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An Investigation of the Effects of Some Parameters on the Shooting Performance of Air Rifle Shooters in Terms of Gender and Level of Competition

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Ethical Statement: It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.

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Abstract

The purpose of this study is to compare the effects of some parameters on the shooting performance of air rifle shootersin terms of gender and level of competition. To achieve this, 20 air rifle shooters who ranked in the Air Guns Turkey Cup and Air Guns Turkey Championships volunteered for the study. In this study, the height and body composition of the participants were measured, and then grip strength, back and leg strength, heart rate, flexibility, vital capacity, static balance, dynamic balance, and reaction time tests were performed. One (1) series, which included ten (10) shots was fired to determine the shooting success of the participants. There found a positive and high statistical significance between the scoresof the elite shooters in a series of shots and their expected vital capacity measurements (r=.656; p<0.05), between the scores of the junior shooters in a series of shots, their measured vital capacity (r=.820; p<0.01), their vital capacity percentage (r=.686; p<0.05), and their right-hand grip strength (r=.703; p<0.05). Furthermore, while a negative and high significance was acquired between the male participants' scores in a series of shotsand the right foot dynamic balance (r= -790; p<0.05), there was a positive and high correlation between the scores of female participants in a series of shots and their expected vital capacity (r=.704; p<0.05). As a result, it was concluded that some performance parameters in terms of gender and level of competition affected the shooting performance of the participants.

Keywords: Air Rifle, Shooting Success, Performance

Özet

Havalı Tüfek Sporcularının Atış Performansı Üzerinde Bazı Parametrelerin Cinsiyet ve Yarışma Kategorisine Göre Etkisinin Araştırılması

Bu araştırmanın amacı, havalı tüfek sporcularının atış performansı üzerinde bazı parametrelerin cinsiyet ve yarışma kategorilerine göre karşılaştırılmasıdır. Bu amaç doğrultusunda, çalışmaya Havalı Silahlar Türkiye Kupası ve Havalı Silahlar Türkiye Şampiyonasına katılan ve derece yapan toplam 20 havalı tüfek atış sporcusu gönüllü olarak katıldı. Bu çalışmada, katılımcıların boy ve vücut kompozisyonları ölçüldü ve daha sonra el kavrama kuvveti, sırt- bacak kuvveti, kalp atım hızı, esneklik, vital kapasite, statik denge, dinamik denge ve reaksiyon süresi testleri yaptırıldı. Katılımcıların atış başarısını belirlemek için bir (1) seri, yani on (10) atış yaptırıldı. Analiz sonuçlarına göre, bir seri atış puanı ve bir seri nişan alma süresi bakımından cinsiyet ve yarışma kategorileri arasında istatistiksel olarak anlamlı farklılık yoktur (p>0,05). Yıldızlar kategorisindeki katılımcıların bir seri atış

puanları ile beklenen vital kapasite ölçümleri (r=,656; p<0,05) arasında; gençler kategorisindeki katılımcıların bir seri atış puanları ile ölçülen vital kapasite (r=,820; p<0,01) yüzdelik vital kapasite (r=,686; p<0,05) ve sağ el kavrama kuvveti (r=,703; p<0,05) ölçümleri arasında pozitif ve yüksek seviye istatistiksel olarak anlamlı bir ilişki olduğu elde edilmiştir. Ayrıca, erkek katılımcıların bir seri atış puanları ile sağ ayak dinamik denge (r-,790; p<0,05) ölçümleri arasında negatif ve yüksek seviyede; kadın katılımcıların bir seri atış puanları ile beklenen vital kapasite (r=,704; p<0,05) ölçümleri arasında pozitif ve yüksek seviyede istatistiksel olarak anlamlı bir ilişki olduğu elde edilmiştir. Buna karşılık hem cinsiyet hem de kategoriler bakımından bir seri atış puanları ile diğer ölçüm sonuçları arasında istatistiksel olarak anlamlı bir ilişki yoktur (p>0,05). Sonuç olarak, cinsiyet ve yarışma kategorisine göre bazı performans parametrelerinin katılımcıların atış performansını etkilediği sonucuna ulaşılmıştır.

Anahtar Kelimeler: Havalı Tüfek, Atış Başarısı, Performans

INTRODUCTION

Since the beginning of time, humanity has sought various ways and methods to acquire a shelter, nutrition, and safety; in other words, we have tried to survive, and over time, this struggle with nature has turned into a sportive activity. Shooting is one of these activities (1). It is an extremely sensitive sport in which people shoot at moving or stationary targets with pistols, rifles and shotguns used for sports purposesand that requires mental performance and maximal control of all body movements (2). Gun stability is very critical for determining performance in shooting sports. For a good shot, the techniques in grip, aiming and trigger control must be flawless (3). The most important indicators of a successful performance are the athlete's shooting score and their rank in competitions. Therefore, it is very important for athletes to score and rank in the tournaments in order to achieve better results.

