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ORIGINAL ARTICLE

A RESEARCH INVESTIGATION INTO THE INFLUENCE OF STRENGTH TRAINING ON ADVANCING SHOULDER MOBILITY AND THE ABILITIES OF BEGINNER ARCHERS

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ABSTRACT

Background Of the Study: Recent times have seen an influx of novice archers presenting with shoulder discomfort and injuries, accounting for approximately 80% of related instances. The personalized physiotherapeutic interventions, there is a potential to ensure that these athletes maintain optimal muscle health. Objective of the study is to evaluate the effect of strength training exercise in improving shoulder function and performance of novice Archers. **Methodology:** The study employs an experimental methodology with a before-and-after testing design. A total of 60 beginner archers were randomly chosen and evenly distributed into two cohorts: a control group and an experimental group, each comprising 30 participants who were evaluated at the Physiotherapy OPD ACS Medical College and Hospital campus, Chennai. The total performance score for each archer was calculated as the aggregate of points from three attempts, with each attempt carrying a maximum of 10 points, culminating in a maximum potential score of 30. **Result:** On comparing the mean values of Group, A & Group B on Apley's Scratch Shoulder Flexibility Test score and Archer Assessment of Target Performance score, shows highly significant difference in mean values at $P \leq 0.001$. But group a shows higher mean value in Apley's Scratch Shoulder Flexibility Test score and Archer Assessment of Target Performance score comparing with group B. **Conclusion:** Significant difference was observed for both flexibility and performance of the archers after regular strength training exercises offered by the therapist to the subjects. The mean and standard deviation computed for both the test group and control group before and after the training concluded that, there was overall improvement.

Keywords: Keywords: Archer, Shoulder, Strength, Flexibility, and Performance.

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INTRODUCTION

Archery is a type of sport that involves using a bow to shoot arrows at targets or during hunting. The bow has been used as a primary weapon in ancient times and has also been developed as a recreational sport by military personnel in countries across Europe, Egypt, and other western regions. Archery is widely considered to be one of the safest sports and can be enjoyed by individuals of all ages. Additionally, archery requires excellent competitive skills to be successful. In recent years, archery has gained popularity as schools, colleges, and recreational programs seek activities that are appropriate for people of all ages. Archery has been a featured sport in both the Olympic and Paralympic Games. The sport of archery involves six distinct stages, including bow holding, drawing, full draw, climbing, release, and follow-through, culminating in the act of shooting. The bow is a mechanical device used to propel a projectile at higher speeds than would be possible by hand³⁻⁵.

Bows are typically available in three styles: long bow, recurve bow, and compound bow. Although these styles differ in appearance, they share a common feature: the riser, which is the center portion of the bow that the archer holds in their bow hand. A bowstring connects the limbs of the bow and is held in place by servings, which include a small brass ring known as a nock locator. When using the bow, the arrow should be long enough so that the point extends at least two inches beyond the riser. Archery is a sport that requires a high degree of skill. Successful archers must possess a unique combination of physical and mental characteristics, including stable perception and skill. Archery is considered a static sport, meaning that it requires a great deal of control. The most vital requirements for archers are strength and endurance, with special emphasis placed on the forearm and shoulder muscles. From a physical therapy perspective, these muscle groups are of particular importance to archers⁵.

Although archery does not require much cardiovascular exertion, it does require significant muscular endurance in the upper body. Maintaining proper balance and control in the core and lower body muscles is also essential. Forearm muscles are particularly important for aiming and providing a sufficient grip. While injuries from trauma are rare in archery, injuries caused by repeated drawing actions are common.⁷

Since archery is a static sport, proper leg positioning, avoiding postural sway, and keeping the legs straight but not over-extended are crucial for archers. Additionally, engaging the glutes, avoiding leaning forward, and maintaining a natural, relaxed position for the back, head, and shoulders are important. Archers must use many muscles in the upper body to shoot arrows. Therefore, some of the most effective exercises for archers focus on the chest, back, and other upper body muscles¹⁰.

One-arm Dumbbell Lateral Raises, Dumbbell Shrug, Single-arm dumbbell row, Bench Dips, end-over Rare Lateral Race, Variation on Push-ups, Planks, Overhead Triceps Extension, Rowing Machine, Good morning exercise

In archery, an archer's performance is calculated by adding up the scores of the arrows that hit the target. This targeting performance depends on several critical factors, including environmental conditions, the performance of the bow and arrow, the technique used by the archer, and the archer's level of fatigue. The quantity of error made by the archer while shooting at different zones relative to the target is a crucial factor in assessing performance. According to an archery safety brochure, the injury rate for archery in 2017 was 0.057 injuries per 1000 participants. In addition to being a safe sport, archery helps build concentration, hand-eye coordination, and mental toughness⁸⁻¹¹.

