International Journal of Sports, Health and Physical Education

ISSN Print: 2664-7559
ISSN Online: 2664-7567
IJSHPE 2025; 7(1): 94-100
www.physicaleducationjournal.in
Received: 12-12-2024
Accepted: 19-01-2025

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Effects of advanced throwers ten programme to measure strength, power and endurance in overhead athletes

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DOI: https://www.doi.org/10.33545/26647559.2025.v7.i1b.182

Abstract
Background: The Throwers Ten program, refined in 1991 by Wilk *et al*., targets shoulder injury prevention and rehabilitation. It emphasizes coactivation, neuromuscular control, dynamic stabilization, and coordination. Strength, power, and endurance are vital for optimal throwing performance. A holistic approach blends resistance training with sport-specific drills to enhance overall athletic abilities. Aim was to investigate the effects of advanced throwers ten programme on strength, power and endurance in overhead athletes using 1RM bench press, seated medicine ball and pushup test respectively.
Method: 30 overhead athletes were selected on basis of inclusion and exclusion criteria and receive advanced throwers ten program session for 6 weeks 3 sessions per week, along with 10 minutes warm-up exercise before training and 10 minutes cool down period after training. Pre and post measurement of 1RM bench press, Medicine ball and Pushup test were taken.
Result: shows there is significant improvement in strength, power and endurance test ($p < 0.0001$).
Conclusion: Advanced throwers ten program is useful to prevent shoulder injuries in overhead athletes.

Keywords: Advanced throwers ten program, medicine ball test, pushup test, 1rm bench press

Introduction
Athletes in sports like baseball, cricket, tennis, and volleyball utilize overhead throwing motions, which can lead to complex injuries such as reduced range of motion and muscular imbalances. Prevention involves consistent, balanced training [1]. Overhead throwing demands flexibility, strength, and coordination. Athletes in these sports must maintain optimal shoulder range of motion, strength, and balance to prevent injuries. Success requires significant upper extremity acceleration and force generation [2]. The overhead throwing motion is highly demanding, exerting immense pressure on the body due to its high velocity and repetitive nature. This often results in injuries, particularly in the throwing arm or shoulder [3]. Jobe and Moynes introduced the initial isotonic shoulder strengthening program in 1982, further developed by Jobe and Bradley in 1988 and expanded upon in the Throwers Ten Training Program by Wilk *et al*. in 1991. This evidence-based regimen targets essential muscles for overhead throwing athletes [4]. The Advanced Thrower's Ten Program, designed for later rehabilitation phases, aims to enhance strength, power, and endurance specific to throwing motions. It incorporates exercises tailored to athletes, focusing on coactivation, neuromuscular control, and muscle balance [5].
Strength is crucial for generating force in various muscle actions like eccentric, concentric, and isometric contractions [6]. Overhead throwing necessitates strengthening the entire upper extremity, including the shoulder, scapula, elbow, and wrist, to tackle its challenges [7]. A balanced development between agonist and antagonist muscle groups aids in dynamic shoulder joint stabilization. The scapulothoracic musculature plays a pivotal role in overhead throwing, acting as force couples around the scapula for movement and stabilization [8].
To prevent injuries in overhead athletes, establishing efficient dynamic stabilization and neuromuscular control of the glenohumeral joint is crucial [8]. Glenohumeral stability depends on coordinated balance between capsuloligamentous structures and neuromuscular control of the upper extremity [9]. Maintaining equilibrium between internal and external rotator muscles is essential for glenohumeral stability and optimal humeral head positioning [10].

Emphasizing rotator muscle strength, especially internal rotators, enhances ball velocity and throwing efficiency. Additionally, eccentric strength of external rotators aids in deceleration during forceful throwing [11].

Explosive muscular power, essential for sudden bursts of power, relies on the force applied and velocity of movement [12]. In throwing, the glenohumeral joint and scapulothoracic complex synchronize to regulate powerful movement patterns [13]. Throwing induces significant demands on dynamic stabilizers due to anterior shear and distraction forces across the glenohumeral joint [14]. The shoulder, scapular region, and core collaborate to generate force for the repetitive throwing motion.

