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The Impact of Hand Grip Strength Exercises on the Target Shooting Accuracy Score for Archers

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Abstract

The purpose of this research is to investigate the impact of hand grip strength exercises on the target shooting accuracy score for male archers. Thirty male archers (n1=15, 19.85±1.35, n2=15 19.71±1.31) ranging 18-20 years old were included in our study from the archery team of the city of Elazig, department of youth sports.

The experiment group has been through our exercise program one hour/day, three days/week for a duration of 12 weeks. Same tests and measurements (age, height, weight, heart beat rate at rest, heart beat rate at exercise, hand grip strength, sit-up, pull-up, push-up, target shooting accuracy test) have been performed for assessment during the week before and during the week after the exercise program.

Kruskal Wallis H test and t test are used to analyze the variation in the strength test results. Regression analysis is used to study the impact of strength exercises on the target shooting accuracy scores. Statistically, we observe that the hand strength grip exercise performed on the experiment group has significant impact on the hand grip strengths (before exercise 63.21±5.81, after exercise 75.12±5.80) (p=0,001) and the target shooting accuracy scores (before exercise 58.21±4.72, after exercise 69.12±3.24) (p=0,001).

Finaly, we can conclude that the hand grip strength and its exercise have significant value in archery and that hand grip strength exercise is one of the factors that improve the target shooting accuracy scores positively.

Keywords: archery, hand grip strength, strength exercise

1. Introductıon

Just like shot put, javelin throw, discus throw are equipment sports that require certain rules and techniques, archery is also an equipment sport that involves behaviours techniquely related and synchronious in nature. The goal in archery shooting is to obtain precise target shooting results (and not just random success results) through conscious and disciplined workouts. The best ages for starting archery is 12-14 years old. (Kilinc et al., 2010) To be a good archer, it requires 1.5 to 2 years. When an archer swtiches from the beginner level to the teenage category (16-18 years old), and then to the adult category over 18 years old, it takes 4-6 years of rigurous trainings. Archery is a branch of sports that requires 3-4 hours/day and 5 times a week exercise (Keast et al., 1989; Kilinc et al., 2010).

The goal in archery is to shoot the yellow and accumulate high points using one bow, one target, sufficient number of arrows and various supporting small other equipments. Bows and arrows can be fiber, wood, carbon or steel. Arrows are 60 to 71 cm. in lenth, weighing 20 to 28 grams. Target is painted to five different colors in circles. These colors are yellow, red, blue, black and white from center to outwards, in sequence. The central point of the target with the yellow color is divided into two with a thin black line. Yellow denotes points ten and nine, and using the same analogy there is red denoting eight and seven, blue for six and five, black for four and three, and white for two and one.

Archers will earn points based on the associated color and circle on the target that they hit. A target of 22 cm in diameter is used for 90, 70, 60 meter shooting, and a target of 80 cm diameter is used for 50 and 30 meter shooting ranges. At indoor competitiones; the target that is at 25 meter range shall be 60 cm and the target that is at 18 meter range shall be 40 cm in diameter (Kılınç et al., 2010; Nishizono A. et al., 1987).

During an archery tournament, each archer spends the whole day shooting targets from early in the morning till evening (Keast et al., 1989). The weight of the bow string pull back is 14-22 kg. varying from one archer to another. Considering that each archer shoots around 144 arrows (not including the trial shots), then each archer lifts 144 x 20=2880 kg. during a tournament. Moreover, the distance to collect the arrows is around 3480m for females and 3840m

for male atheletes. Noting that an archer is lifting 2880 kg. weight and traveling 3360m on a tournament day, this will be two-three times more, on a regular training day (Ertan et al.,2003; Kilinc et al 2010; Landers et al.,1986; Nishizono et al., 1987).

Considering the numbers above, we see that the continuance in strength is the key in archery. On the other side, we should note that the weight of the bow string pull back during shooting is not equivalent to the maximum force. During a series of archery shooting, each shooting takes around 5-8 seconds. Archers should be pulling the bow string during this time interval, aim to the target and complete the shooting (Anakwe et al., 2007; Ertan et al., 2003).

Because success is to hit the target precisely, there are some factors impacting on the target shooting accuracy rate (Landers et al., 1986; Yıldırım et al., 2014). The body positioning, hand and arm strength, reaction speed, shooting skillfulness, bow and arrow handling strength, choice of hand, hand-eye coordination, breathing are some of the factors that may impact accurate shooting. The hand grip strength is also an indication for the functional completeness of the upper-extremity and one of its most important tasks (Gündoğan, 2015; Landers et al., 1986). When we add all these factors together, it might be difficult to complete a successful shooting in 5-6 seconds (Keast et al., 1989). In this study, we will be investigating the positive or negative impact of the hand grip strength and its exercises on the target shooting accuracy scores (Angyan et al., 2003; Charles et al., 2006; Çalışkan et al., 1997; Ertan et al., 2003; Nishizono et al., 1987).

