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ORIGINAL ARTICLE

The Relationship of the Physical Profiles of Kick Boxers Participating in the 2019 World Championships with Their Flexibility Levels and Success Status

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ABSTRACT

Athletes are characterized by body composition and size characteristics that are thought to affect success in any sports branch. The aim of this study is to examine the relationship between the physical profiles and flexibility levels of elite kickboxers participating in the 2019 Senior Kickboxing World Championships and their success status. A total of 303 kickboxers (85 women and 218 men) participated in the study. The athletes who were ranked (in the first 4 athletes according to the official results) were evaluated in the group of successful athletes and those who did not enter were evaluated in the group of unsuccessful athletes. Physical profile and flexibility measurements of the athletes were made. Mean, standard deviation, minimum and maximum values were given as Descriptive Statistics of kickboxers. Statistical analyzes were evaluated with Independent Sample T Test, Mann-Whitney U Test and Pearson Correlation Analysis. Significance level was accepted as $p<0.05$ in the analyzes. The height of the successful male kickboxers in the kick light (KL) branch was found to be significantly higher than the unsuccessful male kickboxers ($p=0.00$). While the muscle mass and bone mass values of the successful male kickboxers in the KL branch were found to be significantly higher than the unsuccessful group ($p=0.03$; $p=0.03$), basal metabolism values were also higher than the unsuccessful group ($p=0.03$). According to the results of Pearson Correlation Analysis, a negative significant result was found between age and success in male kickboxers ($r=-0.199$; $p<0.01$).

Keywords: Kick boxing, physical profile, flexibility, success.

INTRODUCTION

Kickboxing is a combat sport in which two opponents apply full force kicks directly to each other with their hands, legs and feet. Kickboxing has various disciplines [such as point fighting (PF), light contact (LC), full contact (FC), low kick (LK), K1 contact, kick light (KL) and musical form]. PF is a fighting discipline where two fighters fight with the primary goal of scoring. The main characteristic of PF is delivery, technique and speed. Competition in LC kickboxing should be executed as its name implies, with well-controlled techniques. They use techniques from FC and semi contact, but these techniques must be well controlled when they land on legal targets. Equal emphasis must be placed on both punching and kicking techniques (1). LC has been created as an intermediate stage between semi and FC kickboxing. FC is a discipline of kickboxing where the intention of a fighter is to beat his opponent with full power and strength. Punches and kicks must be delivered to legal targets with focus, speed and determination, creating solid contact. Punches and kicks are allowed to the front, side and top of the head, the front and side of the body (above waist) and sweeping is also allowed. LK can be defined as FC kickboxing in which there is also the possibility of attacking the opponent's legs with clean kicks. All other definitions are as those of FC kickboxing (1). K-1 contact is similar to FC and LK competition techniques. However, they have some differences due to their qualities. Elbow techniques are prohibited. If the contestants are not moving, the referee has to stop them. Ritual dance and music are prohibited. The linesmen evaluate punch techniques hitting the allowed areas as equivalent to knee-foot or other techniques. Competition in KL kickboxing should be executed as its name implies, with well-controlled techniques. In KL competitors fight continuously until central referee command stop or break. They use techniques from FC, but these techniques must be well controlled when they land on legal targets. Equal emphasis must be placed on both punching and kicking techniques. KL has been created as an intermediate stage between semi and FC kickboxing. A musical form is a sort of imaginary fight against one or more opponents in which the performer uses techniques coming from oriental martial arts to specifically chosen music. The choice of music is personal (1).

There are many styles that have evolved over time and become independent disciplines (styles such as Muay Thai, American or European Kickboxing, Chinese San Shou, and French Savate). A typical kickboxing match has content that lasts between 2 and 4 minutes, with 1-2 minute rest periods, and can continue for 3 to 12 rounds (2, 3). The interest in kickboxing is increasing worldwide due to its beneficial effects such as personal protection, increasing muscle strength and keeping the body in shape (3). Factors affecting performance in sports have been among the research topics of sports sciences for years. The requirement of kickboxers to perform many technical movements in each match also increases the physical and physiological demands (4). Due to the nature of the competition in kickboxing (such as high-intensity movements in the rounds and short breaks that are not enough for complete rest), moderate-high levels of aerobic and anaerobic power generation are required (5). While the aerobic system contributes to the kickboxer's ability to repeat attacks at the same power and speed level

throughout the total duration of the competition, the anaerobic metabolic pathway ensures optimal use of recovery time and successive attacks during short and intense maximum power attacks, short rest breaks or periods of reduced effort. provides energy for attack situations (3). Kickboxing needs both anaerobic and aerobic systems, and athletes should focus on improving both systems (4, 6).

While some features such as chest width, muscle enzyme activity for energy use, blood pressure, contraction rate, air circulation in the lungs, reaction time, balance, amount of mitochondria per gram in the muscle, anaerobic endurance are under the influence of moderate or low genetic factors; Features such as height, arm length, muscle size, muscle fiber structure, heart size, lung size and volume, resting heart rate, muscle strength, muscle endurance, joint flexibility, aerobic endurance are highly influenced by genes (7, 8). Although these hereditary facts are the basis of being successful in sports activities, individuals with a high level of genetic predisposition also need appropriate working techniques and programming (9).

Due to the different lengths of muscles and ligaments, flexibility is seen in different degrees among people. Because men have more connective tissues than women, women are more flexible than men. Flexibility is synonymous with the range of motion that occurs in the joint and can be limited by muscles, ligaments, tendons or bone structures (10). However, flexibility can be increased by stretching exercises (11). Agre (1985) states that increased flexibility with stretching activities reduces the incidence of muscle-tendon injury, muscle pain, increases the performance of the athlete, and improves the efficiency of movement (12).

In addition, athletes are characterized by body composition and size characteristics that are thought to affect success in any sports branch (13). Body size and structure contribute significantly to performance in many sports branches (8). It is known that athletes competing in different sports have very different body weight, height, muscle mass, lean body mass, fat percentage and even body proportion, and body composition is associated with performance (14, 15). Excess adipose tissue is undesirable extra and dysfunctional weights in body mass during repetitive displacements and jumps against gravity (16). It causes a decrease in performance by increasing energy consumption in the athlete. In contrast, lean body mass contributes to power generation during high-intensity activities, providing greater absolute strength for resistance to high dynamic and static loads (17). It is an undeniable fact that different sports branches can be successfully performed by athletes with different anthropometric characteristics (18).

