Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

ISOLATED AND COMBINED EFFECT OF STRENGTH TRAINING AND SPECIFIC STRENGTH TRAINING ON PERFORMANCE LEVELS AMONG ARCHERS

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Accepted for Publication: March 18, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.09

Abstract

Study purpose. The purpose of the study was to find out the impact of isolated and combined effect of Specific Strength Training, Strength Training, and Combined Strength Training on the performance levels among archers.

Materials and methods. Quantitative research study and non-random sampling method used for the study, a total of sixty (N=60) archers from various archery academies across India aged between 20.5±3.8 years were divided into four groups – Control Group (CG), Specific Strength Training Group (SSTG), Strength Training Group (STG) and Combined Strength Training Group (CTG) received 12 weeks of training schedule. SSTG & STG received alternate days/week where as CTG received alternate days of strength and specific training schedule.

Results. The results of the data were analysed using Analysis of Covariance (ANCOVA) followed by Bonferroni post hoc test and showed that the implementation of training methods significantly impacted the scoring performance index among the archer groups (SST<0.05, ST<0.05 and CT<0.05). The combined training group achieved highest performance index following strength training and specific strength training. However, no significant improvement in scoring performance index was found in the control group.

Conclusions. This research is an evidence that combination of training with shooting is necessary for improving the performance index among archers.

Keywords: isolated, combined, specific strength training, strength training, combined training.

Introduction

Archery is an individual recreational and competitive sport involves Power, Strength, Strength Endurance and Stability among the competing archers. In Archery mostly the upper body muscles were involved which are generally muscles recruiting Shoulder girdle (Mann & Littke, 1989) and arm muscles such as rhomboids, Trapezius, Deltoid, biceps, triceps etc. During shooting process, the archer has to hold the bow with his one arm extended towards the target which is then statically held by maintaining the force where in the string is pulled towards the reference point dynamically loading the strength through the back muscles and maintaining the force until the arrow is released dynamically executed by the draw arm/other arm (Leroyer, Van Hoecke, & Helal, 1993).

The archery shot cycle classified into eleven basic steps which indulges extreme muscular contraction and exhaustion due to repeated shot cycle execution during shooting. During this rigorous shooting archer generally experiences high static tremors as the number of arrows shot in a session increases due to the increased muscular force utilization with the decreased muscular strength and endurance of the specified group of muscles (Laishram, Kumar, & Sandhu, 2008; Satti, Mohan, & Chatla, 2022). The important pre requisite for an archer to develop is the strength, strength endurance, power and stability among the upper arm muscles.

Strength is one of the component which plays vital role in the performance of an archer (Sharma, Singh, & Singh, 2015). The strength of the arm muscles helps in preventing the tremors during the aiming process and also helps in de-

laying & overcoming the fatigue developed the repetitive shot process (Laishram, Kumar, & Sandhu, 2008; Lin, et al., 2010). Strength also plays vital role in the control of bow during the draw, hold & aiming phases of the shot cycle. The successful application of the forces and its distribution among the arms results in the success of an archer's performance (Lin et al., 2010). Resistance training in recent years had become one of the pre requisite for the development of general fitness, specific fitness and athletic conditional ability (Fleck & Kraemer, 1997). The sport specific resistance training should be an integral component for sport preparation which targets through the direct enhancement of specific muscular strength also facilitates improvement in sporting performance of specified sport (Syahputra & Pelana, 2021; Devi, Chatla, Pandey, Kaur, & Devi, 2022). The second important component of which performance of an archer determines is the Strength endurance (Ertan, Kentel, & Tümer, 2003; Landers et al., 1994; Lin et al., 2010). Strength endurance is the ability of an archer to perform shooting under the conditions of fatigue. Repetitive and greater volume of shooting of arrows increases the endurance of an archer there by delaying the onset of fatigue. Strength endurance also plays vital role in increasing the fatigue resistance of recruiting muscles which helps in the performance (Lin et al., 2010; Prasetyo & Siswantoyo, 2018).

