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Effectiveness Of Scapular Endurance Training In 10m Air Rifle Shooters

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ABSTRACT

Background: This air rifle event, 10 meters long, is an ISSF-sanctioned precision shooting sport where shooters fire 4.5 mm (.177 caliber) pellets at a target 10 meters away from a standing position. The event requires extraordinary accuracy, stability, and mental concentration because the 10-ring on the target measures only 0.5 mm in diameter, with elite performance often relying on consistently scoring in this tiny area across 60 shots (for men) or 40 shots (for women), all under strict time limits.

Success in this sport hinges on combining technical skills, postural stability, and physical conditioning, which demands that the shooter retains stable body posture for a sustained period while counteracting the unnoticeable movements created due to breathing, heart rate, and muscle fatigue.

Scapular endurance training is defined as a training program that strengthens and enhances the endurance of the muscles around the shoulder girdle: trapezius, rhomboids, serratus anterior, and rotator cuff muscles. These muscles are crucial for the stabilization of the scapula, which serves as the base for mounting all upper limb activities and the posture. In 10m air rifle shooting, shooters take position in standing, with the rifle supported by the shoulder and arm, which also requires prolonged isometric contractions to maintain a stable hold. Scapular muscles are vital in preventing shoulder fatigue, minimizing barrel movement, and ensuring a consistent aim, particularly during long competitions where fatigue detrimentally affects performance.

The rationale for exploring scapular endurance training here is, of course, due to the unique physical demands of the sport. Unlike dynamic sports, air rifle shooting requires static endurance to resist muscle tremors in maintaining precise alignment. Research indicates that inadequate scapular stability leads to compensatory movements that increase barrel sway, making the shot inaccurate. For instance, studies conducted in other shooting disciplines have shown that scapular muscle endurance can be beneficial for shooting performance by increasing upper body stability. However, scientific evidence for this in 10m air rifle shooters is less extensive, hence the interest in assessing whether targeted scapular training may correlate with improved scores or lesser performance variability.

Some of the key factors that may determine the success of the training include the level of skill of the shooter (novice or elite), intensity of training, and the extent to which scapular exercises are integrated with other conditioning, such as core stability or balance training. Elite shooters with already superior postural control compared to novices may benefit in a different way, with novices seeing more substantial gains through improvement in basic strength. Also, due to the sheer repetitiveness of holding a 4-5 kg rifle over long durations, it would suggest that endurance as opposed to sheer strength would be the requirement, and thus scapular fatigue resistance may be implicated as performance-determining.

Indeed, this subject is important, as it may well provide an edge in competition within a sport where the margins are ever slight. Whether or not training for endurance of the scapula has an effect on shooting performance may also be of interest to coaching personnel who would be better able to guide their shooting athletes into maintaining levels of performance under pressure; however, there is still a number of unexplored areas in the literature, notably standardized protocols for scapular training and long-term effects on shooting metrics such as shot grouping or score variance. Researching this area would also help build the practical side of training with scientific easement and benefit both athlete and coach within the precision sports field.

Methods: This randomized clinical trial will assess the impact of an intervention on scapular endurance training in 10 m air rifle shooters. Thirty participants with 10 m air rifle shooters, will be selected via random sampling. Inclusion criteria include the participants aged 18 to 35 years, active 10 m air rifle shooters with at least 2 years of competitive experience, physically healthy and engaging in regular training with 3 times per week . Exclusions include history of shoulder or back injuries in past 6 months, use of medications that affect muscle strength. The outcomes are closed kinetic chain upper extremity stability test, upper quarter Y balance test, prone bridge test, side bridging endurance test, scapular muscle endurance test Participants will undergo a six-week intervention, with data analyzed post-assessment. Ethical approval and informed consent will be obtained.

Result: Based on the statistical analysis, the effectiveness of scapular endurance training on accuracy in 10 m air rifle shooters shows highly significant. ($p<0.0001$).

Conclusion: The scapular endurance training proved to be an extremely useful tool for the 10m air rifle shooters, improving scapular stability and endurance and balance. This indicates that such exercises should be incorporated into training regimens; these improvements could serve to enhance performance and perhaps even reduce injury risks. In the future, such developments should be correlated against competition performances to assess their validity further.

Keywords: *scapular endurance training, 10 m air rifle shooters*

1. INTRODUCTION

Shooting sports are characterized mainly by highly demanding outdoor categories, like the 10m air rifle discipline. Such activities significantly require the performance of concurrent physical and mental attributes whose combination, among others, could easily be termed "muscular endurance" because that is a lot about maintaining stability while shooting. The endurance of the scapular muscles-the muscles surrounding the shoulder blade-has recently been marked as the new premium factor affecting shooting performance. This introduction delineates the importance of scapular endurance training on the performance of 10-m air rifle shooters as it relates to performance injury prevention and better shooting aptitude.