Technical knowledge and mental focus are applied simultaneously while shooting with an air rifle, and factors such as physical strength and endurance help athletes to hold the rifle in the desired position during the competition (4). While athletes prepare for competitions, the physical factors should be given the same level of importance as the technical factors and should not be neglected by the trainers. As far as we know, there is limited comprehensive study on which factors affect the shooting success of air rifle shooters. For shooters, physical preparation is a component that requires equal attention by their trainers during the competition preparation process. Neglecting the general physical preparation of the athletes or applying the wrong physical training will have a direct impact on the performance of the athletes as well as on the results of the competition. Being fit while competing is very important for athletes to be able to move and to carry out doing the activities that they perform in training as being fit, in other words, physical preparation, makes a difference between the success or failure of air rifle shooters in competitions (3). Muscle strength and endurance, cardiorespiratory endurance, and flexibility are required to improve the physical fitness of athletes. Heart, lungs, and blood circulation are essential for cardiovascular respiration as muscles gather the energy they need through blood. A well-functioning organism helps an athlete to adapt themselves while training. Therefore, a good training program should cover all components such as strength, endurance, speed, flexibility, reaction time, coordination, balance, and agility. To perform a good shot, as well as technical and mental preparation, target-oriented physical training should be applied (5, 6).

In the literature, it has been seen that the research on air rifle shooter is limited, and the factors affecting the shooting performance of air rifle or air rifle shooters have been investigated (7-14). As far as we know, there is limited study in which the effects of physiological and motoric characteristics on the air rifle shooting performance of athletes in the junior and elite levels are investigated in detail. The most distinctive feature of this study that distinguishes it from the existing studies in the literature is that some physiological and motoric characteristics, which are thought to have an impact on shooting performance, are examined in terms of both gender and level of competition. The results to be obtained with this study is thought to provide valuable information to the trainers, conditioners and athletes who design target-oriented training programs in order to train successful athletes in the air rifle shooting sport and to the sports scientists whomay conduct research on the air rifle shooting in the following years.

MATERIAL AND METHOD

Design and Procedures

A total of 20 air rifle shooters (12 females and 8 males) from the provinces of Erzincan and Gümüşhane, competing in the elite and junior levels, volunteered in the study. Some physical characteristics of the participants in terms of their gender and level of competition are given in Table 1. The participants were the athletes who participated in the Air Guns Turkey Cup and Air Guns Turkey Championships and achieved a rank. These participants were provided the Voluntary Consent Form (a parent consent form was taken from the athletes under the age of 18) stating that they voluntarily participated in the study. This study was approved by the Scientific Research and Publication Ethics Committee of Iğdır University (2021/09) and was conducted in accordance with the Declaration of Helsinkinki.

Table 1. Descriptive Statistical Values for Some Physical Characteristics of The Participants According to Their Age and Level of Competition

Variables			n	Minimum	Maximum	Mean (±sd)
Gender	Age (year)	Male	8	13	20	15.75 ± 2.43
		Female	12	13	20	15.75 ± 2.14
	Height (cm)	Male	8	1.48	1.75	166.0 ± .09
		Female	12	1.56	1.74	164.0 ± .05
	Weight (kg)	Male	8	35.50	86.10	63.75 ± 16.93
		Female	12	40.90	71.00	57.48 ± 8.21
Level of Competition	Age (year)	Elite	11	13	15	14.09 ±.70
		Junior	9	16	16	17.78 ± 1.56
	Height (cm)	Elite	11	1.48	1.48	164.0 ± .07
		Junior	9	1.58	1.58	166.0 ± .06
	Weight (kg)	Elite	11	35.50	35.50	59.19 ± 13.66
		Junior	9	45.50	45.50	60.96 ± 11.48

An Experimental Approach to the Problem

The measurements for this study were taken within two days, each day one test, in the provinces of Erzincan and Gümüşhane. Measurements in both provinces were completed taking the same measurement sequence and procedures into account. Heart rate, performance and reaction measurements of the participants were taken before noon, and other measurements were taken onthe same day in the afternoon. All participants were informed on the test proceduresin detail, and their personal information was documented in the data collection form. The participants were given enough time to warm up before the measurements were taken, and they were given a trial test to get used to the test procedures.

Procedures

Height and Body Composition

The height of the participants was determined in centimeters with their feet bare and body weight evenly distributed on both feet using an electronic measuring toolbranded Seca 769 (Seca Corporation Hamburg, Germany) with a precision of 0.001m.The weight, skeletal muscle weight and body fat ratio values of the participants were taken in kilograms (kg) using a body composition analyzer (Inbody 720, Biospace, Seoul, Korea) while they were wearing clothes that would not affect their body weight significantly.

