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RESEARCH ARTICLE

Investigation of The Relationship of Anaerobic Power and Upper Extremity Strength of Sports Climbers and Competition Performances

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Abstract
The aim of this study is to examine the relationship between sport climbers, anaerobic power and upper extremity strength parameters and competition performance. A total of 52 volunteer athletes, 31 male and 21 female, participated in the study in the "Leader Climbing" discipline in the sport climbing competition. Before the competition, finger strength (FS), hand grip strength (HGS), back strength (BS) and medicine ball throwing (MBT) tests were performed to measure the upper extremity strength of the athletes, and the vertical jump test (VJT) was performed for the measurement of anaerobic power. The results of the competition were collected and the relationship between the measurements taken and the scoring was analyzed with the SPSS (ver.23.0) program. According to the correlation analysis between competition performances, anaerobic power and upper extremity strength measurements, in women; relative hand grip strength right (RHGSright), relative hand grip strength left (RHGSleft), relative fingertip grip right (RFTGright), relative fingertip grip left (RFTGleft), relative palmar grip strength right (RPGSright), relative palmar grip strength left (RPGSleft), relative back strength (RBS) values in males; A significant positive correlation was found between the competition scores and the values of HGSright, RHGSright, HGSleft, RHGSleft, RFTGleft, RPGSright, palmar grip strenght right (PGSright), RPGSleft, PGSleft, RBS values ($p<0.05$). In conclusion; significant relationships were found between upper extremity strength values and the result of the competition, but they could not be detected in anaerobic power measurement. It has been determined that upper extremity strength is a determinant in the performance of athletes.

Keywords
Climbing, Upper Extremity Strength, Power, Performance

INTRODUCTION

Sport climbing has not only been recreational activities for those who are involved in extreme sports in recent years, but has also become a sport discipline based on competitive competition and making a name for itself. Sport climbing will also be featured at the Paris 2024 and Los Angeles 2028 Olympic Games after it is included in the official schedule of the 2020 Olympic Games in Tokyo. It is stated that there are more than 25 million climbers in approximately 150 countries around the world today. The emergence of climbing as a competitive discipline has led to research on many subjects. When the studies carried out considering the factors that will affect the climbing are examined; risk taking and motivation (Martha et al. 2009; Jones et al. 2017),

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physiological aspects (España-Romero et al. 2012), biomechanical features (Vigouroux et al. 2011), injuries (Jones et al. 2018) has been studied. In many studies, to evaluate sport climbing performance; anthropometric variables (Mermier, 2000; Watts, 2004; Magiera et al. 2013; Laffaye et al. 2014), upper extremity strength and power, assessment of technical skills (Sibella et al. 2007), and strengths such as hand, finger or forearm strength. Evaluation studies have been carried out (Mcdonald et al. 2011; Amca et al. 2012; Philippe et al. 2012). In the studies conducted to define the high-efficiency climber, it is discussed which one may be more effective on the climbing performance in general.

In studies, it is mentioned that the forearm muscles and fingers, which are especially the upper extremity strength, require continuous and intermittent isometric contractions and that forearm strength is an important factor in climbing (Billat et al. 1995) It has been emphasized that climbing the routes in sport climbing requires extra skill, energy, mental acuity and hand-finger strength (Michael et al. 2019). In addition, it has been mentioned that the arms, forearms, hands and fingers, which are defined as upper extremity strength, should be used intensively in order to maintain balance and change place on the wall while climbing (Vigouroux et al. 2015). It is mentioned that it will be advantageous to have more endurance and strength in the shoulders and arms, which are among the upper extremity strength muscles, in parallel with the increase in the difficulty in climbing (Mermier, 2000; Giles et al. 2006). The point that draws attention as a result of the studies is that the ratio of maximum isometric contraction and finger flexor strength to body weight is significantly different in climbers compared to non-climbers (Quaine et al. 2003; Vigouroux and Quaine 2006; Macleod et al. 2007; Macdonald and Callender 2011; Philippe et al. 2012; Fryer et al. 2015). In addition, it is emphasized that especially anaerobic power is important in speed-based climbing competitions. It has been stated that the energy metabolism, which is active to overcome the difficult transitions encountered for the boulder and leader disciplines in climbing, is with anaerobic power (McArdle et al. 2010).

