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Research Protocol

Physiotherapy Section

Adjunctive Effect of Buteyko Breathing on Cardiorespiratory Fitness and Physiological Parameters among Recreational Athletes: A Protocol for a Randomised Controlled Trial

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ABSTRACT

Introduction: Buteyko Breathing (BB) has shown potential to improve cardiorespiratory endurance in previous studies. The breath-holding effect of BB is the condition of maintaining high carbon-dioxide levels all the time, which can lower blood pH, causing more oxygen to be released into the tissues and increased cardiorespiratory endurance. BB is about slow and shallow nasal breathing, aiming to prevent hyperventilation, which may consequently increase parasympathetic activity.

Need of the study: With limited research available on the effects of BB on athletic performance, especially in enhancing VO2 max, Resting Heart Rate (RHR) and Resting Blood Pressure (RBP). This randomised controlled trial aims to fill this gap by providing valuable insights into how BB can improve Cardio Respiratory Fitness (CRF) and physiological parameters. The objective of this study is to see whether daily BB practice over six weeks would increase cardiorespiratory endurance and lower RHR and RBP.

Aim: To evaluate the effectiveness of BB on CRF and physiological parameters among recreational athletes.

Materials and Methods: A randomised controlled trial will be conducted at Maharishi Markandeshwar (deemed to be university), Mullana, Ambala, Haryana, India, from March 2025 to July 2026. A total of 60 recreational athletes aged 18-40 years regularly engaged in sports for at least two years will be recruited and randomised into an experimental group (Group A), which will receive functional training exercises in combination with the BB exercise, and a control group (Group B) will have only functional training. Normality will be assessed with the Kolmogorov-Smirnov test. Parametric tests (paired t-test, Independent t-test) will be used for normally distributed data, and non-parametric tests (Wilcoxon signed-rank test, Mann-Whitney U test) for non normal data. A value of $p<0.05$ will be considered statistically significant.

Keywords: Athletes, Breathing exercise, Heart rate, Oxygen consumption, Physical endurance

INTRODUCTION

An individual needs to be physically fit to lead a happy and prosperous life. Physical fitness enables an individual to perform assigned responsibilities efficiently and effectively [1]. It is broadly divided into two categories: skill-related and health-related physical fitness. Among them are five components of health-related physical fitness: muscular endurance, body composition, and cardiorespiratory endurance [2]. Cardiorespiratory endurance constitutes the foundational element within the spectrum of health-related physical fitness. This capacity is defined by the efficiency with which the cardiovascular system, comprising the heart, lungs, and vasculature, supplies oxygen and essential nutrients to active muscle tissue. Subsequently, within the cellular structures of these muscles, energy is synthesised from these nutrients through aerobic metabolic pathways [3].

As a result, the more oxygen one's body can utilise, the more energy it can produce to achieve greater aerobic fitness. Therefore, athletes with more developed cardiorespiratory fitness will exhibit enhanced sustained performance due to their physiological capacity to oxygenate musculature [4] efficiently. VO_2 max is a key measure of cardiorespiratory endurance, representing the highest amount of oxygen the body can use during intense exercise. A low VO_2 max is often linked to early fatigue during light physical activity. This is because VO_2 max indicates how well oxygen is delivered, which is essential for the body's energy production [3]. The primary factor influencing VO_2 max is pulmonary function, particularly the mechanisms of ventilation and alveolar diffusion. At the alveolar capillary level, oxygen diffuses across the alveolar capillary membrane, and it binds to haemoglobin and is subsequently delivered through the vascular system to support tissue oxygenation and aerobic metabolism [5].

Numerous traditional approaches, such as High Intensity Interval Training (HIIT), recreational sports training, and aerobic training, have demonstrated efficacy in enhancing cardiorespiratory fitness in recreational athletes [6,7]. Nevertheless, practical implementation of these interventions faces various challenges, including limited generalisability, low adherence rates due to discomfort, heightened risk of minor injuries in recreational athletes, and issues such as overuse injuries [8]. Therefore, a practical and less demanding intervention that effectively enhances cardiorespiratory fitness is needed. Developed by Dr Konstantin Buteyko, the Buteyko Breathing Technique (BBT) is a non pharmacological approach to bronchial asthma, which has garnered clinical acceptance [9]. This method, distinct from pharmacological treatments, centres on patients consciously diminishing their breathing volume through a series of practical techniques. Patients are instructed to regulate their respiratory rate by counting breaths, to employ distraction techniques such as gentle rocking during ambulation, and to establish specific nocturnal routines, including sleeping in a left lateral position with mouth tape. Consequently, when ventilation is reduced via these practices, carbon dioxide levels in the body naturally increase. This elevation subsequently initiates the Bohr effect, a physiological process whereby oxygen is released more efficiently from haemoglobin, thereby enhancing oxygen delivery to tissues; the body utilise oxygen more efficiently at the cellular level [10]. This technique is particularly distinctive because of its counterintuitive premise: breathing less, not more, becomes the goal. Breath-holding holds equal importance to breathing itself within this framework. Practitioners typically work with two core techniques: reduced breathing, which decreases the amount of air

taken in with each breath, and Breath-holding exercises designed to boost carbon dioxide concentrations in the alveoli [9]. Maintaining nasal breathing during exercise enables people to sustain a work level high enough to yield real aerobic benefits [11].