Grip Strength

Participants' grip strength was measured for both right and left hands using a digital strain gauge dynamometer (Takei TKK5401 Takei Scientific Instruments, Tokyo). During the measurements, the participants were asked to apply maximal pressure for at least two (2) seconds until a significant value was taken by grasping the dynamometer with their dominant handwhile standing without the dynamometer and their arms touching their bodies. Then, the same process was performed with participants using the non-dominant hand. The moving part of the dynamometer arm was adjusted to overlapwith the proximal phalange of the ring finger (15). Two (2) trial rounds were performed with both hands, and the best results were documented with an accuracy of 0.1 kg.

Back and Leg Strength

Back and leg strength values of the participants were determined by a back and leg dynamometer (Takei TKK5402 Takei Scientific Instruments, Tokyo). The participants placed their feet on the dynamometer, they pulled the dynamometer bar vertically upwards with their arms stretched, their backs straight and their bodies slightly bent forward. During this process, leg strength was measured when the knees were bent, and the back strength was measured when the knees were stretched (15). Measurements were taken twice (2) for each movement, and the best results were documented with an accuracy of 0.1 kg.

Heart Rate

The average, maximal and resting heart rate values of the participants were obtained using a telemetric heart rate monitor (Polar FT1 TRA/BLK, Polar Electro, Finland). Participants were kept sitting for 20 minutes after wearing the heart rate monitor, and the lowest heart rate measured in the last 5 minutes was recorded as their resting heart rate (HRrest). Participants were not allowed to do any activities such as talking, playing with a mobile phone, that could increase their heart rate while they were sitting. While the average heart rate obtained during the measurement was recorded as the mean heart rate (HRmean) of the participants, the highest heart rate values measured at the end of the measurement were recorded as the maximal heart rate (HRmax).

Flexibility

Flexibility values of the participants were measured using a portable sit-reach box (Baseline, BSL-121085, United States). During the measurement, the participants were seated on the floor with their bare feet, their legs together and the soles of the feet flat on the box. Then, they reached for the indicator on the box with both hands together (palms facing the ground, one hand on top of the other) without bending their knees, pushed the indicator as far as possible and waited for two seconds. The maximum reach of the participants was recorded in cm.An assistant prevented the participants from bending their knees. The test was performed twice (2), and the highest value was recorded for the statistical analysis (16, 17).

Vital Capacity

The vital capacity of the participants was measured using a portable spirometer device (Spirolab III, MIR, Italy). The measurements were taken as the amount of air that could be expelled after a maximal breath. This procedure was repeated by the participants twice (2), and the best value was documented (18).

Static Balance

The static balance values of the participants were obtained using an electronic evaluation platform (Desmotec E-Board, Italy) connected to a computer with a portable and specific software. Before the test, the age, height, and body weight values of the participants were entered on the software, and then the participants were positioned on the e-board with both their bare feet together at 30 degrees. With the help of application on the e-board, the participants were asked to stayat the plus (+) sign on the test screen for 50 seconds while keeping their position. The procedurewasperformed twice (2) and the best results were recorded as mean anterior static and posterior static balance, along with mean right, left, and total static balance.

Dynamic Balance

Dynamic balance values of the participants were determined using a portable dynamic balance and training system (Challenge Disc, TCD006, Togu, Germany). After the participants stood on the test disc, the test which was downloaded via Google Play was started on the tablet. During the test, the participants were first asked to balance the disc with both feet for a minute, and then, they were asked to keep the disc in balance for 30 seconds for both the right and left feet as the second test procedure. Measurements were taken twice (2) for each movement, and the best results were documented.

Determining the Shooting Score

The shooting scores of the participants were determined using a portable 10-meter air rifle (LG400 cal. 4.3 mm, Carl Walther GmbH, Germany) (Figure 1) viaa special software system in the rangeand viaelectronic

evaluation platform interconnecting the target line (SA951 Electronic Scoring Systems, Sius Ag, Switzerland) and the firing line (HS10Hybridscore Electronic Scoring Systems Sius Ag, Switzerland) (Figure 2).

Figure 1. The Portable Air Rifle

Shooting rules of the International Shooting Sports Federation (ISSF) were taken into consideration in the test procedures. Therefore, the 10 m air rifle shots of the participants were performedwhile standing 10 m away from a target. The participants were positioned with their air rifles at the firing line and with other shooting accessories on (trousers, shooting jacket, shoes, gloves, belt, rifle tripods). Before the participants performedthe shots, physical warm-up and mental relaxation exercises were done for 30 minutes in the presence of trainers. During the pre-procedure practices, after 15 minutes of positioning, focusing on the target, breathing and trigger exercises, preparations and trials were performed for 15 minutes with no scores given, and participants were allowed unlimited number of shots. After 30 minutes of preparatory practices, the participants performed10-meterair rifle shots. They were asked to fire one (1) series of shots (10 shots in total), and their shooting scores were documented.

