

The relationship balance of hand grip strength

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The relationship balance of hand grip strength and body balance to archry ability

{Polish abstract}

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Abstract

Introduction. Archery is a static sport that requires good physical strength. This physical strength can affect the achievement of an archery athlete. Physical strength includes hand grip strength and body balance. One way to measure grip strength is to use a handgrip dynamometer. Meanwhile, to measure the balance of the body can use the stock body balance test. Then the sample did a test shooting of 36 arrows with a shooting range of 15 meters. Purpose. this study was to determine the relationship between hand grip strength and body balance with the ability to shoot archery at a distance of 15 meters. Methods. This research is a descriptive-analytic study with a cross-sectional design. The research was conducted at the Archery Training Center, Sleman Regency, Yogyakarta Special Region, Indonesia. The population sample is 60 people aged 12-13 years consisting of 34 boys and 26 girls. The data obtained was then tested for Pearson product-moment correlation and multiple regression correlation tests using the Statistical Product and Service Solutions (SPSS) application version 26. Results. The SPSS analysis test showed that there was a significant relationship between grip strength and archery skills at a distance of 15 meters with a significance value of $p = 0.000$ ($p < 0.05$) with a correlation coefficient of 0.446. Body balance is also related to archery skills at a distance of 15 meters with a significance value of $p = 0.043$ ($p < 0.05$) with a correlation coefficient of 0.262. Meanwhile, in the multiple correlation test, the results obtained were $p = 0.001$ ($p < 0.05$) with a correlation coefficient of 0.480. Conclusion. Based on the results and discussion above, it can be concluded that there is a relationship between hand grip strength, body balance, and archery skills at a distance of 15 meters in junior archery athletes in Sleman Indonesia.

Keywords

strength, grip, balance, archery

Streszczenie

{Polish abstract}

Słowa kluczowe

{Polish keywords}

1 Introduction

Archery is currently being developed in various provinces in Indonesia [1]. This sport is no longer foreign to the community, the many archery sports clubs, extracurricular activities and Student Education and Training Centers in Indonesia are a form of archery sports people's efforts to popularize as well as find and nurture talented prospective athletes who are expected to be able to reach a high level, internationally through planned training programs [2]. The development of archery is increasingly being felt, what is clear is that before archery found its form as an archery sport as it is known today, archery had gone through a long period of growth [3]. Based on different roles, archery was originally used by humans as a tool to defend themselves from dangerous attacks by wild animals, as a tool for finding food, as a tool for hunting, then used for weapons of war and then as a sporting tool both as a recreational sport, or achievements

Archery as we know is a sport that must be trained continuously. This is in accordance with the goals of physical education, with physical exercise in addition to getting fitness it can also improve character [4]. As a sport that is quite popular in Indonesia, archery has a quite varied scope, starting from archery as a sport of achievement and recreation. The ability level of athletes from beginner or junior to master level is also a division in archery. The division of archery classes based on ability level will certainly affect the pattern of training performed. In general, the division of classes based on this ability can be seen from the age of the athletes or how long they have been pursuing archery. Argues that each division or class in archery has a different target distance and size [5]. To improve the ability and strength of an athlete, physical training is needed, especially how an athlete can grip a bow properly. He explained that the exercise could be done with bow training. Bow training is done by asking the athlete to draw the bow in the right and proper position without arrows, and stay in the anchor position for at least 15 seconds. Then return the string to its original position, and do the same movement over and over again. Give rest breaks between each movement so that the body is not too tense so that the benefits of bow training exercises can be achieved.

Archery is a static sport that requires good physical fitness, especially in the upper body muscles, as well as strength and endurance [6]. Isotonic contractions occur when performing archery techniques while pulling the bowstring [7]. The fingers of the bowstring arm must touch the chin, the fingers must be tucked under the chin (brace), and the bow arm, as well as the pulling arm, must be fully locked to achieve an isometric contraction. Thus in archery, the muscles in charge of pulling the bowstring must receive special attention because they work extra hard in pulling and holding the weight of the bowstring which is quite heavy and repetitive in a series of archery movements. As a result, these muscles must have the strength and endurance to pull the bowstring while maintaining the consistency of the axis of motion [8]. Shoulders, finger pull muscles, forearm muscles, hand muscles, back muscles, and trunk muscles are the main muscles that must be developed in archery [9]. Apart from that, additional exercises such as circuit physical training are quite effective in improving the athlete's physique [10].

