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Assessment of target performance in archery

İpek Eroglu Kolayis[a]*, Murat Çilli[a], Hayri Ertan[b], J. Axel Knicker[c]

[a]*Sakarya Universitesi, BESYO, Sakarya, 54100, Turkiye*
[b]*Anadolu Universitesi, Spor Bilimleri Fakültesi, Eskişehir, 2600, Turkiye*
[c]*German Sport Unıversity, Cologne,Germany*

Abstract

Aim of this study is to assess the distribution of targeted arrows between the zones of the target and quantity of the errors. A total of 18 athletes, seven females (age: 16.66±3.44; training age: 5.88±2.92) and 11 males (age: 22.33±12.95; training age: 4.11±2.80) were included in the study. Performances of the athletes were recorded with a digital camera, data were evaluated after being transferred to digital media. The differences in the number of arrows hitting the target and their distance from the center were assessed according to the zones, using the one-sided ANOVA test and the chi-square test. The number of arrows hitting the yellow zone have a statistically significant difference in their distribution percentage between the zones ($p<0.05$). Distribution of the total number of arrows between zones was statistically significantly different ($p<0.05$). The percentages of the arrows hitting the upper zone and the lower zone within the yellow ring were statistically significantly different.

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Keywords: archery; target performance; assesment of performance.

1. Introduction

Performance in archery is designated based on the sum of the scores of the arrows shot by an athlete hit the target. Targeting performance is complicated by various factors including environmental conditions, fatigue, and the athlete's technique, in addition to the effects of the materials that determine the behavior of the bow and the arrow. The positioning of the shot arrows on the target board is considered to imply important information to assess the targeting performance, which is displayed in response to such a complicated texture.

* Corresponding author. Tel.: +90-264-2956641; fax: +90-264-2956643.
E-mail address: ikolayis@sakarya.edu.tr

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Archery contests can be organized outdoors or indoors and the ultimate aim is to collect the highest scores by hitting the yellow area (Kolayis, 2007). During these contests, despite the hard conditions created by factors such as stress or wind, archers perform at least 144 shootings by drawing a bow that has a draw weight of 20 kg on average. The main objective of archery is to decrease the group diameter of the arrows directed to the target. An elite athlete generally creates groups with smaller diameters during practice. If, for any reason, the group is not formed at the center but in a different zone of the target, the athlete can move the group of arrows back to the center by balancing the fine-tuning of the bow. Additionally, positioning the arrow or the arrows to the right, left, upper, or lower zones of the target is considered to reflect such deviations, potentially due to various factors including the archer, the material of the equipment used, or environmental factors. Although there are many parameters that determine performance, the positioning of the arrow on the target provides important clues about the athlete's shooting technique. Based on this, various studies have employed the positioning of the shot arrows on the target to assess the variables affecting performance.

In their study performed in 1989, Beer et al. evaluated the distance of arrows from the center of the target to investigate the effects of eye color on performance. Wang and Landers (1986) assessed performance to determine out the changes in heart rate and hemispheric asymmetry response during targeting process and to determine whether these changes affect performance. In 1991, Landers et al. also used targeting performance to determine the effects of electro-cortical feedback on non-elite athletes.

The distances of the shot arrows from the center and the number of the shot arrows are considered to be different between the upper right and the lower left zones of the target. Assessing the distribution of the errors seen during shooting according to the zones of the target, and determining their quantity may provide important information on the assessment of the performance. This study aims to assess the distribution of targeted arrows between the zones of the target and quantity of the errors.

2. Method

2.1. Subjects

A total of 18 athletes, including seven females (age: 16.66±3.44 years; training age: 5.88±2.92 years] and 11 males (age: 22.33±12.95 years; training age: 4.11±2.80 years) were included in the present study.

2.2. Data Collection Tools

Targeting performances of the athletes were recorded with a digital camera while they were practicing at the archery indoors practice facility; subsequently, data were evaluated after being transferred to digital media.

