

# Relationship between Postural Sway and Shooting Accuracy in Pre Elite Indian National Archers

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## ABSTRACT

**Introduction:** Archery is a game of skill and focus. Good balancing ability of an individual is an integral parameter to the performance of an archer. Proper balance is important to holding the bow and maintaining rhythm through execution. Balance of an archer adds to the stability of the bow, sight picture moves more slowly and covers less area on the target. This study was conducted to study relationship between balancing ability of archer and scoring accuracy at varying distances of 30 m, 40 m and 50 m.

**Material and Methods:** 26 archers were taken for study with training experience of more than 2 years and registered Come and Play Scheme of Sports Authority India, Government of India. The balancing ability was assessed using Stork's balance test and performance assessment by shooting accuracy on field. Correlation between the two parameters was done using the statistical test of Pearson's correlation using SPSS Version 20.

**Results:** Significant positive correlation was obtained between balancing ability and shooting accuracy at distance of 30 m, 40 m and 50 m (at 30 m 0.47\*, at 40 m 0.72\*\* and at 50 m 0.75\*\*). Similar positive correlation was also obtained when balancing ability was judged with eyes closed.

**Conclusion:** It was concluded that good balance is essential for better performance accuracy in archery. With increase in distance of shooting, the importance of body balance increases. Balance helps reduce the struggle to keep the dot balanced.

**Keywords:** Archery, Postural Sway, Body Balance, Shooting Accuracy

## INTRODUCTION

The elements of a good shooting position are consistency and balance. Balancing is the process of maintaining the position of the body's centre of gravity vertically over the base of support and relies on rapid, continuous feedback from visual, vestibular and somatosensory structures and then executing smooth and coordinated neuromuscular actions.<sup>1</sup>

Archery is a sport where good balancing ability is a prerequisite to achieve peak performance. Being a static sport it requires good control on body sway, proper endurance, focus and strength of the upper body. Once the archer has aimed and fixed his posture, the fluctuations of the body must be regulated such that the alignment of the arrow remains within the target boundary, and the individual's centre of gravity within their base of support.<sup>2,3</sup> Standing in archery looks static, but in reality it is not. The body is moving forwards and backwards due to the inherent phenomenon of body sway. Archers use visual, proprioceptive and vestibular

feedback loops to overcome this position and also to resist the external disturbances such as wind that add to this instability. Stability has been determined to be the most important factor in aiming at the target.<sup>4</sup>

Balance ability is related to skill level for archers, with the more proficient archers displaying greater balance ability prior to the arrow shot.<sup>5</sup> Aiming or sight trajectory sways on the target vertically and horizontally, and antero-posterior and medio-lateral postural sways during release may adversely affect the resulting score.<sup>6</sup> To maintain high score in archery constant balance is required and the balance of left foot supporting the bow during shooting is an important factor.<sup>7</sup>

In another study, upright body type exercise program had positive effects on both static and dynamic balance of plantar foot pressure by allowing archers to experience less body sway and physical imbalance in shooting and positive effects on archery record.<sup>8</sup>

Performance in archery is determined by the sum of the scores of the arrows shot by an archer that hit the target. The performance may be affected by various factors such as archer's technique, level of fatigue or environmental conditions. Archery requires the consistency and stability of movement. In order to shoot the arrow correctly to the target, archers need control of right distribution of strength, balanced pose and change of breathing and so on.<sup>9</sup> The mismatch of these factors can influence in athletic performances directly. The archers are required to carry, lift and pull bow and arrow in the process of shooting whilst maintaining a static balance.<sup>10</sup> For an archer to sustain precision and accuracy in the archery competition, the archer is required to counter any form of postural sway to hit a predetermined target.<sup>11</sup> A study has identified clicker reaction time, draw force and reduced sway speed as the variables that best projected shot performance.<sup>12</sup> According to most coaches, training

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**How to cite this article:** Jain R, Gulati A, Aggarwala J, Dhingra M. Relationship between postural sway and shooting accuracy in pre elite Indian National Archers. International Journal of Contemporary Medical Research 2021;8(2):B1-B4.