To elevate power output, combining eccentric and concentric movements leverages muscle elasticity within the stretch-shortening cycle [15]. The cycle starts with a rapid countermovement stretching the muscle eccentrically, activating muscle spindle fibers that prompt immediate contraction, enhancing acceleration during concentric action. Endurance allows sustained submaximal activity, crucial for repetitive muscular contractions without fatigue. Endurance training enhances fatigue resistance by influencing muscle fiber types and energy systems, improving oxygen delivery and distributing workload evenly. Sport-specific endurance improves performance by combining various endurance types [16]. Shoulder muscle fatigue alters joint mechanics, increasing injury risk. Gradually increasing intensity and rest intervals help build shoulder muscle endurance, preventing injuries [17]. Thus, this study aims to investigate the preventive effects of the Advanced Throwers Ten program on shoulder injuries among overhead athletes by assessing pre and post measurements of strength, power, and endurance.

Methodology

The study was conducted at the Sports Authority of Gujarat in Vadodara, focusing on overhead athletes such as badminton players. A sample size of 30 participants were selected through convenient sampling over a duration of 10-12 months, employing an experimental pre-test and post-test design. Materials including consent forms, medicine balls of 1.5 kg and 3 kg, a gym bench, measuring tape, pen and paper, a stopwatch, dumbbells, Theraband, and physio balls were utilized for various assessments and exercises. Inclusion criteria [18] encompass healthy individuals aged 18-30, of both genders, engaging in sports involving throwing activities professionally, and willing to participate. Exclusion criteria [19] entail overhead athletes with recent shoulder discomfort, tendinitis, capsulitis, or dysfunction, shoulder instability within the past year, previous orthopedic shoulder surgery, upper limb fractures within the past two years, or known neurological or cardiorespiratory conditions. Approval was obtained from the ethics committee of biomedical health and research [KPGU/KSPR/EC/23/03/27.3] for this research.

The study involved 30 overhead athletes who met the inclusion and exclusion criteria were recruited. Based on criteria they received the Advanced Throwers Ten program intervention. Before and after the six-week intervention, participants underwent assessments including pushup, 1RM bench press, and seated medicine ball tests. The intervention consisted of three 45-minute sessions weekly, with warm-up and cool-down periods featuring light jogging and stretching. This targeted program aimed to improve shoulder and upper body strength, power, and endurance. All the players provided informed consent and verbal instructions were provided regarding the intervention. Post-exercise data were collected upon completion of the intervention period.

Intervention [20]

Sr. Number	Protocol Name	Procedure
1	A. External Rotation at 0° Abduction:	Sit on a stability ball with involved elbow fixed at side, elbow at 90°, and involved arm across front of body. Grip tubing handle while the other end of tubing is fixed. Pull out arm, keeping elbow at side. Return tubing slowly
	B. Internal Rotation at 0° Abduction:	Sit on a stability ball with elbow at side fixed at 90° and shoulder rotated out. Grip tubing handle while other end of tubing is fixed. Pull arm across body keeping elbow at side. Return tubing slowly and controlled.
2	Scaption with sustained hold:	Sit upright on a stability ball with shoulder blades retracted and depressed. In the first set, raise both arms in line with the shoulder blade to 90°. In the second set keep the right arm at 90° while the left arm raises and lowers for 10 repetitions. Repeat this process but switch arms. Then alternate arms
3	Shoulder Abduction to 90° with sustained hold:	Repeat #2 only with the arms raised straight out to the side, instead of slightly in front of the body.
4	Side lying External Rotation:	Support the body in a “side plank” position, with involved arm at side of body and elbow bent to 90°. Keeping the elbow of involved
		Arm fixed to side, raise arm. Hold seconds and lower slowly. Make sure that your back stays straight through the entire set
5	“T” raises	In these exercises focus upon pulling the shoulder blades together. Lie on your stomach on a stability ball. Raise your arms to your side in a “T” position until it is parallel to the floor. Repeat this process for each side individually, as in two above
6	“Y” raises	Repeat five above, except raise the arms into a “Y” position
7	External Rotation Row -	Repeat five above with the arms in a “W” position so that the shoulder is rotated in maximal external rotation that the shoulder is rotated in maximal external rotation
8	Lower Trapezius Exercises -	These exercises include shoulder extension in 20° of abduction with the arms externally rotated, shoulder extension at 45° of abduction with the arms externally rotated (see picture), wall circle slides, low rowing in standing position, and table press-downs with scapular depression.
9	A. Elbow Flexion:	Sitting on a stability ball with arm against side and palm facing inward, bend elbow upward turning palm up as you progress. Hold and lower slowly
	B. Elbow Extension	Raise involved arm overhead. Provide support at elbow from uninvolved hand.
	(Abduction):	Straighten arm overhead. Hold 2 seconds and lower slowly
10	Wrist flexion, supination and pronation	Repeat exercise #10 from the Thrower’s ten, including wrist extension, wrist flexion, supination, and pronation.