2. Material and Methods

2.1 Research Field and Sample Space

This study was performed on the city of Elazig, department of youth sports archery team. Thirty experimental samples (n1=15, 19.85 ±1.35, n2=15 19.71 ±1.31) were chosen from among male students within the age group of 18-20 years old. Ambidextrous students were excluded from the study. It was emphasized that the participants shall not use any medication the day before the experinatation. The participants who do not have any eye, ear or ortopedical problems were included in the evaluations. All of the experimental sample and the control group students were from among healthy individuals.

2.2 Data Collection and Laboratory Analysis

The study was performed on a volunteer basis from among the archery team atheletes. We established two groups: (1st group) the experimental sample group of students who "perform exercises" (n1=15) and (2nd group) the control group of students who do "not perform exercises" (n2=15). Groups were evaluated over strength exercises for a period of 12 weeks, three days a week, and one hour per day. The researchers have performed exercise programs at the city of Elazig, department of youth sports training field every Monday, Wednesday, and Friday. The week before and the week following the 12-week exercise program, the participants were measured and tested using the same tests (comparing before and after results).

2.3 Pre-informative Study

In order to determine the individual properties of the participants, we first anlayzed the records for each individual and had interviews with the administrative staff. We also gathered information on the life styles and school learning conditions of the participants and the processes at the department of youth sports. In addition, we provided briefings to the administrative staff and the atheletes regarding our study.

2.4 Tests and Measurements Utilized

2.4.1 Age (Age in the Official ID Card)

2.4.2 Height: (Using a Scale That Has 0.01m Sensitivity)

2.4.3 Body Weight (Using a Scale That Has 0.01kg Digital Bascule)

Each experiment participant was weighed bare-footed, wearing shorts only on a sensitive digital bascule (in kg.). Height was also measured (in cm) on a height scale using a metal stick that is stabilized over the head of the participant who is in a straight forward body position. The height (in cm) was read over the metal stick (landers et al., 1986; Paish 1998; Zorba et al., 1995; Savucu et al., 2005).

2.4.4 Rest Heart Beat Rate (Using an Erka Brand Equiment for Aneroid Blood Pressure with a Stetescope)

2.4.5 Exercise Heart Beat Rate

(Using an Erka brand equiment for aneroid blood pressure with a stetescope). In this method, the number of heart beats were measured using a stetescope. In sitting positions, the stetescope diaphram was positioned slightly under the left chest area closer to the under arm pits, and the "lab" and "dap" sounds were counted for a duration of 15 seconds. Note that both sounds were admitted as one count. The 15-second count was multiplied by four to obtain the rate per minute. The heart

beat rate at rest was measured before the exercise and the heart beat rate at exercise was measured immediately after the exercise was completed (Paish 1998; Zorba et al., 1995).

2.4.6 Biomotor Strength Tests

Hand grip strength test (using Jamar hydralic dynamometer device): Hand grip strength was measured using a "hand dynamometer" on right and left hands. During the measurement, the participant stood up straight without bending the measured arm and without touching the body and keeping the arm slightly away from the body. Same measurents were repeated for right and left arms three times each, and the best valuez were recorded in kilograms (Schmidt et al., 1970; Lagerström et al., 1998, Savucu et al., 2005).

Sit-up (using gymnastics mat): Each participant lays on the gymnastics mat on his/her back, knees bended and stable, hands locked on the neck. The participant performed a sit-up by raising up his/her upper body and touching his elbows on his/her knees at each count. For a duration of 30 seconds, we counted the number of sit-ups performed (Landers et al., 1986).

Pull-up (using pull-up wood bar): This test measures the strength arm flexor muscles. In each pull-up, the participant opens the hands parallel to the shoulder, facing forward, and tries to pull the body up till the chin reaches the bar. For a duration of 30 seconds, the number of pull-ups recorded (Landers et al., 1986).

Push-up (using gymnastics mat): This test measures the strenght of bicep and tricep muscles. The participant lays on the gymnastics mat face down, arms stretched and hands on the floor positioned to perform a push-up. At each count of push-up, the participant bends the arms from elbows and touches his chest on the floor, and then returns back to the start position by pushing his arms and raising his chest up. For a duration of 30 seconds, the number of push-ups are recorded (Landers et al., 1986).

2.4.7 Arrow Shooting Hit Test (Using Target Board, Target Paper, Bow, Arrow)

Arrow shooting hit test was performed based on the rules set by the Archery Federation and FITA. For the indoor invetigations, we used 18m distance and 40cm target diameter. Each athlete was assigned a target board. Based on the regulations, the archers shot 4 series and 3 arrows per series (a total of 12 arrow shots). For each series, the archers were allowed 124 seconds. Coming to the shooting line and going to the targets to collect the arrows, the referees gave two signals. Scoring and retrieving the arrows from the targets were performed by the researchers of this study and athletes under the supervision of the referees. The scores were recorded on the forms prepared for the purpose of the study. When evaluating the scores, if there is an arrow on the line joining two different points, then the higher point was recorded as the score. If an archer realizes that he did not finish all his arrows, after the fact that he already left the shooting line, or after the finish signal, then the archer was not allowed to shoot the rest of the arrows, and lost his/her right for shooting all of the assigned arrows. If an archer shot after the finish signal, then the highest scoring arrow on the target was taken out of archer's total score. Until the shooting start signal was given, none of the archers was allowed to lift the bow arm. The archers performed their shootings standing up and without any support. The standing position was set up so that the shooting line will be between two feet or the two feet of each archer are on top of the line. Under no circumstances the archers were allowed to repeat their shootings (Kolayiş et al., 2008; Landers et al., 1986).