Plyometric exercises which helps in the development of power ability among the recruiting muscles, this type of exercises employs quick action involving powerful movement of the muscle with stretch followed by concentric shortening muscular cycle (Ahmad et al., 2013; Dhawale et al., 2018). The major muscles which are used in archery for the initial outburst of power ability are the triceps, biceps, trapezius and posterior deltoid muscles (Ertan, Kentel, & Tümer, 2003). The plyometric exercises are adapted into the archer in order to prevent acute or chronic injuries development as archery is generally considered as the closed kinetic chain movement for repetitive use of the same muscles for the activity (Chelly et al., 2014; Lin, et al., 2010).

Stability is one of the key pre requisite variable for the consistency and reliability of the scores in archery. The stability involves the postural, core and upper body stability which can be observed for the consistency in shooting. The postural & core stability plays vital role in shot cycle execution with accuracy & elite performance. During the shot cycle in archery, one arm exerts dynamic pulling of the bowstring towards the reference point by flexing the elbow, the other arm pushes the bow with extended elbow position to the target, along with being statically held the position in the direction of target until release of arrow from the bow window. When archers draw the bow and aim at the target, they try to maintain stability at the highest level possible by minimizing tremors while maintaining a still posture of the trunk and arms.

Considering the simultaneous prospective of strength, endurance, stability and power coupling with the shooting consistency and rhythmical ability, the study focussed on the isolated and combined effect of strength training and specific strength training on the shooting ability.

Materials and methods

Participants

A total of sixty (N=60) archers including both male and female, aged between 20.5±3.8 years were recruited from various parts of India (Telangana, Andhra Pradesh, Karnataka, Tamil Nadu) for the study. The archers were reported for not having any acute and chronic pathological conditions for 6 months prior to the conduct of the study. Archers observed to be in the specific discipline (Recurve or Compound event) of their training for at least 3 years before shortlisting. Archers were both from recurve and compound divisions with medallists or participation at national level tournaments were recruited.

Study design

All the procedures performed under the study was in accordance with the Ethical Standards laid down by the Institutional Human Ethical committee. The research protocol was approved by the Institutional Ethics Committee for Biomedical Research (Institute of Genetics and Hospital for Genetic Diseases, Osmania University, O.No: 28/IEC/IOG/OU/18 dated: 05-02-2018). Archers training at different archery academies across India along with their coaches were approached and written consent form was taken from them explaining the aims and objectives of the research study. Archers who are willing to participate were segregated into four groups i.e., Control Group {CG} (n=15), Strength Training Group {STG} (n=15), Specific Strength Training Group {SSTG} (n=15) and Combined Training Group {CTG} (n=15). The Archers underwent 12 weeks of training schedule with Strength Training and Specific Strength Training Groups received alternate days of training viz., in Table 1, 2. The Combined Training group received alternate days of strength and specific strength training wherein the control group underwent their routine training schedule under Fig. 1. The data was obtained using data collection sheet at the beginning and the end of sessions their performance was assessed and reported.

Study setting

The study setting of different groups were conducted at four private academies run by NIS qualified Coaches. Initially one-week work shop was made mandatory for incorporation and inoculation of the training methodology for the respective coaches and strength training experts supervising the archers. The coaches & strength training experts were randomly assigned with the training schedule and were periodically supervised by the research investigator for appropriate information transfer and training modification. Initially before adaptation of training schedule the scoring of 72 arrows at 70-meter distance for recurve on standard 122 centimetres target face and compound division 50-meter distance on standard 80 centimetres target face with minimum score of 5 points was recorded accordance with the world archery rule. The scores of 72 arrows were recorded periodically before training and end of training programme i.e., after 12 weeks. The scores were collected at their regular practice venue and were evaluated. The technical and tactical training of the coaches remained unchanged.