Understanding the characteristics of elite athletes can provide insights into what is actually required for competitive success (19). In particular, the physiological characteristics of athletes are usually possible by testing the components of fitness and skill (20). The fact that the athletes perform in the competitions according to their weight and at the same time maintain their physical competence makes the importance of the physical profile more evident in the kick boxing branch. In addition to this, it is thought that it is necessary to know the effect of flexibility on performance in kickboxing, where kick variations are widely used. Researchers tend to focus on high-level athletes in order to identify the requirements that are considered important for success and to define these characteristics in physical, physiological and psychological terms (21).

The aim of this study is to examine the relationship between the physical profiles and flexibility levels of elite kickboxers participating in the 2019 Senior Kickboxing World Championships (WCh) and their success levels.

MATERIAL AND METHODS

Participants: A total of 303 kickboxers, 85 women and 218 men, aged 18-49 years-old, from 41 countries participated in the study. Research measurements were carried out at the 2019 Senior Kick Boxing (WCh) held in Antalya-Turkey. Before starting the study, the participants signed the consent form describing the purpose and content of the study, stating that they participated in the study voluntarily.

Procedure: Male and female athletes included in the study competed in 4 different categories [full contact, kick light, point fight and team point fight] (22). In the study, in which the relationship of the physical profiles of the athletes according to their branches and weights with their flexibility levels and success status, the athletes who were ranked (in the first 4 athletes according to the official results) were evaluated in the group of successful athletes and those who did not enter were evaluated in the group of unsuccessful athletes. Kickboxers' official competition results were reached from the World Association of Kickboxing Organizations (WAKO) 2019 Senior WCh results book published on WAKO's official website (22). Physical profile and flexibility measurements of the athletes were made. All measurements were made on an empty stomach and without clothes on the morning of the competition for each athlete.

Physical Profile Measurement: The height of all participants was measured with an ultrasonic height meter (Langen Messstab 5003, Germany). Body weight, body fat percentage, muscle mass, bone mass, body mass index, basal metabolic rate, body fluid ratio were determined with a body analyzer (Tanita Bc 601, Japan).

Flexibility Test: Flexibility measurements of the athletes were determined on the flexibility measuring bench (S&R Sit and Reach, Turkey). Flexibility of the lower extremity and lumbar extensors of the athletes was evaluated with sit-reach test. Athletes are seated in a long sitting position with their ankles at a 90-degree angle and their bare feet touching the sit and reach board. Athletes were asked to lean forward from their trunks and hold their hands in front of their bodies without bending their knees. The longest distance reached on the ruler on the flexibility table was recorded as the flexibility value in centimeters (cm). The measurement was repeated twice and the highest value was recorded in cm (21).

Statistical Analysis: SPSS 22.0 (SPSS Inc., Chicago, IL) program was used for statistical analysis of the study. The relationships between the physical profile data of the athletes, their flexibility levels and their success status were analyzed according to weights and branches. Mean, standard deviation, minimum and maximum values were given as Descriptive Statistics of kickboxers. Whether the

data showed normal distribution or not was analyzed with the Shapiro-Wilk Test. Data with normal distribution were analyzed with Independent Sample T Test, and data without normal distribution was analyzed with Mann-Whitney U Test. Correlation between data was evaluated with Pearson Correlation Analysis. Significance level was accepted as $p<0.05$ in the analyzes.

RESULTS

Descriptive statistical analyzes of male kickboxers according to their branches are given in Table 1, and descriptive statistical analyzes according to their weights are given in Table 2. Descriptive statistical analyzes of female kickboxers according to their branches are given in Table 3, and descriptive statistical analyzes according to their weights are given in Table 4.

Table 1: Descriptive statistical analyzes of male kick boxers according to their branches.

Branch		Age (year)	Height (cm)	Body Weight (kg)	Body Fat Ratio (%)	Muscle Mass (kg)	Bone Mass (kg)	Body Mass İndex	Basal Metabolic Ratio (kcal)	Body Fluid Ratio (%)	Flexibility (cm)
FC (n=81)	Min Max Mean±SD	19.00 37.00 24.43±3.97	162.00 190.00 176.88±6.39	51.00 137.20 70.49±14.20	5.00 19.90 8.93±3.61	6.00 88.60 59.20±11.55	2.40 4.50 3.16±0.46	17.10 33.80 22.28±2.97	2815.00 5910.00 3902.69±629.07	59.40 77.80 66.80±3.67	-25.00 22.00 8.43±10.92
KL (n=63)	Min Max Mean±SD	18.00 49.00 26.40±7.31	156.00 197.00 180.02±7.83	56.40 114.50 78.01±14.54	5.00 24.10 11.17±5.19	47.90 92.20 65.69±9.84	2.60 4.70 3.42±0.48	18.60 31.70 24.07±3.16	2980.00 6089.00 4243.29±689.86	55.00 73.60 65.08±4.42	-17.00 22.00 9.54±9.43
PF (n=61)	Min Max Mean±SD	18.00 48.00 28.85±9.44	156.00 193.00 177.33±8.43	56.40 116.20 78.54±12.34	5.20 24.70 13.04±4.80	47.90 91.90 64.68±8.61	2.60 4.70 3.37±0.41	17.90 32.10 24.92±3.02	3160.00 6070.00 41.82±585.82	55.40 69.00 63.44±3.46	-18.00 22.00 7.13±9.42
TPF (n=13)	Min Max Mean±SD	18.00 46.00 24.31±7.95	158.00 193.00 177.15±10.81	62.30 116.20 76.55±13.88	6.80 19.90 12.62±4.00	50.60 91.90 63.44±10.64	2.70 4.70 3.32±0.51	20.50 31.20 24.29±2.76	3364.00 6070.00 4145.69±703.96	58.50 68.20 63.36±2.78	-18.00 22.00 6.83±13.29

n; Number of kickboxer, **FC;** Full Contact, **KL;** Kick Light, **PF;** Point Fight, **TPF;** Team Point Fight, **Min;** Minimum, **Max;** Maksimum, **Mean±SD;** Mean ± Standard Deviation.