Aspects of body balance play a role in the success of archery activities [11]. The ability to maintain body balance in various positions, the ability to maintain the center of gravity on a pedestal, especially in an upright position and maintain balance in a moving position, as well as the ability to maintain balance when shooting is very much needed by an archer, especially when aiming at targets and releasing a bow [12]. The process of releasing arrows also requires a static balance that must be maintained during the shooting process. Good balance and, according to biomechanics, less effort from the muscles involved in the movement can allow the archer to perform good technique and less effort from the muscles involved in the movement [13]. Anatomy and mechanics of motion are all important in proper archery technique, with the axis of motion being the most important. The axis of motion I and the axis of motion II are the precise and correct axis of motion in archery [14]. The attitude of the bow holding arm must be in a straight line, and the axis of motion is the attitude of the shoulders. The position of the arrow is the axis of motion II, and the pulling arm must be in a straight line [15]. Archery is also a precision sport that requires accuracy and consistency [12]. For each arrow fired, the archer must be able to perform the correct action. Based on the description above, the motion of archery involves anatomical aspects, especially in the structure of the bow handler's arm which must be straight, and the bowstring pulling fingers which must be strong to withstand the bowstring pull. The bow pulling fingers must receive more attention because when holding the bowstring, the fingers must be strong and not tense. This will be very influential when the archer is released [16].

Based on the results of observations on junior archery athletes in Sleman Regency, Special Region of Yogyakarta, the results of archery accuracy by club members varied greatly. Common mistakes that are often made by archers related to archery techniques, namely: a) the pulling elbow is too high above the arrow line, b) the front and back shoulders are too high, c) the hands or fingers are too much in the bow, d) the chest is puffed out, e) bowstring touches the center of the chin, f) body weight is placed on the heel, g) no set up position, h) pulls do not reach the holding position, i) bowstring touches the center of the chin during anchoring, j) pulls continuously with does not reach the holding position, k) shoots too quickly and loses connection with the back muscles.

In addition to the above, another problem is the athlete's lack of balance when shooting, so that the bow wobbles due to working extra hard in pulling and holding the weight of the bowstring which is quite heavy and repeated in a series of archery movements when shooting and resulting in an inaccurate target. The latest data from the archery accuracy test by shooting 36 times the average score obtained is 210. This result is still far from the overall score of 360. In the sport of archery, the results of performance and achievement can be seen in the achievement of the score, namely the number of arrows hit on the target face or target target [17]. So it can be concluded that accuracy in archery is closely related to the strength of the fingers which function as a bowstring puller and body balance. So there is a problem of how significant the relationship between grip strength and body balance with the ability to shoot 15 meters arrows in junior archery athletes in Sleman Regency, Special Region of Yogyakarta.

Method

This research is a descriptive study with a cross sectional design. The purpose of this study was to determine the relationship between grip strength, body balance, and archery skills at a distance of 15 meters in junior archery athletes in Sleman Regency, Special Region of Yogyakarta. This research was conducted at the Sleman Regency archery field in January 2022. The population used in this study were Sleman Regency archery athletes, the sample size of this study was 60 Sleman Regency junior archery athletes using the purposive sampling method and the following criteria: 1) active as archery athletes in Sleman Regency, 2) Physically and mentally healthy, 3) 12–13 years old, 4) Willing to take the test, 5) Have shot at 15 meters.

The independent variables are grip strength and body balance, and the dependent variable is the skill level of archery at a distance of 15 meters. Body balance was measured using the stork balance stand test [18]. Grip strength was measured using a hand grip strength tool [19]. Shooting 36 arrows at a target face with a diameter of 80 cm is used to determine the level of archery skill. A score of 1–10 will be awarded for each shooting opportunity. Using the application (SPSS) version 26, the data is then tested with the Pearson product-moment test and multiple correlation tests. The following is a hand grip strength test described in table 1. After testing the grip strength, proceed with testing the balance speed described in table 2.