Statistical analysis

The statistical analysis of the results was analysed based on SPSS software (version 21.0: SPSS Inc, Chicago, Illinois,

Table 1. 12-weeks Strength Training Schedule for archers

Type	Strength Training Group (Monday, Wednesday and Friday)		
	Week 1-4	**Week 5-8**	**Week 9-12**
Warmup (15 min)	Cardio endurance (8 min) Dynamic Stretching (7 min)	Cardio endurance (8 min) Dynamic Stretching (7 min)	Cardio endurance (8 min) Dynamic Stretching (7 min)
Strength Training (45 min) Initially 1 RM of each archer is determined - resistance for both Lower & Upper body 50-70% of 1 RM			
Lower Body: (15 min) {8-10 Reps X 3 sets} 1. Quadriceps 2. Glute Muscles 3. Calf Muscle 4. Hamstring Muscles	1. Goblet Squats with Fixed or Varied Resist. 2. Hip Hinge with Varied Resist. 3. Calf Raise with fixed Resist.	1. Smith varied Resistance Squats. 2. Dead Lifts with varied resist. 3. Calf Raise with varied Resist	1. Smith varied Resistance Squats. 2. Dead Lifts with varied resist. 3. Calf Raise with varied Resist.
Upper Body: (20 Min) {10-12 Reps X 3 Sets} 1. Posterior Deltoid, Latissimus Dorsi, Triceps 2. Anterior Deltoid, Trapezius, Pectoralis Major, Biceps 3. Lateral Deltoid and Supraspinatus	1. Rowing machine with Fixed or Varied Resistance 2. Push ups with Varied Elbow Position 3. Lateral Rises with varied Resistance	1. Bent over Rowing with Fixed or Varied Resist. dumbbells Rare Deltoid Flies 2. Resistance Push ups with Varied Elbow Position. Front Raises with Resistance 3. lateral Raises with varied resistance	1. Bent over Rowing with Fixed or Varied Resist. Barbell Inclined French press Rare Deltoid Flies 2. Chest press machine with varied resistance. Front Raises with Resistance Bicep curls 3. lateral Raises with varied resistance
Lower Back & Core Group: (10 Min) {8-10 Reps X 3 Sets} 1. Rectus abdominis 2. External oblique, Internal oblique, transverse abdominis 3. Longissimus and Quadratus Lumborum	1. Plank hold 2. Abdominal Crunches 3. Leg Raises 4. Side Planks 5. Flying Pose on abdomen	1. Abdominal V Hold 2. Abdominal Crunches 3. Flying Pose on abdomen 4. Side Plank with one complete arm extended and other folded at elbow.	1. Abdominal V Hold 2. Abdominal Crunches 3. Flying Pose on abdomen 4. Side Plank with one complete arm extended and other folded at elbow
Cool-down	Static Stretches from toe to head is followed by holding the pose for 5 seconds		