Table 2: Descriptive statistical analyzes of male kick boxers according to their weights.

Weight		Age (year)	Height (cm)	Body Weight (kg)	Body Fat Ratio (%)	Muscle Mass (kg)	Bone Mass (kg)	Body Mass İndex	Basal Metabolic Ratio (kcal)	Body Fluid Ratio (%)	Flexibility (cm)
51-60 kg (n=34)	Min Max Mean±SD	18.00 30.00 22.32±3.35	156.00 182.00 170.50±5.98	51.00 61.90 57.26±2.97	5.00 12.70 6.98±2.33	45.00 55.90 50.56±2.77	2.40 2.90 2.69±0.14	17.10 23.40 19.78±1.56	2815.00 3625.00 3258.94±182.80	62.30 77.80 68.64±3.37	-10.00 22.00 10.41±8.47
61-70 kg (n=50)	Min Max Mean±SD	18.00 42.00 25.28±5.33	158.00 183.00 174.90±5.41	62.30 73.10 66.12±2.70	5.00 19.90 8.89±3.49	30.20 63.10 56.73±4.84	2.70 3.30 3.02±0.15	19.20 28.00 21.67±1.62	3160.00 4081.00 3673.52±194.36	58.50 74.60 66.09±3.43	-25.00 22.00 5.40±11.40
71-80 kg (n=53)	Min Max Mean±SD	18.00 49.00 25.21±6.47	163.00 193.00 178.75±5.45	70.80 80.10 74.65±2.66	5.00 19.10 10.12±3.50	56.10 72.70 63.86±3.11	3.00 3.70 3.33±0.15	19.80 27.50 23.48±1.46	3255.00 4665.00 4111.85±225.03	58.20 74.10 65.58±3.29	-17.00 22.00 12.25±8.66
81-90 kg (n=40)	Min Max Mean±SD	18.00 49.00 28.76±8.41	157.00 190.00 179.78±6.75	72.80 91.80 83.06±4.04	5.40 22.50 13.54±4.69	6.00 75.20 66.37±10.62	3.00 3.90 3.54±0.19	22.60 31.00 25.74±1.91	3603.00 4861.00 4407.23±254.04	55.90 71.00 63.27±3.82	-14.00 22.00 7.85±9.24
91 kg and more (n=34)	Min Max Mean±SD	19.00 47.00 29.91±9.13	175.00 197.00 186.85±4.96	70.80 137.20 98.01±12.06	7.20 24.70 15.64±4.68	65.80 92.20 78.21±6.02	3.40 4.70 4.02±0.29	23.20 33.80 27.97±2.40	4258.00 6089.00 5130.03±434.30	55.00 69.50 62.28±3.84	-17.00 22.00 5.20±10.60

n; Number of kickboxer, **Min;** Minimum, **Max;** Maksimum, **Mean±SD;** Mean ± Standard Deviation.

Table 3: Descriptive statistical analyzes of female kick boxers according to their branches.

Branch		Age (year)	Height (cm)	Body Weight (kg)	Body Fat Ratio (%)	Muscle Mass (kg)	Bone Mass (kg)	Body Mass İndex	Basal Metabolic Ratio (kcal)	Body Fluid Ratio (%)	Flexibility (cm)
FC (n=32)	Min Max Mean±SD	19.00 37.00 24.44±4.39	153.00 184.00 167.78±6.44	48.30 89.60 61.40±11.45	6.60 37.70 17.01±6.69	39.60 63.30 48.18±6.54	2.10 3.40 2.57±0.34	17.20 30.70 21.94±3.65	2249.00 3637.00 2761.00±364.90	53.50 74.40 62.76±4.72	-11.00 22.00 1.10±7.78
KL (n=24)	Min Max Mean±	19.00 43.00 25.50±5.	155.00 178.00 165.13±6.0	47.50 116.90 58.93±13.	7.30 36.50 16.76±6.	35.60 70.50 46.00±6.8	1.90 3.70 2.46±0.	18.00 36.90 21.46±3.	2146.00 4237.00 2638.04±409.	49.90 70.30 62.70±4.	-11.00 22.00 13.59±7.9

	SD	57	8	79	43	5	35	68	74	67	5
PF (n=22)	Min Max Mean± SD	18.00 47.00 24.05±7.56	154.00 182.00 166.32±7.34	47.50 69.30 57.50±6.59	11.50 24.00 18.33±3.69	35.60 52.50 44.55±5.23	1.90 2.80 2.39±0.27	17.50 24.00 20.76±1.90	1972.00 2978.00 2560.36±293.69	56.30 66.60 61.05±3.00	-10.00 22.00 11.64±8.60
TPF (n=7)	Min Max Mean± SD	19.00 23.00 20.57±1.72	155.00 182.00 167.43±8.77	49.80 69.30 61.99±8.21	11.50 24.70 20.16±4.89	38.10 52.20 46.79±5.03	2.10 2.80 2.50±0.26	18.30 25.10 22.14±2.77	2216.00 2978.00 2719.43±281.44	56.60 66.60 59.66±3.48	-10.00 22.00 6.00±13.28

n; Number of kickboxer, **FC;** Full Contact, **KL;** Kick Light, **PF;** Point Fight, **TPF;** Team Point Fight, **Min;** Minimum, **Max;** Maksimum, **Mean±SD;** Mean ± Standard Deviation.

Table 4: Descriptive statistical analyzes of female kick boxers according to their weights.

