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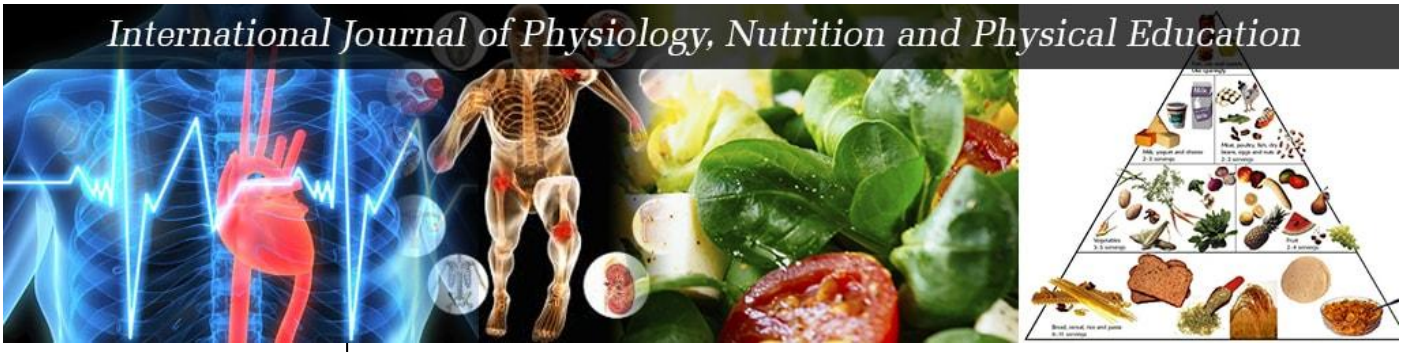

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Effect of a 12 week psychological skills intervention on performance of national-level archers

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Abstract
Psychological readiness is a critical determinant of success in precision sports such as archery, where minor lapses in focus can markedly affect outcomes. This randomized controlled trial investigated whether a structured mental-skills programme could enhance competitive performance in national-level archers. Thirty athletes (ages 16-21) were randomly assigned to one of three groups: a Psychological Intervention group (n = 10), a Self-Regulation group (n = 10), and an Active Control group (n = 10). The intervention comprised a 12-week, thrice-weekly (50-60 min) psychological skills training programme, while the control group continued standard physical practice. Archery performance scores were assessed before and after the intervention using standardized competition procedures and analysed with analysis of covariance (ANCOVA) controlling for baseline scores. The overall model was significant, $F(3, 26) = 38.62$, $p < .001$, $R^2 = .817$. The covariate of pre-test performance strongly predicted post-test results, $F(1, 26) = 60.06$, $p < .001$, partial $\eta^2 = .698$. Importantly, group membership produced a large effect, $F(2, 26) = 17.89$, $p < .001$, partial $\eta^2 = .579$. Bonferroni pairwise comparisons revealed that both the Psychological Intervention and Self-Regulation groups achieved significantly higher adjusted post-test means than the Control group ($p < .001$), whereas the two intervention groups did not differ significantly ($p = .791$). These findings demonstrate that a structured 12-week psychological skills programme significantly improves competitive archery performance and should complement technical and physical training in elite preparation cycles.

Keywords: Archery, psychological skills training, self-regulation, mental skills intervention, sport performance

Introduction
Elite sport demands a sophisticated combination of physical preparation and psychological readiness. While coaches and athletes devote significant time to refining physical skills, it is increasingly clear that success in high-precision, target-based disciplines such as archery depends as much if not more on mental factors. Classic and contemporary research suggests that in sports requiring accuracy and steadiness, performance may be 70-80 % psychological and only 20-30 % physical, highlighting the critical role of mental training in competitive outcomes. Yet in many training environments, psychological skill development remains secondary to technical practice.