Figure 2. Firing and Target Lines

Determining the Shooting Reaction Time

A shooting trajectory recorder (SCATT USB, SCATT, Moscow, Russia) was mounted on the 10m air rifle to determine the reaction times (aiming times in the series) of the participants, and the data were collected by an electronic software system (SCATT Shooting Performance and Analysis System, Zao SCATT Moscow Russia) (Figure 3). Shooting reaction time, which is the average reaction time (aiming time) of ten (10) shots that were included in the shooting performance (the series of shots) was recorded in seconds. During the shooting performance, 4.5 mm air rifle bullets suitable for the international competition system (RWS R-10 Match Heavy, Umarex Sportwaffen GmbH, Fort Smith, AR, USA) were used, and the muzzle trajectory and duration were recorded.

Figure 3. The Shooting Training System and Software (SCATT)

Statistical Analysis

In this study, SPSS 25.0 (SPSS Inc., Chicago, IL) was used for the data analysis. Kolmogorov-Smirnov normality test was used to determine whether the quantitative variables showed normal distribution or not. The Independent Samples T-Test was used to compare the measurement results of the participants in terms of gender and level of competition, and Pearson correlation analysis was used to examine the relationship between scores in a series of shooting and the measurement results. Simple linear regression analysis was used to study the effect of measurement results on thesuccess from the series of shooting. A value of $p<0.05$ was considered to show statistically significant results.

FINDINGS

Table 2. Comparison of the Shooting Performances of the Participants ın terms of Gender and Level of Competition

Variables	Gender	N	X	StD	t	p
The scores in a series of shots	Male	8	961.2	53.5	.718	.482
	Female	12	941.8	62.6		
Aiming Time in a series of shots	Male	8	2.55	2.56	-.693	.497
	Female	12	3.47	3.10		
Competition Level						
The scores in a series of shots	Elite	11	935.6	50.4	-1.193	.248
	Junior	9	966.6	65.9		
Aiming Time in a series of shots	Elite	11	3.23	2.60	.214	.833
	Junior	9	2.94	3.31		

*p>0.05

The comparison of the measurements in terms of the gender and competition levels of the participants is given in Table 2, and the results from Pearson correlation analysis showing the relationship between the scores in the series of shots and the measurements are given in Table 3. According to the results of the analysis, there is no statistically significant correlation between the gender and the competition levels in terms of both thescores from series of shots and the aiming times from the series ($p>0.05$). It was found that there was a positive and statistically high significant relationship between the scores inthe series of shotsof the elite shooters and their expected vital capacity measurements ($r=.656$; $p<0.05$).Furthermore, there was a positive and statistically high significant correlation among the vital capacity ($r=.820$; $p<0.01$), vital capacity percentage ($r=.686$; $p<0.05$) and right-hand grip strength ($r=.703$; $p<0.05$) measurements obtained inthe series of shotsof the junior shooters. In addition, the correlation between male participants' scores inthe series of shots and their right foot dynamic balance ($r=-.790$; $p<0.05$) was statistically negative and high; however, the correlation between female participants' scores in the series of shots and their expected vital capacity ($r=.704$; $p<0.05$) was statistically positive and high. There was also no statistically significant correlation between the scores in the series of shots and other measurement results in terms of both gender and competition levels ($p>0.05$). Results from simple linear regression analysis done to discover the effect of the measurements on the scores inthe series of shots were given in Table 4 (elite shooters), Table 5 (junior shooters), Table 6 (male shooters), and Table 7 (female shooters).The effect that the expected vital capacity of elite shooters on their scores in a series of shots was 39.5% ($r2=.395$; $p<0.05$, Table 4). The effect of measured vital capacity results of the junior shooterson theirscores from a series of shots was 62.3% ($r2=.623$; $p<0.01$, Table 5). There was also found a correlation between the right foot dynamic balance of male participants and their shooting scores (61.2% effect: $r2=.612$; $p<0.05$, Table 6). Similarly, the correlation between expected vital capacity measurement of female participants and their shooting scores was statistically significant (53.8% effect: $r2=.538$; $p<0.05$, Table 7). Nevertheless, it has beenrevealed that other parameters did not have a statistically significant effect on the shooting scores.

Table 3. Results Showing Relationship Between the Scores in the Series of Shots and The Measurement Results in Terms of Gender and Competition Levels of the Participants