**DOI:** <http://dx.doi.org/10.21276/ijcmr.2021.8.2.20>



elite archers the consistency of an archer's postural set at the moment of arrow release is commonly perceived to be an important determinant of success. Another study results showed that precise postural consistency may not be the primary feature distinguishing between the performance of archers at the higher skill levels.<sup>13</sup> Yet, another study reported the effectiveness of a core stability training program in reducing the postural sway and improved performance in field amongst experimental adolescent archers as compared to the control group.<sup>14</sup>

The present study was conducted with the aim to assess and quantify the balance ability of preadolescent archers and its relationship with shooting accuracy at distances of 30 m, 40 m and 50 m.

## MATERIAL AND METHODS

### Subjects

A total of 26 archers, including 13 females and 13 males registered under Come and Play Scheme of Sports Authority of India participated in the present study. The average age of the archers being 18.76 ( $\pm 3.51$ ) years. All the archers had more than 2 years of training experience. Informed consent was taken from the subjects before any data collection was done. The participants visited the Human Performance Lab, Jawahar Lal Nehru Stadium for initial assessment. Demographic data was recorded. The protocol for the performance of Storks test was explained to them. All procedures were followed in accordance with the ethical standards of the committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975 that was revised in 2000. ([http://www.wma.net/e/policy/17-c\\_e.html](http://www.wma.net/e/policy/17-c_e.html)).

### Data Collection Tools

#### Static Balance Assessment Test

For the assessment of balance, Stork's balance test was used.<sup>15</sup> Subject was asked to remove shoes and place the hands on the hips, then position the non-supporting foot against the inside of knee of supporting leg. The subject was then asked to raise the heel to balance on the ball of the foot. Before the performance of the test, the subject was given 1 minute to practice. The stopwatch was started as the heel was raised from the floor. The test was stopped in case if hands come off the hips, supporting foot swivels or moves in any direction, non-supporting foot loses contact with the knee or heel of the supporting foot touches the floor. The test was

performed both with eyes open and then eyes closed. Total time in seconds was recorded and the best of three attempts was considered for analysis.

### Performance Assessment

The archers was assessed for performance on field with the bows they were most comfortable in. They were asked to shoot 10 arrows each at 30 meters, 40 meters and 50 meters. The average score of 10 arrows at each distance was taken for statistical analysis.

## STATISTICAL ANALYSIS

Statistical analysis was done using IBM SPSS 20.0. The normality and heterogeneity of the data was assessed first, following which, the relationship between balancing ability and performance accuracy was assessed using two-tailed Pearson's correlation coefficient.

## RESULTS

The mean number of years of training for male archers ( $n=13$ ) who participated in the present study was 2.7 years, while for female archers ( $n=13$ ) it was 3.5 years. Average and standard deviation of height, weight and body mass index of the participant archers is mentioned in Table 1.

Postural balance was assessed using the Stork's balance test in archers. Scoring of shooting was also assessed on field. When correlation between body balance and shooting accuracy was assessed moderate correlation was obtained as shown in Table 2. Similar results were obtained when Stork's test was done with eyes open as well as eyes closed.

The relationship between body balance and shooting accuracy at distance of 30 m, 40 m and 50 m has been plotted in graphs (Figure 1 and 2). Figure 1 shows the results obtained when Stork's test was done with eyes open and Figure 2 shows results when Stork's test was done with eyes closed. The line on the graph shows positive moderate relationship between the two variables and this line is seen to be the most slant at distance of 50 m where the coefficient of correlation is highest amongst the three distance of 30 m, 40 m and 50 m.

## DISCUSSION

Correlation analysis of body balance and accuracy of shooting in national level archers stated that there was a significant positive correlation between these two parameters at distance of 30 m, 40 m and 50 m of shooting. At distance of 50 m, the value of correlation coefficient was highest.