Table 2. 12-weeks of Specific Strength Training Schedule for archers

Type	Specific Strength Training (Tuesday, Thursday and Saturday)		
	1-4 Weeks	**5-8 weeks**	**8-12 Weeks**
With Bow (30 min)	1. Thera band Exercises: Both the hands Half Draw hold – (8-10 Reps × 3 Sets) Full Draw Hold – (8-10 Reps × 3 Sets) Over Draw Hold – (8-10 Reps × 3 Sets) Backwards Draw hold – (8-10 Reps × 3 Sets)	1. One Hand Bow Holding – different positions {target, overhead} – (8-10 Reps × 2 Sets) 2. Half Draw hold for 45 seconds – (6 Reps × Sets) 3. Full Draw hold for 60 seconds – (6 Reps × 2 sets) shift the balance from one leg to other front, back, sideways 4. Over draw and hold for 45 seconds – (6 Reps × 2 sets) 5. Pulling Backwards – (6 Reps × 2 Sets)	1. One Hand Bow Holding – different positions {target, overhead} – (8-10 Reps × 3 Sets) 2. Half Draw hold for 45 seconds – (8 Reps × 3 Sets) 3. Full Draw hold for 60 seconds – (8 Reps × 3 sets) shift the balance from one leg to other front, back, sideways 4. Over draw and hold for 45 seconds – (8 Reps × 3 sets) 5. Pulling Backwards – (8 Reps × 3 Sets)
Without Bow (20 min)	1. Static Strap – the strap length maintained at 80% of draw length of specified archer – hold for 15 seconds (4 Reps × 2 Sets) 2. Single arm hold – Side Plank with one complete arm extended and other folded at elbow – Started with Bow Arm for 2 min hold and other arm with 1 min hold	1. Static Strap – the strap length maintained at 80% of draw length of specified archer – hold for 30 seconds (6 Reps × 2 Sets) 2. Single arm hold – Side Plank with one complete arm extended and other folded at elbow – Started with Bow Arm for 3 min hold and other arm with 1.5 min hold	1. Static Strap – the strap length maintained at 80% of draw length of specified archer – hold for 30 seconds (8 Reps × 3 Sets) 2. Single arm hold – Side Plank with one complete arm extended and other folded at elbow – Started with Bow Arm for 4 min hold and other arm with 2 min hold
Cooling Down (15 min)	Static Stretches from toe to head is followed by holding the pose for 5 seconds followed by Partner stretching for complete relaxation		

