

Comparative Effects of Buteyko Breathing Technique Combined with Progressive and Regressive Resistance Training on explosive power Performance among National-Level Handball Players

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Abstract

The present study was conducted to examine and compare the effects of Buteyko Breathing Technique combined with Progressive Resistance Training (BBT + PRT) and Buteyko Breathing Technique combined with Regressive Resistance Training (BBT + RRT) on explosive power performance among national-level handball players. An experimental pre-test–post-test randomized group design was employed for the study. Twenty national-level male handball players aged 20–25 years were randomly allocated into two experimental groups, with 10 participants in each group. Both groups participated in a 12-week training programme incorporating Buteyko Breathing Technique, while the resistance-training protocol differed between the groups. The BBT + PRT group followed a progressive loading pattern from 45% to 100% of one-repetition maximum (1RM), whereas the BBT + RRT group followed a regressive loading pattern from 100% to 45% of 1RM. Explosive power was assessed using the Standing Broad Jump test before and after the intervention. Descriptive statistics and paired-samples t-tests were employed for data analysis, with the level of significance set at 0.05. The findings revealed a significant improvement in explosive power in the BBT + PRT group, with the mean score increasing from 2.552 m to 2.605 m ($t = -15.821$, $p < .001$). A significant improvement was also observed in the BBT + RRT group, with the mean score increasing from 2.559 m to 2.583 m ($t = -5.041$, $p = .001$). The BBT + PRT group demonstrated a greater observed mean improvement of 0.053 m compared with 0.024 m in the BBT + RRT group. It was concluded that both combined training programmes significantly improved explosive power among national-level handball players, while BBT combined with progressive resistance training produced a greater observed improvement. However, a direct between-group statistical analysis is required to establish whether the difference between the two training approaches is statistically significant.

Keywords: Buteyko Breathing Technique, Progressive Resistance Training, Regressive Resistance Training, Explosive Power, Standing Broad Jump, Handball Players, Resistance Training.

1. INTRODUCTION

Handball is a physically demanding intermittent team sport requiring repeated high-intensity actions such as sprinting, accelerating, decelerating, jumping, changing direction, throwing, blocking, and physical contact. Successful performance depends on the interaction of technical, tactical, physiological, muscular, and neuromuscular capacities (Karcher & Buchheit, 2014; Michalsik & Aagaard, 2015). Among these, muscular strength and explosive power are particularly important because many decisive actions require the rapid production of force, including jumping, acceleration, changes of direction, and forceful movements against opponents (Bragazzi et al., 2020; Chaabene et al., 2020).

Explosive power refers to the ability of the neuromuscular system to produce force rapidly and is influenced by maximal strength, rate of force development, motor-unit recruitment, movement velocity, coordination, and the stretch-shortening cycle (Cormie et al., 2011a; Suchomel et al., 2016). Since many handball movements are performed within very short time periods, the ability to rapidly express force is essential for competitive performance. Consequently, developing explosive power is an important objective in the conditioning of national-level handball players.

Resistance training is an established method for developing muscular strength and power. Its adaptations include improvements in neural activation, muscular strength, muscle function, and force-producing capacity (Suchomel et al., 2016; Grgic et al., 2018). Evidence specific to handball also supports its effectiveness. Bragazzi et al. (2020), through a systematic review and meta-analysis, reported significant positive effects of resistance training on maximal strength, isometric strength, muscle power, and throwing performance. However, the effects of resistance training depend on how intensity, volume, frequency, exercise selection, and loading progression are organized (Suchomel et al., 2018; Grgic et al., 2018).

Progressive resistance training applies the principle of progressive overload by systematically increasing or modifying the training stimulus as adaptation occurs. Appropriate progression can maintain sufficient overload and promote continued neuromuscular development, although excessive loading may compromise movement velocity and explosive performance (Cormie et al., 2011b; Suchomel et al., 2018). In contrast, regressive resistance training involves reducing the external training load according to a predetermined programme. Such variation in loading may alter the balance between mechanical loading, fatigue, and movement velocity. Because maximal power depends on the interaction between force and velocity, different loading patterns may produce different effects on explosive performance (Cormie et al., 2011a). Despite substantial evidence supporting resistance training for handball performance, comparatively limited research has directly compared progressive and regressive loading strategies in relation to explosive power.