Psychological Skills and Archery Performance
Sports psychology examines how thoughts, emotions, and behaviours influence athletic performance and how psychological skills can be trained to enhance competitive outcomes. Among these skills, mental Psychological also referred to as visualization or mental rehearsal has received particular attention. Imagery involves the deliberate creation or re-creation of sensory experiences that approximate real competition, engaging visual, kinesthetic, and emotional systems to strengthen neural pathways involved in skilled movement. Research shows that structured imagery improves concentration, boosts confidence, and reduces performance-related anxiety, ultimately translating to superior results in precision sports such as archery, shooting, and gymnastics. Self-regulation is another core psychological construct relevant to sport. It encompasses the cyclical processes of forethought, performance monitoring, and self-reflection, enabling athletes to set goals, deploy attentional strategies, and

adjust behavior in real time. High self-regulation allows archers to maintain composure, fine-tune technique, and recover from errors during competition. Zimmerman's social-cognitive model identifies self-regulation as both a predictor of expertise and a skill set that can be deliberately cultivated through targeted interventions

Evidence from Prior Studies

Empirical work supports the efficacy of these psychological interventions. Controlled trials have demonstrated that structured imagery sessions can reduce competitive anxiety and significantly enhance archery accuracy and consistency (e.g., Hasmar & Riyadi, 2019 [2]; Jaafa & Kassim, 2016) [3]. Similar benefits have been reported for broader psychological skills training programs that integrate self-regulation techniques, including improvements in confidence, emotional control, and motor execution among elite athletes. International success stories further illustrate these principles: for example, South Korean archers, dominant in Olympic competition, routinely integrate mental imagery and noise-simulation training into their preparation.

Despite such evidence, Indian archers have historically received limited systematic psychological training. High-profile cases such as performance lapses under pressure at major international events underscore the need for structured mental-skills programs tailored to the demands of elite archery. Addressing this gap is essential for improving consistency and competitiveness on the world stage.

Purpose of the Study

Guided by this background, the present investigation evaluates the effect of a 12-week psychological skills intervention focused on mental imagery and self-regulation on the competitive performance of national-level Indian archers. It was hypothesized that participants receiving the intervention would demonstrate significantly greater improvements in standardized archery performance scores than those engaged in routine training alone, even after adjusting for baseline ability.

By rigorously testing a structured psychological program within a randomized controlled design, this study seeks to provide evidence-based guidance for coaches and sport psychologists. The findings are expected to clarify how mental skills training can complement physical practice to optimize outcomes in precision sports such as archery.

Methodology

Research Design

A pre-test-post-test randomized controlled design was used to examine the effect of a structured psychological skills intervention on competitive archery performance. Thirty national-level archers were randomly assigned to one of three groups: (a) Imagery intervention, (b) Self-regulation intervention, and (c) Active control. Pre-intervention testing was conducted one week before the program and post-testing immediately after the 12-week intervention. This design allowed for evaluation of group differences in post-test performance while controlling for baseline scores.

Participants

Thirty (n = 30) male and female archers aged 16-21 years were recruited from the National Centres of Excellence (NCOE) of the Sports Authority of India and the Lakshmibai National Institute of Physical Education (LNIPE), North-East Regional Centre, Guwahati. All participants were current national competitors with a minimum of three years of competitive experience. Written informed consent was obtained from all participants, and institutional ethical approval was secured prior to data collection. Participants were randomly allocated to the Imagery group (n = 10), the Self-regulation group (n = 10), or the Control group (n = 10).

Intervention Protocol

The intervention lasted 12 weeks, with sessions held three times per week (Monday, Wednesday, Friday) and each session lasting 50-60 minutes.

- **Imagery Group:** Received structured imagery training emphasizing multi-sensory rehearsal of archery routines. Sessions included internal and external imagery perspectives, incorporation of visual, auditory, and kinaesthetic cues, and slow-motion Psychological for error correction.
- **Self-Regulation Group:** Received training in self-monitoring, goal setting, arousal regulation, positive self-talk, and reflective practices. The curriculum followed Zimmerman's cyclical model of forethought, performance, and self-reflection.
- **Control Group:** Continued their regular technical and physical archery practice without additional psychological training.

Measures

Primary Outcome - Archery Performance

Performance was assessed using standardized competition-style scoring. Each archer shot the regulation number of arrows at Olympic-standard targets under official competition rules. Scores were recorded as total points per round and averaged across two trials for reliability.

Covariate - Baseline Performance

Pre-test performance scores, collected using the same procedure as post-test, were used as a covariate to control for initial skill level.