There are many known breathing techniques to improve cardiorespiratory parameters. As BB is a new approach, it has not gained much popularity among athletes. To the best of our knowledge, limited literature is available evaluating the effects of the BBT in athletes. Among them, none of the studies investigates the effect of BB among recreational athletes.

REVIEW OF LITERATURE

Cardiorespiratory endurance is a key determinant of athletic performance, with VO_2 max serving as a reliable indicator of aerobic capacity and cardiopulmonary efficiency. Therefore, effective training interventions to improve VO_2 max remain essential for enhancing athletic performance [12]. A recent systematic review published in 2025 emphasised the importance of respiratory muscle training for improving cardiopulmonary endurance in athletes. The review reported that respiratory muscle training enhances Maximum Inspiratory Pressure (MIP), Forced Expiratory Volume in one second (FEV_1), and Forced Vital Capacity (FVC), leading to improvements in VO_2 max [13].

Fahrizal D et al., conducted a quasi-experimental study that examined the synergistic effect of BBT and endurance training on cardiopulmonary fitness rather than only endurance training. A total of 22 males aged 15-17 years were included in the study; 11 were in the experimental group receiving triangle run training combined with BB, whereas 11 were in the control group receiving only the triangle run training. The findings showed a more significant improvement in VO_2 max in the experimental group of 13.14%, whereas only 7.17% in the control group over a duration of four weeks of intervention [10].

Obhaliya Y et al., assessed the immediate effect of BB on VO_2 max among college students aged 19 to 25 years, showing the acute impacts of the BBT on cardiorespiratory endurance. They recruited participants and assessed baseline measurements of age, height, weight, and BMI. Then the participants took the Queen's College Step Test, and the pulse rate and VO_2 max were measured, which focused on regulated breathing patterns, the mitigation of hyperventilation, and the enhancement of carbon dioxide retention. This intervention was delivered for a duration of 20 minutes each day over the course of one week. Post-intervention, there was a statistically significant elevation in VO_2 max ($p=0.001$), coupled with a decrease in pulse rate ($p=0.001$), thereby implying an improvement in cardiorespiratory efficiency. These results suggest that even a brief application of BBT can yield immediate physiological advantages [14].

Likewise, research conducted by Wibowo S et al., aimed to determine the impact of functional training on recreational runners. A total of 24 participants were included in the study. The training protocol included resistance training with dumbbells and kettlebells, conducted three times/week for six weeks. The parameters included in the research were cardiovascular endurance or VO_2 max via the Balke test, and strength via minute ventilation, tidal volume, and distance walked in the Balke test. The intervention group demonstrated significant improvements in both muscular strength and cardiovascular endurance compared with baseline and the control group ($p<0.05$). The study concluded that short-term HIFT is an effective supplementary training method for improving strength and endurance in recreational runners [15].

In yet another RCT study, Kusumaningtyas M and Handari HK investigated the efficacy of the BBT for improving cardiorespiratory endurance among 59 physiotherapy students. The intervention group (n=29) were taught the BBT, and the exercises were done three times/week for four weeks, while the control group (n=30) were allowed to continue their routine activities. Cardiorespiratory fitness or VO_2 max was measured using the Harvard Step Test method. This study concluded that the BBT shows a significant increase in cardiorespiratory endurance ($p=0.027$) while the control group showed insignificant results ($p=0.425$) [16].

Various methods are used to train the respiratory muscles, including breathing exercises and inspiratory muscle training programmes. The BBT is a simple approach that may improve breathing efficiency, autonomic function, and oxygen delivery to the tissues. Therefore, there is a need for more randomised controlled trials to explore the effect of BB. Hence, this study aims to evaluate the impact of BBT on recreational athletes' physiological parameters and cardiorespiratory fitness.

Primary objective:

- To evaluate the combined effectiveness of the BBT in combination with functional training exercise on CRF and physiological parameters among recreational athletes.
- To evaluate the effectiveness of functional training exercise on CRF and physiological parameters among recreational athletes.

Secondary objectives:

- To compare the effect of functional training exercise alone versus functional training combined with BBT on CRF and physiological parameters among recreational athletes.

The null hypothesis states that the combination of functional training exercise and BB may not have a significant difference when compared with functional training exercise alone on CRF and physiological parameters in recreational athletes.