Outcome measures

1 RM Bench [21]

The 1RM (one-repetition maximum) bench press is used as a measure of upper body strength and muscular endurance.

Procedure

Individuals participating in this weightlifting protocol will first be instructed to grip the bar securely. They will then proceed to press a weight previously agreed upon by both the tester and the volunteer. The lifting process involves lowering the bar until it touches the chest, followed by an immediate press into a full arm extension. After each attempt, the weight will be adjusted by adding 5-20 lbs. based on the performance of the individual. This process of adjusting the weight and attempting the lift will continue until a maximum weight is established. Between each attempt, a rest period of 2 to 5 minutes will be allowed, with a maximum of 4 attempts utilized in total.

Seated Medicine Ball Test [22]

The seated medicine ball test assesses upper body power and explosiveness. It measures the distance or velocity of a seated throw, providing valuable insights into an athlete's upper body strength and power, aiding in performance evaluation and progress tracking.

Procedure

The seated medicine ball test involves the subject sitting in a chair with back support, holding the ball in both hands with arms extended away from the chest. A 10-meter distance is marked on the ground. The subject forcefully pushes the ball away from the center of the chest, and the distance the front end of the ball travels is recorded. Three trials are performed with both 1.5 kg and 3 kg balls, with 90-second rest intervals between trials. The intraclass reliability coefficient (ICC) across all six trials was found to be 0.96, indicating high reliability of the test.

Pushup Test [23]

The push-up test is a simple yet effective tool for assessing upper body strength and endurance, promoting functional movement patterns, and monitoring changes in fitness levels over time.

Procedure

The push-up test was conducted with participants assuming either the standard position for men, supporting themselves on their hands and toes, or the modified position for women, utilizing a hands and knees stance. Participants were positioned prone, with their hands placed apart at a width equal to that of their shoulders. The test commenced with participants in the "up" position, their elbows fully extended. During the descent phase, participants flexed their elbows until their upper arms were parallel to the testing surface. Each participant performed a maximum of three trials, each lasting 15 seconds, followed by a rest period of 45 seconds. The number of push-ups completed within each 15-second trial was meticulously recorded. The test exhibited high reliability, as indicated by the intraclass correlation coefficient (ICC) of 0.958, suggesting strong consistency and agreement among the results obtained from the trials.

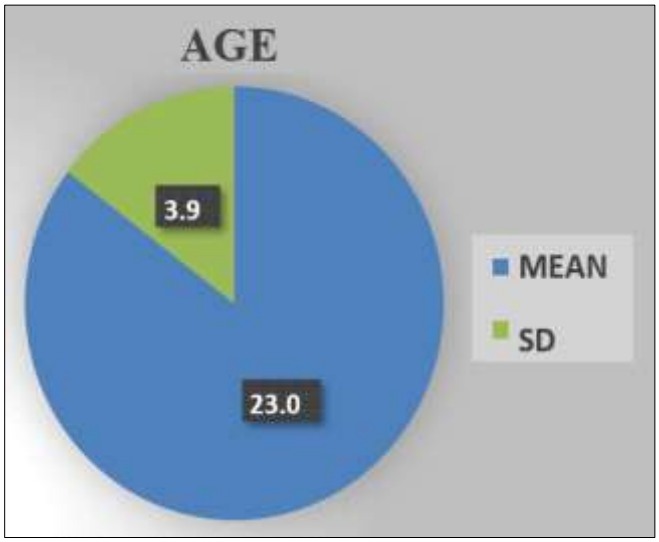
Statistical analysis

The result of the study was analyzed by using IBM SPSS Version 29.0.0 (Armonk, NY: IBM Corp). The sample size was calculated by using G-Power software version 3.1.9.4. The main outcome variable taken into consideration for sample size calculation from the previous study conducted by M. Yuskel *et al*. The outcome variable values (Seated medicine ball test) were before protocol mean=19.9, after protocol mean = 20. Keeping the values of a error as 0.05 since (95% confidence interval) and b error as 0.2 (since power of study 80%). The calculated sample size is 30. The age of the participants in this study was from 18 to 30 Years. Total 60 Participants participated in the study. The mean age of the participant's was 21.51. There were 23 Female and 37 Male participants. Mean age of the female was 21.47and the mean age of male was 22.38.

