

Do the physical elements improving archery performance? ¿Los elementos físicos mejoran el rendimiento del tiro con arco?

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Abstract. Archery is a sport that uses a series of lower body coordination to maintain static balance in the upper body, which is then designed to shoot arrows at the target. This study aimed to determine differences in the physical condition of archery athletes in the provinces of East Java, West Java, and DKI Jakarta in the XX National Sports Week (PON) XX multi-event event in Papua. A total of 27 archery athletes as research subjects were divided into 3 groups: East Java, West Java, and Jakarta. Data collection used physical tests, including the Superman Back Hold (SBH) test, right (HGR), and left (HGL) hand grip strength and static balance tests. The results of the one-way ANOVA test showed significant results for all variables ($p \leq 0.05$), and the Tukey's HSD post hoc test showed that the East Java group had the best SBH, HGR, HGL, and statistical balance values compared to West Java and Jakarta. In conclusion, East Java Province has archery athletes with better physical conditions, superman back holds, hand grip strength, and static balance than the provinces of West Java and DKI Jakarta.

Keywords: Archery, Hand Grip, Strength, Superman Back Hold

Resumen. El tiro con arco es un deporte que utiliza una serie de coordinación de la parte inferior del cuerpo para mantener el equilibrio estático en la parte superior del cuerpo, que luego está diseñada para disparar flechas al objetivo. Este estudio tuvo como objetivo determinar las diferencias en la condición física de los atletas de tiro con arco en las provincias de Java Oriental, Java Occidental y DKI Yakarta en el evento multievento XX de la XX Semana Nacional del Deporte (PON) en Papúa. Un total de 27 atletas de tiro con arco como sujetos de investigación se dividieron en 3 grupos: Java Oriental, Java Occidental y Yakarta. La recopilación de datos utilizó pruebas físicas, incluida la prueba Superman Back Hold (SBH), la fuerza de agarre de la mano derecha (HGR) y la izquierda (HGL) y pruebas de equilibrio estático. Los resultados de la prueba ANOVA unidireccional mostraron resultados significativos para todas las variables ($p \leq 0,05$), y la prueba post hoc HSD de Tukey mostró que el grupo de Java Oriental tenía los mejores valores de SBH, HGR, HGL y equilibrio estadístico en comparación con Occidente. Java y Yakarta. En conclusión, la provincia de Java Oriental tiene atletas de tiro con arco con mejores condiciones físicas, sujeción de espalda de Superman, fuerza de agarre manual y equilibrio estático que las provincias de Java Occidental y DKI Yakarta.

Palabras clave: tiro con arco, agarre manual, fuerza, sujeción de espalda de Superman

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Introduction

Archery is a sport that requires specific physical abilities to support the performance of archery athletes, good physical abilities are needed (Susanto et al., 2021). Movement in archery consists of stance, set, setup, drawing, anchoring, aiming, release, and follow-through (Yi et al., 2007). This movement must be stable because if it is not, it will have a negative impact on the results of the final arrow release.

Physical condition plays a vital role in supporting concentration and accuracy in archery (Prasetyo et al., 2020). Good physical ability is obtained by physical training that is structured, organized, and programmed (Nasrulloh et al., 2022). Archery is a sport that uses a series of lower body coordination to maintain static balance in the upper body, which is then used to shoot arrows at the target. When the archer is shooting, under the up and down movement of the bow, there can be changes in the middle of the body, so the balance of the body must be improved, and the archers can minimize body shaking and can improve performance through balance training (Norton, 1996). Several studies state that muscle-strengthening exercises to maintain body balance have been carried out a lot at this

time (Baek et al., 2008), and many research results also state that muscle-strengthening exercises have a positive effect on balance. Park et al. (2016) have reported that the ability to maintain static balance has increased after doing posture stability exercises.

We all know that consistent arm strength is key in archery (Mohd Saleh et al., 2022). Note that the weight of the bowstring pulled back during archery is not equivalent to the maximum force (Sezer, 2017). During a series of archery moves, each takes about 5-8 seconds (Sezer, 2017). So, the archer must draw the bowstring during this interval, aim at the target and finish the shot (Anakwe et al., 2007; Ertan et al., 2003). Therefore these muscles must have strength as well as endurance in order to be able to perform the motion of pulling the bowstring consistently and steadily in accordance with the axis of motion (Yulianto et al., 2015). The purpose of physical training in shooting sports is to provide conditions for archers to survive in these conditions (Sezer, 2017). This statement means that archers must have good strength and endurance abilities so that balance is maintained and can produce accurate archery shots that are right on target.

One thing to note is the grip strength and static balance (Cerrah & Ertan, 2013; Mohd Saleh et al., 2022). To make

a full draw, an archer needs maximum strength in pulling the strings (Debnath & Debnath, 2016). The hand grip strength functions as a bow puller when aiming because when releasing an arrow, it really takes calm and strength of the fingers to pull the bowstring so that the shooting of the arrow becomes smooth. The slightest mistake when releasing an arrow will have a significant effect on the accuracy obtained when releasing an arrow (Yulianto et al., 2015). Good lumbar extension strength will improve balance (Behennah et al., 2018). One indicator that states lumbar strength is the Superman back hold test (Hwang & Park, 2018).