Procedure

Participants first completed the pre-test performance assessment. The two experimental groups then commenced their respective 12-week psychological skills programs while the control group maintained normal training. All groups participated in their usual physical conditioning and technical practice. At the conclusion of the intervention, all participants repeated the performance assessment under identical conditions.

Statistical Analysis

Data were analysed using Analysis of Covariance (ANCOVA) with post-test performance as the dependent variable, group (Imagery, Self-regulation, Control groups) as the fixed factor, and pre-test performance as the covariate. This approach adjusted for any baseline differences among groups. Significance was set at $p < .05$, and partial eta squared (η^2) was reported as an effect-size measure to indicate the magnitude of group differences. All analyses were performed using IBM SPSS Statistics (version 26).

Results

All thirty participants who were randomised completed the full 12-week programme and the post-test assessments. Baseline characteristics were comparable across the three groups Imagery, Self-regulation, and Control indicating successful randomisation. No adverse events were reported,

and data from all participants were included in the final analyses. Descriptive statistics summarising pre- and post-test performance scores for each group are presented in Table 1, followed by the results of the analysis of covariance (ANCOVA) and pairwise comparisons. Figures illustrating adjusted mean differences and confidence intervals accompany these tables to provide a visual representation of the group effects.

Table 1: Descriptive Statistics of Pre- and Post-Test Performance Scores

Group (Condition)	N	Pre-Test M ± SD	Post-Test M ± SD
Imagery Group	10	299.70 ± 13.31	324.00 ± 12.99
Self-Regulation Group	10	297.20 ± 10.93	319.00 ± 10.25
Control Group	10	293.20 ± 20.44	302.80 ± 12.13

Table 1 reveals that all three groups started with broadly comparable baseline performance and that the two intervention arms improved much more than the control over 12 weeks. The Imagery group (N = 10) moved from 299.70 ± 13.31 at pre-test to 324.00 ± 12.99 at post-test (≈ +24.30 points; ~8.1% gain). The Self-Regulation group (N = 10) increased from 297.20 ± 10.93 to 319.00 ± 10.25 (≈ +21.80 points; ~7.3% gain). By contrast, the Control group (N = 10) rose modestly from 293.20 ± 20.44 to 302.80 ± 12.13 (≈ +9.60 points; ~3.3% gain).

At baseline, variability (SD) was highest in the Control group (20.44**)** compared with the Imagery (13.31) and Self-Regulation (10.93) groups, suggesting greater heterogeneity in initial performance among controls. Post-test standard deviations narrowed for all groups (Psychological Intervention: 12.99; Self-Regulation: 10.25; Control: 12.13), indicating a mild convergence of scores after training, with both intervention groups retaining relatively tight distributions.

Practically, these descriptive patterns show:

- Clear absolute improvements for both intervention groups, with the largest mean at post-test in the Imagery group (324.00), closely followed by Self-Regulation (319.00);
- A smaller improvement in the Control group consistent with routine practice and test familiarity rather than targeted psychological training; and
- Stable or slightly reduced variability after the programme, implying that gains were reasonably consistent within groups.

Together, the magnitudes of change and the post-test ordering (Imagery ≥ Self-Regulation » Control) anticipate the inferential results (ANCOVA and pairwise comparisons) that confirm statistically significant group differences after adjusting for baseline.