The most common injuries in archery are as follows: Rotator cuff injuries, Muscle strain, Chest bruising, Hand cuts, Tendonitis

The shoulder complex is a crucial area for archers, as it involves complex biomechanics that significantly impact performance. Physical therapy plays an essential role in strengthening the archer's shoulder and ensuring long-term success in performance. Given that physical therapy is required consistently and monitored over a longer period, it has become increasingly important in recent times. However, there is limited research and publications on the subject of physical therapy for archers¹³⁻¹⁵.

Overall, archery can be considered a comprehensive exercise that provides various health benefits along with developing archery skills, building resistance, and strengthening the cardiovascular system. These health benefits include muscle strengthening, endurance development, balance improvement, weight control, increased muscle-to-fat ratio, enhanced blood flow to the brain, improved breathing, and overall relaxation.¹⁶

METHODOLOGY

This is a comparative study that looks at pre- and post-test results. The study involves 60 subjects who were selected using a convenient sampling method and underwent an 8-week study at the Physiotherapy Outpatient Department at the ACS Medical College campus. The pre-test and post-test were conducted using Apley's scratch shoulder flexibility test and Archer assessment of target performance score. The study focused on male archers between the ages of 20 and 29 who were considered novice archers. Subjects with a history of shoulder problems or injuries were excluded from the study.

Procedure: All subjects were evaluated based on the inclusion criteria, and 60 archers were randomly selected and divided into two groups: a control group and a test group. The procedures were explained to the subjects, and written informed consent was obtained. The control group did not participate in strength training exercises, while the test group participated in

warm-up activities, stretching, and strength training exercises such as one-arm dumbbell lateral raising, dumbbell curl, and chest expansion exercises. The strength training exercises for the test group included dumbbell shrugs, single-arm dumbbell rows, bench dips, push-ups, and planks, followed by a cool-down period. The intervention was planned to last for 40 minutes per session, six days per week, for a total duration of eight weeks.

Pre-Test: Before the intervention, the flexibility and performance of the archers were evaluated using Apley's scratch shoulder flexibility test and Archer's assessment of target performance score. Both the control and test groups underwent a pre-test to determine their initial performance. After the pre-test, the archers participated in stretching exercises to warm up their muscles before any further testing. The stretching exercises focused on the muscles involved in archery, including rhomboids, levator scapulae, upper trapezius, middle trapezius, lower trapezius, deltoids, and pectorals. These muscles are important for archery, and stretching them before testing can help prevent injury and improve overall performance.

Flexibility test: The Apley's test was used to assess the flexibility of the archers. During this test, the archer was asked to reach behind their head and touch the superior aspect of the opposite scapula, which measured the degree of abduction and external rotation. The flexibility test score was measured in inches using an inch tape and was recorded separately for both the control and test groups.

Strength training exercise: After completion of pre-test, strength training exercises are given for the archers to improve their function and performance. These strengthening exercises are given on a daily basis as per the allotted session in a week regularly. The strength training exercises are as follows.

One arm dumbbell lateral raising – The body

kept still, eyes facing forward, and straight arms, slowly raise the dumbbell up to around shoulder height.

Dumbbell shrugging: Grabbing a pair of dumbbells and holding up in the sides with a neutral grip.

Single arm dumbbell row: The dumbbell was brought up to the chest, concentrating on lifting it with the back and shoulder muscles rather than the arms.

Bench dips: the body weight exercise to activate muscles in the arms, shoulders, knee and chest. They are also known as triceps dips.

Push up: a common exercise beginning from prone position. By raising and lowering the body using the arms, push-ups exercise the pectoral muscles, triceps, and anterior deltoids

Planks: a classical exercise that strengthens whole body from head to toe. It strengthens the core muscles including abdominals and lower back.

Post-Test:

The tests such as flexibility and performance which was performed during pre-test was once again performed after the strength training

exercises to ensure that there will be a significant improvement in the function and performance of the archers, once they put into action. The post-test is also carried out separately for both the control group and test group.