2.4.8 Implementing the Exercise Program

To begin the exercise program and the test implementations, all the necessary equipments, gears, and set ups were prepared at the City of Elazig, Department of Yout Sports' training field.

In the 12 week exercise program, involving biomotor strength workouts:

Density (intensity); was calculated using karvoned formula that is based on the maximal heart beat of the participant in which maximal heart beat count (MHBC)=220-age (Bompa 1999).

Target Heart Beat Count = (MHBC-Rest Heart Beat Rate) x (% 80) + Rest Heart Beat Count

Duration; during each exercise seances, consisted of warm-up (5-10 minutes), main section (30-40 minute) and cool-down (5-10 minutes) phases. The total duration was 40 minutes in the beginning (including warm-up and cool-down), and was incremented 10 minutes each at the beginneing of the 5th and 9th weeks (i.e., main section). During the warm-up and cool-down sections of the exercise, participants performed isometric, isotonic, elasticity (flexibility) and stretching exercises, aiming the larger muscle groups in the waist area, and upper extremity hand and arm mucles, in order to reduce or prevent potential joint and muscle problems that may arise part of the regular and scheduled exercise process.

In the main exercise section, shoulder press, leg extension, chest press, dips (push in), dumbell shoulder press, overhead triceps extension, biceps burbell curl exercise, lat pull down, long pull, level abdominal, leg raises exercises and fitness workouts were performed 3 sets of 6 reps. Performed strength exercises using hand grip and arm muscle enhancing chrome power twister and hand/wrist strengthening squeeze hand gripper, forward and backward sit-ups on the

gymnastics mat, pull-ups on the pull-up bar, and push-ups on the gymnastics mat each 3 sets of 6 reps. Frequency; exercise seances were performed every other day, for a period of 12 weeks, on pre-determinied 3 days of the week, one hour a day. The main exercise section was performed 3 sets of 6 reps. In the workout, there were 1 minute rest between each set and 2 minute rests between different types of exercises (Bompa, 1999).

2.5 Arrangement of the Data and Analysis Phase (Statistical Analysis)

In this study, using City of Elazig, Department of Youth Sports team archers, the archers were requested to perform hand grip exercises and we analyzed the impact of the exercises on the arrow target shooting accuracy scores. The archers were divided into two groups as the experiment sample group and the control group, 15 archers each. Both the experiment sample and the control group archers performed the strength tests and the results were recorded. Before the exercise program, each archer performed 12 arrow target shooting test, and the results were recorded. Later, the 15 experiment sample archers were subjected to the 12 week exercise program. After the completion of the exercise program, each of the experiment sample group and the control group archers performed strength tests and 12 arrow target shooting test, and the results were recorded. The demographic characteristics and the average of the strength test results for the archers were obtained and evaluated. The data was inspected to confirm normality. Checked for outliers and missing data. Kruskal Wallis H test and t test were used to perform variance analysis of the differences in biomotor strength test results of the archers' before and the exercise program for both the experiment sample group and the control group. Regression analysis was used to investigate the impact of biomotor strengths on the target shooting accuracy scores. The results were demonstrated as tables. The data analysis was performed using SPSS 21.0 software package. In our analysis, we used $\alpha = 0.05$ confidence level (Özdamar, 1999).

3. Fındıngs

Table 1.The Marginal Table regarding the Demographic Information of the Athletes Participated in the Study.

Variables	Groups Experiment Sample(n=15) Before Exercise	 After Exercise	Control(n=15) Before Exercise	 After Exercise
Age(year) $\overline{X}$ ±S.D.	19.85±1.35	19.85±1.35	19.71±1.31	19.71±1.31
Height(cm.) $\overline{X}$ ±S.D.	1.67±0.05	1.67±0.05	1.75±0.05	1.75±0.05
Weight(kg) $\overline{X}$ ±S.D.	70.71±8.30	68.67±8.23	71.52±6.38	72.55±6.49
Rest heart beat rate (beat count/min) X ±S.D.	77.62±7.65	74.43±6.32	79.00±9.90	79.62±9.27
Exercise Heart beat rate (beat count/min) X ±S.D.	130.62±7.33	126.47±3.55	132.38±11.04	132.00±11.45
Sit-up(#/30sec) X ±S.D.	33.24±4.54	44.04±3.04	33.71±5.00	31.90±6.00
Pull-up(#/30sec) Median(Min-Max)	4.00(1.00-6.00)	8.00(4.00-12.00)	3.00(1.00-7.00)	4.00(1.00-8.00)
Push-up(#/sec) X ±S.D.	29.39±4.09	39.09±4.82	30.04±4.48	32.62±5.75
Right Hand Grip Strength(kg) $\overline{X}$ ±S.D.	63.21±5.81	75.12±5.80	64.70±4.51	64.23±4.74
Left Hand Grip Strength(kg) $\overline{X}$ ±S.D.	58.21±4.72	69.12±3.24	60.55±5.61	60.23±3.71