Based on the literature studies, it was aimed to contribute to the literature by examining the relationship between the competition performances, upper extremity strength parameters and anaerobic power outputs of the athletes

MATERIALS AND METHODS

Participants

Volunteer athletes who participated indiscipline of "Leader Climbing" the Turkey Interschool Climbing Championship organized by the Turkish Mountaineering Federation (TMF) participated in this study. A total of 52 volunteer athletes consisting of 31 men (16,45 ± 1,23 years) and 21 (16,47 ± 1,12 years) women randomly selected.The study approval was obtained from Giresun University, Social Sciences, Science and Engineering Research Ethics Committee with the decision numbered 50288587- 050.01.04-80503 and dated 09 March 2022 and numbered 20/23.All stages of the study were carried out in accordance with the Declaration of Helsinki.

Inclusion criteria of our study included participating in a sport climbing competition, being actively involved in sports and not having any disability. Lack of inclusion criteria as study exclusion criteria.

Data Collection Tools

Before the competition, height (stadiometer), weight and BMI values (Tanita), anaerobic power (vertical jump test on the Fusion Sport jump mat) and upper extremity strength tests from the athletes who accepted the study voluntarily; back strength (back-leg dynamometer), medicine ball throwing (medicine ball), hand grip strength (handgrip dynamometer), finger strength (pinchmeter device) were measured. After the competition, the rankings of the climbers were taken as a result of the competition. Test measurements are taken in the competition hall. The evaluated factors are as follows:

Height and Body Weight Measurements

The height of the climbers was measured with a Holtain brand stadiometer, and body weight (BW) and Body Mass Index (BMI) measurements were measured with the Tanita MC-580 body analyzer. The bioelectrical impedance measurement method (TANITA), which is one of the measurement methods of body composition, is a fast and relatively inexpensive measurement compared to other methods. Bioelectrical impedance is the measurement of the resistance of body tissues to a small amount of harmless electric current. With these results, information such as

height, weight and gender are used to determine the body fat ratio of the person (Uludag, 2015).

Vertical JumpTest Measurement

Vertical jump values were made using Fusion Sport brand electronic jump mat. Vertical jump test 15-minute active warm-up; It was applied after 5 minutes of running, 5 minutes of short jumps, 5 minutes of stretching and the athletes jumped to the highest point they could jump as soon as they felt ready and the values were recorded. The jump distances of the athletes were measured electronically in "cm" and the best of 3 attempts was recorded. The measured "cm" value is converted to "watt" units. In our study, anaerobic power measurement was obtained from the vertical jump test (Sarvan Cengiz and Orcutas, 2019). The conversion of the data obtained by performing the vertical jump test to the peak power is provided by the following formula developed by Harman et al.

Peak Power (W) = 61.9 x jump distance (cm) + 36 x body weight (kg) + 1,822 (Harman et al. 1991)

Back Strenght Measurement

Measurements were made using the Takei TKK–5402 back-leg dynamometer. After placing the feet on the dynamometer table with the knees tense, the values obtained by the participants after they pulled the dynamometer bar that they grasped with their hands vertically upwards at the maximum level, while the arms were tense, the back straight and the body slightly bent forward, the traction was repeated three times and the best result was in "kg" recorded (Gökhan et al. 2015).

Medicine Ball Throw Measurement

Measurement of throwing medicine balls, 2 kilograms of medicine ball and a 10-meter tape measure were used. In the sitting position, the back, shoulders and head are against the wall, and the upper extremity is 90° abducted and the elbows are flexed, and a 2 kg medicine ball is held between both hands. In this position, it was requested to throw the ball forward as far as possible. Three shots were fired with maximum effort. Among the results obtained, the highest value was taken in "cm" (Buke et al. 2019).

Hand Grip Strenght Measurement

Participants' hand grip strength was measured with a 0.1 kg precision digital grip strength dynamometer (TKK 5401 GRIP D; Takei, Japan) with an adjustable grip span, capable of measuring between 5.0 and 100.0 kg of force. In the measurement application, the participants were asked to stand upright with their feet hip-width apart and to look forward with their elbows in full extension. They were asked to hold the dynamometer in a neutral, relaxed position (not in extension or flexion) by the testing hand, with the index finger flexed to 90°. Participants were instructed to squeeze the grip with full strength for at least 3 seconds. During the test, they were informed not to shake the dynamometer and not to hold their breath. Participants will alternately perform three attempts for each hand, and the average of the three attempts will be recorded in kilograms (kg). A time of 60 seconds was given between each trial (Kim et al., 2018).

