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Effects of Breathing and Imagery Exercises on Postural Sway and Shooting Performance in Olympic Archers: A Pilot Study

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Abstract

Archery requires the integration of motor coordination, postural control, and mental focus. This pilot study aimed to evaluate the effects of breathing and imagery exercises on motor and cognitive performance in beginner archers. The goal was to assess the feasibility of applying these techniques and to provide methodological groundwork for a future full-scale doctoral study. Twenty-one novice archers were randomly assigned to a Breathing Group (n=7), Imagery Group (n=7), and Control Group (n=7). Over 8 weeks, the intervention groups practiced structured breathing (Nadi Shodhana Pranayama) or guided imagery exercises in addition to standard archery training. Pre- and post-tests measured target shooting performance, respiratory function (FEV1), postural sway, handgrip strength, reaction time, attention, and imagery ability. Statistical analysis included paired-samples t-tests and one-way ANOVA with post-hoc comparisons. Both intervention groups showed significant improvements in target shooting, reaction time, attention, and handgrip strength ($p<0.05$). The Breathing Group demonstrated increases in FEV1 and postural sway performance. The Imagery Group showed superior mental imagery skills. Between-group comparisons revealed that both interventions were significantly more effective than the control condition in most parameters. Breathing and imagery exercises enhanced both cognitive and physical components of archery performance in beginners. The findings support the integration of such techniques into holistic sports training programs. These interventions appear feasible and effective, offering accessible methods to improve focus, balance, and motor control in precision sports like archery.

Keywords: *archery, breathing exercises, mental imagery, postural balance, cognition*

Introduction

Archery is a complex sport requiring the coordination of physical and cognitive systems, including postural control, attention, respiratory regulation, and motor planning (Spratford & Campbell, 2017). Accurately delivering an arrow to the target requires not only technical skill but also the integration of multiple elements such as postural stability, attention span, reaction speed, and respiratory control components that have increasingly been targeted through breathing techniques and mental imagery (Savvides et al., 2020). Alternate nostril breathing (Nadi Shodhana Pranayama), rooted in yoga, has been associated with reduced stress, enhanced parasympathetic activity, and improved attention span (Ghiya, 2017; Savvides et al., 2020). Similarly, structured imagery exercises have been shown to support motor learning, increase self-confidence, and sharpen goal-oriented focus by facilitating cognitive rehearsal and attention control (Upadhyay et al., 2023). Accordingly, imagery practices may enable athletes to enhance self-regulation and maintain a greater sense of calm under competitive pressure (Robin & Dominique, 2022). Recent evidence indicates that both imagery and medi-

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tation improve archery accuracy, with imagery demonstrating greater efficacy particularly among skilled athletes while meditation may support focus and relaxation in novices (Yachsie et al., 2023). When applied in combination, these techniques may facilitate motor-cognitive integration by simultaneously engaging motor planning, attentional focus, and emotional regulation domains that are crucial for precision-based tasks such as archery.

There remains a lack of integrative training approaches specifically designed for novice archers, who face the dual challenge of developing both foundational motor control and psychological regulation skills. Investigating these methods at an early stage of skill acquisition not only addresses a critical research gap but also offers the potential to establish effective training foundations. Demonstrating the effectiveness of such combined techniques in novice populations can contribute to the development of foundational training strategies that are applicable to advanced or elite level archers. Therefore, the purpose of this study is to investigate the combined effects of breathing and imagery exercises on performance-related outcomes in novice archers.

Methods

This research is a pretest–posttest controlled experimental pilot study aiming to investigate the effects of breathing and imagery exercises, applied over an 8-week period, on target shooting performance, respiratory function, postural sway, attention level, mental imagery ability, handgrip strength, and reaction time in individuals who are olympic archery.