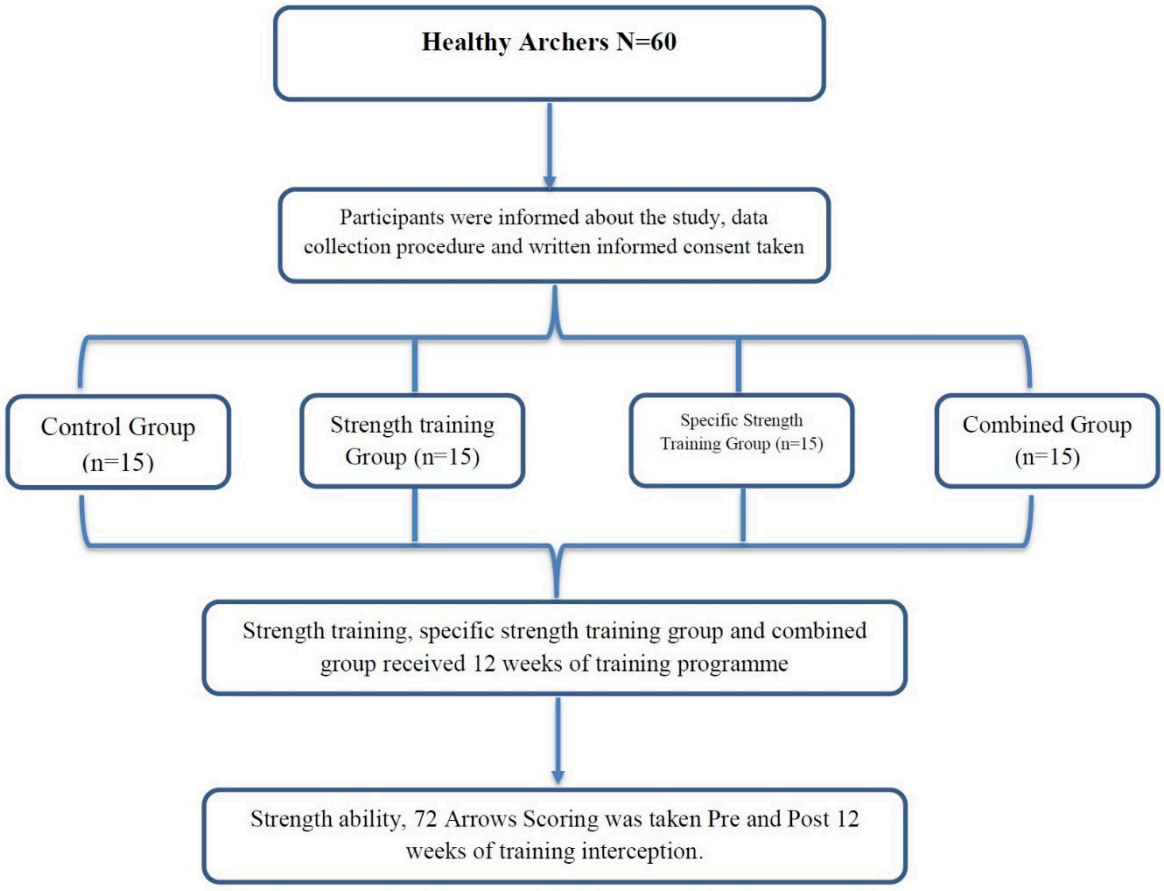

Fig 1. Schematic Representation of Research Protocol

USA). The data was presented on Mean ± Standard Deviation. The results were statistically analysed through paired t test to determine the effect of the training schedule on the performance ability and ANOVA followed by Bonferroni Post hoc test was adapted to differentiate among the groups with the level of significance was fixed at 0.05 level.

Results

The data of pre-test and post-test were arranged and tabulated for further treatment. For the research investigation, the researcher divided the players into four groups. For testing the significance effect of strength training, specific strength training and combined training on the scoring ability of archers (t) test was employed to determine the difference between in the performance between pre-test and post-test means of each group which was presented in the following Table 3. Significant at 0.05 level of confidence.

From table 3 is clearly stated that, the obtained t test values 12.243, 12.866 and 16.725 of Specific Strength Training Group, Strength training group and combined training group respectively, were greater than the table value 2.45 at 0.05, whereas the control group t test value 1.24 is less than the table value. Thus SSTG, STG and Combined training group had significantly effects the shooting/scoring ability among archers.

Assessing the major impact of the training methods on the scoring/shooting performance index Analysis of Co-variance was employed with Bonferroni post hoc test.

Table 4 indicated that the F ratio value was 111.512 greater than table value 2.758 with df. 3 and 55 at 0.05 level. Thus result of the study indicated that there was significant difference exist among the adjusted post-test means of Control group, Specific Strength Training Group, Strength Training Group and Combined training group on the scoring/shooting ability among archers.

Table 3. Mean, standard deviation and dependent 't' test for the pre and post test on shooting ability among control group, Specific Strength Training Group, Strength training group and combined training group

Test	Control Group	SSTG	STG	CTG
Pre Test (mean ± SD)	531.20 ± 14.958	535.33 ± 12.965	533.44 ± 7.04	536.13 ± 8.68
Post Test (mean ± SD)	537.27 ± 9.896	557.93 ± 10.068	568.35 ± 8.62	591.60 ± 10.49
Paired t-test	1.24	12.243	12.866	16.725

Table t-value = 2.45

Table 4. Analysis of Covariance on shooting/scoring ability among Control Group, Specific Strength Training Group, Strength Training Group and Combined Training Group

Group	Pre Test	Post Test	Adj. Post	Source	Sum SS	Df	Mean SS	F	P Value
CG	531.20 ± 14.958	537.27 ± 9.896	532.635	Between	25772.971	3	8590.990	111.512	0.0001
SSTG	535.33 ± 12.965	557.93 ± 10.068	557.385						
STG	533.44 ± 7.04	568.35 ± 8.62	569.10	With in	4237.244	55	77.041		
CG	536.13 ± 8.68	591.60 ± 10.49	590.68						

Significant at 0.05 level of confidence

Table 5. p-value of Adjusted Post Mean difference and p-values among Control Group, Specific Strength Training Group, Strength Training Group and Combined Training Group with Bonferroni Correction α value at 0.00833