Data Analysis: The collected data were tabulated and analyzed using both descriptive and inferential statistics. All the parameters were assessed using statistical package for social science (SPSS) version 24, with a significance level of p value less than 0.05 and a 95% confidence interval set for all analysis. The Shapiro Wilk test was used to determine the normality of the data. In this study, Shapiro wilk test showed that the data was normally distributed on the dependent values of Apley's Scratch Shoulder Flexibility Test (significance 0.384) & AATPS (significance 0.441) at $P >$ Hence parametric test was adopted. Paired t-test was adopted to find the statistical difference within the groups & Independent t-test (Student t-Test) was adopted to find statistical difference between the groups.

Table-1 Comparison of Apley's Scratch Shoulder Flexibility Test Score Between Group – A And Group - B In Pre and Post Test

TEST	GROUP - A		GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	.883	.415	.936	.343	-5.42	58	.590*
POST TEST	.445	.451	.853	.341	-3.95	58	.000***

(* - $P > 0.05$), (** - $P \leq 0.001$)

The above table reveals the Mean, Standard Deviation (S.D), t-test, degree of freedom (df) and p-value between (Group A) & (Group B) in pretest and posttest weeks.

This table shows that there is no significant difference in pretest values between Group A & Group B ($*P > 0.05$).

This table shows that statistically highly significant difference in posttest values between Group A & Group B ($*** - P \leq 0.001$).

Table-2 Comparison of Archer Assessment of Target Performance Score Between Group – A And Group - B In Pre and Post Test

TEST	GROUP - A		GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	11.66	1.82	11.36	1.79	.643	58	.528*
POST TEST	16.16	1.93	12.80	2.00	6.62	58	.000***

(* - P > 0.05), (***) - P ≤ 0.001)

The above table reveals the Mean, Standard Deviation (S.D), t-test, degree of freedom (df) and p-value between (Group A) & (Group B) in Pre test and Post test weeks.

This table shows that there is no significant difference in Pre test values between Group A & Group B (*P > 0.05).

This table shows that statistically highly significant difference in Post test values between Group A & Group B (***) - P ≤ 0.001).

Table- 3: Comparison of Apley's Scratch Shoulder Flexibility Test Score Within Group-A And Group-B Between Pre Test And Post Test

GROUP	PRE TEST		POST TEST		t - TEST	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D		
GROUP- A	.883	.415	.445	.415	8.14	.000***
GROUP- B	.936	.343	.853	.341	5.51	.000***

(*** - P ≤ 0.001)

The above table reveals the Mean, Standard Deviation (S.D), t-value and p-value between pre-test and post-test within Group – A & Group – B

There is a statistically highly significant difference between the pre test and post test values within Group A and Group B (***) - P ≤ 0.001).

Table -4: Comparison of Archer Assessment of Target Performance Score Within Group-A & Group-B Between Pre & Post Test Values

GROUP	PRE-TEST		POST TEST		t - TEST	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D		
GROUP- A	11.66	1.82	16.16	1.93	-33.71	.000 ^{***}
GROUP- B	11.36	1.79	12.80	2.00	-15.57	.000 ^{***}

(***- $P \leq 0.001$)

The above table reveals the Mean, Standard Deviation (S.D), t-value and p-value between pre-test and post-test within Group-A & Group-B.

There is a statistically highly significant difference between the pretest and posttest values within Group A and Group B (***- $P \leq 0.001$).

RESULTS

On comparing the mean values of Group A & Group B on Apley's Scratch Shoulder Flexibility Test score, it shows a significant decrease in the post test mean values in both groups, but (Group A - Strength Training) shows 0.445 which has the lower mean value is more effective than (Group B - Control) 0.853 at $P \leq 0.001$. Hence the null hypothesis is rejected.

On comparing the mean values of Group A & Group B on Archer Assessment of Target Performance score, it shows a significant increase in the post test mean values in both groups, but (Group A - Strength Training) shows 16.16 which has the higher mean value is more effective than (Group B - Control) 12.80 at $P \leq 0.001$. Hence the null hypothesis is rejected.

On comparing pretest and posttest within Group A & Group B on Apley's Scratch Shoulder Flexibility Test and Archer Assessment of Target Performance score shows highly significant difference in mean values at $P \leq 0.001$.

DISCUSSION

The aim of the study is to examine the sports specific components performed by archers. The major finding of this study was that the novice archers who undergone the strength training exercise regularly performed well with accuracy superior to that of the other group considered in the study. In this study, 30 subjects were selected who practice archery regularly in the age group between 20 to 29. The outcome measures were evaluated by the flexibility and performance of the archers before and after the strength training exercise duly given in the specific period of time on regular basis.