Participants

Although this is a pilot study, the sample size was determined based on methodological guidance suggesting that pilot trials may include approximately 10–50% of the projected sample size of the main trial (Billingham et al., 2013). This pilot study, conducted as a preparatory phase for the main thesis research, was designed to evaluate the feasibility of the methods and measurement tools. Participants were randomly assigned to one of three groups: Breathing Exercise Group (BG; n=7), Imagery Group (IG; n=7), and Control Group (CG; n=7). Participants were assigned to groups using a systematic sequential allocation method. This method was selected to ensure balanced group sizes within the constraints of the pilot study design.

Inclusion Criteria

Inclusion criteria included the completion of the informed consent form, successful performance in the Upper Extremity Stability Test (UEST), successful performance in the Upper Quarter Y Balance Test (UQ-YBT), and being actively engaged in archery practice.

Exclusion Criteria

Exclusion criteria included diagnosed musculoskeletal, neurological, vestibular, pulmonary, or orthopedic disorders, hearing loss, and lack of time (Figure 1).

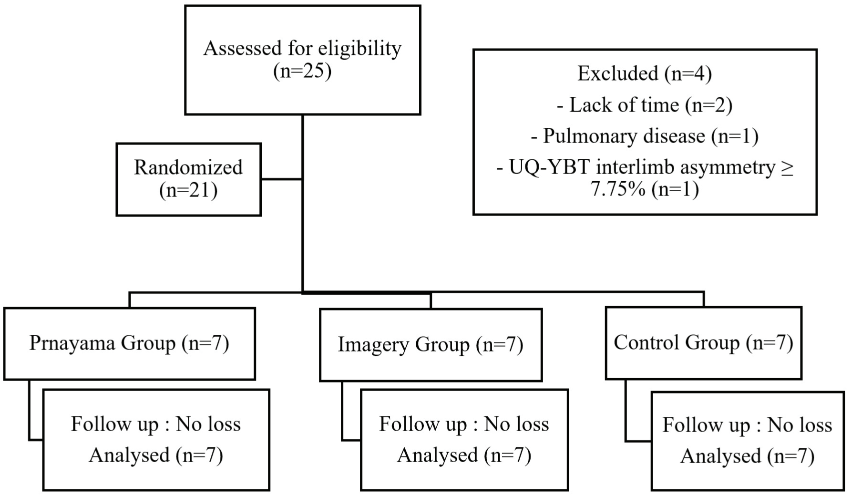

FIGURE 1. Participant Flow Diagram

Measures

Archery Performance: Assessed using the Archery Shooting Performance Test based on FITA rules. Archers shot three rounds of three arrows within 124 seconds per round. Scores were calculated according to target zones (World Archery Federation (FİTA), 2020).

Postural Sway Assessment: Measured via the Sway Medical Balance App (SMBA), an FDA-approved, ISO 13485-certified mobile tool. Participants held a phone at chest level during five balance stances (10 seconds each). The SMBA generated scores from 0 to 100, with higher scores indicating better stability (Mummareddy et al., 2020).

Respiratory Function Assessment: Evaluated using a portable spirometer (MicroQuark, Cosmed, Italy) by a physiotherapist, following ATS/ERS standards for acceptability and repeatability (Graham et al., 2019).

Attention Test: Assessed using the Burdon Attention Scale (BAS), which evaluates sustained attention and visual scanning.

Mental Imagery Assessment: Measured with the Sport Imagery Questionnaire (SIQ) , consisting of 20 items across five subscales. The Turkish version was validated by Yarayan & İlhan (Yarayan1 et al., 2018).

Reaction Time: Tested via the Human Benchmark online platform. Participants reacted to a visual stimulus in five trials; the average response time (ms) was recorded (Ersin et al., 2022).

Handgrip Strength: Measured with a Jamar dynamometer following ASHT guidelines. Participants used their dominant hand for a single maximal effort (Fess, 1992) (Table 1).