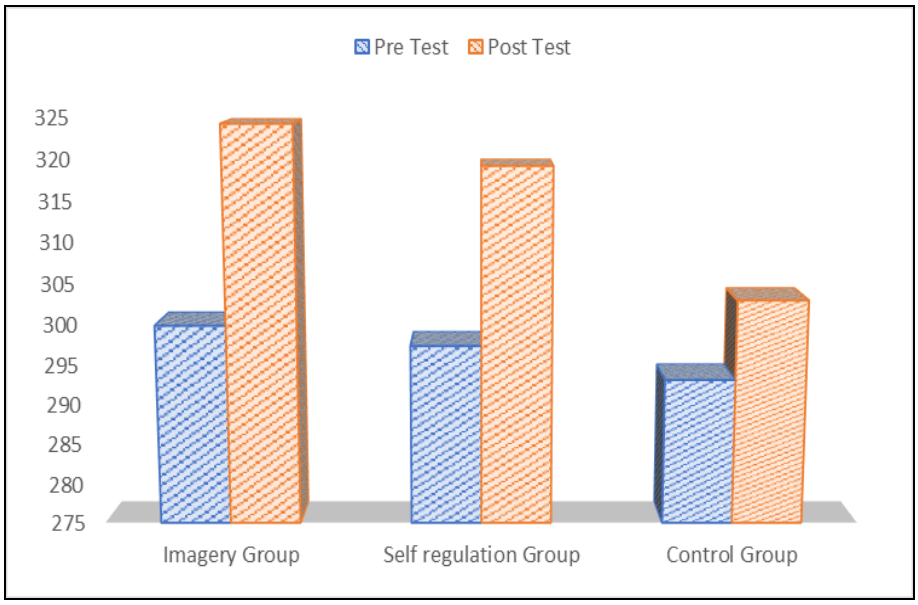

Fig 1: Mean Pre- and Post-Test Performance Scores for the Three Study Groups

Table 2: Analysis of Covariance (ANCOVA) Results for Post-Test Performance Scores

Analysis of Covariance (ANCOVA) Results for Post-Test Performance Scores						
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	5099.506[a]	3	1699.835	38.620	.000	.817
Intercept	1138.863	1	1138.863	25.875	.000	.499
Pre_Perf	2643.240	1	2643.240	60.055	.000	.698
Group	1574.712	2	787.356	17.889	.000	.579
Error	1144.360	26	44.014			
Total	2988036.000	30				
Corrected Total	6243.867	29				
a. R Squared = .817 (Adjusted R Squared = .796)						

Table 2 reveals the inferential results of the analysis of covariance (ANCOVA) that tested whether post-test archery performance differed across the three groups once pre-test scores were controlled. The overall model was highly significant, $F(3, 26) = 38.62$, $p < .001$, indicating that the combination of baseline performance and group membership explained a very large proportion of the variance in post-test scores. The model's R^2 of .817 (adjusted R^2 = .796) shows

that approximately 82 % of the variability in final performance was accounted for by these predictors a strong fit for an experimental study of this size.

The covariate, pre-test performance (Pre_Perf), was itself a powerful predictor of post-test outcomes, $F(1, 26) = 60.06$, $p < .001$, partial $\eta^2 = .698$. This means that athletes' baseline scores strongly influenced their eventual performance, a finding consistent with the expectation that starting skill level matters in competitive archery.

Most critically, the main effect of Group remained significant even after adjusting for baseline differences, $F(2, 26) = 17.89$, $p < .001$, partial $\eta^2 = .579$. A partial eta-squared of .579 represents a large effect size, showing that the type of training intervention accounted for nearly 58 % of the explainable variance in post-test scores beyond what was predicted by initial ability.

Table 3: Pairwise Comparisons of Adjusted Post-Test Means across Groups (Bonferroni Corrected)

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Experimental	Self-Regulation	3.397	2.974	.791	-4.214	11.008
	Control	17.032*	3.015	.000	9.316	24.748
Self-Regulation	Experimental	-3.397	2.974	.791	-11.008	4.214
	Control	13.635*	2.985	.000	5.996	21.275
Control	Experimental	-17.032*	3.015	.000	-24.748	-9.316
	Self-Regulation	-13.635*	2.985	.000	-21.275	-5.996
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Bonferroni.						

Table 3 reveals the Bonferroni-corrected pairwise comparisons of the adjusted post-test mean performance scores after controlling for baseline differences, highlighting where the significant group effects (see Table 2) lie.

The Imagery group recorded a mean advantage of 17.03 points over the Control group, which was highly significant ($p < .001$, 95 %). The Self-Regulation group also outperformed the Control group with a mean difference of 13.64 points, likewise highly significant ($p < .001$, 95 % CI). These large, positive, and statistically significant differences confirm that both forms of psychological training produced meaningful competitive gains well beyond those achieved through regular practice alone.

By contrast, the comparison between the two experimental groups Imagery versus Self-Regulation showed a small, non-significant difference of 3.40 points (p = .791, 95 % CI). Thus, although the Imagery group achieved the highest adjusted mean score, its advantage over Self-Regulation was not statistically significant.