Relative hand grip strength

Measured hand grip strength values were divided by body mass and relative hand grip strength (RHGS) values (kg/kg) were determined.

Pinch Finger Strenght Measurement

A pinchmeter (Baseline®) was used to evaluate the finger grip strength of the participants. The measurement application is the standard position recommended by the American Association of Hand Therapists (ASHT), sitting in a chair with back support, shoulder adduction and neutral rotation, elbow 90° flexed, forearm midrotation and supported, wrist neutral, fingertip grip (2 points), palmar grip (C3-point pad) and lateral grip (key), three types of finger grip strength were measured. Each test was started with the dominant hand. In the test procedure, three measurements were made with 60-second intervals between each measurement for finger grip strength, and the averages were taken and recorded in kilograms (kg) (Haidar et al, 2004; Halpern et al, 1996; Özen et al, 2011). In order to prevent the pinchmeter from falling, the person taking the measurement held it from the distal end. In the test procedure, 3 measurements were made with one minute intervals between each measurement for finger strengths (lateral grip (key), palmar grip (C3- point pad), fingertip grip (2 points) and the highest value was taken and recorded in kg.

Relative finger grip strength

Measured finger grip strength values were divided by body mass and relative finger grip strength values (kg/kg) were determined.

Performance Assessment

The sport climbing competition was held in the "Leader Climb" area and the scoring system was determined according to the one who holds the most handles. The design of the climbing walls consists of four routes determined by the route builder assigned by the Turkish Mountaineering Federation (TMF) according to the VI /VI+ difficulty levels according to the UIAA route measurement rating system. The athletes who have done the warm-up training were rated by the referees assigned by the TMF when it came to the turn of the competition. The scoring system was determined according to the one who holds the most handles, and in the competition, points were made according to the ranking between 0 and 100 points according to the number of handles the climber could hold. While 21+ handles in men were evaluated as 100 points, 37+ handles in women were evaluated as 100 points, and the person who could not hold any handle was accepted as 0 points. Before performing the climbing activity, the strength and anaerobic power test measurements were taken for the athlete whose turn it was to climb.

Statistical analysis

The analysis of the data obtained in the study was carried out with the SPSS (ver.23.0) program. Skewness-Kurtosis test was used to measure the skewness and kurtosis values in relation to the normal distribution of the study data. When the values of the parameters for the Skewness-Kurtosis test are between -1.5 and +1.5, the pattern is considered to have a normal distribution (Tabachnick and Fidel 2013). In our study, it was determined that all the parameters processed in the data set by SPSS were found to be in this range and it was found to provide a normal distribution. The relationship between the variables that have a normal distribution and determine our research model and the performance was examined with the Pearson Correlation Coefficient method. The correlation method is one of the commonly used methods to determine the positive or negative relationship between two variables. The significance level between the variables was accepted as $p<0.05$ and the confidence interval was 95%.

RESULTS

Our study included a total of 52 people, 31 male and 21 female climbers. The average age of participants was 16,55 ± 1,32 years, height average was 170,9 ±7,9 cm, weight average was 58,2±7,8 kg, BMI average was 18,6 ±1,8 kg/m2,

The descriptive statistics of the demographic information of the participants are given in Table 1. The results of the competition of male and female athletes participating in the research are shown in Table 2. The mean scores of the male athletes were found to be 76,66 ± 20,04 and 73,21 ± 22,35 of the female athletes.The anaerobic power (vertical jump test value) and upper extremity test (medicine ball throwing, hand grip strength, pinch finger strength, back strength) evaluation averages of the male and female participants in the study are shown in Table 3.Considering the relationship between the values obtained by the vertical jump test applied to the male (r=-,086, p=,322) and female (r=-0,48, p=,418) athletes participating in the study to determine their anaerobic power and the competition scores, no significant relationship was found between the peak power and the competition score (p>0,05) (Table 4). According to the correlation analysis of the climbing experience of the athletes participating in the study and the competition scores, a significant positive moderate relationship was found between the climbing experience and the competition score in men (r=,619, p=,001) and in female athletes (r=,479, p=,014) (Table 5). According to correlation analysis between upper extremity strength values and competition scores of male climbers in the study; RHGS right (r=,618, p=,001), RHGS left (r=,641, p=,001), PG left (r=,585, p=,001), RPG left (r=,627, p=,001) significant positive moderate and high correlation; HGS right (r=,464, p=,004), HGS left (r=,491, p=,003), RFTG left (r=,301, p=,05), PG right (r=,384, p=,017),RPG right (r=,444, p=,006), RBS (r=,394, p=,014) a significant positive, weak and moderate correlation was found. In the correlation of female athletes; RBS (r=,603, p=,002) significant positive moderatecorrelation; RHGS right (r=,474, p=,015), RHGS left (r=,491, p=,012), RFTG right (r=,457,

p=,019),RFTG left (r=,441, p=,023), RPG right (r=,444, p=,022), RPG left (r=,441, p=,023), significant positivemoderate correlated (Table 6)