Variables	The scores inthe series of shots			
	Competition Level		Gender	
	Elite	Junior	Male	Female
Aiming Time in the series of shots	-.433	.013	-.012	-.322
Skeletal Muscle Weight	-.282	.634	-.247	.372
Body Fat Ratio	-.391	-.418	-.647	-.224
Expected Vital Capacity	**.656***	.412	.419	**.704***
Measured Vital Capacity	-.082	**.820****	.455	.413
Vital Capacity Percentage	-.282	**.686***	.323	.105
Resting Heart Rate	-.009	-.084	-.275	-.280
Average Heart Rate	-.091	.201	-.367	-.182
Maximum Heart Rate	-.182	-.259	-.359	-.281
Flexibility	.473	.324	.467	.539
Left Hand Grip Strength	.009	.594	.347	.508
Right Hand Grip Strength	.027	**.703***	.380	.503
Leg Strength	-.009	.544	.407	.448
Back Strength	.173	.510	.252	.566
Dynamic Balance of Both Feet	-.591	.042	-.419	-.431
Right-Foot Dynamic Balance	.009	-.251	**-.790***	.070
Left-Foot Dynamic Balance	-.336	-.059	-.299	.231
Path Length on the Disc	.364	.042	-.252	.385
Total Static Balance	-.373	.117	-.371	-.028
Right-Foot Static Balance	-.373	.092	-.371	.035
Left-Foot Static Balance	-.373	.117	-.371	-.028
Anterior Static Balance	-.374	.117	-.371	.014
Posterior Static Balance	-.373	.117	-.371	-.025

Table 4. Results of Simple Linear Regression Analysis Revealing the Effect of Measurement Results of Elite Shooters on Their Scores in the Series of Shots

Variables		ANOVA		Coefficients				
	r^2	F	p	B	Std Error	β	t	p
Aiming Time in the series of shots	.165	1.78	.214	961.13	24.06		39.95	.000
				-7.9	5.92	-0.41	-1.34	.210
Skeletal Muscle Weight	.031	0.29	.605	981.06	86.18		11.38	.000
				-0.2	0.37	-0.18	-0.54	.610
Body Fat Ratio	.220	2.54	.145	1021.37	55.6		18.37	.000
				-0.31	0.19	-0.47	-1.59	.150
Expected Vital Capacity	**.395***	5.88	.038	660.99	113.97		5.8	.000
				92.61	38.2	0.63	2.42	.040
Measured Vital Capacity	.001	0.00	.990	934.67	75.22		12.43	.000
				0.31	23.87	0	0.01	.990
Vital Capacity Percentage	.121	1.24	.295	1021.76	78.89		12.95	.000
				-0.83	0.74	-0.35	-1.11	.300
Resting Heart Rate	.014	0.13	.731	978.9	122.95		7.96	.000
				-0.37	1.05	-0.12	-0.36	.730
Average Heart Rate	.049	0.46	.514	1010.92	112.02		9.03	.000
				-0.62	0.92	-0.22	-0.68	.510
Maximal Heart Rate	.021	0.20	.668	991.42	126.65		7.83	.000
				-0.42	0.95	-0.15	-0.44	.670

Flexibility	.235	2.77	.131	805.9	79.25		10.17	.000
				3.63	2.18	0.49	1.66	.130
Left-Hand Grip Strength	.022	0.21	.661	896.08	88.54		10.12	.000
				1.49	3.27	0.15	0.45	.660
Right-Hand Grip Strength	.032	0.29	.601	890.92	83.96		10.61	.000
				1.61	2.98	0.18	0.54	.600
Leg Strength	.002	0.02	.893	945.72	74.77		12.65	.000
				-0.16	1.18	-0.05	-0.14	.890
Back Strength	.022	0.20	.662	906.47	66.45		13.64	.000
				0.41	0.9	0.15	0.45	.660
Dynamic Balance of Both Feet	.305	3.95	.078	1037.36	52.9		19.61	.000
				-33.88	17.05	-0.55	-1.99	.080
Right-Foot Dynamic Balance	.001	0.00	.979	933.9	66.05		14.14	.000
				0.56	20.76	0.01	0.03	.980
Left-Foot Dynamic Balance	.191	2.12	.179	1016.73	57.49		17.69	.000
				-29.58	20.3	-0.44	-1.46	.180

Table 5. Results of Simple Linear Regression Analysis Revealing the Effect of Measurement Results of Junior Shooters on Their Scores in the Series of Shots