Adjusted Post Test Mean				Mean Difference	P Value	Bonferroni correction α-Value
CG	SSTG	STG	CTG			
532.635	557.385	–	–	24.75	0.00015	0.00833
532.635	–	569.10	–	36.465	0.0001	
532.635	–	–	590.68	58.045	0.00001	
–	557.385	569.10	–	11.715	0.0034	
–	557.385	–	590.68	33.295	0.0001	
–	–	569.10	590.68	21.58	0.00012	

Significant at 0.05 level of confidence

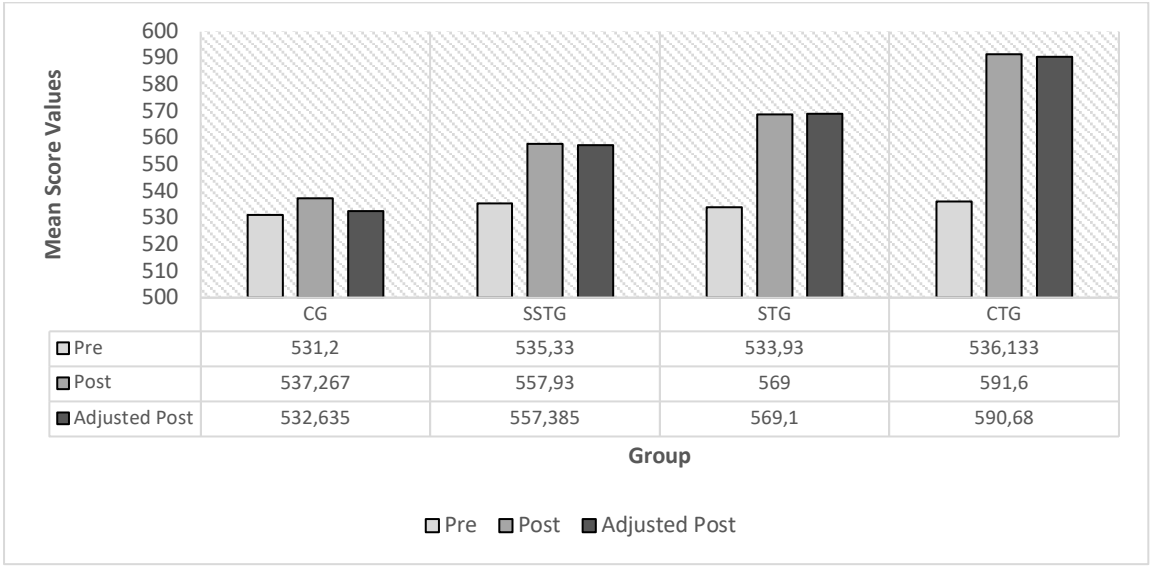

Fig 2. Pre, Post and Adjusted post mean Score values of Control Group, Specific Strength Training Group, Strength Training Group and Combined Training Group

The p-values of adjusted post-test mean difference among the Control Group, Specific Strength Training Group, Strength Training Group and Combined Training Group were significantly less than Bonferroni corrected α-value at 0.00833 indicated that there is a significant difference exists through the training methods on the scoring ability among archers under table 5.

Discussions

The present study aimed at to find out the effect of isolated and combined effect of Strength Training and Specific Strength Training on the performance levels among archers. The main research findings of the study suggested that there was significant change in scoring ability among all the subjects of various experimental groups such as Specific Strength Training Group, Strength training group and Combined Training Group under research protocol which was carried out for period of 12 weeks of innervation and its impact on the performance levels of archers with that of control group. This suggests that there is a significant impact of training methods among the three groups SSTF, STG and CTG.

The results conform with the findings of (Sharma, Singh, & Singh, 2015) have studied on the effect of 6 weeks training

on the development of static strength among archery players. Dhawale, Yeole and Jedhe (2018) also found out the effect of upper extremities plyometric training on strength and accuracy among performance levels of archery players. Whereas (Humaid, 2014) had investigated that the impact of Arm muscle strength, Draw length and technique on the Achievement levels among archers. The above research studies indicated that there is significant impact on the performance index through strength training.