Table 1. Level of grip strength

Category	Level of grip strength	
	Male	Female
Not enough	< 19,4	> 49
Enough	19.4–31.2	44–48
Good	> 32.2	35–43

Table 2. Balance test rate

Speed	Score [second]
Not enough	< 10
Enough	10–24
Average	25–39
Good	40–50
Very good	> 50

Results

The results showed that there was a significant relationship between grip strength and body balance with the ability to shoot 15 meters arrows in junior archery athletes in Sleman Regency,

Special Region of Yogyakarta. Of the 60 respondents, there were 34 (57%) male respondents and 26 (43%) female respondents according to table 3 below.

Table 3. Gender characteristics

Gender	Frequency	Percentage (%)
Male	34	57
Female	26	43
Total	60	100%

Respondents with a total of 60 people, divided into 34 male respondents and 26 female respondents. In the male respondents, there were 30 respondents with a weak grip strength level and 4 respondents with a normal grip strength level. For female re-

spondents, there were 16 respondents with a weak grip strength level, 8 respondents with a normal grip strength level, 2 respondents with a strong grip strength level. The following describes the characteristics of the level of grip strength in table 4.

Table 4. Grip strength level characteristics

Category	Male		Female	
	Frequency	%	Frequency	%
Not enough	30	88	16	61
Enough	4	12	8	31
Good	0	0	2	8
Total	34	100%	26	100%

Respondents with a total of 60 people were divided into 34 male respondents and 26 female respondents. For male respondents, there were 30 respondents with less grip strength and 4 respondents with sufficient grip strength. For female respon-

dents, there were 16 respondents with less grip strength, 8 respondents with sufficient grip strength, 2 respondents with strong grip strength, described in table 5.

Table 5. Characteristics of respondents at the balance test level

Category	Male		Female	
	Frequency	%	Frequency	%
Very less	11	88	3	11%
Not enough	15	12	8	32%
Pretty good	5	0	4	15%
Good	0	0	4	15%
Very good	3	0	7	27%
Total	34	100%	20	100%

Respondents were divided into 34 male respondents and 26 female respondents. For male respondents, there were 5 respondents who received a score of 171–210, 9 respondents who received a score of 211–240, 6 respondents who received a score of 241–270, 3 respondents who received a score of 271–300, 8 respondents who received a score of 301–330 and 4 respondents

who received a score 331–360. For female respondents, there were 2 respondents with a score of 171–210, 5 respondents with a score of 211–240, 6 respondents with a score of 241–270, 1 respondent with a score of 271–300, 7 respondents with a score of 301–330 and 5 respondents with a score of 331–360. The following are the characteristics of the respondent's score in table 6.

Table 6. Score characteristics of respondents shoot 15 meters

Category	Male		Female	
	Frequency	%	Frequency	%
171-210	5	15	2	8
211-240	9	26	5	19
241-270	6	17	6	23
271-300	3	8	1	4
301-330	8	23	7	27
331-360	4	11	5	19
Total	34	100%	20	100%

The SPSS analysis test showed that there was a significant relationship between hand grip strength and archery skills at a distance of 15 meters with a significance value of $p = 0.000$ ($p < 0.05$) with a correlation coefficient of 0.446. Based on the correlation value, there is a moderate correlation between grip strength and archery skills at a distance of 15 meters. Body balance is also related to archery skills at a distance of 15 me-

ters with a significance value of $p = 0.043$ ($p < 0.05$) with a correlation coefficient of 0.262. Based on the correlation value, there is a moderate correlation between body balance and archery skills at a distance of 15 meters. Meanwhile, in the multiple correlation test, the results obtained were $p = 0.001$ ($p < 0.05$) with a correlation coefficient of 0.480. Based on the correlation value.