Variables	**r^2**	**ANOVA**		**Coefficients**				
		F	**p**	**B**	**StD Error**	**β**	**t**	**p**
Aiming Time in the series of shots	.025	0.18	.687	975.87	31.93		30.56	.000
				-3.13	7.45	-0.16	-0.42	.690
Skeletal Muscle Weight	.250	2.34	.170	796.21	113.33		7.03	.000
				0.68	0.45	0.5	1.53	.170
Body Fat Ratio	.183	1.57	.250	1045.42	66.32		15.76	.000
				-0.32	0.25	-0.43	-1.25	.250
Expected Vital Capacity	.225	2.03	.197	685.42	198.44		3.45	.010
				86.33	60.58	0.47	1.43	.200
Measured Vital Capacity	**.623****	11.55	.011	651.82	93.78		6.95	.000
				88.06	25.92	0.79	3.4	.010
Vital Capacity Percentage	.297	2.96	.129	739.55	133.47		5.54	.000
				2.06	1.2	0.55	1.72	.130
Resting Heart Rate	.013	0.09	.774	1007.27	138.24		7.29	.000
				-0.38	1.28	-0.11	-0.3	.770
Average Heart Rate	.002	0.01	.916	946	190.73		4.96	.000
				0.19	1.71	0.04	0.11	.920
Maximal Heart Rate	.008	0.06	.819	1023.75	241.34		4.24	.000
				-0.44	1.86	-0.09	-0.24	.820
Flexibility	.139	1.13	.323	816.22	143.13		5.7	.000
				3.85	3.62	0.37	1.06	.320
Left-Hand Grip Strength	.346	3.70	.096	841.07	67.99		12.37	.000
				3.52	1.83	0.59	1.92	.100
Right-Hand Grip Strength	.316	3.23	.115	849.45	68.03		12.49	.000
				3.38	1.88	0.56	1.8	.120
Leg Strength	.279	2.70	.144	840.58	79.25		10.61	.000
				1.49	0.9	0.53	1.64	.140
Back Strength	.168	1.42	.273	896.97	62.36		14.38	.000
				0.78	0.66	0.41	1.19	.270
Dynamic Balance of Both Feet	.015	0.11	.754	1016.26	154		6.6	.000
				-17.79	54.61	-0.12	-0.33	.750
Right-Foot Dynamic Balance	.094	0.73	.422	1058.3	109.64		9.65	.000
				-34.59	40.52	-0.31	-0.85	.420

Left-Foot Dynamic Balance	.020	0.15	.714	926.7	107.4		8.63	.000
				14.16	37.14	0.14	0.38	.710
Path Length on the Disc	.026	0.19	.680	984.55	47.65		20.66	.000
				-0.5	1.17	-0.16	-0.43	.680
Total Static Balance	.031	0.22	.653	903.77	135.95		6.65	.000
				0.99	2.12	0.18	0.47	.650
Right-Foot Static Balance	.038	0.28	.614	898.94	130.51		6.89	.000
				2.1	3.98	0.2	0.53	.610
Left-Foot Static Balance	.031	0.22	.652	903.27	136.43		6.62	.000
				2.01	4.26	0.18	0.47	.650
Anterior Static Balance	.041	0.30	.603	892.5	138.34		6.45	.000
				2.39	4.39	0.2	0.54	.600
Posterior Static Balance	.020	0.15	.714	916.94	132.24		6.93	.000
				1.55	4.04	0.14	0.38	.710

**p<0.01; *p<0.05

Table 6. Results of Simple Linear Regression Analysis Revealing The Effect of Measurement Results of Male Shooters on Their Scores In The Series of Shots

Variables	**r^2**	**ANOVA**		**Coefficients**				
		F	**p**	**B**	**StD Error**	**β**	**t**	**p**
Aiming Time in the series of shots	.001	0.01	.941	962.92	29.83		32.28	.000
				-0.65	8.53	-0.03	-0.08	.940
Skeletal Muscle Weight	.001	0.00	.994	961.96	95.47		10.08	.000
				0	0.37	0	-0.01	.990
Body Fat Ratio	.214	2.09	.198	1049.56	63.57		16.51	.000
				-0.34	0.23	-0.51	-1.45	.200
Expected Vital Capacity	.247	1.97	.210	791.83	121.93		6.49	.000
				54.21	38.6	0.5	1.4	.210
Measured Vital Capacity	.255	2.05	.202	810.96	106.42		7.62	.000
				42.74	29.85	0.51	1.43	.200
Vital Capacity Percentage	.001	0.22	.658	889.48	155.45		5.72	.000
				0.64	1.37	0.19	0.47	.660
Resting Heart Rate	.067	0.49	.512	1059.29	142.17		7.45	.000
				-0.82	1.18	-0.27	-0.7	.510
Average Heart Rate	.081	0.53	.494	1075.11	157.43		6.83	.000
				-0.9	1.24	-0.29	-0.73	.490
Maximal Heart Rate	.168	1.21	.313	1146.52	169.44		6.77	.000
				-1.35	1.23	-0.41	-1.1	.310
Flexibility	.340	1.82	.226	846.11	87.29		9.69	.000
				3.25	2.41	0.48	1.35	.230
Left-Hand Grip Strength	.128	0.88	.385	904.68	63.33		14.29	.000
				1.72	1.83	0.36	0.94	.390
Right-Hand Grip Strength	.078	0.51	.504	909.18	75.88		11.98	.000
				1.59	2.24	0.28	0.71	.500
Leg Strength	.144	1.01	.353	898.23	65.44		13.73	.000
				0.77	0.77	0.38	1.01	.350
Back Strength	.065	0.42	.542	92557	58.59		15.8	.000
				0.38	0.59	0.26	0.65	.540
Dynamic Balance of Both Feet	.169	1.22	.312	1052.28	84.55		12.45	.000
				-31.87	28.87	-0.41	-1.1	.310
Right-Foot Dynamic Balance	**.612***	9.48	.022	1126.43	55.15		20.43	.000
				-61.46	19.97	-0.78	-3.08	.020
Left-Foot Dynamic Balance	.086	0.56	.481	1015.18	74.46		13.63	.000