The Buteyko Breathing Technique (BBT) is a breathing-retraining approach involving controlled breathing, nasal breathing, reduced breathing volume, breath control, and relaxation. Although BBT has primarily been studied in clinical populations, particularly individuals with asthma, evidence suggests that it may influence respiratory symptoms and respiratory control (Bowler et al., 1998; Wu et al., 2026). However, findings from clinical populations cannot automatically be generalized to trained athletes. Research on respiratory muscle training provides supporting evidence that respiratory-focused interventions may improve respiratory muscle function and selected athletic performance outcomes (HajGhanbari et al., 2013; Illi et al., 2012; Xavier et al., 2025). Nevertheless, respiratory muscle training differs from BBT because the former generally involves specific resistive or threshold loading, whereas

BBT primarily focuses on breathing retraining. Therefore, existing respiratory-training evidence should not be interpreted as direct evidence that BBT improves explosive power.

The potential combination of BBT with resistance training is therefore of interest because resistance training directly targets muscular strength and power, while breathing-based training may complement physical conditioning through effects on respiratory regulation and exercise-related physiological responses. However, the contribution of BBT to explosive performance, particularly when combined with different resistance-training strategies in national-level team-sport athletes, remains insufficiently established.

In the present study, explosive power is the primary performance construct. The standing broad jump is used as an objective field-based measure of lower-body explosive performance and provides a practical assessment of horizontal power following the intervention (Marin-Jimenez et al., 2024). Accordingly, the present investigation examines whether combining BBT with progressive and regressive resistance-training strategies can improve explosive power among national-level handball players.

1.1 Need for the Study

Explosive power is an important component of handball performance, and previous research has established the positive effects of resistance training on muscular power (Bragazzi et al., 2020). However, training adaptations may vary according to the loading pattern used. At the same time, breathing-based interventions have gained attention as potential adjuncts to athletic training, with respiratory training showing benefits for respiratory function and selected athletic performance outcomes (HajGhanbari et al., 2013; Xavier et al., 2025).

Despite these findings, limited research has directly examined BBT combined with different resistance-training loading patterns for improving explosive power in national-level handball players. Therefore, the present study was undertaken to examine and compare BBT combined with progressive resistance training and BBT combined with regressive resistance training as approaches for improving explosive power performance.

1.2 Purpose of the Study

The purpose of the study was to examine and compare the effects of Buteyko Breathing Technique combined with progressive resistance training and Buteyko Breathing Technique combined with regressive resistance training on explosive power performance among national-level handball players.

1.3 Hypotheses of the Study

1. It was hypothesized that Buteyko Breathing Technique combined with progressive resistance training would significantly improve explosive power performance among national-level handball players.
2. It was hypothesized that Buteyko Breathing Technique combined with regressive resistance training would significantly improve explosive power performance among national-level handball players.
3. It was hypothesized that the improvement in explosive power performance would differ significantly between the Buteyko Breathing Technique combined with progressive resistance training group and the Buteyko Breathing Technique combined with regressive resistance training group.

2. METHODOLOGY

2.1 Research Design

The study employed an experimental research design using a pre-test–post-test randomized group design. The purpose was to examine the effects of Buteyko Breathing Technique (BBT) combined with two

different resistance-training methods—Progressive Resistance Training (PRT) and Regressive Resistance Training (RRT)—on explosive power performance among national-level handball players. Participants were assessed before and after the 12-week training intervention.

2.2 Participants

The participants consisted of 20 national-level handball players, with 10 participants in each experimental group. The age of the participants ranged from 20 to 25 years. All participants were actively involved in handball training and were considered suitable for participation in the experimental training programme.

2.3 Group Allocation

The participants were randomly selected and allocated into two experimental groups, with 10 participants in each group:

- Group I: Buteyko Breathing Technique + Progressive Resistance Training (BBT + PRT)
- Group II: Buteyko Breathing Technique + Regressive Resistance Training (BBT + RRT)

Random allocation was used to minimize systematic differences between the two groups before the intervention.

2.4 Training Intervention

Both experimental groups participated in a 12-week combined training programme consisting of Buteyko Breathing Technique and resistance training. The only difference between the groups was the pattern of resistance-training intensity.

Group I performed BBT combined with progressive resistance training, whereas Group II performed BBT combined with regressive resistance training.

2.5 Buteyko Breathing Technique Protocol

The participants in both experimental groups performed the Buteyko Breathing Technique for approximately 30–45 minutes as part of the training programme throughout the intervention period. The BBT component was administered consistently to both groups so that the primary difference between the groups remained the resistance-training protocol.