Lin et al. (2010) signified the importance of muscles used in the archery are of the shoulders and upper back such as rhomboids, levator scapulae, trapezius, deltoid (Anterior, posterior and lateral), latissimus dorsi and the most important stabilizer rotator cuff muscles (supraspinatus, infraspinatus, teres minor and subscapularis). As there is a need of maintaining a proper stability during archery shooting, muscles belonging to the upper extremities are the utmost responsible and should be activated contrary with the lower extremities (Ertan, 2009). These upper muscles help to push, pull and hold the bow until the arrow is released from the bow window till it hits the specified target where in muscles remain in the activated form. Laishram, Kumar, and Sandhu (2008) and his associates studied the effect of strength training among the upper extremities targets the building of strength among major muscles such as Trapezius, Pectoralis major, biceps, triceps, deltoid and stabilizers such as rotator cuff muscles ensures the prevention of tremors and stability during shooting and consistency of scores among archers.

Conclusion

The principle conclusion based on the current research study shows the implementation of strength and specific strength training can progressively improve the performance index of archers. It was also signified that Combined Strength Training had greater impact on the performance index among archers. The findings of this study could potentially be applied for future studies extrapolating with the yogic practices.

Acknowledgement

We express our gratitude to those who have provided support for this research activity.

Conflict of Interest

No conflict of interest.

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ОКРЕМИЙ І КОМБІНОВАНИЙ ВПЛИВ СИЛОВИХ ТРЕНУВАНЬ І СПЕЦІАЛЬНИХ СИЛОВИХ ТРЕНУВАНЬ НА РІВНІ ПОКАЗНИКІВ ЛУЧНИКІВ

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 5 табл., 2 рис., 17 джерел.

Мета дослідження. Метою дослідження було з'ясувати вплив окремого та комбінованого ефекту спеціальних силових тренувань, силових тренувань і комбінованих силових тренувань на рівні показників лучників.

Матеріали та методи. У дослідженні використовували кількісне дослідження та метод невипадкової вибірки, загалом шістдесят (N=60) лучників із різних академій стрільби з лука з усіх регіонів Індії віком 20,5±3,8 років розподілили на чотири групи: контрольна група (КГ), група спеціальних силових тренувань (ГССТ), група силових тренувань (ГСТ) і група комбінованих силових тренувань (ГКТ), і вони отримали 12-тижневий розклад тренувань. ГССТ та ГСТ отримували почергові дні/тиждень, тоді як ГКСТ отримала почергові дні графіка силових тренувань і спеціальних тренувань.

Результати. Результати даних були проаналізовані за допомогою коваріаційного аналізу (ANCOVA) з наступним апостеріорним критерієм Бонферроні та показали, що впровадження методів тренування статистично значущо вплинуло на індекс результативності в групах лучників (ССТ<0,05, СТ<0,05 та КТ<0,05). Група комбінованих тренувань досягла найвищого індексу результативності після силових тренувань і спеціальних силових тренувань. Проте в контрольній групі статистично значущого покращення індексу результативності не виявлено.

Висновки. Це дослідження є доказом того, що поєднання тренувань зі стрільбою є необхідним для покращення індексу результативності лучників.

Ключові слова: окремий, комбінований, спеціальні силові тренування, силові тренування, комбіновані тренування.

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Cite this article as: Chatla, A. K., Narasimha Rao, K V., Pandey, D., Devi, L. S., & Satyanarayana, V. (2023). Isolated and Combined Effect of Strength Training and Specific Strength Training on Performance Levels Among Archers. *Physical Education Theory and Methodology, 23*(2), 214-220. https://doi.org/10.17309/tmfv.2023.2.09

Received: 11.01.2023. Accepted: 18.03.2023. Published: 28.04.2023