Table 1. Measured Parameters and Test Instruments Used in the Study

Category	Parameter	Test Instrument Used
Performance	Target Shooting Score (3 arrows)	Archery Score Sheet (maximum 30 points)
Posture	Postural Sway	Sway Medical Mobile Application
Respiration	Respiratory Function Parameters	Spirometry Test
Cognitive	Attention Skill	Bourdon Attention Test
Mental	Imagery Skill	Sport Imagery Questionnaire Test
Motor Function	Reaction Time	Humanbenchmark Website
Motor Function	Handgrip Strength	Jamar Hand Dynamometer

Research Design

Breathing Exercise Protocol: Participants performed Nadi Shodhana (Alternate Nostril Breathing) for 15 minutes per session, following a progressive structure:

Weeks 1–2: Basic practice — Inhale and exhale solely through the right nostril (5 reps), then the left (5 reps), repeated continuously. Sessions began with 3 deep preparatory breaths.

Weeks 3–5: Cross-nostril breathing — Inhale through the left and exhale through the right (5 reps), then vice versa (5 reps), maintaining equal durations for inhalation and exhalation.

Weeks 6–8: Advanced breathing — Same pattern as weeks 3–5, but with doubled inhalation/exhalation durations and a 2-second breath-hold after each exhale to enhance parasympathetic activation.

Imagery Exercise Protocol: Participants in the imagery group engaged in 6-minute guided imagery sessions three times per week. Seated in a quiet environment with eyes closed, they listened to an audio recording via headphones, which described the 12 basic steps of archery (e.g., nocking, drawing) with integrated visual and kinesthetic cues.

Control Group: Participants in the control group did not perform any breathing or imagery exercises. They only participated in the routine archery training program, which consisted of standard shooting sets practiced three times per week as part of basic archery education.

Ethical approval was obtained from the Istanbul Medipol University Ethics Committee. All participants provided written informed consent. The pilot study was part of a thesis project and conducted for scientific evaluation.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 25. Normality was assessed using the Shapiro–Wilk test; all variables showed normal distribution. Accordingly, parametric tests were applied. Within-group changes were analyzed using paired t-tests, and between-group differences were examined via one-way ANOVA with Bonferroni-adjusted post-hoc comparisons. Cohen's d effect sizes and 95% confidence intervals were reported.

Results

Significant within-group improvements were observed across multiple performance and physiological measures, particularly in the intervention (IG) and breathing groups (BG). After Bonferroni correction (adjusted threshold ≈0.002), target shooting scores improved significantly in all groups, with the most pronounced effect in IG. Reaction time, mental imagery, and Bourdon attention test scores also showed significant gains in IG and BG, indicating enhancements in both psychomotor speed and cognitive function. Notably, the IG group demonstrated the largest effect sizes across these domains, highlighting the strong impact of the intervention.

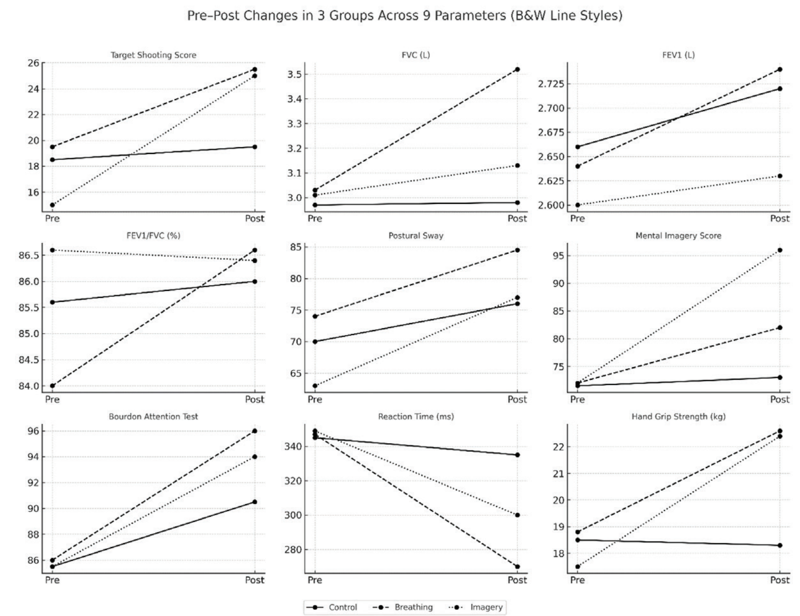

FIGURE 2. Comparison of Pre–Post Intervention Effects in 3 Groups Across 9 Outcome Measures