As shown in given table/graph:

Table 1: Demographic data of participants:

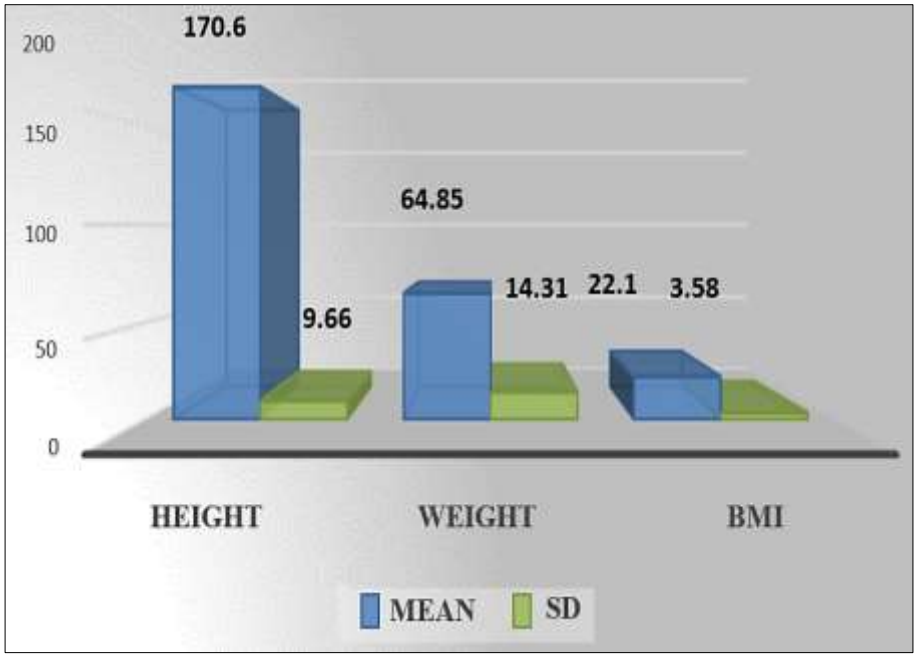
Participants	Mean	SD
Age	23.03	3.94



Graph 1: Demographic data of participants:

Table 2: Body Composition:

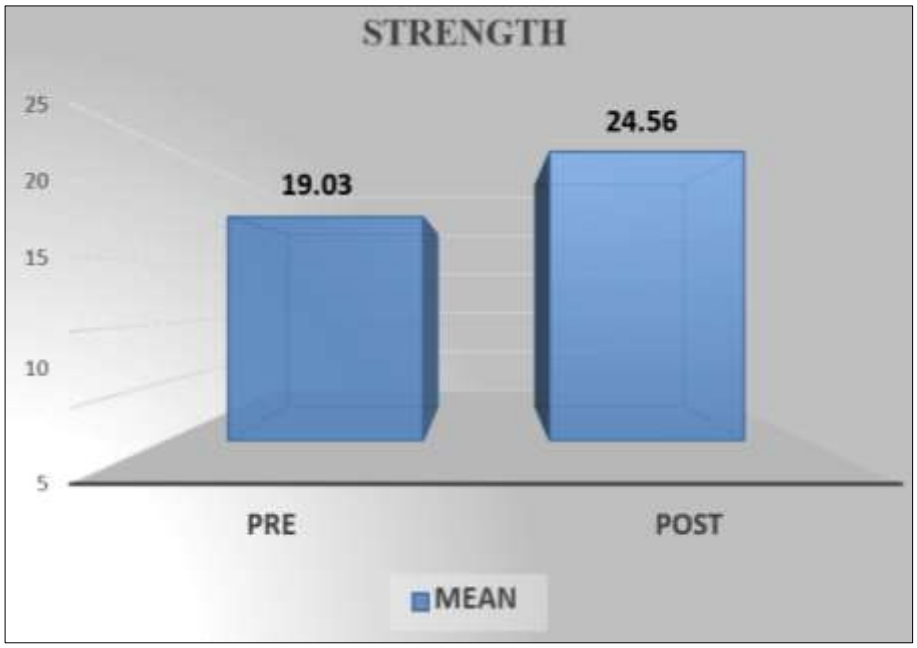
	Height (cm)	Weight (kg)	BMI kg/m2)
Mean	170.69	64.85	22.1
SD	9.66	14.31	3.58