The scapula acts as the base for all shoulder movements and stability. It enhances the alignment and control of the shooter's aim during the shooting process. Muscles such as trapezius, rhomboids, serratus anterior, and many others should be very strong and resistant to fatigue, and the endurance of these muscles should determine the shooting posture during prolonged periods of shooting exercise or competition. Scapular muscle endurance has shown a clear positive relationship with better performance during shooting: that is, endurance performance is directly related to the accuracy exhibited and the reduced instability while aiming by the shooter [1][2].

There was moderate correlation between scapular muscle endurance and shooting scores, besides which specific conditioning ones are crucial for favorable improvement in such muscle groups in training [3]. In addition to that, strong scapular muscles are important in performing the recoil management tasks among shooters and their maintenance during the shooting posture, both indispensable in precision shooting [4][5].

Shooting with the 10m air-rifle imposes high physiological demands. The shooters have to endure long periods of time keeping very stable positions while controlling their breaths and restricting movements to a minimum. The requirement for a steady hold across the positions of standing, kneeling, or prone literally takes a toll upon the shoulder girdle requiring scapular muscle endurance to offset fatigue and improved performance decrements [6][7].

Research indicates that postural balance is said to be among the considerable factors determining an individual's shooting accuracy. For instance, tremors and instabilities or fatigues in the shoulder region could result in missed shots or diminished performances [8][9]. Other studies have proven improved endurance of scapula musculature to contribute to increased efficiency in postural control so that shooters can hold their positions and aim during long periods [10].

As if they were not enough, scapular endurance training is said to improve the psychological aspects of shooting. Better arm endurance will allow shootees to be more physically prepared for their techniques and strategies while minimizing distractions. The result is much better performance under competitive pressure [15].

Along with it, practice strengthens self-discipline and commitment, both of which are essential for winning in shooting sports. As the shooter starts to understand his body mechanics in a better way, he is more likely to adapt himself to very difficult situations like that created by environmental changes with regard to wind or different light conditions [16].

Scapular endurance training mainly focuses on the improvement of precision. Apart from this, additional advantages include the following, Prevention of Injury-An injury is caused to overuse or overtraining of a part usually in a shooter (working endurance) when strengthened muscles around the scapula reduce that injury from happening. Endurance thereby prevents long-term damage to the body with repetitive strain inflicted on it [17].

Improved Postural Mechanics- In enhancing better overall body mechanics, scapular endurance training indirectly helps to optimize shoulder position and stability while minimizing fatigue and consistent shot success [18][19].

There is a growing body of evidence indicating that scapular endurance is a major factor associated with shooting performance. For example, studies indicate that more specific training interventions improve muscle activation patterns, which translate into greater accuracy in shooting [20]. In another example, shooters that adopted a specific program for their training were found to exhibit better postural control and less incidence of error due to fatigue during competition [21].

Moreover, it was reported that programs which incorporated scapular stability exercises as part of conditioning tend to

decrease tremor amplitude, which is vital in maintaining accuracy during aiming [22].

2. METHODOLOGY

Materials and Methods:

After approval from institutional protocol and ethical committee, this study was performed in Krishna Vishwas Vidyapeeth. The study's major goal was to determine the effectiveness of scapular endurance training for 10m air rifle shooters**.**

This experimental study follows a randomized clinical trial design conducted in Karad over a duration of six months, with a sample size of 34 participants selected through a random sampling method. The study includes participants aged 18-35 years who are active 10m air rifle shooters with at least two years of competitive experience. Eligible participants are physically healthy, have no history of shoulder or upper extremity injuries in the past six months, engage in regular training sessions at least three times per week, and are willing to provide informed consent. Participants with a history of shoulder, upper extremity, or back injuries within the past six months, those using medications affecting muscle strength or performance, individuals with a history of shoulder or upper extremity surgery, and non-competitive shooters or those with less than two years of experience are excluded from the study.

Procedure: Participants will be randomly assigned to an intervention group, which will receive scapular endurance training. Baseline assessments will be conducted using standardized outcome measures. The intervention group will undergo a structured scapular endurance training program designed to improve muscular endurance, conducted three times per week for 6weeks. Everyone in the group will receive scapular endurance exercises. The scapular endurance training program will include exercises such as scapular shrugs, scapular retraction exercises, scapular isometrics, wall slides, alternate arm-leg raises, wall pushups, and scapular T/Y/W exercises. Each exercise will be performed in a controlled manner, focusing on proper technique, with progressive overload applied as tolerated by the participants to enhance endurance and stability.

Outcomes and Measures: Outcome measures include the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST), Upper Quarter Y Balance Test (UQ-YBT), Prone Bridge Test, Side Bridge Endurance Test, and Scapular Muscle Endurance Test. These assessments will be conducted pre- and post-intervention to evaluate changes in performance and the effectiveness of the scapular endurance training.