Table 7. Test analysis of hand grip strength, body balance, and 15 meter archery

Variable	R Value	P Value	Conclusion
Hold & Shoot	0.446	0.000	Important
Body Balance & Shooting	0.262	0.043	Important
Handgrip, Body Balance & Shooting	0.480	0.002	Important

Discussion

To provide a good archery technique requires coordination, arm muscle endurance, grip strength, flexibility, pull length, arm length, and balance. Good sport and good physical condition in the long run are needed to support the dominant factors in archery. The physical condition referred to here is that archers not only have great muscle strength but also have good muscle endurance, so that the athlete's performance is not only good at the start of the match but also remains consistent throughout the match. [6]. Several factors such as physical, technical, and mental affect an athlete's performance when competing in archery competitions. Visual coordination (accuracy), sense of movement (feeling/kinesthetic senses), and arm strength are important factors that need attention [20]. Accuracy is closely related to the muscle strength of the fingers which function as a wristing puller [21].

Archery is a relatively static sport that requires upper body strength and endurance, especially in the forearms and shoulder girdle [22]. Shooting movements will be more efficient if the bow arm is straight when shooting, meaning that the energy expended when holding it will be well coordinated [23]. Archery comparatively demands very specific strength and endurance for successful shooting and repeated performance, both during training and competition. Compared to other strength or endurance events, it does not require very much effort in terms of body balance [24]. In this study, balance is significantly related to archery skills. This is because balanced archery is needed. When doing archery, an athlete must be able to hold his body while aiming at the arrow [25]. So, body balance in archery is of course the main reference for basic archery techniques [23]. Good balance, athletes will have the skills to maintain an attitude to maintain the desired body posture [26]. Balance, namely the ability to maintain body balance when placed in various positions, the ability to maintain the center of gravity in the fulcrum, especially when in an upright position and maintain balance when in a moving position, balance when shooting is needed by an archer, especially when aiming at targets and releasing the bow. in the release process (release of arrows) the balance must be maintained while in a state of shooting [1]. To get a good technique, archers must train their balance according to biomechanical guidelines so that they don't expend a lot of wasted energy. So that the correct posture greatly influences the holding and aiming techniques, so that the realistic technique can also be done correctly. Body posture when doing this technique must also be considered so that the body does not lean to the left or to the other side, so that when aiming (aiming) can focus on the intended target.

In addition to balance, the arms play an important role in determining accuracy because arm muscle strength and hand grip strength are very important in the archer's ability to direct arrows to certain targets [27]. Significant correlation analysis tests confirm this. An archer's movements will be consistent and stable during practice and competition if they have good arm strength and grip. Success in archery is influenced by several factors including physical condition and mobility [28].

Archery requires athletes to perform repetitive movements with a high level of precision and accuracy. Said that the physiological patterns produced in archery are not the same as

other sports that are dominant in aerobic or anaerobic abilities [29]. The position taken when shooting is that one hand is used to hold (push) the bow in a definite position, while the other hand pulls the bowstring to the position of the base of the thumb of the hand used to pull the bowstring to touch the chin. Movements performed from set up to release have a very important role in the quality of an archery athlete's shot. Improving physical and technical abilities to achieve maximum archery performance certainly cannot be achieved with just one or two practice sessions. However, there is a need for formation that is carried out consistently and progressively which is carried out regularly.

Proper archery technique requires a balance between the role of the upper body as a thrower, and the lower body as a pedestal. Some aspects that need to be improved on the archer's upper body include the strength of the hand grip when gripping and pushing the handle, with a strong front arm so it doesn't sway easily, and back arm strength to do the right drawing and release. Argues that an archer's feet must be stable. Leg strength which includes the ability to walk at high intensity, the ability to support the body and absorb shocks is needed to be able to perform optimally in archery. It is not uncommon for athletes to feel tired when they have to stand for quite a long time, coupled with the journey when taking arrows and returning to the shooting line which also requires strong leg muscle endurance [30].