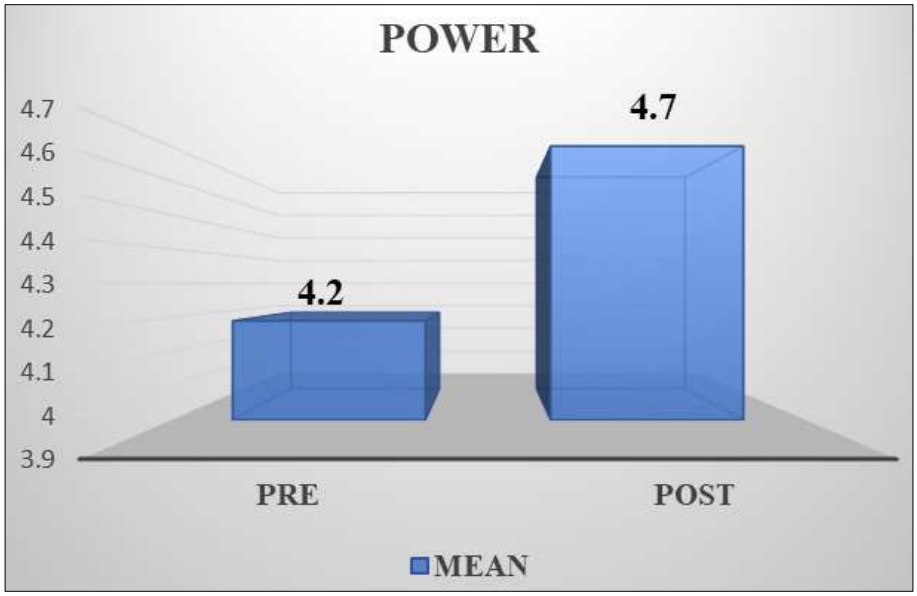
Graph 2: Body Composition:

Table 3: Pre-& Post Mean±SD scores of Outcomes:

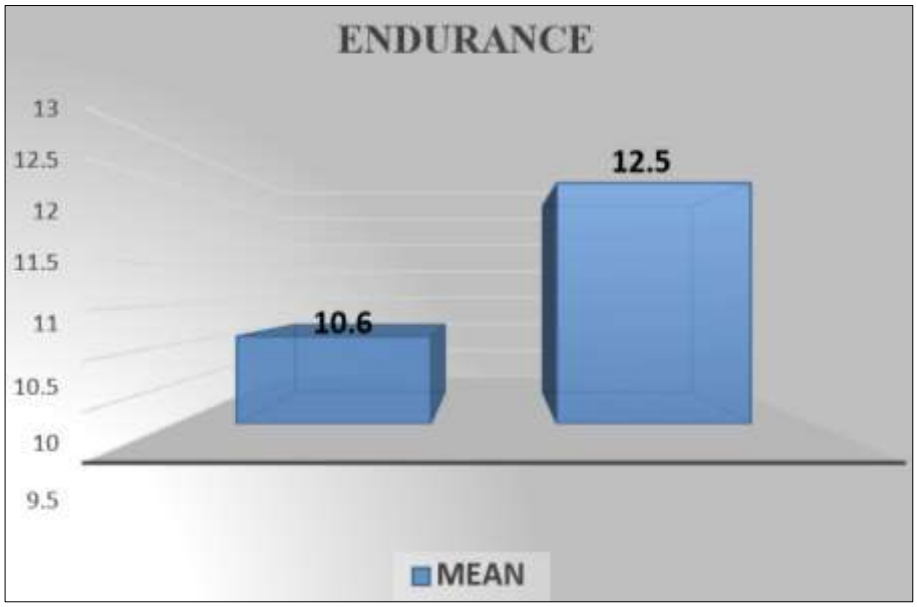
Outcomes	Pre		Post		T-value	p-value
	Mean	SD	Mean	SD		
1 RM BP	19.03	7.93	24.56	12.23	5.009	<0.0001
SMBT	4.2	1.43	4.7	1.33	6.131	<0.0001
PUSH-UP	10.6	2.35	12.5	3.18	5.39	<0.0001



Graph 3: Graphical presentation of Strength



Graph 4: Graphical presentation of Power



Graph 5: Graphical presentation of Endurance

Discussion

The study evaluated the effect of the Advanced Throwers Ten program on strength, power, and endurance in overhead athletes. Thirty participants of both genders were involved. A pretest-posttest design tracked changes before and after program implementation.