Weight		Age (year)	Height (cm)	Body Weight (kg)	Body Fat Ratio (%)	Muscle Mass (kg)	Bone Mass (kg)	Body Mass İndex	Basal Metabolic Ratio (kcal)	Body Fluid Ratio (%)	Flexibility (cm)
58 kg and less (n=43)	Min Max Mean± SD	19.00 43.00 23.53±4.74	153.00 172.00 162.95±5.22	47.50 66.70 52.87±3.93	6.60 24.70 15.81±4.88	35.60 48.40 42.17±3.09	1.90 2.60 2.27±0.17	17.20 25.10 19.91±1.70	1972.00 2784.00 2432.05±167.34	56.60 74.40 63.59±4.02	-11.00 22.00 10.77±9.47
59 kg and more (n=40)	Min Max Mean± SD	18.00 47.00 25.35±6.44	160.00 184.00 170.95±5.58	55.70 116.90 67.19±11.29	7.90 37.70 19.14±6.33	44.10 70.50 51.35±5.29	2.40 3.70 2.74±0.27	18.80 36.90 23.16±3.63	2549.00 4237.00 2936.28±327.41	49.90 68.00 60.56±4.07	-11.00 22.00 12.55±7.24

n; Number of kickboxer, **Min;** Minimum, **Max;** Maksimum, **Mean±SD;** Mean ± Standard Deviation.

The analysis of the comparison of the physical profiles and flexibility levels of male kick boxers with their success status according to their branches is given in Table 5.

Table 5: The analysis of the comparison of the physical profiles and flexibility levels of male kick boxers with their success status according to their branches.

Branch		Success Status	Age (year)	Height (cm)	Body Weight (kg)	Body Fat Ratio (%)	Muscle Mass (kg)	Bone Mass (kg)	Body Mass İndex	Basal Metabolic Ratio (kcal)	Body Fluid Ratio (%)	Flexibility (cm)
FC (n=81)	Mean± SD	(1) n=22	24.55±4.51	177.18±7.14	73.22±21.82	9.37±4.00	58.44±17.40	3.21±0.63	22.59±4.20	3965.77±897.66	66.90±3.48	11.16±9.39
		(2) n=59	24.39±3.79	176.76±6.15	69.47±10.10	8.77±3.48	59.48±8.61	3.15±0.38	22.17±2.40	3879.17±501.96	66.77±3.76	7.42±11.35
	T/U		638.00**	0.26*	633.00**	615.50**	596.00**	637.50**	618.50**	625.50**	0.88*	529.00**
	p		0.91	0.80	0.87	0.72	0.57	0.90	0.75	0.80	0.89	0.20
KL (n=63)	Mean± SD	(1) n=17	29.76±9.43	184.29±8.11	82.38±16.10	11.25±5.36	70.19±11.64	3.64±0.57	24.48±3.11	4552.29±798.51	64.74±4.24	12.51±7.21
		(2) n=46	25.15±6.00	178.43±7.19	76.40±1.75	11.14±5.18	64.03±8.65	3.34±0.42	23.92±3.20	4128.98±616.03	65.21±4.52	8.45±9.97
	T/U		276.50**	0.32*	308.00**	379.50**	0.12*	0.08*	0.75*	0.19*	0.59*	301.00**
	p		0.08	0.00***	0.20	0.86	0.03***	0.03***	0.53	0.03***	0.71	0.16
PF (n=61)	Mean± SD	(1) n=21	33.29±11.21	177.48±9.08	80.00±10.44	13.02±3.85	66.25±8.18	3.44±0.38	25.37±2.34	4270.14±551.74	63.86±2.73	6.82±9.82
		(2) n=40	26.53±7.51	177.25±8.13	77.78±13.29	13.04±5.28	63.86±8.82	3.33±0.42	24.69±3.33	4136.98±604.66	63.22±3.80	7.29±9.32
	T/U		293.50**	0.79*	0.40*	0.09*	0.86*	0.91*	0.10*	0.84*	0.11*	391.50**
	p		0.05	0.92	0.51	0.98	0.31	0.32	0.41	0.40	0.50	0.67
TPF (n=13)	Mean± SD	(1) n=4	23.50±4.20	178.75±10.11	76.20±7.74	13.33±2.87	62.80±7.07	3.30±0.33	23.85±1.45	4089.25±491.71	62.33±1.93	4.10±18.62
		(2) n=9	24.67±9.37	176.44±11.62	76.71±16.32	12.30±4.54	63.72±12.28	3.32±0.59	24.49±3.24	4170.78±806.45	63.82±3.10	8.04±11.38
	T/U		15.50**	0.81*	15.00**	0.20*	17.00**	16.50**	0.29*	18.00**	0.27*	0.09*
	p		0.70	0.74	0.64	0.69	0.88	0.82	0.72	1.00	0.39	0.64

n; Number of kickboxer, **FC;** Full Contact, **KL;** Kick Light, **PF;** Point Fight, **TPF;** Team Point Fight, **Mean±SD;** Mean ± Standard Deviation, **Success status (1);** Successful**, Success Status (2);** Unsuccessful, *****; Independent Sample T Test , ******; Mann Whitney U Test, *******; p<0.05.

The analysis of the comparison of the physical profiles and flexibility levels of female kick boxers with their success status according to their branches is given in Table 6.

n; Number of kickboxer, **FC;** Full Contact, **KL;** Kick Light, **PF;** Point Fight, **TPF;** Team Point Fight, **Mean±SD;** Mean ± Standard Deviation, **Success status (1);** Successful**, Success Status (2);** Unsuccessful, *****; Independent Sample T Test , ******; Mann Whitney U Test, *******; p<0.05.

The analysis of the comparison of the physical profiles and flexibility levels of male kick boxers with their success status according to their weights is given in Table 7.

Table 6: The analysis of the comparison of the physical profiles and flexibility levels of female kick boxers with their success status according to their branches.