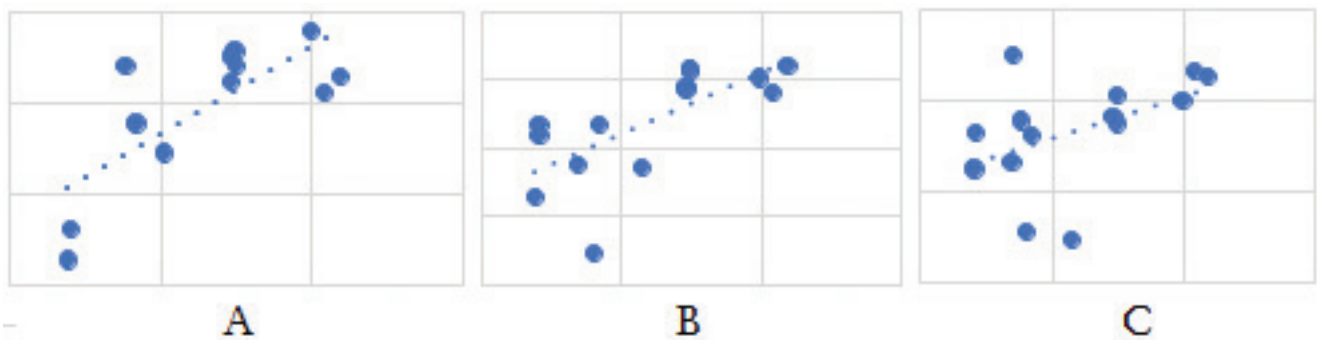
	Training (years)	Height (cm)	Weight (kg)	BMI (kg/m <sup>2</sup> )
Archers (Females)	2.7 $\pm$ 0.7	158.9 $\pm$ 6.9	51.1 $\pm$ 7.4	20.22 $\pm$ 2.4
Archers (Males)	3.5 $\pm$ 0.7	172.5 $\pm$ 7.4	67.6 $\pm$ 9.3	22.6 $\pm$ 2.2

**Table-1:** Demographic details of subjects

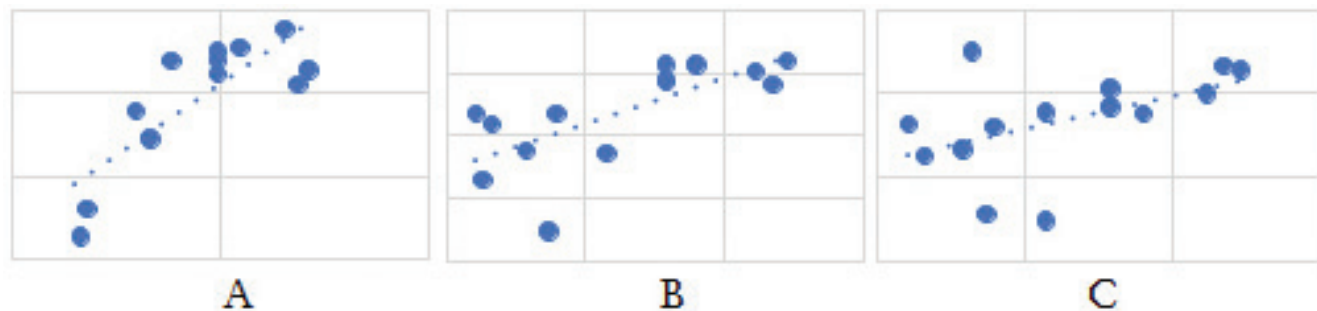
	Scoring at 30 m	Scoring at 40 m	Scoring at 50 m
Body Balance (eyes open)	0.47 *	0.72 **	0.75 **
Body Balance (eyes closed)	0.49 *	0.74 **	0.81 **

\*significant at the level of  $p=0.05$ , \*\*significant at the level of  $p=0.01$

**Table-2:** Correlation coefficient between body balance (with eyes open and eyes closed) and shooting accuracy in archers.