Table 1. Descriptive statistics of male and female athletes in sport climbing

Parameters	Male climbers n=31		Female climbers n=21	
	M	**SD**	**M**	**SD**
Age (years)	16,4	1,23	16,48	1,12
Height(cm)	175	5,98	164,6	6,56
Weight (kg)	61,5	6,97	53,03	6,07
BMI (kg/m2)	17,6	1,20	20,01	1,55
Experience (months)	22,0	22,52	16,36	27,80

Table 2. Competition scores of female and male climbers

	Female climbers (n=21)				Male climbers (n=31)			
	Min.-Max values		**M**	**SD**	**Min.-Max values**		**M**	**SD**
Competition Scores	47,34	100	73,21	22,35	31,82	100	76,66	20,04

Table 3. Evaluation results of participants

	Male Climbers (n=31)				Female climbers(n=21)			
	Min.	**Max**	**M**	**SD**	**Min**	**Max**	**M**	**SD**
VJT (watt)	5299	6682	6134	352,93	4750	6026	5223	284,4
MBT (cm)	420	660	528	91,72	300	530	409	52,00
HGS right (kg)	28,7	60	43,65	7,19	22,3	47	29,9	5,73
HGS left (kg)	27,8	58,7	41,13	7,74	21,8	41,4	28,7	5,29
LG right (kg)	8	15,5	12,20	1,75	6,5	11,5	8,85	1,48
LG left (kg)	9	15	11,66	1,54	6	12,5	9,05	1,49
FTG right(kg)	5,50	11,5	7,79	1,49	5	9,5	6,60	1,18
FTG left (kg)	5	12,5	7,50	1,55	5	10	6,25	1,22
PG right (kg)	8,50	16	10,91	1,96	7	15,5	8,91	1,75
PG left (kg)	7,50	15	10,32	1,82	6,5	13,5	8,84	1,87
BS (kg)	81,5	209	128,3	28,71	61	137,5	88,5	22,04

VJT: Vertical jump test, MBT: Medicine ball throwing, HGS: Hand grip strenght, LG: Lateral grip (key), FTG: Finger tip grip (2 points), PG: Palmar grip (C3- point pad), BS: Back strength

Table 4. The Relationship between participants' anaerobic power and competition scores

		Male Climbers n=31 Competition Scores	Female climbers n=21
Anaerobic Power (watt)	**r**	-,086	-0,48
	p	,322	,418

Anaerobic power measurement was obtained from the vertical jump test. The conversion of the data obtained by performing the vertical jump test to the peak power is provided by the following formula developed by Harman et al. 1991.

Table 5. The Relationship between participants' experience and competition scores

		Male Climbers n=31 Competition Scores	Female climbers n=21 Competition Scores
Experience (months)	**r**	,619	,479
	p	**,000****	**,014***

**p<0,01 *p<0.05

Table 6. The Relationship between participants' upper extremity strength parametersand competition scores

		Male Climbers n=31	Female climbers n=21
		Competition Scores	**Competition Scores**
MBT (cm)	r	,117	,028
	p	,265	,452
HGS right (kg)	r	**,464**	,113
	p	**,004***	,313
HGS left (kg)	r	**,491**	,184
	p	**,003***	,212
RHGS right (kg)	r	**,618**	**,474**
	p	**,000****	**,015***
RHGS left (kg)	r	**,641**	**,491**
	p	**,000****	**,012***
LG right (kg)	r	,186	,061
	p	,159	,396
LG left (kg)	r	,130	,051
	p	,243	,412
RLG right (kg)	r	,299	,226
	p	,051	,162
RLG left (kg)	r	,257	,243
	p	,081	,145
FTG right (kg)	r	,156	,191
	P	,200	,204
FTG left (kg)	r	,225	,152
	p	,111	,255
RFTG right (kg)	r	,290	**,457**
	p	,057	**,019***
RFTG left (kg)	r	**,301**	**,478**
	p	**,050***	**,014***
PG right (kg)	r	**,384**	,282
	p	**,017***	,108
PG left (kg)	r	**,585**	,230
	p	**,000****	,157
RPG right (kg)	r	**,444**	**,445**
	p	**,006***	**,022***
RPG left (kg)	r	**,627**	**,441**
	p	**,000****	**,023***
BS (kg)	r	,243	,348
	p	,094	,061
RBS (kg)	r	**,394**	**,603**
	p	**,014***	**,002****