Branch		Success Status	Age (year)	Height (cm)	Body Weight (kg)	Body Fat Ratio (%)	Muscle Mass (kg)	Bone Mass (kg)	Body Mass İndex	Basal Metabolic Ratio (kcal)	Body Fluid Ratio (%)	Flexibility (cm)
FC (n=32)	Mean± SD	(1) n=10	25.70±5.77	168.80±5.43	60.90±10.23	17.30±7.90	48.18±6.54	2.57±0.36	21.73±3.57	2749.40±366.94	62.66±3.88	12.26±7.06
		(2) n=22	23.88±3.62	167.32±6.92	61.62±12.19	16.88±6.27	48.18±6.64	2.57±0.34	22.03±3.77	2766.27±372.51	62.81±5.13	10.58±8.20
	T/U		93.00**	0.53*	106.00**	105.50**	86.50**	108.00**	103.00**	107.00**	0.35*	0.72*
	p		0.49	0.56	0.87	0.86	0.34	0.94	0.79	0.90	0.94	0.58
KL (n=24)	Mean± SD	(1) n=9	26.00±7.04	168.22±5.07	63.50±20.66	16.36±8.62	49.06±8.69	2.62±0.44	22.20±5.70	2809.11±563.55	63.00±6.19	12.29±7.55
		(2) n=15	25.20±4.74	163.27±6.02	56.19±6.86	17.00±5.03	44.17±4.93	2.37±0.26	21.02±1.76	2535.40±253.44	62.52±3.73	14.37±8.33
	T/U		67.50**	0.35*	50.00**	56.00**	47.00**	44.00**	61.00**	49.00**	0.28*	55.00**
	p		1.00	0.05	0.30	0.49	0.22	0.16	0.70	0.27	0.81	0.46
PF (n=22)	Mean± SD	(1) n=8	26.50±11.66	167.00±8.04	59.25±6.23	17.75±4.24	46.29±5.63	2.48±0.29	21.25±1.88	2653.38±288.70	61.49±3.59	8.68±8.67
		(2) n=14	22.64±3.65	165.92±7.21	56.51±6.80	18.66±3.46	43.56±4.92	2.34±0.27	20.48±1.92	2507.21±293.41	60.80±2.73	13.33±8.39
	T/U		51.00**	0.91*	0.98*	0.50*	0.52*	0.58*	0.94*	0.73*	0.36*	34.50**
	p		0.73	0.75	0.36	0.59	0.25	0.29	0.37	0.27	0.62	0.14
TPF (n=7)	Mean± SD	(1) n=2	19.50±0.71	167.50±3.54	59.55±13.79	17.70±8.77	45.95±5.87	2.45±0.35	21.15±4.03	2691.00±339.41	61.60±7.07	6.00±22.63
		(2) n=5	21.00±1.87	167.40±10.60	62.96±7.04	21.14±3.52	47.12±5.38	2.52±0.27	22.54±2.60	2730.80±299.07	58.88±1.73	6.00±11.69
	T/U		0.04*	0.15*	5.00**	0.03*	0.85*	0.63*	0.43*	0.82*	0.00*	0.12*
	p		0.34	0.34	1.00	0.45	0.81	0.78	0.60	0.88	0.68	1.00

Table 7: The analysis of the comparison of the physical profiles and flexibility levels of male kick boxers with their success status according to their weights.

Weight		Success Status	Age (year)	Height (cm)	Body Weight (kg)	Body Fat Ratio (%)	Muscle Mass (kg)	Bone Mass (kg)	Body Mass İndex	Basal Metabolic Ratio (kcal)	Body Fluid Ratio (%)	Flexibility (cm)
51-60 kg (n=34)	Mean± SD	(1) n=10	23.30±3.43	171.20±4.96	56.12±3.82	6.28±1.68	50.01±3.66	2.66±0.17	19.24±1.12	3197.00±264.07	69.53±2.96	13.29±7.09
		(2) n=24	21.92±3.31	170.20±6.43	57.73±2.48	7.30±2.53	50.79±2.36	2.53±0.13	20.00±1.68	3284.75±135.26	68.26±3.52	9.21±8.84
	T/U		89.00**	0.55*	0.05*	90.50**	0.08*	104.00**	0.35*	92.00**	86.50**	81.00**
	p		0.24	0.67	0.15	0.25	0.46	0.54	0.20	0.29	0.21	0.14
61-70 kg (n=50)	Mean± SD	(1) n=10	27.80±6.92	173.40±6.24	66.72±3.21	10.73±3.24	56.60±3.46	2.98±0.17	22.24±1.45	3638.10±184.65	64.34±2.58	8.07±9.44
		(2) n=40	24.65±4.75	175.28±5.21	65.97±2.59	8.44±3.44	56.77±5.17	3.03±0.14	21.53±1.65	3682.38±197.97	66.53±3.51	4.73±11.85
	T/U		138.00**	166.00**	178.50**	115.50**	172.50**	165.00**	136.50**	0.86*	0.34*	170.00**
	p		0.13	0.41	0.60	0.04***	0.51	0.39	0.12	0.53	0.07	0.47
71-80 kg (n=53)	Mean± SD	(1) n=13	24.31±7.20	179.08±5.09	74.03±2.24	10.12±3.18	63.53±1.89	3.32.±0.09	23.25±1.61	4108.92±137.08	65.23±2.45	12.13±8.92
		(2) n=40	25.50±6.29	178.65±5.62	74.85±2.78	10.12±3.63	63.97±3.43	3.34±0.16	23.56±1.42	4112.80±248.46	65.70±3.54	12.29±8.70

	T/U		204.00**	0.98*	216.50**	257.00**	0.05*	240.00**	.620*	252.00**	0.36*	241.00**
	p		0.25	0.81	0.37	0.95	0.67	0.67	0.52	0.87	0.66	0.69
81-90 kg (n=40)	Mean± SD	(1) n=13	33.23±10.84	179.15±8.56	81.49±4.72	12.50±4.95	62.90±17.78	3.52±0.24	25.38±2.24	4355.46±327.50	64.26±3.80	10.15±9.24
		(2) n=27	26.59±6.08	180.07±5.86	83.81±3.51	14.03±4.58	68.04±3.78	3.55±0.16	25.91±1.75	4432.15±212.88	62.80±3.81	6.74±9.21
	T/U		124.00**	173.00**	0.36*	0.91*	154.50**	0.14*	0.47*	0.08*	0.99*	140.50**
	p		0.14	0.94	0.09	0.34	0.54	0.66	0.42	0.38	0.26	0.31
91 kg and more (n=34)	Mean± SD	(1) n=18	31.56±10.69	187.61±5.79	97.45±14.55	14.32±4.41	78.85±6.87	4.05±0.33	27.52±2.53	5160.06±449.54	63.46±3.51	6.67±11.38
		(2) n=16	28.06±6.87	186.00±3.81	98.64±8.91	17.13±4.66	77.49±5.01	3.99±0.25	28.49±2.21	5096.25±360.34	60.95±3.87	3.56±9.74
	T/U		129.00**	0.01*	127.50**	0.37*	0.09*	0.11*	0.90*	140.50**	0.31*	0.58*
	p		0.60	0.35	0.57	0.52	0.52	0.54	0.25	0.90	0.06	0.40

n; Number of kickboxer, **Mean±SD;** Mean ± Standard Deviation, **Success status (1);** Successful**, Success Status (2);** Unsuccessful, *****; Independent Sample T Test , ******; Mann Whitney U Test, *******; p<0.05.