**Figure-1:** Correlation graphs between body balance (with eyes open) and shooting accuracy (A: at distance 50 m; B: at distance 40 m; C: at distance 30 m)



**Figure-2:** Correlation graphs between body balance (with eyes closed) and shooting accuracy (A: at distance 50 m; B: at distance 40 m; C: at distance 30 m)

Moderate positive correlation was seen at distance of 30 m. This difference in values states that good balancing ability provided more benefit when shooting at a greater distance.

The present study provides light to the essentiality of good postural balance for better performance in shooting sports. In archery, once the archer has aimed and fixed the posture of the arms, the fluctuations of the body must be preserved in the alignment of the arrow with the target, and the centre of gravity within the base of support.<sup>2,3</sup>

In archery, when shooting according to the up and down movement of the bow, there can be a change in centre of the body, so the stability has to be increased in body balance, and archers can minimize the shaking of the body and can help improvement in scores through balance training.<sup>16</sup>

Balance ability was significantly related to shooting accuracy for junior archers but not senior archers.<sup>17</sup> The senior archers had superior balance ability when compared with junior archers; a high level of stability is a prerequisite to becoming an elite archer and, at this level of expertise, the range of postural sway is small and was not an important discriminating factor for elite senior archers.

In a similar study it was seen that postural sway during the setup and release phases of archery were the significant indicators for shooting performance and, thus, reducing postural sway could increase shooting performance of skilled archers.<sup>18</sup> Synchronization of body and bow sway influence the accuracy of the shot, suggesting that training of body balance and bow stability would be beneficial to improve archery performance.<sup>19</sup>

Yet another study indicated the stability of dynamic balance of the body at shooting is known to be imperative in archery,

along with the stability of the archery posture of the upper limbs and the synchronization between the stability of the base of support and supporting surface of the lower limbs. In a previous study by Kim & Kim in 2005 found that consistent posture, sense of rhythm, distribution of power, respiratory control, concentration, equipment, and psychological anxiety influence archers performance. Further, proper balance of the body and distribution of upper limb muscular strength, as well as consistent heart rate and respiration, are also reported to directly influence the performance.<sup>20</sup> In a related study it was reported that body balance should be improved in archery since the body's centre of gravity moves with vertical movements of the bow.<sup>21</sup> Moreover, a study in 2008 investigated how 12 weeks of balancing training conducted conferring to sprinter/skater pattern in 12 female archers affected their postural regulation and shooting records. In their study, the authors reported that movements in the x-axis and y-axis of the body's centre of gravity decreased, leading to enhanced body balance. When changes in shooting records (6 shoots from 70 m) resulting from improved body balance were investigated, the post-test records ( $M \pm SD = 8.64 \pm 0.59$ ) were found to be slightly improved than the pretest records ( $M \pm SD = 8.03 \pm 1.06$ ).<sup>22</sup>

The present study is a pilot study done on elite archers preparing for national and International Competitions and throws light on the importance of balance ability linked to better accuracy in shooting arrows especially at distances larger than 30 m. The study needs to be conducted on a larger sample size with use of equipment like force platform for precision testing of balancing ability. Measurement of heart rate during the time of shooting will provide more insight into

the physiological conditioning beneficial for enhancement of performance in shooting sports.

## CONCLUSION

It was concluded that good balance is essential for better performance accuracy in archery. The study indicated that with increasing distance of shooting, the impact of body balance on shooting accuracy also increases. Functional movement screening both for static and dynamic balance may be included during induction in camps for training. Later, laboratory tests both for testing and training can be beneficial. For an archer, balance training coupled with core strength training especially for upper body and legs must be an essential part of routine training regime.

This will require field sessions to develop strength, balance, stamina and core body skills, as well as the sessions for correcting muscle imbalances to improve posture and body sway.

Future study proposes to include heart rate variability and body composition of players and its effect on performance accuracy.

## ACKNOWLEDGEMENTS

The authors would like to acknowledge the players who gave their training time and interest to be part of the study. The authors are also grateful to the coaches training elite archers who gave their inputs and wisdom during field coaching. This article is being inspired to understand the unique characteristics of coaching and players cognitive-motor coming from humble background skills leading to India's good performance at Olympic level.