Table 2. Within-Group Differences Across All Parameters

Parameter (Group)	Pre Mean	Post Mean	Cohen's d	Within-Group p-value
Target Shooting Score (CG)	17.8	19.4	2.92	0.001
Target Shooting Score (BG)	18.8	25.8	3.13	0.001
Target Shooting Score (IG)	14.8	25.0	12.19	0.001
FVC (CG)	2.94	2.95	0.92	0.10
FVC (BG)	3.01	3.52	1.16	0.06
FVC (IG)	3.01	3.09	1.39	0.04
FEV1 (CG)	2.50	2.52	1.25	0.05
FEV1 (BG)	2.46	2.92	1.45	0.03
FEV1 (IG)	2.60	2.64	0.77	0.16
FEV1/FVC (CG)	85.6	85.9	0.39	0.43
FEV1/FVC (BG)	84.7	85.9	0.13	0.77
FEV1/FVC (IG)	85.9	84.6	-0.78	0.15
Sway (CG)	70.6	75.2	2.21	0.01
Sway (BG)	73.6	84.4	1.30	0.04
Sway (IG)	62.4	75.2	1.28	0.05
Mental Imagery Score (CG)	70.0	70.6	1.09	0.07
Mental Imagery Score (BG)	71.0	73.4	2.68	0.001
Mental Imagery Score (IG)	73.0	95.0	31.1	0.001
Bourdon Attention Test (CG)	87.8	91.4	2.68	0.001
Bourdon Attention Test (BG)	88.0	96.6	7.54	0.001
Bourdon Attention Test (IG)	88.4	95.6	4.38	0.001
Reaction Time (CG)	379.2	356.0	-1.47	0.03
Reaction Time (BG)	359.0	290.0	-7.71	0.001
Reaction Time (IG)	359.2	297.0	-3.40	0.001
Handgrip Strength (CG)	17.4	19.4	1.26	0.05
Handgrip Strength (BG)	16.8	21.6	2.49	0.01
Handgrip Strength (IG)	16.6	21.4	2.92	0.001

Note: To control the risk of Type I error due to multiple within-group comparisons, a Bonferroni correction was applied. Accordingly, the adjusted significance threshold was set at 0.05/24≈0.002. Only p-values below this threshold were considered statistically significant.

Several other variables, such as handgrip strength and FVC, showed moderate improvements that did not meet the corrected significance threshold but may indicate practical benefits. These results suggest that the intervention yielded robust within-group gains, particularly in cognitive-motor performance (Figure 2; Table2).

Post-hoc analyses revealed that target shooting performance significantly improved in the breathing group (BG) compared to the control, while mental imagery ability was markedly enhanced in the imagery group (IG) compared to both BG and CG. Sustained attention was also significantly better in BG relative to CG. In contrast, no statistically significant between-group differences were found for reaction time or handgrip strength after Bonferroni correction. These findings suggest that imagery training is particularly effective for cognitive enhancement, while breathing exercises may confer benefits in attentional focus. Each intervention demonstrated domain-specific strengths in post-intervention outcomes (Table 3).

After applying Bonferroni correction for multiple comparisons (adjusted $p<0.002$ for within-group tests and $p<0.003$ for post-hoc tests), significant within-group improvements remained for target shooting score in all groups, mental imagery score in IG, Bourdon attention test in BG and IG, and reaction time in BG and IG. For between-group comparisons, post-hoc analyses revealed significant differences favoring the Imagery and Breathing groups over the Control group in target shooting performance (CG vs. BG: $p=0.003$), mental imagery score (CG vs. IG: $p=0.0001$; BG vs. IG: $p=0.0001$), and Bourdon attention test (CG vs. BG: $p=0.0010$).