2.3. Data Collection

Athletes participating in the study shot two series of six arrows (12 arrows in total) to a target located at a distance of 18 meters, at an indoor practice facility. Following each series of shooting, target images were recorded from three different angles by a camera. Target images were calibrated by the image processing tool of the Matlab software and converted to metric units. Targeting performance was assessed by measuring the distance to the center, based on arrows grouped as 10, 9, 8, 7, and 6 and outside. The target paper was divided into four equal quadrants on the x and y axis: Zone 1 representing the upper left part, Zone 2 representing the upper right part, Zone 3 representing the lower left part, and Zone 4 representing the lower right part of the target. Arrows landing outside the target paper were excluded from the assessment.

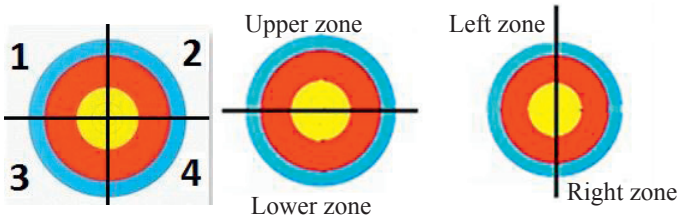

Fig. 1. Archery targets and evaluated zones

2.4. Statistical Analysis

The differences in the number of arrows hitting the target and their distance from the center were assessed according to the zones, by SPSS 15.0 software using the one-sided ANOVA test and the chi-square test.

3. Results

Distribution of the arrows shot by 18 archers participating in the study, according to the points hit on the target paper, is shown in Chart 1

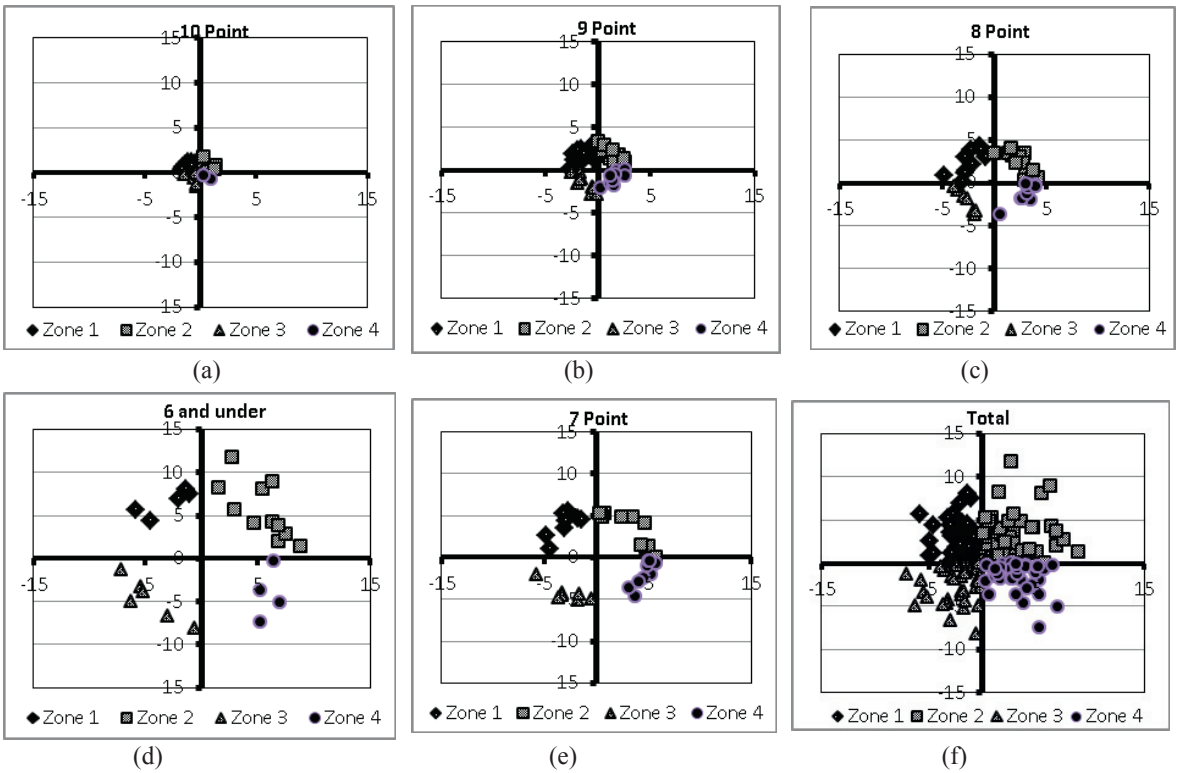

Chart 1. Distribution on the target and overall positioning according to their location (f), of the arrows hitting 10 points (a) and 9 points (b) and 8 points (c) 7 points (d) and 6 points and below (e).