The analysis of the comparison of the physical profiles and flexibility levels of female kick boxers with their success status according to their weights is given in Table 8.

Table 8: The analysis of the comparison of the physical profiles and flexibility levels of female kick boxers with their success status according to their weights.

Weight		Success Status	Age (year)	Height (cm)	Body Weight (kg)	Body Fat Ratio (%)	Muscle Mass (kg)	Bone Mass (kg)	Body Mass İndex	Basal Metabolic Ratio (kcal)	Body Fluid Ratio (%)	Flexibility (cm)
58 kg and less (n=43)	Mean ±SD	(1) n=13	24.54±6.64	164.69±4.42	52.35±2.75	14.35±4.96	69.93±98.01	2.28±0.16	19.25±1.16	2445.38±134.57	64.25±4.02	8.58±11.23
		(2) n=30	23.10±3.69	162.20±5.42	53.09±4.37	16.44±4.79	42.02±3.27	2.26±0.17	20.19±1.83	2426.27±181.52	63.30±4.05	11.71±8.64
	T/U		176.5**	149.5**	180.0**	0.01*	149.50**	182.0**	0.47*	0.18*	0.91*	164.50**
	p		0.62	0.23	0.69	0.20	0.23	0.72	0.42	0.74	0.49	0.42
59 kg and more (n=40)	Mean ±SD	(1) n=16	26.44±8.85	170.75±5.48	68.31±14.11	19.44±7.69	52.04±6.12	2.77±0.32	23.69±4.18	2974.69±394.37	60.84±4.60	12.69±5.37
		(2) n=24	24.63±4.23	171.03±5.76	66.44±9.21	18.94±5.41	50.89±4.75	2.72±0.25	22.81±3.25	2910.67±280.40	60.37±3.77	12.45±8.37
	T/U		188.00**	0.85*	182.00**	177.50**	174.00**	173.50**	168.50**	178.50**	0.53*	179,00**
	p		0.91	0.86	0.78	0.69	0.62	0.60	0.52	0.71	0.72	0.72

n; Number of kickboxer, **Mean±SD;** Mean ± Standard Deviation, **Success status (1);** Successful**, Success Status (2);** Unsuccessful, *****; Independent Sample T Test , ******; Mann Whitney U Test, *******; p<0.05.

DISCUSSION

Understanding the characteristics of elite athletes can provide insights into what is actually required for competitive success (19). Researchers tend to focus on high-level athletes in order to identify the requirements that are considered important for success and to define these characteristics in physical, physiological and psychological terms (21). In this study, the relationship between the physical profile and flexibility levels of elite kickboxers participating in the 2019 Senior Kickboxing WCh with the success of the athletes was evaluated.

In this study, in the descriptive analysis evaluation of male kickboxers according to FC, KL, PF and TPF branches, the mean age and standard deviation values were found to be 24.43±3.97 years-old, 26.40±7.31 years-old, 28.85±9.44 years-old and 24.31±7.95 years-old, respectively. In the descriptive analysis evaluation of male kickboxers according to 51-60 kg, 61-70 kg, 71-80 kg and 91 kg and more weight groups, mean age and standard deviation values were 22.32±3.35 years-old, 25.28±5.33 years-old, 25.21±6.47 years-old, 28.76±8.41 years-old and 29.91±9.13 years-old, respectively. In the descriptive analysis evaluation of female kickboxers according to FC, KL, PF and TPF branches, the mean age and standard deviation values were found to be 24.44±4.39 years-old, 25.50±5.57 years-old, 24.05±7.56 years-old and 20.57±1.72 years-old, respectively. In the descriptive analysis evaluation of female kickboxers according to 58 kg and less, 59 kg and more weight groups, the mean age and standard deviation values were found to be 24.44±4.39 years-old, 25.50±5.57 years-old, 24.05±7.56 years-old and 20.57±1.72 years-old, respectively. According to the results of the Pearson Correlation Analysis, a negative significant

result was found between age and success in male kickboxers (r= -0.199; p<0.01).

In the study of Marinho et al. (2011) the mean age of 13 male mixed martial arts (MMA) athletes was 30±4 years-old (23). Savas et al. (2004) determined the mean age of male boxers as 20.67±1.40 years-old, taekwondo players as 20.20±1.61 years-old and karate players as 20.87±1.60 years-old (24). Toskovic et al. (2004) reported age mean scores of male and female (novice and experienced) taekwondo players as 21.00±2.7 years-old (male-novice), 24.9±8.6 years-old (male-experienced), 20.0±1.2 years-old (female -novice) as 31.0±8.3 years-old (female-experienced) (25). Can et al. (2019) they found that the mean age of the Turkish Boxing and Kickboxing National Teams was 25.5 ± 2.57 years-old and 24.3 ± 4.03 years old, respectively (26). The mean age of the boxers participating in the Montreal Olympics was found to be 23.5 years-old (27). When the literature is examined (23, 24, 26, 27), we see that the mean age of elite kickboxers is similar to our study.

When the male kickboxers participating in our study are grouped according to their branches and weights, we see that the highest mean age is 33.23±10.84 years-old (Table 5) and the lowest mean age is 23.30±3.43 years old (Table 7). Sevim et al. (1993) state the optimal success period in boxing as 21-25 years-old, maturity and senior stage as 26-28 years-old (28). In our study, the mean age of all successful groups was below 30 years-old, except for the groups of male kickboxers grouped according to weights and branches, 81-90 kg (33.23±10.84 years-old) and over 91 kg (31.56±10.69 years-old). Our results regarding the mean age of successful groups were the success of Sevim et al. (1993) is compatible with stage ages.