* $\overline{X}$ ±S.D.; Average ± Standard Deviation

Table 2.The Average Performance Levels of Athletes based on Target Shooting Accuracy Scores

Variables	Groups Experiment Sample(n=15) Before Exercise	 After Excercise	Control(n=15) Before Exercise	 After Excercise
Archery Target Shooting Accuracy Score (12 shootings) $\overline{X}$ ±S.D.*	68.10±3.88	89.71±3.21	64.42±5.34	67.66±3.41

* $\overline{X}$ ±S.D.; Average ± Standard Deviation

Based on the analysis in Table 2, and performing 12 shootings per participant, we obtain the total target shooting accuracy score for before and after the exercise. The average of total scores for all participating students (performing 12 shootings/student) before the exercise is 68.10, and after the excersise is 89.71. On the other side, the control group student average of total scores is 64.42 for before, and it is 67.66 for after the exercise (performing 12 shootings/ student).

Table 3. Before and after exercise data comparison.

Variables	Groups Experiment Sample(n=15) Before Exercise	After Exercise	p	Control(n=15) Before Exercise	After Exercise	p
Age(year) $\overline{X}$ ±S.D.	19.85±1.35	19.85±1.35		19.71±1.31	19.71±1.31	
Height(cm.) $\overline{X}$ ±S.D.	1.67±0.05	1.67±0.05		1.75±0.05	1.75±0.05	
Weight(kg) $\overline{X}$ ±S.D.	70.71±8.30	68.67±8.23	0.448[a]	71.52±6.38	72.55±6.49	0.891[a]
Rest heart beat rate (beat count/min) X ±S.D.	77.62±7.65	74.43±6.32	0.070[a]	79.00±9.90	79.62±9.27	0.070[a]
Exercise Heart beat rate (beat count/min) X ±S.D.	130.62±7.33	126.47±3.55	0.022[a*]	132.38±11.04	132.00±11.45	0.927[a]
Sit-up(#/30sec) X ±S.D.	33.24±4.54	44.04±3.04	p<0.001[a*]	33.71±5.00	31.90±6.00	0.271[a]
Pull-up(#/30sec) Median(Min-Max)	4.00(1.00-6.00)	8.00(4.00-12.00)	p<0.001[b*]	3.00(1.00-7.00)	4.00(1.00-8.00)	0.795[b]
Push-up(#/sec) X ±S.D.	29.39±4.09	39.09±4.82	p<0.001[a*]	30.04±4.48	32.62±5.75	0.459[a]
Right Hand Grip Strength(kg) $\overline{X}$ ±S.D.	63.21±5.81	75.12±5.80	p<0.001[a*]	64.70±4.51	64.23±4.74	0.819[a]
Left Hand Grip Strength(kg) $\overline{X}$ ±S.D.	58.21±4.72	69.12±3.24	p<0.001[a*]	60.55±5.61	60.23±3.71	0.871[a]
Archery Target Shooting Accuracy Score X ±S.D.	68.10±3.88	89.71±3.21	p<0.001[a*]	64.42±5.34	67.66±3.41	0.481[a]

[a] ANOVA; [b] Kruskal Wallis H test;*****The variation in before and after measurements is statistically reasonable

Table 3 displays the comparison of the measurements before and after the exercise program for the experiment sample group and control group. No difference was observed regarding the age and heights of both groups before and after the exercise program. Table 3 indicates that the weight difference for the experiment sample groups archers before and after the exercise program is statistically insignficant (p=0.448). We note that the exercise program was not efficient to reduce the weights of the athletes, only an avarege of 2.004 kg of body weight loss was observed. The weight difference for the control group before and after the exercise program is also statistically insignficant (p=0.891). The control group athletes had an avarege of 1.003 kg of body weight loss.

We compared the rest heart beat rate of the experiment sample group atheletes before and after the exercise program. We found that the difference in the rest heart beat rate before and after the exercise for the archers in the experiment sample group who participated in the exercise program is statistically insignficant (p=0.070). We find that the exercise program was not significant to reduce the rest heart beat rate of the athletes and only an average of 3.19 beat/minute reduction was observed. The difference in the rest heart beat rate for the control group is also statistically insignficant (p=0.970). The rest heart beat rate for the control group athletes increased an average of 0.620 beat/minute between the two measurements.