MBT: Medicine ball throwing, HGS: Hand grip strenght, RHGS: Relative hand grip strenght, LG: Lateral grip (key), RLG: Relative lateral grip, FTG: Finger tip grip (2 points), RFTG: Relative finger tip grip, PG: Palmar grip (C3- point pad), RPG: Relative palmar grip, BS: Back strength, RBS: Relative back strenght **p<0,01, *p<0,05

DISCUSSION

Based on the model of the climber with low body weight and high hand and finger strength in the literature, the relationship between a relative value and performance was examined by dividing both the upper extremity strength values and the strengths by the weight of the participants. In addition, the relationship between anaerobic power, athletic experience and medicine ball throwing values and performance score was examined.

In the study of Mermier et al. in 2000, measurements of some parameters were made to determine the sport climbing performance, and 24 male and 20 female climbers with 0,10 and 44 years of experience, aged between 18 and 49, had to climb two routes with a length of 11-30 meters. were asked and scored according to the system of holding the handles, that is, reaching the summit. The climbing performance of the person was determined by summing the results obtained from the two routes. Similar to the subject of this thesis research, in this study, the measurements taken for each participant were based on anthropometric, physiological and physical components and the effect of the measured parameters on climbing performance was investigated. The variables measured for each subject were anthropometric (height, weight, leg length, arm span, % body fat), demographic (self-reported degree of climbing, years of climbing experience, weekly training hours), and physical (knee and shoulder extension, knee flexion, hand). grip and finger strength, bent arm suspension, grip strength, hip and shoulder flexibility, and upper and lower body anaerobic strength). Considering the effects of the study on performance, the performance of components including upper and lower extremity strength, endurance, fat ratio and climbing grade was explained as 58.9%, hip flexibility as 1.8% and anthropometric characteristics as 0.3%. The above study, which includes the hand grip and finger grip strengths of the upper extremity strengths, supports the finding that the finger and hand grip strengths of the male and female participants in this study are significant.

In the study published by Laffaye et al in 2016, it was tried to determine the physical and anthropometric differences between elite, intermediate and novice athletes and to analyze the determinants of climbing ability. In the study with 41 participants, the athletes were divided into three groups according to their climbing skills and categorized as novice (<6a), skilled (6c-7b) or elite (≥8a) mountaineers according to the French scale. In addition to the anthropometric features, the measurements taken are physically; general and specific strength, jumping on the handle (arm) test, bench press test and hand and finger grip strength tests. Considering the results of this test, in which the effect of the measurements taken on the climbing skill was examined, it was concluded that the climbing ability was related to the special strength from the general strength, and that the ability could be explained mostly by skills that can be developed with training such as endurance, hand grip strength, finger strength and upper extremity strength, rather than anthropometric characteristics. Statistically significant results were obtained in hand grip strength, finger strength and arm strength. The factors affecting climbing performance were explained as 64.22%, finger and hand grip strength value, arm strength jump over the handle test score and upper extremity strength values as 46% and anthropometric characteristics as 4%. When the research findings are examined, this study is meaningful and consistent with the study of Laffaye et al.

In the study of Gurer ve Duman in 2022, the effect of regular sports climbing on upper extremity strength was investigated. Participants; The control group consisted of 12 sedentary individuals and the study group consisted of 12 experienced climbers. Experienced climbers were trained for 8 weeks and finger strength, hand grip strength and bent arm hanging strength were measured. The study was carried out in the leader climbing style. In the study, statistically significant differences were found as a result of 8-week climbing training in right and left hand grip strength, right and left finger strength and arm strength. As a result, it has been concluded that there will be a positive increase in the specified parameters in sports climbing regularly (Gurer and Duman 2022). In the above study, which includes upper extremity strength, the muscle groups that develop with regular climbing training and the muscle groups that are related to performance in this study are common. The fact that the strength measurements correlated in the findings and the strength measurements developed in Gurer's study are the same, supports the importance of upper

extremity strength for sport climbing and the findings of a significant relationship in this study.