There was no significant difference between successful and unsuccessful groups in the flexibility values of male and female kickboxers, who were classified as successful and unsuccessful according to both branches and weights (Table 5, 6, 7, 8). Although there were no significant differences between the flexibility values of male and female kickboxers classified as successful and unsuccessful according to their branches and weights, the flexibility values of the athletes who were successful in the FC and KL branches of male kickboxers were higher than the unsuccessful group (Table 5). Again, although the flexibility values of male kickboxers in 51-60 kg, 61-70 kg, 81-90 kg and 91 kg and more weight groups were not significant, they were significantly higher in successful groups compared to unsuccessful groups (Table 7). In female kickboxers, the flexibility values of the athletes who were successful in the FC branch were higher than the unsuccessful group, although it was not significant (Table 6).

It is known that kickboxers must have a high level of strength, power, aerobic and anaerobic capacity along with their technical and tactical skills (29). Besides excellent technique, other motoric features such as 'flexibility' are also important for achieving speed and agility (30). Bilgin et al. (2014) found no significant difference between the flexibility levels of successful (39,74±9,76 cm) and unsuccessful (36,54±10,14 cm) kickboxers in their study in which they examined some basic motoric characteristics of elite Turkish kickboxers according to their weight categories and sportive success (31). Rydzik and Ambrozy (2021) found the average flexibility level of 20 kickboxers aged 18-32 with high performance to be 15.98±0.65 cm. (29). Zorba et al. (1999), the sit-and-reach test flexibility values of Turkey and Russia Boxing National Teams; 11.80±3.03 cm for light-weight Russian kickboxers (n=5, age=23.00±1.58 years), 6.66±2.65 cm for Turkish kickboxers (n=6, age=24.83±3.06 years), Russian kickboxers for middle-weight (n=6, age=24.60±2.06 years) 15.00±4.98 cm, Turkish kickboxers (n=6, age=23.44±2.45 cm) 7.66±1.58 cm, heavy-weight for Russian kickboxers (n=6, age=26.16±2.13 years) 11.50±3.33 cm, and 8.14±2.67 cm in Turkish kickboxers (n=6, age=22.71±1.88 cm).(32). Wazir et al. (2019) they found the sit-and-reach flexibility values of elite taekwondo players as 32.5±6.29 cm, and 30.1±7.87 cm for non-elite taekwondo players (33). The fact that there was no significant difference between the flexibility levels of successful and unsuccessful kickboxers in our study was consistent with Bilgin et al. (2014) study, while Rydzik and Ambrozy (2021) found the flexibility levels of kickboxers to be higher than the flexibility values obtained in our study. Zorba et al. (1999) found the flexibility values of Russian and Turkish boxers different from our study. A certain level of joint mobility is required in all sports activities (34). Achieving a score from an attacking or defensive move in combat sports depends mainly on the quickness of movement, joint mobility and reaction time (35). In addition, kickboxers must have a certain level of flexibility as they frequently use kick variations. Insufficient muscleflexibility hinders joint mobility, which limits the implementation of techniques in combat sports. Injuries are common in combat sports and flexibility is also effective in minimizing the injury risk (36). The fact that there was no significant difference between the flexibility and success levels of successful and unsuccessful kickboxers in our study suggests that all of the participants were high-level kickboxers who participated in the WCh and that they may have similar flexibility levels.

The mean height of the male kickboxer group who were successful in the KL branch was found to be significantly higher than the unsuccessful group. (Table 5; 0.00, p<0.05). While the mean height of male kickboxers in the successful group in KL was 184.29±8.11 cm, it was 178.43±7.19 cm in the unsuccessful group. Savas et al. (2004) determined the mean height of boxers as 180.87±7.08 cm, taekwondo players 173.60±6.63 cm and karate players 176.40±7.60 cm, respectively (24). Ziytak (2011) determined the mean height of boxers as 174.00±5.42 cm, judo athletes as 169.93±3.21 cm, karate athletes as 171.66±4.02 cm and aikido players as 175.07±4.02 cm, respectively (37). Pala (2011) determined the mean height of male Turkish National Boxers to be 174.40±8.13 cm (38). Cinar et al. (2009) found the mean height of Turkish boxers to be 177.46±13.01 cm, and the mean height of Ukrainian boxers to be 178.07±13.01 cm, in their study to determine the physical fitness values of the Turkish and Ukrainian National Teams (39). Cakamakci et al. (2002) in their study comparing the physical feature of the Turkish and Georgian Boxing National Teams, they found the mean height of Turkish boxers to be 176.63± 8.01 cm, while the mean height of Georgian boxers was

180.11± 8.08 cm (40). Bilgin et al. (2014) medallist (175.36±8.30 cm) and nonmedallist (179.96±7.09 cm) kickboxers did not find any difference in height (31). Marinho et al. (2011) found the mean height of MMA athletes to be 176.0 ± 0.05 cm (23). In many studies in the literature, the mean height of boxers was found to be shorter, unlike our study (23, 24, 37, 38, 39, 40). There are many different branches in kickboxing, and the physical characteristics that will create an advantage or disadvantage for each branch may be different. In our study, the average height of the successful group in the KL branch was found to be high, and in line with this result, it can be said that tall stature may provide an advantage for kickboxers in the KL branch.