East Java Province is an area that has the best archery athletes in Indonesia, as evidenced by the achievements that have been achieved so far, namely by getting the overall champion in a national multi-event competition called the National Sports Week (PON) for 41 years or 10 times the overall champion (Rahayu, 2021). It is necessary to look for factors that cause East Java to perform better than other regions, one of which is by examining physical condition. Therefore, this study aimed to determine differences in the physical condition of archery athletes in the provinces of East Java, West Java, and DKI Jakarta in the XX National Sports Week (PON) XX multi-event event in Papua. This research will discuss the physical conditions of grip strength, superman back holds, and static balance in the East Java region compared to regions that have fairly good achievements, namely West Java and DKI Jakarta.

Material and Methods

Research design and participants

This research was a quantitative study with a non-experimental design, meaning there was no intervention (Reio, 2016). All participants in this study were professional athletes from the Indonesian national archery team who were healthy and not injured. Twenty-seven archery athletes were sampled in this study which was divided into 3 groups, namely East Java, West Java, and DKI Jakarta, each consisting of 9 athletes. This study involved 27 archery athletes from the East Java, West Java, and DKI Jakarta Regional Centers, each consisting of 9 male athletes with an average age of 22.11 ± 1.17 years in the East Java group, 23.25 ± 1.05 years in the West Java group, 22.67 ± 1.12 years in the DKI Jakarta group.

Instruments and data collection

Data collection used physical tests, including the superman back hold (SBH) test, right (HGR), and left (HGL) hand grip strength and static balance tests. The SBH test was carried out by holding as long as possible in the superman position expressed in seconds (Reiser et al., 2017). Right and left grip strength was done by pulling as hard as possible by squeezing the hand against the Hand grip strength dynamometer, the results of which are expressed

in kilograms (Kg) (Hamilton et al., 1994; Pangaribuan et al., 2020; Véliz Véliz et al., 2020; Pitombeira Pereira Pedro et al., 2023). In contrast, static balance was measured by carrying out a test using a balance beam tool which was expressed in seconds (DeSimone, 2021; Hastuti et al., 2015). The test was only done once without any treatment.

Statistical analysis

Data analysis used the normality test (Shapiro Wilk), homogeneity test (Barlett test), one-way ANOVA and followed by Tukey's HSD post hoc test. In analyzing, the researcher used R studio software version 4.2.1. Data presentation was carried out using mean \pm standard deviation (SD).

Results

The descriptive statistical results of four variables consisting of superman back hold (SBH), left hand grip strength (HGL), right hand grip strength (HGR), and static balance in three different groups can be seen in Table 1.

Table 1.

Descriptive results of the variables SBH, HGL, HGR, static balance

Variable	Group (Mean \pm SD)		
	East Java	West Java	DKI Jakarta
SBH (Second)	54.56 \pm 7.52	44.25 \pm 8.49	44.44 \pm 3.57
HGL (Kg)	72.44 \pm 5.55	63.50 \pm 5.64	64.89 \pm 3.02
HGR (Kg)	76.56 \pm 3.05	70.00 \pm 3.93	69.67 \pm 2.78
Static Balance (Second)	55.67 \pm 7.00	47.13 \pm 4.06	48.89 \pm 4.08

The data in the Table shows that the East Java group has the highest value in the HGL, HGR, and static balance variables, while the SBH variable has the highest in the West Java group. For more details, presented in the Figure 1 below.

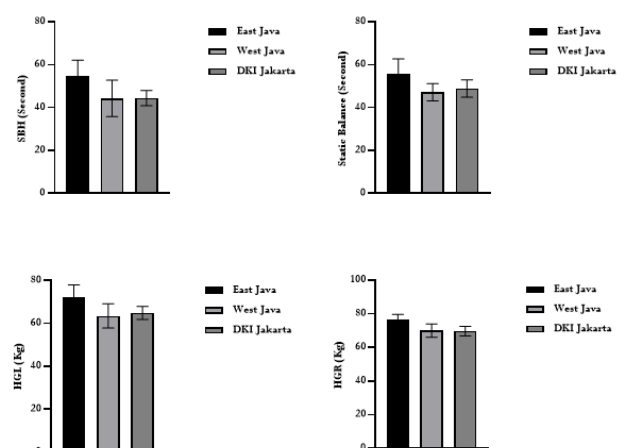


Figure 1. The result of SBH, static balance, HGL, and HGR in 3 groups

Furthermore, after knowing descriptively the mean \pm standard deviation (SD) data of the four variables, then proceeded with carrying out the normality and

homogeneity tests as prerequisite tests before the one-way ANOVA test. The normality and homogeneity test results are presented in Table 2 below.