There are several kinds of exercises that can be done to strengthen the leg muscles of an archer. One of them is balance training. Said that leg strengthening exercises that can be done to improve archer strength and balance are jumping with a skipping rope, bending the knees until they touch the chest in a standing position, jumping as far as possible, 30 meter sprint, 4x9 shuttle run meters by stopping and touching the line, and standing unaided when seated [31]. Added that core muscle strength greatly influences the performance of various sports such as surfing, shooting, and including archery [32]. Core muscle strength which affects the athlete's balance when standing for a long time, can be improved through the following exercises, namely plank, bracing maneuver, bridge, quadruped bird dog, and modified curl-up. To increase the hand grip strength used by archery athletes in gripping a bow, provides examples of several athlete grip strengthening exercises, one of which is by doing bench press exercises using an adjusted weight [33]. There are two types of grip positions in the bench press exercise to get the most out of the exercise. The first is the wide-grip bench press where the position of the hands is wide apart when doing the bench press, and the second is the close-grip bench press where the position of the hands is more closed. These two movements can train several parts of the muscles at once apart from hand grips. Some of them are the chest, back, shoulders and abdomen.

In some cases, it may need to be adjusted according to the age of the athlete's development. If the athlete is still developing, it is better if the coach emphasizes weight training using their own weight or better known as body-weight workouts. Pull ups are an alternative that can be done by athletes to increase grip strength and increase muscle mass, especially in the arms. Pull ups implement an exercise system using one's body weight by depending on the bar, and lifting the body so that the head is able to go beyond the bar. Sánchez-Moreno says that pull ups can be used to train several parts of the upper body, which can

also be used as a measure of muscle strength against body weight. Pull up exercises are also very common in various sports that focus on upper body strength such as rowing, climbing, and archery is no exception. [34].

The ability to grip the hand or hand grip cannot be mastered with just one or two exercises. There needs to be consistency and perseverance in training if an athlete wants to maximize his potential. According to an explanation from Mangolo, physical exercise both with and without tools that can increase grip strength will be very beneficial in various sports activities [35]. Good training, of course, must have increased results with assistance that is based on scientific theory and training principles that are correct and appropriate. Without regular training, it will be very difficult for athletes to achieve the achievements they expect. The hand grip strength training program covers all the joints in the hand, such as the joints in the fingers, thumbs and wrists. Although an athlete's grip strength can also be influenced by several factors such as age, body size, and gender, that does not mean that this ability cannot be maximized by athletes. Alshdokhi, said that based on the research he conducted, regular grip strengthening exercises carried out for 8 weeks would have a very good impact on an athlete's grip strength. In addition, he also added that there are 35 muscles that develop when doing grip strength training which is composed of various types of hand muscle groups and the forearm [36].

Leelanoi mentions several exercise programs that can be carried out by athletes on a regular basis to increase muscle strength in archery, both for the upper body, core, and lower body muscles. You can train your upper body muscles by doing movements such as barbell bench press, barbell row, barbell shrugs, seated dumbbell shoulder press, standing barbell curls, and close-grip barbell bench press. Whereas core or core muscle exercises can be done with crunch movements, while to train the lower body muscles, several exercises that can be done are barbell squats, seated leg curls, and barbell standing calf raises. [37]. Barbell bench press can be done with the body lying on a long bench, and pushing the barbell parallel to the chest. The position of the hands gripping the bar with the width adjusted. Do this movement for 4 sets of 12 repetitions. The next movement is the barbell row, Pisz says that the barbell row is done by standing in a half-squat position, and the hands are straight below while holding the barbell. Then, lift the barbell by pulling it up to your chest. Perform this movement for 4 sets of 12 repetitions [38]. Meanwhile the movement to increase upper body strength is by doing barbell shrugs. Meechan explains that barbell shrug is done by standing upright while holding the barbell with your hands straight down, then lifting the barbell by lifting both shoulders simultaneously, then returning to its original position. This movement can be done 4 sets of 12 repetitions [39].