In our study, the body fat ratio of the successful group (%10.73±3.24) in the 61-70 kg weight classification of male kickboxers was found to be significantly higher than the unsuccessful group (%8.44±3.44). Wazir et al. (2019) the mean body weight of elite kickboxers was 51.3±9.0 kg, and nonlite kickboxers 51.9±10.6 kg. They found the body fat ratio of elite kickboxers to be 11.9±3.65%, BMI of 18.3±1.78, of nonelites to 15.12±6.55%, and BMI of 19.3±2.38 (33). The body weight of USA international taekwondo players was 70.9 ± 12.0 kg and their body fat ratio was 7.5 ± 1.5% (41). The body weight of Taiwanese international taekwondo players was 65.4 ± 6.9 kg and their body fat ratio was 13.2 ± 1.0% (42). The body weight of German international taekwondo players was 70.6 ± 12.2 kg and their body fat ratio was 8.7 ± 1.7% (43). The body weight of Turkish international taekwondo players was 71.1 ± 10.7 kg and their body fat ratio was 11.8 ± 1.9% (44). The body weight of Japanese male international taekwondo players was 66.8 ± 8.9 kg and their body fat ratio was 7.5 ± 1.6% (45). The presence of a certain amount of fat in the body of every person is one of the physiological effects of the body. It is normal for each person to be different. Body fat mass and lean body mass make up body composition (46). In our study, the body fat ratio of successful kickboxers in the 61-70 kg classification was found to be higher than the unsuccessful group (Table 7). Body fat ratio values of elite combat athletes differ in the literatüre (33, 41, 42, 43, 44, 45). Especially in combat sports with weight categories, fat percentage is one of the most important variables (33). While it is not possible to provide recommendations about the optimal body fat percentage required to facilitate performance, the available data suggest that low levels may be a prerequisite for international competition (47).

In our study, the muscle mass (70.19±11.64 kg), bone mass (3.64±0.57 kg) and basal metabolism ratios (4552.59±798.51 kcal) of male kickboxers competing in the KL branch were also found to be higher in the successful group. Muscle mass is the active tissue that is mainly responsible for the body's energy expenditure. Increases in muscle volume; It increases resting energy expenditure, which can help in reducing body weight and fatty acid oxidation (48). Muscle mass in the body affects the motor functions and maximal power of the athlete (49, 50). More muscle strength contributes to the athlete's overall performance (51). According to the results of many studies, it is emphasized that there is a relationship between muscle mass and muscle strength, and that athletes with more muscle volume and mass have better strength performance. (52, 53, 54). In addition, muscle fiber length, muscle cross-sectional area, muscle mass, arm-leg volume, arm-leg mass are the characteristics that play a decisive role on sports performance. In many studies conducted with athletes, it was determined that the strength performance of the athletes increased as the arm-leg volume, muscle mass and muscle cross-sectional area increased (52). In our study, the fact that the muscle mass values of male kickboxers who were in the successful group competing in the KL branch were higher than the unsuccessful group is consistent with the literature (49, 50, 51, 52, 53, 54). It is known that the mechanical load acting on the bones and the sportive activity have an important role in the increase and protection of bone mass (55). In addition, positive effects are observed on joints, tendons, ligaments and muscles. Regional muscle strength has a decisive effect on bone mass and endurance, regardless of gender, age and body structure (56). Mechanical load and sportive activity on bones cause 40-50% increase in bone mass and activation of various adaptation mechanisms. Therefore, the material properties of bone such as mass, density, strength, hardness, energy absorption increase under mechanical stress (57, 58). In studies in particular muscular strength and bone mass is noted a significant relationship (59, 60, 61, 62).

In the findings of this study, the bone mass and muscle mass of the successful group of male kickboxers in the KL branch were found to be significantly higher than the unsuccessful group. In line with this result, it can be said that muscle and bone mass are important components for success in kickboxing. Noyan (2010) defined basal metabolism as all of the physical and chemical events that include the breakdown of nutrients taken into the body and obtaining energy from them (catabolism) and the biosynthesis of new substances (anabolism) (63). Koivisko (2009) on the other hand, defined basal metabolic rate as the energy expended by cells while at rest to protect the body (64). As the muscle mass in the body increases, the basal metabolism accelerates, as the need for energy and building blocks for these tissues to survive will increase. It is known that people with more muscle mass will have a higher metabolic rate, as more muscles will work in each movement. In our study, the fact that the muscle and bone mass of the successful group of male kickboxers in the KL branch were found to be significantly higher than the unsuccessful group suggests that they increase by positively affecting the basal metabolism values. When the literature is examined, it is seen that many studies have been conducted on the physiological and performance characteristics of both boxers and kickboxers (65, 66, 67, 68, 69, 70).

The performance of a heavy-weight athlete like a boxer is a combination of many different elements. Technical, tactical, physical and physiological components are more or less complementary to performance according to their importance or role in sports branches (71). Looking at the results in high-level performance sports, it is seen that success and failure are related to many factors (72). The optimal level of physical fitness of a competitor is the key element of efficiency in a sports competition. Thanks to defining the level of physical fitness, one can select training

loads in the appropriate amounts of exercises with respect to both quality and quantity. Regular measurements of this level also allow the assessment of the effects of the training (73).

A further understanding of the major factors underpinning successful performance can also be used to identify those who possess the ideal physiological profile for MMA success, therefore facilitating talent identification and athlete (74). Such information may also be useful to identify physical attributes that are favourable for competitive success and serve as an indicator of the minimum fitness standards required to compete at specific levels (47). Information on anthropometric, physical performance and motor coordination profiles of elite level athletes is beneficial to coaches or teachers as it can be used as a reference to planning athlete training programmes and distinguishing their athletes in accordance to their data. Although these characteristics are not the only determinants of success, they do serve to provide additional input for coaches and may aid in optimizing their athlete's potential (33).

CONCLUSİON

The height of the successful male kickboxers in the KL branch was found to be significantly higher than the unsuccessful male kickboxers. While the muscle mass and bone mass values of the successful male kickboxers in the KL branch were found to be significantly higher than the unsuccessful group, basal metabolism values were also higher than the unsuccessful group. According to the results of Pearson Correlation Analysis, a negative significant result was found between age and success in male kickboxers. It is important to investigate the factors affecting success. It is thought that physical profile measurements to be made regularly in large competitions with large participation will be beneficial for trainers and athletes in order to reach the current data of successful athletes for kickboxing.

Limitations: All athletes participating in the WAKO 2019 Senior WCh could not participate in this study due to lack of time. It is thought that it will be beneficial to conduct studies that will obtain more participants and more measurement data in the future.

Conflict of Interest: The authors confirm that this article content has no conflicts of interest.

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