Table 2.
Normality and homogeneity test results

Variable	p (value)	
	Normality test	Homogeneity test
SBH (Second)	0.373*	0.071*
HGL (Kg)	0.323*	0.199*
HGR (Kg)	0.076*	0.605*
Static Balance (Second)	0.053*	0.201*

(*)Significant with a value of $p \geq 0.05$

Based on the results of the normality test using the Shapiro Wilk and homogeneity using the Barlett test in Table 2, it was found that all variables were normally distributed and were also homogeneous with a $p \geq 0.05$. The one-way ANOVA test then carries out the data that meets the prerequisite test to determine whether all groups have differences in the variable values. The results of the one-way ANOVA test obtained a value of $p = 0.005$. This means that all groups have significant differences in the variables SBH, HGL, HGR, and static balance. The Tukey test was carried out to find out the differences in each group. Tukey's HSD post hoc test results are presented in Table 3 below.

Table 3.
Differences in variable values in the 3 groups using the the Tukey test

Variable	Groups		p-value
	East Java	West Java	
SBH (second)		DKI Jakarta	0.019†
		DKI Jakarta	0.012†
	West Java	DKI Jakarta	0.976
HGL (kg)	East Java	West Java	0.002†
		DKI Jakarta	0.008†
	West Java	DKI Jakarta	0.832
HGR (kg)	East Java	West Java	0.000†
		DKI Jakarta	0.000†
	West Java	DKI Jakarta	0.997
Static balance (second)	East Java	West Java	0.009†
		DKI Jakarta	0.029†
	West Java	DKI Jakarta	0.874

(†)Significantly different with a significance level of 5% with Tukey's HSD post hoc test

Based on Table 3, it was known that the results of the Tukey's HSD post hoc test stated that the East Java group had a significant p-value with the West Java and DKI Jakarta groups in all variables. If we look back at the average results, the East Java group has better SBH, HGL, HGR, and static balance than the West Java and DKI Jakarta groups.

Discussion

The Superman back hold a test that can also be used as a back extension exercise that is effective in strengthening the lower back and toning the buttocks and hamstrings (Wiriawan et al., 2024). Exercising using both hands and feet, like Superman's back hold, can increase the needs of the body's muscles so as to improve sports performance

(Hwang & Park, 2018). In a study using muscle measurements on EMG, the Superman back hold exercise by raising both arms and legs has shown the highest peak amplitude of activity in the lumbar multifidus compared to other back extension exercises (Kim et al., 2016). It was previously known that the Lumbar multifidus is one of the main stabilizers of the lumbar spine muscles and is closely related to low back pain when dysfunction occurs (MacDonald et al., 2009).

Archery is a sport that is done by standing and aiming at the target (Wiriawan et al., 2024). Therefore archery requires coordination and stability so that the shot is right on target (Wiriawan et al., 2024). When the archer begins to maintain a bow-carrying posture, an imbalance begins (Park et al., 2016). It has been reported that most archers have an unbalanced body posture (Dalleau et al., 2012). An imbalance of the body, with a decrease in balance ability, can have a big effect on the performance of archers. And with the quality of events that have to be done repeatedly with the same movement, physical imbalance increases the possibility of damage to posture (Sharma, 2014). Therefore, the aspect of body posture stability is very important for archers because it can reduce body sway just before releasing the arrow (Barrera et al., 2020).

The results of this study indicate that the East Java group consisting of archery athletes from the East Java regional training center got the highest score on the SBH variable with an average of 54.56 ± 7.52 seconds and static balance with an average of 55.67 ± 7.00 . This explains that the archery athletes at the East Java regional training center have a better body balance than the archery athletes at the West Java and DKI Jakarta regional training centers. This is in line with the achievements made, namely at the XX National Sports Week (PON) XX in Papua, and East Java archery athletes managed to become overall champions by getting seven gold (Halide, 2021), which includes categories or competition numbers: women's individual recurve, women's team recurve, mixed recurve, women's team compound, women's individual national, women's team national, and mixed team national.

Hand grip strength is also important in archery (Prasetyo et al., 2018). Sezer (2017), in his research, concluded that hand grip strength has a significant value in archery and that hand grip strength training is one of the factors that increase the value of target shooting accuracy positively. Hand grip strength is an objective component of the functional integrity of the upper limb, as well as an indication of individual muscle strength (Shah & Sirajudeen, 2012). Picking up a bow and arrow using hand strength and feeling control over the bow and arrow are important things to note (Sezer, 2017). The better control an archer has over the bow and arrow during shooting, the more confident he will be in shooting, and the results will be appropriate and accurate. This will produce archery techniques with a good degree of accuracy (Nicolay & Walker, 2005). This

condition has been owned by the East Java group, which has the highest right and left-hand grip strength values between the West Java and DKI Jakarta groups. This result has led the East Java group consisting of archery athletes from the East Java Regional Training Center to become the overall champion in the XX National Sports Week (PON) XX multi-event in Papua.

Conclusions

East Java Province has archery athletes with better physical conditions of superman back hold, hand grip strength, and static balance than the provinces of West Java and DKI Jakarta. This condition is in line with the achievements achieved by archery athletes from East Java Province, who have won the overall championship in the XX National Sports Week (PON) XX multi-event in Papua. This achievement has been maintained for 41 years. Recommendations in this study, it is hoped that other regions will improve these physical components related to superman back hold, hand grip strength and static balance to improve the performance and achievements of athletes, especially archery athletes.

Conflicts of interest

All researchers declare that there is no conflict of interest in this research.

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