We compared the exercise heart beat rate of the experiment sample group atheletes before and after the exercise program. It was discovered that the difference in the exercise heart beat rate before and after the exercise for the archers in the experiment sample group who participated in the exercise program is statistically signficant (p=0.022). We find that the exercise program was significant to reduce the exercise heart beat rate of the athletes and an average of 4.150 beat/minute reduction was observed. The difference in the exercise heart beat rate for the control group is however statistically insignficant (p=0.927). The exercise heart beat rate for the control group athletes decreased an average of 0.380 beat/minute between the two measurements.

We compared the number of sit-ups (in 30 seconds) of the experiment sample group for before and after the exercise program. It was discovered that the difference in the number of sit-ups performed before and after the exercise for the archers in the experiment sample group who participated in the exercise program is statistically signficant (p<0.001). We find that the exercise program was significant to increase the number of sit-ups of the athletes and an average of 10.80 count/30seconds increase was observed. The difference in the number of sit-ups for the control group is however statistically insignficant (p=0.271). The number of sit-ups for the control group athletes decreased an average of 1.81 count/30seconds between the two measurements.

We compared the number of pull-ups (in 30 seconds) of the experiment sample group for before and after the exercise program. It was discovered that the difference in the number of pull-ups performed before and after the exercise for the

archers in the experiment sample group who participated in the exercise program is statistically signficant ($p<0.001$). We find that the exercise program was significant to increase the number of pull-ups of the athletes and an average of 4.00 count/30seconds increase was observed. The difference in the number of pull-ups for the control group is however statistically insignficant ($p=0.795$). The number of sit-ups for the control group athletes increased an average of 1.00 count/30seconds between the two measurements.

We compared the number of push-ups (in 30 seconds) of the experiment sample group for before and after the exercise program. It was discovered that the difference in the number of push-ups performed before and after the exercise for the archers in the experiment sample group who participated in the exercise program is statistically signficant ($p<0.001$). We find that the exercise program was significant to increase the number of push-ups of the athletes and an average of 9.00 count/30seconds increase was observed. The difference in the number of push-ups for the control group is however statistically insignficant ($p=0.459$). The number of sit-ups for the control group athletes increased an average of 2.58 count/30seconds between the two measurements.

We compared the right and left hand grip strength measurements of the experiment sample group for before and after the exercise program. It was discovered that the difference in the had grip strength measurements before and after the exercise for the archers in the experiment sample group who participated in the exercise program is statistically signficant ($p<0.001$). We find that the exercise program was significant to increase the hand grip strength of the athletes and an average of 11.91 kg increase was observed for the right hand grip strength and an average of 10.91 was observed for the left hand grip strength. The difference in the hand grip strength for the control group is however statistically insignficant (for right hand grip strength $p=0.819$, and for left hand grip strength $p=0.871$). The hand grip strength for the control group athletes decreased an average of 0.47kg. and 0.32kg. for the right and left hands, respectively.

We compared the target shooting (12 shots/each archer) accuracy scores of the experiment sample group for before and after the exercise program. It was discovered that the difference in the target shooting accuracy scores before and after the exercise for the archers in the experiment sample group who participated in the exercise program is statistically signficant ($p<0.001$). We find that the exercise program was significant to increase the target shooting accuracy scores of the athletes and an average of 21.61 points increase was observed. The difference in the target shooting accuracy scores for the control group is however statistically insignficant ($p=0.481$). The target shooting accuracy scores for the control group athletes increased an average of 3.24 points.

As a result of our analysis, we discover that the exercise program had the most significant impact on the sit-up, pull-up, push-up, hand grip strength and target shooting accuracy scores. The least impact of the exercise program was observed in the weight changes of the participants.

Finally, we can conclude that the exercise program has a significant impact on the biomotor strength test measurements and the exercise heart beat rate (but not including the weight and rest heart beat rate measures) and contribute to the bimotor growth of the archers.

Table 4. The Investigation of the Impact of Experiment Sample's Biomotor Strength Tests on the Target Shooting Accuracy Score

Variables	Experiment Sample Group (n=15)			
	Before Exercise		After Exercise	
	r	p[a]	R	p[a]
Age(year)	0.262	0.523	0.160	0.733
Height(cm.)	-0.458	0.276	-0.762	**0.033**[*]
Weight(kg)	-0.161	0.727	-0.348	0.378
Rest heart beat rate (beat count/min)	-0,563	0.133	0.241	0.551
Exercise Heart beat rate (beat count/min)	-0.117	0.689	-0.136	0.721
Sit-up (#/30sec)	-0.180	0.653	0.082	0.799
Pull-up (#30sec)	-0.594	0.120	-0.597	0.118
Push-up (#/sec)	0.535	0.151	-0.451	0.261
Right Hand Grip Strength(kg)	0.350	0.371	0.729	**0.034**[*]
Left Hand Grip Strength(kg)	0.344	0.361	0.731	**0.031**[*]

[a]Regression Analysis; $\alpha=0.05$; [*]Impact is statistically reasonable; r=Coleration

In Table 4, we compare the impact of the experiment group's biomotor tests on the arrow target shooting accuracy scores. As a result of our analysis, we conclude that none of the biomotor strength tests has significant impact on the arrow target shooting accuracy score, alone. However, after the exercise program, we note that the following bimotor strength tests has signifcant impact on the arrow target shooting accuracy score, alone: (i) height factor, (ii) right hand grip strength factor, and (iii) left hand grip strength factor. In this case, we conclude that the height and hand grip strengths of the archers are the significant factors on the arrow target shooting accuracy scores.