2.6 Progressive Resistance Training Protocol

The Progressive Resistance Training (PRT) group followed a systematic increase in training intensity from 45% to 100% of 1RM, with repetitions decreasing progressively from 20–22 repetitions to 1 repetition. The prescribed loading pattern progressed from 45% to 100% 1RM, with 2 sets at 45–65% 1RM and 3 sets at 65–100% 1RM. The progressive increase in resistance was designed to provide a systematic training stimulus for the development of muscular strength and explosive performance (Kraemer et al., 2002).

2.7 Regressive Resistance Training Protocol

The Regressive Resistance Training (RRT) group followed the reverse loading pattern, with training intensity decreasing progressively from 100% to 45% of 1RM, while repetitions increased correspondingly from 1 to 20–22 repetitions. The prescribed loading pattern progressed from 100% to 45% 1RM, with 3 sets at 65–100% 1RM and 2 sets at 45–65% 1RM. Thus, the RRT protocol represented the reverse sequence of the progressive resistance-training programme.

Thus, the principal difference between the two experimental conditions was the direction of resistance progression: increasing resistance in the PRT group and decreasing resistance in the RRT group.

2.8 Duration and Frequency

The intervention was conducted for a total period of 12 weeks. Both groups followed their respective

BBT and resistance-training programmes throughout the intervention period.

2.9 Assessment of Explosive Power

Explosive power performance was assessed using the Standing Broad Jump (SBJ) test. The test was selected as a practical field-based measure of lower-limb explosive performance. The same testing procedure and conditions were maintained for the pre-test and post-test assessments to ensure consistency of measurement.

2.10 Data Collection Procedure

Data were collected at two stages: pre-test and post-test. The pre-test was conducted before commencement of the 12-week intervention, while the post-test was conducted following completion of the training programme.

Standing broad jump performance was recorded during both testing sessions, and the pre-test and post-test scores were used to determine changes in explosive power following the intervention.

2.11 Statistical Procedure

The collected data were analyzed using descriptive statistics and paired-samples t-tests. Mean and standard deviation were calculated to describe the performance scores of the participants.

A paired-samples t-test was used separately for each experimental group to determine whether a statistically significant difference existed between pre-test and post-test explosive power performance. The level of significance was set at 0.05.

The use of pre- and post-intervention measurements with paired t-tests is consistent with the analysis commonly used to examine within-group changes following an experimental training intervention.

3. ANALYSIS AND INTERPRETATION

The data obtained from the pre-test and post-test assessments of explosive power were statistically analyzed using descriptive statistics and paired-samples t-tests. The level of significance was set at 0.05. The results are presented in the following tables.

3.1 Descriptive Statistics

Table 1 Descriptive Statistics of Explosive Power Performance

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE BBTwPRT	2.5520	10	.10497	.03319
	POST BBTwPRT	2.6050	10	.09891	.03128
Pair 2	PRE BBTwRRT	2.5590	10	.11060	.03497
	POST BBTwRRT	2.5830	10	.10730	.03393

Interpretation: Table 1 shows that the mean explosive power performance of the BBT + PRT group increased from 2.552 m in the pre-test to 2.605 m in the post-test, indicating a mean improvement of 0.053 m (5.3 cm). Similarly, the BBT + RRT group improved from 2.559 m to 2.583 m, representing a mean improvement of 0.024 m (2.4 cm).

3.2 Paired t-Test for BBT + Progressive Resistance Training and BBT + Regressive Resistance Training

Table 2 Paired-Samples t-Test of Explosive Power Performance in the BBT + PRT Group and BBT +RRT Group

	Paired Differences	t	df	Sig. (2-
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		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				tailed)
					Lower	Upper			
	PRE BBTwPRT - POST BBTwPRT	.05300	.01059	.00335	-.06058	-.04542	-15.821	9	.000
	PRE BBTwRRT - POST BBTwRRT	.02400	.01506	.00476	-.03477	-.01323	-5.041	9	.001

Interpretation:

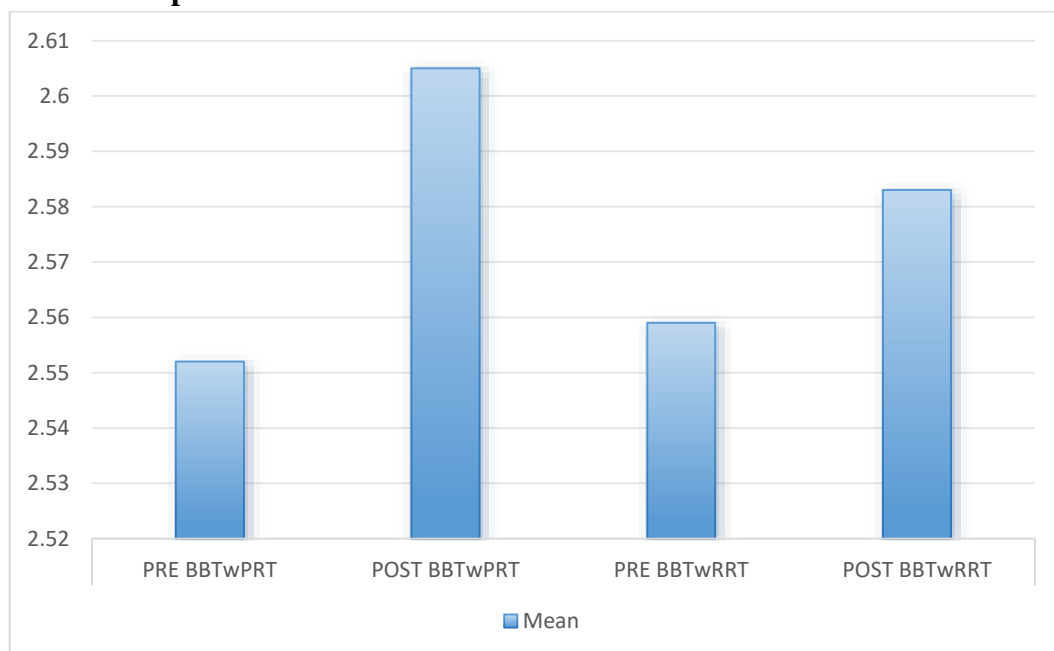
Table 2 indicates a statistically significant improvement in explosive power performance following the BBT + PRT intervention. The mean performance increased from 2.552 m to 2.605 m. The obtained t value of -15.821 was statistically significant at the 0.05 level ($p < .001$). The 95% confidence interval for the pre-post difference ranged from -0.061 to -0.045 m.

The result indicates that 12 weeks of Buteyko Breathing Technique combined with progressive resistance training significantly improved explosive power performance among the participants.

Table 2 also shows a statistically significant improvement in explosive power performance following the BBT + RRT intervention. The mean performance increased from 2.559 m in the pre-test to 2.583 m in the post-test. The obtained t value of -5.041 was statistically significant ($p = .001$), indicating that the improvement following the intervention was statistically significant. The 95% confidence interval for the pre-post difference ranged from -0.035 to -0.013 m.

Thus, the findings indicate that 12 weeks of Buteyko Breathing Technique combined with regressive resistance training also significantly improved explosive power performance.

Figure 1. Comparison of Pre-Test and Post-Test Mean Scores for Explosive Power in BBT + PRT and BBT + RRT Groups



3.3 Comparative Interpretation of Changes

The results indicate that both BBT + PRT and BBT + RRT produced statistically significant improvements in explosive power performance following the 12-week intervention. The BBT + PRT group improved from a pre-test mean of 2.552 m to a post-test mean of 2.605 m, showing a mean improvement of 0.053 m (5.3 cm). In comparison, the BBT + RRT group improved from 2.559 m to 2.583 m, showing a mean improvement of 0.024 m (2.4 cm).

Although both groups demonstrated statistically significant improvement, the comparison of their pre-test and post-test means shows that the BBT + PRT group demonstrated greater improvement in explosive power performance than the BBT + RRT group. Thus, based on the magnitude of observed pre-post mean change, BBT combined with progressive resistance training produced a greater improvement in explosive power performance in the present study.

3.4 Summary of Findings

The analysis produced the following major findings:

1. BBT + PRT significantly improved explosive power performance ($t = -15.821$, $p < .001$).
2. BBT + RRT significantly improved explosive power performance ($t = -5.041$, $p = .001$).
3. The BBT + PRT group showed a greater mean improvement (0.053 m) than the BBT + RRT group (0.024 m).
4. Both interventions were associated with statistically significant improvements in explosive power following the 12-week training programme.