Based on grouping of the arrows according to the zone hit on the target, the number and percentage of the arrows hitting the yellow (10 and 9 points), red (8 and 7 points), and blue (6 and below) rings from the center outwards and the statistical differences between them are shown in Table 1.

Table 1. Frequency and percentage distribution of the arrows hitting the target

	Score							
	Yellow (10 and 9)*		Red (8 and 7)		Blue (6 and under)		Total*	
	f	%	f	%	f	%	f	%
1. Zone	35	59.32	19	32.20	5	8.47	59	100
2. Zone	33	48.53	24	35.29	11	16.18	68	100
3. Zone	17	45.95	14	37.84	6	16.22	37	100
4. Zone	12	33.33	20	55.56	4	11.11	36	100
Total	97	48.50	77	38.50	26	13.00	200	100

When the number of arrows hitting the yellow zone on the target were assessed according to their distribution between the four zones, there was a statistically significant difference in their distribution percentage between the zones ($p<0.05$). However, there was no statistically significant difference in the zone distribution of the arrows hitting red or blue rings. On the other hand, distribution of the total number of arrows between zones was statistically significantly different ($p<0.05$).

Distribution of the arrows according to the scores and their percentage, based on the grouping by the upper-lower and the left-right zones hit on the target, is shown in Tables 2 and 3.

Table 2. Distribution of the arrows hitting upper-lower zones according to the scores (n=200)

	Score							
	Yellow * (10 and 9)		Red (8 and 7)		Blue (6 and under)		Total*	
	f	%	f	%	f	%	f	%
Upper Zone	68	34.00	43	21.50	16	8.00	127	63.5
Lower Zone	29	14.50	34	17.00	10	5.00	73	36,5

*p<0,05

Table 3. Distribution of the arrows hitting left-right zones according to the scores (n=200)

	Score							
	Yellow (10 and 9)		Red (8 and 7)		Blue (6 and under)		Total	
	f	%	f	%	f	%	f	%
Left Zone	52	26.00	33	16.50	11	5.50	96	48
Right Zone	45	22.50	44	22.00	15	7.50	104	52

*p<0,05

It was seen that 63.5% of the arrows hit the upper zone of the target. The difference in the frequency of the arrows distributed between the upper and lower zones was statistically significant ($p>0.05$). In particular, the percentages of the arrows hitting the upper zone and the lower zone within the yellow ring were statistically significantly different. Such a statistically significant difference was not observed between the arrows hitting the right and left zones.

Based on the data obtained from the participating athletes, the distribution of the arrows hitting the same scores between zones and their mean distance to the center along with standard deviation values are presented at the Table 4.

Table 4. Positioning of the arrows according to the scores on the target and the arithmetic mean ± standard deviation of their distance from the center

	10 Point			9 Point			8 Point			7 Point			6 and under		
	n	Distance (cm)		n	Distance (cm)		n	Distance (cm)		n	Distance (cm)		n	Distance (cm)	
		X	S		X	S		X	S		X	S		X	S
1. Zone	19	1.13	0.40	16	2.40	0.54	11	3.81	0.72	8	5.28	0.58	5	7.47	0.68
2. Zone	11	0.86	0.46	22	2.37	0.44	13	3.71	0.46	11	5.38	0.45	11	8.47	1.75
3. Zone	7	0.94	0.49	10	2.30	0.37	7	3.67	0.28	7	5.45	0.48	6	7.53	0.68
4. Zone	2	0.83	0.38	10	2.06	0.43	11	3.56	0.35	9	5.32	0.37	4	7.66	1.22

Among all the arrows shot by 18 archers, those hitting 10 points were mostly located within Zone 1, whereas the Zone 4 was hit by the least number of arrows. Nevertheless, the distance of the arrows hitting 10 points from the center was not statistically significantly different between zones. Arrows hitting 9 points were mostly located within Zone 2; however the distance of the arrows hitting 9 points from the center was not statistically significantly different between zones. Arrows hitting 8, 7, or 6 points and below were also more frequently located within Zone 2 and there was no statistically significant difference with respect to distance to the center in these zones as well ($p>0.05$).