In the study conducted by Ozen et al. in 2010, the participants consisted of 13 elite climbers and 13 non-elite climbers. The measurements included in the study consisted of some anthropometric measurements as well as right and left claw and pinch finger strength and respiratory parameters, and a comparison was made between the two groups. As a result of the study, left hand grip strengths were found to be statistically different between elite and non-elite athletes. The reason for the statistically significant difference in left hand grip strength between elite athletes and non-elite athletes is that elite athletes develop left hand grip strength with training and equal load, while non-elite athletes have a high percentage of strength in the right hand, which is generally used as the dominant hand in daily life. It is thought to have less power. While the right hand strengths were close to each other in elite and non-elite athletes, the high level of elite athletes in left-hand strengths and low levels of non-elite athletes caused a statistically significant difference. "In sport climbing, right hand and left hand muscles develop at the same rate as they are loaded at the same rate." (Ozen et al. 2011). Although the right hand fingertip strength was higher in the measurement in this study, the lack of a significant relationship with the result of the competition can be explained by the possibility that most of the male participants were right handed and the right hand fingertip strengths were close to each other, while the reason for the left hand fingertip strength to be significant was the low scores of the athletes with high scores. This may be due to the fact that the left hand fingertip strengths are higher than the athletes who score points. In this study, it was seen that the right hand fingertip strength was higher in male participants, while the left hand strength measurement correlation values of male participants were higher than the right hand, which supports the study of Ozen et al. and is consistent.

In another study evaluating energy contributions during climbing, it was stated that aerobic and anaerobic systems were used (Bertuzzi et al. 2007). One study concluded that during climbing, the heart rate is high versus the relatively low oxygen intake level, and that aerobic metabolism may play a secondary role in rock climbing. (Billat et al. 1995). Similarly, another study observed a disproportionate increase in heart rate compared to oxygen intake during climbing, but concluded that climbing requires not only anaerobic but also aerobic metabolism (William Sheel et al. 2003). No significant relationship was found between the competition result and the competition result. When a literature review is made between anaerobic power and climbing performance, it is emphasized that anaerobic power is important on performance in general, especially isometric contractions with negative slope with difficult moves and speed-based climbing discipline. One of the reasons why no significant correlation was found in the measurement of anaerobic power may be due to the negative slope and low difficulty of the climbing wall, as it consists of routes determined according to VI / VI+ difficulty levels according to the UIAA route measurement rating system. Therefore, the fact that it does not have an effect that will cause isometric contractions and make a difference on anaerobic power may not have a statistically significant relationship.

The results of the research showed that the strength parameters were compatible with the low body weight, high finger and grip strength and endurance climber model in the literature.In the research, endurance tests were not applied and only strength values were examined. Back strength measurement, which is not included in many studies in the climbing disciplines in the literature, was made and a significant relationship was established between the results of the competition.It is a known belief that performance will increase as climbing experience increases.Based on the ratio of maximal isometric finger strength to body weight in the studies in the literature, the same ratio was applied to the force parameters measured in this study and positive relationships were determined.It was concluded that upper extremity muscles are important in climbing performance. From finger strengths, it was concluded that palmar grip is more effective than other finger strengths for climbing performance. No significant relationship was found for key grip finger strengths.

Since the relationship between strength parameters and anaerobic power and competition performance in the leader climbing discipline may cause different results with the variability of the leader climbing walls, the diversity of the route and slope, making the measurements in the

discipline of speed climbing with the same rules valid worldwide will make this research stronger. Since the height of the climbing experience will increase the relationship between the strength parameters and the result of the competition, it will be important that the athletes who are measured are at the elite level. It is important to take these measurements in Sport Climbing skill selections.

Conflict of interest

No conflict of interest is declared by the authors. In addition, no financial support was received.

Ethics Statements

Ethical approval of the study was obtained from Giresun University, Social Sciences, Science and Engineering Research Ethics Committee with the decision numbered 50288587- 050.01.04-80503 and dated 09 March 2022 and numbered 20/23.

Author Contribution

Study Design, AHB; Data Collection, MK; Statistical Analysis, MK; Manuscript Preparation, AHB, MK; Literature Search, MK. All authors have read and agreed to the published version of the manuscript.

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