Apart from the three movements above, another upper body strengthening exercise program for archery athletes is seated dumbbell shoulder press. This exercise can be applied in a way, the athlete sits upright on a bench, while lifting two dumbbells in both hands and positioning them parallel to the shoulders. Then, lift both dumbbells simultaneously until your hands are straight up, then return to their original position. Like the previous exercise, this exercise can also be done for 4 sets of 12 repetitions. Boutros, also adds that this exercise doesn't have to

be done with heavy weights, but can be adjusted to the abilities of each athlete, you can use dumbbells or use a bottle filled with sand or water. Standing barbell curls are no less important for building the upper body muscles of an athlete [40]. Perform this movement by standing straight while lifting the barbell with the hand pointing down. Then, lift the barbell by bending both hands closer to the shoulders, then lower both hands but not to the bottom, only half then do the previous movement again. Repeat this movement for 4 sets of 12 reps. The final movement that can train the athlete's upper body muscles is the closed-grip barbell bench press. This movement has been explained previously where the athlete needs to lie down on a bench, while holding the barbell above it with a position that is not too wide between the hands. Then, lower the barbell from the safety until it reaches the chest, then the barbell will position the hands straight ahead, and return to its original position.

The six movements that can be done to build upper body strength can be applied according to the athlete's ability level and condition. The more often you do measurable and structured physical exercise, the more optimal the results you will get. Archery, which tends to take advantage of the stability of the body from the top to the bottom, shows that the strength of each part of the athlete's body greatly influences the quality of his archery. If the movements of the upper body muscle exercises have been explained, then next is how to strengthen the core muscles of the body or we often know them as the core. This core muscle functions to maintain the stability of an athlete's body because it is the center of the body or the support between the upper body and lower body. Having strong core muscles can also support daily activities such as walking, running, or even just standing for long periods of time [41].

One of the ways athletes can do to increase core muscle strength is by regularly doing abdominal crunches, which at first glance look like sit-ups, but differ in form. If sit ups place more emphasis on the ability to lift the body so that it can touch the knees, while crunches place more emphasis on the grip of the abdominal muscles during the movement. Crunches are done by lying on the floor or a flat surface while bending your knees. Then lean your hands forward while lifting your body but concentrate your strength on your stomach. Feel the abdominal muscles tighten as the body leans forward, when it is maximal, return to its original position and repeat the movement.

Feet are also the main foundation in archery. Exercising leg strength is just as important as any other part of the body. To be able to increase leg muscle strength, athletes can perform several movements such as barbell squats, seated leg curls, and barbell standing calf raises. Based on the explanation from Case, the multi-joint movements contained in the barbell squat exercise can be used to assess the strength of the leg muscles such as the ability to perform dynamic movements, balance and strength. This movement is done by positioning the barbell on the shoulder, with a squatting body position. Then stand up straight with the barbell position still on your shoulders, after perfect squatting again and do this movement repeatedly. [42].

Meanwhile, seated leg curls can be applied using special tools available at a fitness center or fitness center. The movement is carried out by the athlete sitting on a leg curls bench, and placing his feet on the lower cushion provided. Perform move-

ments such as kicking both legs until they are parallel to the thighs for 4 sets of 12 repetitions with adjusted weight. The last is the barbell standing calf raises movement, which is a movement by positioning the body standing upright while carrying the barbell on the shoulders. Then do the tiptoes for a few reps. If athletes get used to exercise movements that can support their abilities in archery, the results they will get will certainly be maximized.

To achieve ideal results, aspects that support these achievements must be pursued. These two factors are quite prominent, according to our observations in the field and the results of coaching archery athletes at the regional and national levels. Because of the large pushing and pulling forces that must be carried out continuously by the arm muscles, arm muscle endurance is needed in archery [43]. The upper arm thrust can also be trained through water media, such as swimming activities [44]. The standing position and stability of the athlete's stroke will be greatly influenced by his body balance [45]. Multiple correlation tests showed that the two parameters were significantly related to the skills and abilities of junior athletes at a distance of 15 meters.

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Conclusion

Based on the results of the discussion above, it can be said that there is a relationship between hand strength, body balance, and 15 meter archery skills in junior archery athletes in Sleman Regency, Indonesia. Researchers suggest archery coaches and athletes increase hand strength and improve balance through several exercises. This is necessary to improve the achievements of junior archery athletes. A physical training program to improve body strength and balance for junior archery athletes needs to be carried out regularly, measurably and systematically. In addition, the variations of the exercises used are also adapted to the motor needs of archers by using body weight training (their own body weight) so that their body growth does not experience problems.

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