The boxplot distributions illustrate distinct post-intervention patterns across the three groups. Both the Breathing (BG) and Imagery (IG) groups outperformed the Control (CG) in target shooting, attentional capacity, and mental imagery, with IG showing especially consistent and elevated scores in imagery ability. BG demonstrated the fastest reaction times, while IG exhibited the narrowest variability in cognitive performance. Although improvements in postural sway, FVC, and grip strength were observed in the intervention groups, noticeable variability remained. These visual patterns support the domain-specific benefits of each intervention: breathing exercises primarily enhanced physiological and attentional measures, whereas imagery training yielded stronger cognitive and performance-related gains (Figure 3).

Table 3. Post-hoc Comparisons Between Groups

Parameter	Group 1	Group 2	Mean Difference	Lower Confidence Limit	Upper Confidence Limit	p-value
Target Shooting Score	CG	BG	6.4	2.44	10.36	0.001
Target Shooting Score	CG	IG	5.6	1.64	9.56	0.01
Target Shooting Score	BG	IG	-0.8	-4.76	3.16	0.85
Mental Imagery Score	CG	BG	2.8	-0.37	5.97	0.09
Mental Imagery Score	CG	IG	24.4	21.2	27.5	0.001
Mental Imagery Score	BG	IG	21.6	18.4	24.7	0.001
Bourdon Attention Test	CG	BG	5.2	2.38	8.02	0.001
Bourdon Attention Test	CG	IG	4.2	1.38	7.02	0.001
Bourdon Attention Test	BG	IG	-1.0	-3.82	1.82	0.62
Reaction Time	CG	BG	-66.0	-113.1	-18.9	0.01
Reaction Time	CG	IG	-59.0	-106.1	-11.9	0.02
Reaction Time	BG	IG	7.0	-40.1	54.1	0.92
Handgrip Strength	CG	BG	2.2	-0.79	5.19	0.16
Handgrip Strength	CG	IG	2.0	-0.99	4.99	0.22
Handgrip Strength	BG	IG	-0.2	-3.19	2.79	0.98

Note: To control for the risk of Type I error due to multiple pairwise comparisons, a Bonferroni correction was applied. Given the 15 post-hoc comparisons conducted, the adjusted significance threshold was set at $p<0.003$ (0.05/15). Only p-values below this threshold were considered statistically significant; CG: Control Group, BG: Breathing Group, IG: Imagery Group.

