik eden unsurlar, yapma nedenleri ve geleceğe yönelik beklentileri. Spormetre, Beden Eğitimi ve Spor Bilimleri Dergisi, 4(3), 91-102.
Aykın AG, (2010) Kick Boks Fedarasyonunun İdari ve Mali Yapısının İncelenmesi, Sosyal Bilimler Enstitüsü Spor Yöneticiliği Anabilim Dalı. Yüksek Lisans Tezi, Antalya: Akdeniz Üniversitesi, (2010).
Bilge, M. (2007) Türk Erkek Hentbol Milli Takımında Anaerobik Güç-Kapasite, Kalp Atım Hızı İle Vücut

Kompozisyonu Arasındaki İlişkinin İncelenmesi. Doktora Tezi Gazi Üniversitesi Sağlık Bilimleri Enstitüsü.

Daniels, K. and Thornton, E. (1992). Length of training, hostility and the martial arts: a comparison with other sporting groups. British Journal of Sports Medicine, University of Liverpool, 26, 118-120.

Daniels, K. and Thornton, E.W. (1990). An analysis of the relationship between hostility and training in the martial arts. Journal of Sports Sciences, 8, 95-101.

Deryahanoğlu, G. (2014). Kick boks hakemlerinin karar verme ve atılganlık düzeylerinin algılanan mesleki yeterlilik üzerine etkisinin incelenmesi. Yüksek Lisans Tezi, Sakarya Üniversitesi Eğitim Bilimleri Enstitüsü, Sakarya.

LENZA., Schnelligkeitstraining in Kleinen Spielen, Westerburg, 2006

Marsh, G. D., Paterson, D. H., Govındasamy, D. ve Cunnıngham, D. A. (1999) Anaerobic Power Of The Arms and Legs Of Young and Older Men, Experimental Physiology, 84, 589-597.

McHugh M. P., Tyler T. F., Tetro D. T., Mullaney M. J., Nicholas S. J. (2006) Ankle Sprains Are Among The Most Common Sports İnjuries. American Journal Of Sports Medicine Volume; 34 Issue: 3.

Piorkowski BA, Lees A, & Barton GJ, 2011. Single maximal versus combination punch kinematics. Sports Biomechanics, 10(01), 1-11

Sözmez, G. T. (2002). Egzersiz ve Spor Fizyolojisi. Bolu: Ata Ofset Matbaacılık

Tamer K. (2000) Sporda Fiziksel-Fizyolojik Performansın Ölçülmesi ve Değerlendirilmesi. 2. Baskı. Ankara: Bağırgan Yayınevi.

Ünal, K. (2012). Farklı kuşak seviyelerinde taekwondo sporu yapan çocuklarda aahperd sağlıkla ilişkili fiziksel uygunluk test bataryasının karşılaştırılması. Yüksek Lisans Tezi, Hacettepe Üniversitesi, Sağlık Bilimleri Enstitüsü, Ankara

Karatosun H, 2010. Antrenman Fizyolojik Temelleri Üçüncü Baskı Altundağ Matbaası, Isparta