Tinazeic⁵ and their team, in their work witnessed such kind of improvement during the investigation of multi-dimensional analysis of male archers. Even though the age group selected by the team is different from the present investigation, the pattern of improvement remains same, which is one more evidence for the justification of the attempt made in this study. Cevdet Tinazci³³, in their

analysis concluded that reduction in mobility increased the performance of archers, which was contradictory to the results obtained in the study.

Jiun Sien Lau et. al discussed about the anthropometric and physical fitness variables on archery shooting performance. Archers with higher height and longer arm span have more advantages in archery. In the subjects considered in the study, this argument was valid enough since the archer's group was male, where some of the subjects possess the condition mentioned by the authors, which resulted in the significant improvement in the performance. This supports the argument made by the authors⁴.

Archers' performance was also studied by a team Alexandros et. al³² in a physiological and psychological aspects which reflect the performance as obtained in the present study. Dehydration and fatigue affected the performance to a significant level as it triggers the heart rate. Since in the present study, these aspects were taken in a serious consideration, this impact was less on the archer performance.

From the flexibility score during pre-test and post-test, with respect to test group and control group, the standard deviation increased from 1.82 to 1.93 and 1.79 to 2 respectively. This trend indicated that the improvement in flexibility score after regular strength training exercise was overall for the entire subject groups considered and not a particular set of subjects. This was considered as a valid output from the investigation that the training was fair enough in addressing all the subjects equally. Similar to that of flexibility, performance of the archers also equally competent in the output measured after the regular strength training exercise. The significant improvement

witnessed in the score and analysis was the motivation behind the regular physiotherapy training given to the sports such as archery, which in turn lead to better results.

Cross body stretch with limited internal rotation was more effective than that of absence of stretch controls. This was reported by Philip McClure et.al, which support the argument of the present work where stretching exercise was given to the archers before the strength training exercise. Hassan et. Al., analyzed the flexibility of shoulder joints and concluded that routine screening, correct exercise programs and proper strategies given by the coaches were more important in the improvement of flexibility and performance of the athletes^{34,35}.

This was also reflected in the present study for the control group who had not participated regularly in the training exercises given by the therapists. Another research article published by Punjama et. Al highlighted the effectiveness of neck and shoulder stretching exercise in effective reduction of neck and shoulder pain. They too had a limitation as the present study that the group size was small which was not enough to predict the overall performance accurately. Mark et. al reported in his study that a training routine reduced the forward shoulder posture in swimmers and concluded that the distance of acromion was -9.9, whereas for control group it was just -2.0²⁴.

Future studies can adopt a randomized controlled study design to investigate the effects of archery on function and performance in terms of flexibility, and performance among archers while controlling for the effects of all known confounding variables. As of now, in the study only male archers were considered, which could be extended to female archers too in future so that a complete investigation in the function and

performance of archers through effective strength training exercise will be estimated.

Ethical Clearance: Ethical clearance has obtained from Faculty of Physiotherapy, Dr. MGR. Educational and Research Institute, Chennai, Tamil Nadu, Reference number: No: A-04/PHYSIO/IRB/2021-2022 Dated: 07/01/2021.

Conflict of interest: There was no conflict of interest to conduct and publish this study.

Fund for the study: It was a self-financed study.

CONCLUSION

Archers who regularly underwent the strength training exercise given by the therapist resulted in superior shoulder function and performance in terms of both precise and accuracy.

Significant difference was observed for both flexibility and performance of the archers after regular strength training exercises offered by the therapist to the subjects. The mean and standard deviation computed for both the test group and control group before and after the training concluded that, the improvement was overall and significant.

Further studies may adopt a randomized controlled design to confirm the effects of archery on these outcome measures. Nevertheless, this study may benefit athletes and coaches seeking to identify the physical fitness profile and performance of amateur archers. Moreover, these results can be used to develop an evidence-based training strategy to improve sports performance of amateur archers.

Limitations Of the Study: The study was performed in the age group of 20 – 29 years, The

study was done with smaller group size of 30, Short duration study, Study was restricted only for male archers.

Recommendations of the Study: Further studies need to be conducted to prove the efficacy of the procedure involved in this study with Different age group, larger sample, Different field of players, Different positional demands of individual, Female archers

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