In research terms, these findings demonstrate significant performance enhancement for both intervention groups relative to the control condition (p < .001 for each), while also indicating that the two active interventions were statistically equivalent to one another. The use of Bonferroni adjustment ensures that these significance levels remain robust despite multiple comparisons, reinforcing the conclusion that the observed improvements are genuine and not due to chance.

Pairwise comparisons confirmed that both intervention groups outperformed the control group at $p < .001$, whereas the difference between the two active interventions was small and not significant ($p = .791$). These results demonstrate that structured psychological preparation whether delivered as a multi-component mental-skills programme or focused self-regulation training enhances competitive archery performance beyond standard physical training alone.

Discussion

Principal Findings

The present randomized controlled trial evaluated the effect of a 12-week psychological skills intervention on imagery and a parallel self-regulation programme on the competitive performance of national-level archers. After adjusting for baseline ability through ANCOVA, both experimental conditions produced statistically significant and practically meaningful improvements in performance relative to the control group. The Imagery group achieved the largest adjusted post-test mean, improving by approximately 24 points, while the Self-Regulation group improved by roughly 22 points. In contrast, the Control group gained only about 10 points, a change consistent with routine practice and test familiarity rather than targeted psychological training.

Comparison with Previous Studies

The findings align closely with earlier research that has examined mental skills training in precision sports. Hasmar and Riyadi (2019) [2] reported significant gains in thirty-metre archery scores following a structured imagery programme, while Jaafa and Kassim (2016) [3] observed reduced anxiety and improved accuracy among archers who received guided imagery training. Dhillon and colleagues (2016) [1] likewise demonstrated that psychological skills training combining relaxation and visualization improved both confidence and shooting outcomes in elite archers. Similar effects have been reported in other precision sports such as rifle shooting and gymnastics, where mental rehearsal and self-regulatory strategies have been shown to enhance consistency and execution (e.g., Marshall & Gibson, 2017) [4].

The present study strengthens this body of evidence by employing a rigorous randomized design with national-level athletes and by using formal competition scoring as the primary outcome. Importantly, it shows that a broader imagery and a self-regulation-focused programme yield comparable benefits, suggesting that a variety of structured mental-skills approaches can effectively augment archery performance.

Mechanistic Insights

Several mechanisms can explain the observed improvements.

- **Multi-sensory rehearsal and neural activation:** Mental practice engages many of the same neural networks involved in actual motor execution, including premotor and parietal regions, strengthening the cortical representation of the shot routine. By repeatedly simulating optimal performance with vivid visual, auditory, and kinaesthetic cues, archers can refine movement timing and coordination without physical fatigue.

- **Improved attentional control and focus:** Structured psychological training teaches athletes to maintain a narrow, task-relevant focus, minimizing distractions such as audience noise or intrusive thoughts. This is critical in archery, where even slight lapses in concentration can result in substantial score differences.
- **Confidence building and anxiety reduction:** Rehearsing successful performance scenarios enhances self-efficacy and lowers cognitive and somatic anxiety. Lower arousal facilitates smoother execution of fine-motor skills and reduces the risk of "target panic," a common problem in competitive archery.
- **Enhanced self-regulation:** Training in goal setting, self-monitoring, and reflective adjustment enables athletes to recognize and correct performance deviations in real time. The cyclical process of forethought, performance, and self-reflection described by Zimmerman supports sustainable skill acquisition and consistent competition results.

Together, these mechanisms create a psychological environment that supports precision, stability, and confidence under competitive pressure.

Conclusion

This randomized controlled trial provides compelling evidence that a structured 12-week psychological skills programme can significantly enhance competitive performance in national-level archers. Athletes who participated in either the comprehensive imagery or the self-regulation programme achieved large, statistically significant gains in post-test archery scores compared with those who continued standard physical training alone. Importantly, these improvements remained after adjusting for baseline performance, demonstrating that the benefits stem from the psychological training itself rather than from pre-existing differences. By combining multi-sensory mental rehearsal, attentional control, confidence building, and anxiety regulation, the intervention offered a practical and effective complement to technical and physical preparation. These findings affirm that psychological readiness is a decisive factor in precision sports and should be treated as an integral part of athlete development. Coaches and sport administrators are encouraged to incorporate structured mental-skills training into regular training cycles to optimize performance and maintain consistency under competitive pressure.

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