## REFERENCES

- Nashner LM. Practical biomechanics and physiology of balance. In: Jacobson GP, Newman CW, Kartush JM, editors. Handbook of balance function testing. San Diego (CA): Singular Publishing Group, 1997: 261-79.
- Balasubramanian R, Riley MA, Turvey MT. Specificity of postural sway to the demands of a precision task. *Gait & Posture*. 2000;11:12-24.
- Ertan H, Knicker AJ, Soyulu, Strueder. Individual variation of bowstring release in high level archery: A comparative case study. *Human Movement*. 2011;12:273-276.
- Hung TM, Tang WT, Shiang TT. A case study of integrated sport sciences for an Olympic archer. *Journal of Medical & Biological Engineering*. 2009;29:164-171.
- Hrysomallis C. Balance ability and Athletic Performance. *Sports Medicine*. 2011;41:221-232.
- Tinazci, C. Shooting Dynamics in Archery: A Multidimensional Analysis from Drawing to Releasing in Male Archers. *Procedia Engineering*. 2011;13:290-296.
- Seung H. Effects of balance and kinematic factors on archery score during archery shooting. *Journal of the Korea Convergence Society*. 2018;9:239-246.
- Kim DK. The effects of the upright body type exercise program on body balance and record of archers. *Korean Journal of Sport Biomechanics*. 2018;28:9-18.
- Park JM, Hyun GS, Jee YS. Effects of pilates core stability exercises on the balance abilities of archers. *Journal of Exercise Rehabilitation*. 2016;12:553:558.
- Tabrizi HB, Abbasi A, Jahadian H. Comparison of static and dynamic balance and its relationship with anthropometric characteristics in athletes of selected sports. *Journal of Sport Science*. 2014;6:33-36.
- Musa RM et al. Anthropometry correlation towards archery performance. *Machine learning in sports, SpringerBriefs in Applied Sciences and Technology*. 2019;29-35.
- Spratford W, Campbell R. Postural stability, clicker reaction time and bow draw force predict performance in elite recurve archery. *European Journal of Sport Sciences*. 2017;17:539-545.
- Stuart J, Atha J. Postural consistency in skilled archers. *Journal of Sports Sciences*. 1990;8:223-234.
- Suppiah PK, Kiet TWK, Musa RM, Abdullah MR, Lee JLF, Maliki ABHM. The effectiveness of a core muscles stability program in reducing the postural sway of adolescent archers: A panacea for a better archery performance. *International Journal of Physiotherapy*. 2017;4:296-301.
- Taha Z, Musa RM, Majeed AA, Alim MM, Abdullah MR. The identification of high potential archers based on fitness and motor ability variables: A support vector machine approach. *Human Movement Science*. 2018;57:184-193.
- Norton KI, Olds T, Olive S, Craig N. Anthropometry and sports performance. In: Norton KI, Olds T, editors. *Anthropometrica*. Sydney: UNSW Press; 1996. p. 287-363.
- Mason BR, Pengrim PP. Body stability and performance in archery. *Excel*. 1986;3:17-20.
- Mohamed MN, Azhar AH. Postural sway and shooting accuracy of skilled recurve archers. *Movement, Health & Exercise*. 2012;1:49-60.
- Sarro KJ, Viana TC, Barros RM. Relationship between bow stability and postural control in recurve archery. *European Journal of Sport Science*. 2020;1-6.
- Kim JH, Kim HY. Kinematic analysis on the release movement for expert archers. *The Korean Journal of Physical Education*. 2005;25:415-424.
- Kim KC, Ryu JS, Yun HJ. A study of relationship between body stability and a bow stability. *The Research Institute of Physical Education & Sports Science*. 1993;12:13-19.
- Kim JP. The Effect of Balance Exercise on Postural Control and Shooting Record in Archers. *Korean Journal of Sport Biomechanics*. 2008;18:65-74.

**Source of Support:** Nil; **Conflict of Interest:** None

**Submitted:** 01-01-2021; **Accepted:** 25-01-2021; **Published:** 28-02-2021