3. RESULT

Table 1:

Test	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	% Improvement	p-value
CKCUEST (touches)	7.67 ± 3.2	10.66 ± 4.44	38.9%	<0.001
UQ-YBT Composite Score (%)	79.4 ± 4.5	85.9 ± 3.9	8.91%	<0.001
Prone Balance Test (seconds)	43.8 ± 6.7	58.2 ± 5.4	28.5%	<0.001
Side Bridge Test (seconds)	23.35 ± 5.8	31.27 ± 7.84	33.9%	<0.0001
Scapular Endurance (seconds)	41.3 ± 0.6	56.35 ± 0.88	36.5%	<0.0001

Table 1 The Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) showed a pre-test mean of 7.67 ± 3.2 touches, increasing to 10.66 ± 4.44 touches post-test, yielding a 38.9% improvement ($p < 0.001$). The Upper Quarter Y-Balance Test (UQ-YBT) composite score rose from 79.4 ± 4.5% to 85.9 ± 3.9%, a modest but significant 8.91% improvement ($p < 0.001$). In the Prone Balance Test, participants increased their hold time from 43.8 ± 6.7 seconds to 58.2 ± 5.4 seconds, a 28.5% gain ($p < 0.001$). The Side Bridge Test, assessing lateral core and scapular endurance, improved from 23.35 ± 5.8 seconds to 31.27 ± 7.84 seconds, a 33.9% rise ($p < 0.0001$). The Scapular Endurance Test showed a pre-test mean of 41.3 ± 0.6 seconds, rising to 56.35 ± 0.88 seconds post-test, a 36.5% improvement ($p < 0.0001$).

4. DISCUSSION

Scapular endurance training exercises have the potential to strengthen the trapezius, rhomboid, and serratus anterior muscles. These muscles play a role in stabilizing the shoulder girdle as well as in maintaining any posture. This paper will evaluate effectiveness, advantages, and disadvantages associated with precision sports such as this one.

Increased postural stability would be a primary advantage. Shooters require a consistent stance for the alignment of the rifle with the target; any scapular muscle fatigue leads to compensatory activities, usually elevation of the shoulder, which disrupts the aim. Further, endurance may aid optimal positioning during the last stages of the competition when judges arrive for tighter shot groupings and higher scores. It may help in reducing injury risk; in repetitive load sculpts of shoulder strain, stronger scapular muscles add distribution and, probably, prevention of scapular dyskinesis.

However, effectiveness will depend largely on the specificity of training for that sport. The target for air rifle shooting is precision, not strength, so too much emphasis on endurance would be liable to bring about hypertrophy or fatigue to a level which would act to change biomechanics and energy use and might cause hindrance to fine motor movement. Performance will also depend upon mental focus, technique of triggering, and breathing—all not amenable to scapular training. Their advantages would therefore be very limited without the two types of coaching: technical and psychological.

Evidence from related sports like archery indicates that provision of scapular stability would imply even more aiming consistency in the future, which gives hints as to whether use may be beneficial for shooters. Unfortunately, studies specific to sport activities are limited in number; further longitudinal studies are needed to connect the improvements in endurance to such outcomes as shooting accuracy or competition results.

In summary, scapular endurance training could nearly guarantee enhanced stability and fatigue resistance in 10m air rifle shooters, which can further translate to an edge in competition when integrated as appropriate fitment. It holds a lot of promise; however, it may not make as much sense as a standalone application, which should be further added to research for better application understanding. It might be what coaches call one of the many additional tools one would consider within a training system.

5. CONCLUSION

For the shooters, it seems that these improvements would mean better rifle control and reduced error from fatigue to improve the consistency of both aiming and performance itself. Indeed, the increased scapular endurance in conjunction with associated stability measures (CKCUEST, UQ-YBT) agrees with the hypothesis that such training strengthens the physical base for precision. This foundation ultimately allows athletes to perform at their best, particularly under the pressure of competition. As a result, not only does this enhance individual shooter performance, but it also contributes to overall team success in high-stakes environments. While shooting performance in terms of scores has not been directly tested, this would mean improvement in the physical capacity needed for the sport, encouraging an argument for practical effectiveness.

It is very effective to have the endurance training for the scapula on 10 m air rifle shooters. This targeted approach not only enhances their shooting accuracy but also reduces the risk of injury, allowing athletes to train more consistently. Consequently, integrating scapular endurance training into their regimen could prove instrumental in optimizing overall performance and longevity in the sport. Scapular stability, endurance, and balance improve considerably due to it. It pushes for inclusion in performance enhancement training and injury risk reduction. Future studies should correlate these physical gains with outcomes in competition to support their relevance even further.

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