Table 5. The Investigation of the Impact of Control Groups' Biomotor Strength Tests on the Target Shooting Accuracy Score

Variables	Control Group (n=15) Before Exercise		After Exercise	
	R	p[a]	r	p[a]
Age(year)	-0.524	0.231	-0.560	0.147
Height(cm.)	-0.009	0.969	-0.367	0.341
Weight(kg)	-0.067	0.790	0.167	0.669
Rest heart beat rate (beat count/min)	0.149	0.699	0.349	0.409
Exercise Heart beat rate (beat count/min)	-0.060	0.879	-0.281	0.511
Sit-up (#/30sec)	0.399	0.198	0.406	0.219
Pull-up (#30sec)	-0.556	0.130	-0.379	0.355
Push-up (#/sec)	0.111	0.776	0.611	0.109
Right Hand Grip Strength(kg)	0.289	0.299	0.210	0.264
Left Hand Grip Strength(kg)	0.254	0.261	0.254	0.260

[a] Regression Analysis; $\alpha = 0.05$; *Impact is statistically reasonable; r=Coleration

In Table 5, we analyze the impact of the control group's biomotor tests on the arrow target shooting accuracy scores. As a result of our analysis, we observe that none of the strength variables has significant impact on the arrow target shooting accuracy score, before and after the exercise program.

4. Discussions and Conclusions

Performance is the score of an athlete that he/she solidly accomplishes resulting from the combination of physical, physiological, biomotor, psychological, mental, technical and tactical factors. There are more than one factors effecting the performance score of an athlete (Ostojic et al., 2006). When we look from the training and motion sciences perspective, all the factors impacting the performance has to be measured and tested and the values obtained should be utilized to develop exercise plans and programs. In many sports branches, the researchers are working on performance analysis using a holistic approach (Ostojic et al., 2006). It is important to detect the strengths and weaknesses of the athletes and using the data to develop a training (exercise) plan and program (Ostojic et al., 2006). As in all branches, the significance of a robust and accurate shooting arises during the training/exercise process in archery as well (Wang et al., 1986).

Grabbing bow and arrow using hand strength and feeling the control over bow and arrow is important during shooting. The more control an archer has over the bow and arrow during shooting, the more confidence he/she will have and the shootings will be according robust and accurate. This would result in a good shooting technique and accuracy rate (Nicolay et al., 2005). The hand grip strength is an objective component of upper extremity functional integrity, as well as an indication of the individual's muscle strength (Çalışkan et al., 1997). It might be a significant advantage for humans to be able to use the right hand or both hands (ambidexter). (Incel N.A.] In many fields, generally 80-90% of the times right hand is used and all offensive and defensive tactics are planned based on this general concept. Hence, using both hands equally well may be utilized tactically and individuals using left hand or who are ambidexter may gain significant advantages. In archery, because both hands are used to grab bow and arrow, the hand grip strength for both hands significantly impacts the performance and scoring in an advantageous way (Nicolay et al., 2005).

This study has been executed to investigate the impact of a 12 week exercise program on the target shooting accuracy scores of the archers.

There was not any statistically significanct difference in the measurements of age, height, weight of the archers for before and after the exercise program. We found out that the exercise program was not effective on reducing the weights of the archers, but an average of 2.004 kg weight loss was observed. Meanwhile, the archers in the control group had a weight gain of 1.003 kg. on the average. However, these differences were not statistically significant.

Many studies on blood pressure and Heart Beat Rate have shown that the exercise reduces blood pressure and Heart Beat Rate (Keast et al., 1989; Martin et al., 1990; Wang et al., 1986). Reaction of Heart Beat Rate to exercise is peracute. The pulse rate increases and continues until reaching the steady state. Elevation of the Heart Beat Rate is a means of increasing Heart Beat Rates and blood flow, thereby, oxygen transport to the muscles (Keast et al., 1989; Martin et al., 1990). In a study conducted by Hoeger, Heart Beat Rate rest less than 59 beats / min. is indicated as Excellent, 60-69 beats / min. Good, 70-79 beats / min. Medium, 80-89 beats / min. Weak, and greater than 90 beats / min (Hoeger, 1991). as Very Weak. Wilmore in his study found a significant decrease in $p < 0.05$ level in resting Heart Beat Rate within 20-week duration after exercise. As a result of the study, moderate and high intensity endurance exercise has been proven to reduce the pulse at rest (Wilmore, 1996). Two similar studies were conducted by Black and Salazar. At certain times of the day they have studied the experimental subjects and found that the aerobic exercise reduces number of heartbeats and blood pressure. They observed that moderate-intensity aerobic exercise is a program that protects blood pressure during daily stress of life (Black 2004;