The results of the study demonstrate a significant improvement in the power levels of overhead athletes. Table 4.1.4 illustrates significant differences between pre and post interventions. Specifically, the pre and post Mean± SD for Power in the Seated Medicine Ball test were 4.19±1.43 and 4.7±1.33, respectively. The corresponding t- value and P-value for the Seated Medicine Ball test are 6.131 and < 0.0001, demonstrating statistical significance.

These outcomes are supported by N Sivakumar, G Mohanraj, *et al*. (2020) have found that there is significant difference in throwing distance and throwing accuracy among novice badminton players using Medicine Ball throw test and Functional throwing performance index, respectively among 10 players 3 sessions/week for 4 weeks. Furthermore, Gokalp and Kirmizigil (2020) [23] found that the Thrower's Ten exercises effectively improved upper extremity balance, explosive power, and isokinetic strength in sedentary individuals. Increased muscular strength likely contributed to enhanced throwing distance, primarily through strengthened scapular retractor muscles. Consistent with this, Zaras, Spengos, *et al*. (2013) [24] observed improved shot-put performance in novice throwers after 6 weeks of either strength or ballistic power training. Both types of training led to distinct muscle adaptations, including preserved type IIx muscle fibers and increased cross-sectional area (CSA), suggesting neural adaptations contributed to enhanced throwing performance.

The study suggests that elastic band training enhances power in overhead athletes through neuronal adaptations similar to those seen in heavy resistance training. Substantial loading is crucial for power development, triggering maximal motor recruitment and elevated firing frequencies. The mechanisms contributing to increased throwing velocity include targeted increases in the cross-sectional area of fast-twitch fibers,

improved neural activation, changes in muscular properties, heightened myosin-adenosine triphosphatase activity, improved motor unit synchronization, and elevated firing frequency.

The findings of the study suggest a significant enhancement in both strength and endurance among athletes engaged in overhead activities. Table 4.1.4 reveals significant distinctions between pre and post interventions. Specifically, the pre and post Mean±SD for Strength in the 1 RM bench press were 19.03±7.93 and 24.56±12.33, respectively, with a corresponding t-value and p-value of 5.009 and < 0.0001, respectively. Similarly, for Endurance, the pre and post Mean±SD for the Pushup test were 10.6±2.35 and 12.53±3.18, respectively, with a t-value of 5.39 and a P-value < 0.0001, respectively.

Patel *et al*. discovered that both scapular retractor strength training and the Thrower's Ten program yielded positive outcomes for recreational overhead athletes. Scapular retractor training improved throwing accuracy notably, while also enhancing scapular positioning and optimizing kinetic chain efficiency. The Thrower's Ten program, using Theraband, led to increased middle trapezius strength, improved throwing distance, and enhanced neural adaptation, motor unit recruitment, and power output. Myers *et al*. found that combining the Advanced Throwers Ten program with traditional training improved strength and endurance. Consistent muscle loads between protocols suggest both approaches are effective. Strength and hypertrophy correlate across resistance-training methods. Isometric holds enhance motor unit recruitment, potentially aiding muscle growth.

Ahmed, Khalaf, *et al*. observed significant improvements in physical variables and digital javelin throwing proficiency with a preventive training regimen targeting speed, strength, flexibility, agility, balance, endurance, and coordination. Myers, Toonstra, *et al*. found both the Advanced Throwers Ten program and traditional training increased strength and endurance, with consistent muscle loads suggesting efficacy of either approach. They also noted a correlation between strength gains and muscle hypertrophy across resistance-training methods, and highlighted the potential of sustained isometric holds to enhance motor unit recruitment and hypertrophy.

The Advanced Throwers Ten program incorporates dynamic and sustained hold sequences to engage and challenge the rotator cuff muscles, enhancing endurance and dynamic stability for overhead athletes. This program addresses the crucial but often overlooked need for neuromuscular control of the glenohumeral joint, essential for injury prevention and rehabilitation. Strength training is vital for reducing injury risk and restoring function due to the repetitive stresses of overhead throwing.

Conclusion

The main aim of the study was to find that Advanced throwers ten program is effective to measure strength, power and endurance in overhead athletes. As per the result the Advanced throwers ten program showed improvement in strength, power and endurance. Thus, this program is effective to prevent the shoulder injury among overhead athletes.

Therefore, null hypothesis is rejected and alternate hypothesis is accepted.

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