				-18.97	25.28	-0.29	-0.75	.480
Path Length on the Disc	.101	0.35	.577	977.26	33.66		29.03	.000
				-0.41	0.7	-0.23	-0.59	.580
Total Static Balance	.060	0.38	.560	1011.64	84.02		12.04	.000
				-0.76	1.24	-0.24	-0.62	.560
Right-Foto Static Balance	.061	0.39	.556	1012.22	84.18		12.03	.000
				-1.54	2.47	-0.25	-0.62	.560
Left-Foot Static Balance	.058	0.37	.565	1010.74	83.61		12.09	.000
				-1.5	2.47	-0.24	-0.61	.570
Anterior Static Balance	.044	0.27	.620	1004.96	85.96		11.69	.000
				-1.35	2.57	-0.21	-0.52	.620
Posterior Static Balance	.076	0.49	.508	1016.74	81.35		12.5	.000
				-1.65	2.35	-0.28	-0.7	.510

**p<0.01; *p<0.05

Table 7. Results Of Simple Linear Regression Analysis Revealing the Effect of Measurement Results of Female Shooters on Their Scores in The Series of Shots

		ANOVA		Coefficients				
	r^2	F	p	B	StD Error	β	t	p
Aiming Time in the series of shots	.118	1.34	.273	965.98	27.4		35.25	.000
				-6.96	6.01	-0.34	-1.16	.270
Skeletal Muscle Weight	.427	2.23	.167	764.4	120.18		6.36	.000
				0.79	0.53	0.43	1.49	.170
Body Fat Ratio	.214	2.73	.129	1031.51	56.82		18.16	.000
				-0.34	0.2	-0.46	-1.65	.130
Expected Vital Capacity	**.538***	11.62	.007	460.17	141.87		3.24	.010
				156.47	45.9	0.73	3.41	.010
Measured Vital Capacity	.122	1.39	.266	844.69	84.31		10.02	.000
				30.74	26.08	0.35	1.18	.270
Vital Capacity Percentage	.001	0.00	.967	937.75	98.31		9.54	.000
				0.04	0.94	0.01	0.04	.970
Resting Heart Rate	.067	0.72	.416	1048.19	126.68		8.28	.000
				-1	1.18	-0.26	-0.85	.420
Average Heart Rate	.089	0.98	.346	1087.76	148.62		7.32	.000
				-1.33	1.34	-0.3	-0.99	.350
Maximal Heart Rate	.010	0.10	.755	1000.27	183.17		5.46	.000
				-0.46	1.45	-0.1	-0.32	.760
Flexibility	.340	5.14	.047	693.85	110.42		6.28	.000
				6.45	2.84	0.58	2.27	.050
Left-Hand Grip Strength	.372	5.93	.035	801.96	59.36		13.51	.000
				4.79	1.97	0.61	2.44	.040
Right-Hand Grip Strength	.344	5.24	.045	818.25	56.12		14.58	.000
				4.18	1.83	0.59	2.29	.050
Leg Strength	.158	1.88	.200	841.51	75.17		11.2	.000
				1.52	1.11	0.4	1.37	.200
Back Strength	.278	3.86	.078	801.21	73.37		10.92	.000
				2	1.02	0.53	1.97	.080
Dynamic Balance of Both Feet	.138	1.61	.234	1040.79	80.06		13	.000
				-33.67	26.57	-0.37	-1.27	.230
Right-Foot Dynamic Balance	.019	0.19	.670	907.81	79.71		11.39	.000
				11.25	25.62	0.14	0.44	.670
Left-Foot Dynamic Balance	.101	1.12	.314	906.82	37.6		24.12	.000
				0.98	0.92	0.32	1.06	.310

Path Length on the Disc	.002	0.02	.881	955.19	88.79		10.76	.000
				-4.88	31.71	-0.05	-0.15	.880
Total Static Balance	.001	0.00	.962	948.76	141.46		6.71	.000
				-0.12	2.35	-0.02	-0.05	.960
Right-Foot Static Balance	.005	0.05	.833	914.18	129.17		7.08	.000
				0.91	4.22	0.07	0.22	.830
Left-Foot Static Balance	.001	0.01	.930	954.35	140.01		6.82	.000
				-0.42	4.65	-0.03	-0.09	.930
Anterior Static Balance	.001	0.01	.931	954.29	141.15		6.76	.000
				-0.43	4.77	-0.03	-0.09	.930
Posterior Static Balance	.001	0.00	.985	944.6	141.44		6.68	.000
				-0.09	4.6	-0.01	-0.02	.990