Salazar et al., 1990). In a similar study Bicer Y.S. found that resting and exercising Heart Beat Rates of experimental group athletes' number of heart beats, taken before and after 3 months of exercise program, decreased from 75.62 ±7.65 to 71.43 ± 6.32; and from 131.62 ±6.34 to 127.57 ±4.65, respectively (Bi çer, 2013). In our study, differences of resting Heart Beat Rate of the experimental and control groups before and after exercise were found statistically insignificant (p = 0.070a, p = 0.070[a]). It was determined that the exercise program had no effect on experimental group students' resting Heart Beat Rate which reduced to only 3.19 beat / minute on average while control group students' had an average increase of 0.620 beats per minute between the two measures. However, this was not evaluated as a statistically reasonable result. The results of the experimental group (p = 0.022a *) were found to be statistically reasonable when the differences of the exercising Heart Beat Rate exercising were considered, whereas the control group (p = 0.927a) was not. It was determined that the exercise program was effective in reducing the Heart Beat Rate and the exercising Heart Beat Rate reduced by 4,150 beats / minute on average. A mean decrease of 0.380 beats / min was found in the exercising Heart Beat Rate between the measurements before and after of the control group students, but this was not considered a significant decrease.

The effect of strength to success in all sports has been strongly acknowledged by everyone. The concept of power is misinterpreted by those who are not involved in the sport, particularly, and by those who are involved in the sport but do not closely follow the scientific development of the sports. In general, a strong athlete's is interpreted as a person who is solid in body, go-getter, brave, tough person, and the view that such athletes are more successful is emerging. Nowadays, strength and strong athlete are evaluated by establishing proportions of the athletes' body structure and the power they produce per kilogram (Bompa 1999). When a strong athlete is mentioned now, the athlete who has the static force of the athlete, the basic force, the concentric force, the eccentric force, the velocity force, the absolute force, the force limit, the relative force, the starting force, the continuity of the force, the dynamic isometric force, specific strength, functional strength and who improves these forces in the direction in accordance to the sport branch and makes the best use in the competitions (Gilbert et al., 1983), comes to mind. In particular, the quality and quantity of force is becoming more important in weight sports. When heavyweight and lightweight are matched, lightweight strengths appear to be stronger and more successful than heavyweight, with the results of tests, measurements, and competitions applied, compared to heavyweights. This situation applies to individual sports as well as team sports (Savas et al., 2004). The handgrip strength test is a general physical performance test, measuring the forearm strength, and the test results are more valuable to the athletes (weightlifting, baseball, etc.) who perform gripping, throwing or lifting movements. Therefore, the handgrip test results of sedentary individuals and athletes who do not use forearm strength specifically in their branches may be similar (Gilbert et al., 1983).

In a study conducted by Saka et al., participants showed a 5% increase in handgrip in both hands, 36% increase in one minute push, 27% increase in shuttle and 45% increase in bar fingers (p <0.001) after six weeks of sports training (Saka et al., 2008). In sports, handgrip strength is a sign of the whole physical power of the body. The purpose of the handgrip strength; is to measure Hear Beat Rates of finger, hand and forearm (Niebuhr et al., 1990). Researchers indicate that the handgrip strength is directly related to the general structure of strength of the body and it is thought to give general information about the physical strength in a sense (Niebuhr et al., 1990). In a study of Aydaş, in 2000, on National Boxing (n = 10, age = 22.7 ±3.3), Gendarmerie Force Boxing (n = 10, age = 22.8 ±1.5) and Bilkent University Boxing (n = 10, age = 23.1 ±2.0) teams handgrip strengths of the right hands, left hands of the National Boxing Team, Gendarmerie Force Boxing and Bilkent University Boxing Teams were found 45.3 kg-41.9 kg, 41.6 kg-40.2 kg, and 44.1 kg-42.8 kg, respectively (Aydaş, 2000). Kutlu et al., in their study on male taekwondo players (n = 25, age = 22,42 ±9) found that the handgrip strengths of right and left hands 47.30 ± 5.84 kg and 46.17 ± 5.66 kg, respectively (Kutlu et al., 1996). Şener, in his study on the examination of some conditional features of 12 male fencing national team athletes (age = 21.0), 1994, found that the unarmed handgrip (recessive) strength of the fencers as 50.08 kg. Şener found the average strength of the armed hand (dominant) 53.92 kg (Şener, 1994). In a study conducted in 1992, Hazar found the relative grip strength of 17 elite male wrestlers 0.657 kg. Thehandgrip strengths of the wrestlers were found to be 48.47 kg before and 52.29 kg after the weight loss for the right hand and 46.42 kg before, and 48.59 kg after the weight loss for the left hand (Hazar et al., 1992). According to another research, the right and left handgrip strength of the boxers, taekwondo players and karate players were found 26.27 kg-23.80 kg, 27.87 kg- 22.67 kg and 27.87 kg-27.73 kg, respectively (Savas et al., 2004).