4. Discussion and conclusions

According to the results obtained by the 12 arrows shot by each of the 18 archers participating in the study, as demonstrated on Table 1, 54.32% of the arrows targeted at the yellow ring hit the Zone 1, which is the left upper part of the target, and the least cluster percentage, 8.47%, targeted blue and below. This finding shows that the upper left zone of the target was prominently hit by the arrows positioned within the yellow ring. Of the arrows hitting Zone 2, once again the highest share were within the yellow ring with percentage of 48.53% and the least hit falling in Zone 2, which is the upper right part of the target, positioned within the blue ring. Zone 3, representing the lower left part of the target, was mostly hit by the arrows positioned within the yellow ring, with a percentage of 45.95%, and the least hit in this zone were within the blue ring. Furthermore, among the arrows positioned within the yellow ring, 36.08% hit Zone 1 and 12.37% hit Zone 4. A statistically significant difference was observed in the distribution of the arrows hitting the yellow ring between the zones on the target. Tables 2 and 3 show the distribution of the arrows according to the upper, lower, left, and right zones of the target. These data show that 63.5% of the arrows hit the upper part of the target. The difference between the number of arrows hitting the upper and lower zones of the target was statistically significant. However, no statistically significant difference was seen in their distribution between the right and left zones.

Table 4 represents the mean distance from the center and standard deviation of the same arrows. No statistically significant difference was seen in the distance from the center of the arrows hitting Zones 1, 2, 3, and 4 according to the point they hit.

There are various studies evaluating performance as a dependent variable in archery. For example, in their study performed in 1989, Beer et al. evaluated the distance of the arrows from the center of the target in order to assess the effects of eye color on performance.

Wang and Landers (1986) have assessed performance to determine the changes in heart rate and hemispheric asymmetry response during targeting process and to determine whether these changes affect the performance. In 1991, Landers et al. also used targeting performance to determine the effects of electro-cortical feedbacks on non-elite athletes.

Shooting performance, as a branch of individually performed sports like archery where the athlete's self-paced is crucial, is also monitored by the points hit on the target. Landers et al. have examined the peripheral contraction under high and low stress conditions in experienced and inexperienced rifle-shooters and they evaluated performance based on the deviations from the center on the target.

Horsak and Heller (2011) examined finger and beam movements during archery shooting and evaluated the shooting performance in terms of good or bad arrows.

Studies performed on postural release in archery have associated the balance factor with its effects on performance and positioning of the arrows on the target (Zemkova, 2013).

Studies performed thus far show that performance in archery is assessed based on FITA points, shooting points, or the distance from the center.

In the present study performed with the aim of evaluating shooting performance in archery, the points that the arrows shot from 18 meters apart hit on the target paper of 18 meters, the positions of these points and their distance to the center were taken into consideration. Skill development in archery requires that the arrows hit points close on the target. This enables the development of tailor-made personal equipment and fine-tunings. Adjustments made according to the clustering of the arrows on the target board can ensure that the arrows gather at the center. Nevertheless, not all the arrows shot during a competition may be positioned on the targeted point even if the athlete has developed the required skills. To enhance performance in archery, the causes of such deviations in arrow shooting can be defined in light of these studies.

Accordingly, the reason why the arrows cluster on specific points can be discussed to evaluate the archers' performance. Individual differences can be considered. The differences in the performance displayed by elite athletes and others can be deliberated. In this respect, further studies may assess the psychological, physical and environmental factors observed during arrow shooting, based on their positioning on the target, and the acquired data may be used for performance development in archery.

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