**p<0.01; *p<0.05

DISCUSSION

In this study, the effects of some parameters on the shooting performance of the participants who were in the air rifle shooting sport, in terms of gender and competition levels were investigated. Ihalainen et al. (19) stated that athletes participating in international competitions had better shooting scores, more stable hold of the gun, cleaner trigger pulls, and better aiming accuracy than athletes participating in national competitions, and that at all the time intervals that were analyzed, these athletes had a more controlover the first stage of pull and over the second stage at the last second before the shot. It was found that men had higher scores inthe series of shots than females, but there was no statistically significant correlation between these values in terms of genders and competition levels. Erten (20) stated that due to this matter, the high level of strength and endurance is not needed in shooting sports as it isin some other sports. It is actually more important to try to control the external factors that affect the weapon, to use strength in a balanced way, to maintain a great position and to gain a sense of rhythm. Similarly, factors such as motivation, attention, knowledge, acceptance of victory and defeat, and coping with stress havean important place in shooting performance. It has been stated that a successful shot cannot be acquired with only strength or technique but can be made by combining them with mental exercises. Timing of the breath and high attention levels of shooters can particularly contribute to increased performance (21, 22). Shooters should control their breath at the time of shooting. They need to maintain sighter alignment while breathing and hold their breath while finishing aiming and firing (23).

In this study, it was found that female athletes had higher scores than male athletes in terms of average shooting time in the series of shots (reaction), but there was no statistically significant correlation in these shooting-related values in terms of gender and competition levels. Hitting the target is expected to improve performance because the further away the target is from the center, the higher the probability of making a shot in the middle. Since 3 seconds is believed to be the standard rule, these three seconds before the shot have been studied to evaluate the effects of mechanical measurements of the shot (24). Reinkemeier et al. (25) suggested that since the time to fire an air rifle and the time to perform a soft trigger pull in pistol shots is about 3 seconds, the evaluation period should be between 2 and 4 seconds. Köykkä et al. (26) explained thatwithout taking the physical stress into account, biathlon prone shooting performance, stability of hold, aiming accuracy, trigger cleaning and trigger timing are the most important factors. In addition, it was stated that the variables defining trigger cleaning, aiming accuracy and trigger timing affect 80% of the mean firing performance. It has also been mentioned that grip stability is both directly and indirectly related to firing performance and trigger cleaning. Moreover, the studies of Erten (20) and Çetinkaya (27) showed that the athletes with a lot of experience and higher shot counts were resilienttowards pressure, and their shooting success was better due to their higher training age and competition experience.

Considering the relationship between the scores inthe series of shots and the measurement results of the elite shooters, it was found that there was a positive and high statistical correlation between the scores in the series of shots and the expected vital capacity measurements. However, it was found that there was no statistically significant correlation between the scores in the series of shots and the results from other measurements. Additionally, it was found that there was a positive and high statistical correlation between

the measured vital capacity, vital capacity percentage and right-hand grip strength scores of the junior shooters, and their scores in the series of shots, but there was no statistically significant correlation with other measurements.

In Ortega and Wang's study (28) including airgun shooters with an average age of 13.4 years, it was found that heart rate had a positive correlation with self-efficacy and performance, and it was an important predictor of shooting performance. Additionally, advanced shooters had a significantly lower average heart rate before taking a shot and used more self-talk, relaxation, sight, and automaticity than novice and intermediate shooters. It has been suggested that changes in heart rate is useful in determining a person's pre-competition physiological state, so with that, practical strategies can be determined by trainers and athletes to improve pre-performance physiological state as a way of optimizing performance.

When the relationship between scores intheseries of shots and the measurement results of male participants was inspected, it was found that there was a negative and high statistical correlation between the scores in the series of shots and the right foot dynamic balance measurements, whereas there was a positive and high statistically significant relationship between the scores in the series of shots and the expected vital capacity values of the female participants. Furthermore, it was found that there was no statistically significant relationship between the scores of both males and females in the series of shots and other measurement results. In a study of Konttinen et al. (22) with elite and non-elite male shooters, it was found that there was a decrease in theirpreparatory heart rate that did not change even after the shooting scores of each shooter.Much of this change was determined to be greater in non-elite shooters than in elite shooters. It has been suggested that this is due to heart rate patterns reflecting skill-related aspects of preparation performance. Sobhani et al. (14) investigated the effects of some variables on shooting performance of elite and non-elite air pistol athletes. They found statistically significant correlation in Y Balance Test with participants' left foot back between the resting heart rate and intrinsic motivations ofelite and non-elite participants and suggested that women's pistol shooting performance could be affected by dynamic balance, core endurance, resting heart rate, and motivation.

CONCLUSIONS

As a result, it was concluded that some performance parameters affected the shooting performance, the average HR values of the female participants in the shooting time were higher than the men, and the participants in the youth category showed better shooting performance than the athletes competing in the stars category.

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