However, the handgrip strength values in our research groups are slightly higher than the values in the literature. The reason of this is thought to be the bow and arrow holding habits and arrow shooting lessons of the archers an in the fencers. Looking at the studies above, it can be seen that the handgrip strength of the athletes in the same sports branch may be quite different from each other.

As it is supported by literature, it is seen that the exercise performed in our study has a reasonable and significant effect on the biometric strength tests (push-up, sit-up, pull-up and handgrip strength) and exercising heart beat rate measurement data of the experimental group athletes except the weight and resting Heart Beat Rate, and it's observed to contribute in the biometric improvement of the athletes.

The training program was found to be effective in increasing the motoric strength of the students thereby increasing the average sit-ups, pull-ups, push-ups, right handgrip strength and left handgrip strength 10.80 pcs/30sec., 4.00pcs/30sn, 9.70 pcs/30sec., 11.91 kg and 10.91 kg, respectively. Statistically, these increases were also found to be reasonable in direct proportional in the positive direction to the results of the literature ($p < 0.001$).

Archery is an equipment sport that requires technically interrelated and harmonious behaviours as well as the equipment sports based on certain technique and rules such as shot put, javelin, and discus throw. As in the case of sports, purpose of the archery is not a random success with a conscious and disciplined training, but a full target shooting success. There are a number of factors that affect the shooting accuracy rate, considering the success means full target shot (Johanson M.). The attributes such as body posture, hand-arm strength, shooting skill, gripping of pistol grip, hand, choice of hand, eye coordination, breathing can have an impact on the accurate and direct shot (Chong et al., 1994; Incel et al., 2002; Kolayiş et al., 2008).

The aim of physical training in shooting sports is to provide a condition that the archer can withstand the conditions of the competition in terms of body and mind. The archer having good physical conditions is the person who controls Heart Beat Rate strength and his/her whole body accordingly has higher shooting rate and improves this success consistently day by day (Kolayiş et al., 2008;.). Exercises that strengthen the Heart Beat Rates, improve the respiratory and circulatory system, and increase body flexibility are the most discussed subjects of physical education program (Chong et al., 1994).

The purpose of gripping bow and arrow is to stabilize the arrow on the target at the desired point and to keep the arrow stable until it leaves the bow. This is achieved by holding and gripping the arrow and bow correctly. If the fingers, wrist, elbow, shoulder, body, feet are not aligned when the arrow is released, the target line will deteriorate, and the arrow will shot somewhere else other than the point where the arrow is aimed (Gabriel et al., 2001; Gilbert et al., 1983). Archer will give direction to the arrow, of course.

According to the moment law in physics, when an object is subjected to more than one force, the object moves and is directed in the direction of the resultant of these forces. Arrow and bow are objects too; and they are directed according to the resultant of the forces applied by the fingers (Nicolay et al., 2005). In order to keep the arrow right on the target, archer must have control of his/her arm, wrist and especially fingers. Uncontrolled fingers, hand and arm will distort the target line during shooting. The arrow and the bow can be held with the right or left hand if they at the point of choice of hand. Ideally, the same force dominates the both hands (Gabriel et al., 2001; Gilbert et al., 1983; Kolayiş et al., 2008).

In our study, dominant hand was selected from strong right-handed athletes within both groups. The measurement values were compared statistically by collecting strike marks of 12 shooting scores before and after exercise of the control group students who were not exercised and the experimental group who were included in the exercise program. And according to these results, there was a statistically insignificant increase in the control group at the end of 12 weeks while a 3.24-point increase was observed. In the experimental group, an increase of 21.61 points was observed and this increase was found to be statistically reasonable ($p < 0.001$).

As a result, it is observed that the exercise of the experimental group athletes provided the maximum change by increasing the sit-up, pull-up, push-up, exercise heart rate and arrow target shooting accuracy scores. The least effect of exercise was observed in weight change. Another remarkable point in our study is the detection of height factors of the athletes and the handgrip strength being very effective in changing the target shooting accuracy score. Accordingly, it can be said that the high handgrip strength of tall athletes and therefore tall persons affects target shooting accuracy score, in the positive manner. However, the lack of height related literature and statistically reasonable data of our study have presented a research idea to investigate the subject.

Since there are limited studies in literature on the subject, such studies are needed in order to answer the questions in the specific studies about the advantages or disadvantages are provided for the strength exercise test and arrow target shooting accuracy scores of the athletes engaged in archery.

As a result, we can say that the handgrip strength is of great importance in the sport of archery, and it is one of the factors that affect the target shooting accuracy scores of the archers, in the positive direction.

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