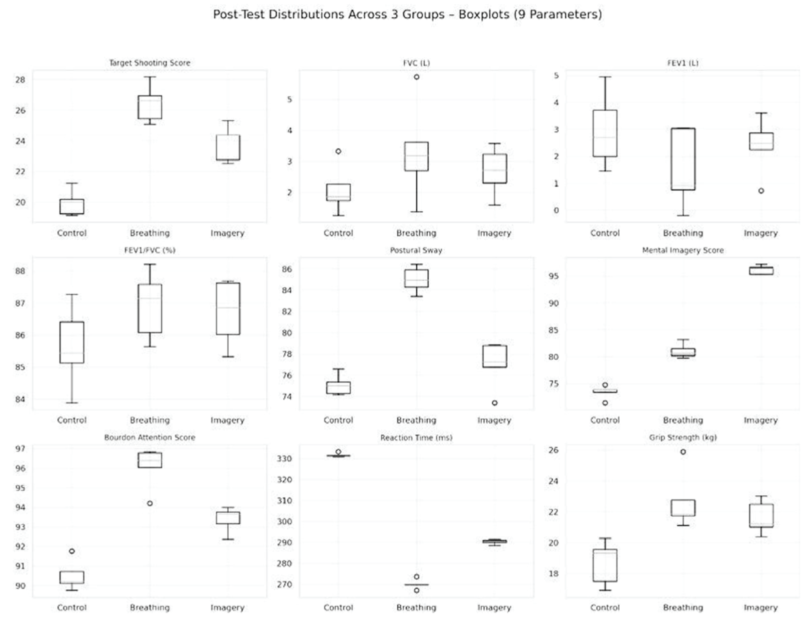

FIGURE 3. Boxplot comparison of post-test results across the Control, Breathing, and Imagery groups for nine measured parameters
Note. Each subplot presents the post-intervention distribution of scores for a specific performance or physiological parameter. The X-axis indicates the three experimental groups (Control, Breathing, Imagery), while the Y-axis represents the raw scores of each respective variable, measured in their appropriate units (e.g., liters for FVC and FEV1, milliseconds for reaction time, kilograms for grip strength). In each plot, the horizontal line within the box denotes the median value; the box spans the interquartile range (IQR), and the whiskers extend to 1.5 times the IQR. Outliers are plotted as individual data points beyond the whiskers.

Discussion

This pilot study suggests that breathing and mental imagery exercises can improve both motor and cognitive performance in novice archers. Within the breathing group, improvements in FEV_1 and postural sway imply enhanced thoracic flexibility and trunk control. Prior studies have reported a positive association between pulmonary function and balance, and our findings support this link (Almeida et al., 2013). Additionally, the parallel increases in handgrip strength and respiratory function in the breathing group may indicate broader neuromuscular benefits, as previously observed between FEV_1 and peripheral strength (Qaisar et al., 2020). Although breathing exercises improved attention and respiratory function, their effect on shooting performance was limited, likely due to their indirect influence on motor skills. In the imagery group, enhanced imagery ability, attention, and shooting performance reflect the positive influence of cognitive engagement on motor execution. This is consistent with evidence suggesting that mental focus can enhance postural control and attentional stability through central nervous system mechanisms (Boulanger et al., 2017). The group's stable sway scores and improved attention further support this interpretation.

Reduced reaction times and improved attention in the breathing group may reflect enhanced cognitive control, potentially linked to the calming effects of breath-based practices. These observations align with findings that mindfulness and breath regulation improve emotional balance and reduce anxiety symptoms (Stubenrauch, 2011). Similarly, the imagery group's superior mental performance and shooting accuracy underscore the value of mental rehearsal in supporting psychological readiness and task precision.

Our results on FVC are consistent with previous findings on Nadishodhana pranayama, which has been shown to enhance lung volumes via improved thoracic mobility and parasympathetic activation (Sandeep & Sukhdev, 2016). These physiological mechanisms may underlie the observed respiratory improvements.

The interventions showed high adherence, with no dropouts. Participants found them easy to follow, time-efficient, and beneficial. Requiring minimal equipment and cost, the protocols are practical for integration into routine practice. As accessible strategies, they may be effectively applied in both coaching and rehabilitation contexts to enhance motor control, attentional focus, and psychological preparedness in athletes and patients.

This pilot study is limited by its small sample size, which reduces statistical power and the ability to detect smaller effect sizes, as well as by the lack of blinding and absence of a placebo control, which may have introduced bias or expectancy effects. However, its integrative design—combining breathing and imagery exercises—offers a practical, low-cost approach targeting both cognitive and physical performance. These findings provide preliminary support for future applications in sport and rehabilitation contexts and will be further validated in the main study, which is planned with a larger sample and improved methodological controls. Future studies should focus on scaling up the intervention with larger samples and exploring the long-term effects of combining breathing and imagery techniques within archery-specific training programs.

Conclusion

This study suggests that breathing and mental imagery exercises can positively influence cognitive and physical performance in novice archers. The combined use of these techniques offers a practical, low-cost approach that may enhance attention, postural control, respiratory function, and shooting accurac.

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Conflicts of Interest
The authors declare no conflict of interest.

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