4. DISCUSSION AND CONCLUSION

4.1 Discussion of Findings

The present study examined the effects of Buteyko Breathing Technique combined with Progressive Resistance Training (BBT + PRT) and Buteyko Breathing Technique combined with Regressive Resistance Training (BBT + RRT) on explosive power among national-level handball players following a 12-week intervention. Both groups demonstrated statistically significant improvement. The BBT + PRT group improved from 2.552 m to 2.605 m, with a mean improvement of 0.053 m (5.3 cm) ($t = -15.821$, $p < .001$), while the BBT + RRT group improved from 2.559 m to 2.583 m, with a mean improvement of 0.024 m (2.4 cm) ($t = -5.041$, $p = .001$).

The improvements may be attributed primarily to the systematic resistance-training stimulus, which involved loading from 45% to 100% of 1RM and varying repetitions according to the respective loading pattern. Such resistance training can enhance muscular strength, neuromuscular coordination, and force-producing capacity, all of which contribute to explosive performance (Kraemer et al., 2002; Cormie et al., 2011a, 2011b). These findings are consistent with Bragazzi et al. (2020), whose meta-analysis of 18 studies involving 275 handball players reported significant positive effects of resistance training on muscle power ($ES = 0.892$). Schneider et al. (2024) likewise reported a large positive effect of resistance training on sport-specific performance among elite athletes ($SMD = 1.16$).

The findings can also be explained by the relationship between strength and explosive power. Increased force-producing capacity provides a foundation for rapidly expressing force, while appropriate resistance training may improve the ability to produce force at higher velocities (Cormie et al., 2011a, 2011b; Suchomel et al., 2016).

4.2 Effect of Progressive and Regressive Resistance Training

The BBT + PRT group showed a greater observed improvement (5.3 cm) than the BBT + RRT group

(2.4 cm). The progressive loading pattern, in which resistance increased from 45% toward 100% 1RM while repetitions decreased from 20–22 to 1, may have provided a systematically increasing stimulus for neuromuscular adaptation. This is consistent with evidence supporting progressive resistance training for improving strength and jumping performance (Kraemer et al., 2002; Suchomel et al., 2016; Zhu et al., 2024).

The BBT + RRT group also demonstrated significant improvement despite following the reverse loading sequence, with resistance decreasing from 100% to 45% 1RM and repetitions increasing from 1 to 20–22. The combination of high-intensity and higher-repetition training may have provided sufficient stimulus for improvements in muscular and neuromuscular performance.

However, the smaller improvement observed in the RRT group may suggest that the direction of loading progression influenced the magnitude of adaptation. This interpretation should be made cautiously because the present analysis used within-group paired t-tests and did not include a direct between-group inferential test. Therefore, the findings establish that both interventions significantly improved explosive power, while the greater observed improvement with BBT + PRT does not by itself establish statistical superiority over BBT + RRT.

4.3 Possible Contribution of Buteyko Breathing Technique

BBT was included in both experimental groups and may have provided a supportive component through controlled breathing and respiratory regulation. However, because there was no BBT-only or control condition, its independent contribution to the improvement in explosive power cannot be determined.

Evidence from respiratory-training research provides some physiological support for breathing-based interventions. HajGhanbari et al. (2013) reported improvements in respiratory muscle function and selected sport-performance outcomes, while Xavier et al. (2025) found improvements in respiratory muscle strength and selected physical-performance variables among athletes. Nevertheless, the evidence quality has limitations, and respiratory muscle training differs from BBT. Therefore, the present improvements should be interpreted as effects of the combined BBT and resistance-training programmes, rather than evidence that BBT alone improves explosive power.

4.4 Conclusion

Based on the findings, the following conclusions were drawn:

1. BBT + Progressive Resistance Training significantly improved explosive power among national-level handball players after 12 weeks.
2. BBT + Regressive Resistance Training also significantly improved explosive power after the 12-week intervention.
3. The BBT + PRT group showed a greater observed improvement (5.3 cm) than the BBT + RRT group (2.4 cm).
4. The findings are consistent with previous evidence supporting resistance training as an effective method for improving muscular power and athletic performance.
5. BBT may have provided a supportive breathing component; however, its independent effect cannot be established because both groups received BBT and no BBT-only/control group was included.

Overall, BBT combined with Progressive Resistance Training appears to be a promising approach for improving explosive power among national-level handball players. Further research with larger samples, appropriate control conditions, and direct between-group comparisons is required to establish the independent contribution of BBT and determine whether progressive loading is statistically superior to regressive loading.

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