The alternative hypothesis states that the combination of functional training exercise and BB may have a significant difference when compared with functional training exercise alone on CRF and physiological parameters in recreational athletes.

MATERIALS AND METHODS

A single-centred, two-parallel-groups randomised controlled trial will be conducted at the Maharishi Markandeshwar (Deemed to be) University, Mullana, Ambala, Haryana, India, from March 2025 to July 2026. Before enrollment, ethical approval will be obtained from the Institutional Ethical Committee (IEC No.: 3463). The trial with identifier: CTRI: 2025/08/093434 was prospectively registered in the Clinical Trials Registry of India. Written informed consent will be obtained from all the participants.

Inclusion criteria: Participants aged between 18 and 40 years, including both males and females were included. All participants will be recreational athletes who have been regularly involved in sports activities for at least the past two years.

Exclusion criteria: Participants with any musculoskeletal or intramuscular disorders, a history of thoracic surgery, cardiac, recent injury or other pulmonary complications will be excluded from the study.

Sample size calculation: Sample size calculated by the formula,

$$n=2(Z\alpha/2+Z\beta)^2/d^2,$$

where n is the sample size per group,

$Z\alpha/2$=value at the significance level,

$Z\beta$=power, and d=effect size.

From the previous study by Chaudhary S et al., [17], the mean±SD (Pre: 52.31±5.615 and Post: 60.44±5.127) was taken.

SD pooled=√(SD1)2+(SD2)2/2=5.38

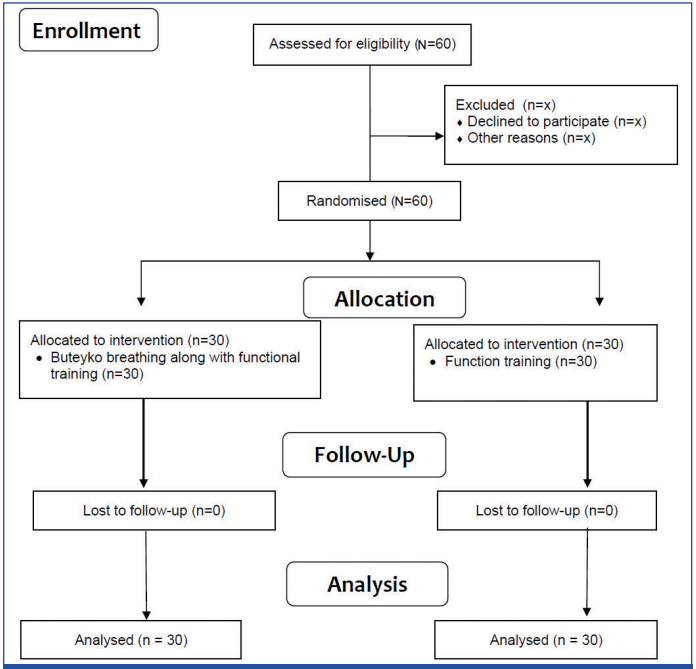
Then the effect size, d, was calculated using d=Mean post-Mean pre/SDpooled=1.515.

Since 1.51 is too large an effect size, the estimated sample size assuming an effect size (d) of 0.8, a significance level (α) of 0.05, power of 80%, and an allocation ratio of 1:1.

$$n=2(Z\alpha/2+Z\beta)^2/d^2=52$$

After considering a 15% dropout rate, the final sample size is 60 participants. Sixty eligible participants will be randomly assigned according to the Consolidated Standards of Reporting Trials (CONSORT) guidelines [Table/Fig-1] (n=30 per group) to

- Group A, BB with functional training [Table/Fig-2] and
- Group B, only functional training exercise [17].



[Table/Fig-1]: CONSORT flow diagram.

Both groups will complete the same functional training three times weekly, which is a combination of strength and endurance training [Table/Fig-3] [18].

Participants will be randomly allocated into two groups using computer-generated randomisation. The allocation concealment will be maintained using sequentially numbered sealed opaque envelopes, and the randomisation sequence will be generated and implemented by the primary researcher. Blinding of participants and researchers will not be done.

Primary outcomes:

1. **Cardiorespiratory Fitness (CRF):** will be measured by the Queen's College Step Test; the step test will be conducted on a 16.25-inch stool for three minutes at a cadence of 24 cycles per minute for males and 22 cycles per minute for females, using a metronome. Post-exercise, the subject remained standing, and carotid pulse will be recorded for 5-20 seconds of recovery. The 15-second pulse will be converted to beats per minute, and VO_2 max will be estimated using the equation (VO_2 max=111.33-(0.42×pulse rate) for men, and for females, VO_2 max=65.8-(0.1847×pulse rate) [19].

Secondary outcomes measure:

2. **RBP** will be assessed by an Omron 705CP automated sphygmomanometer, which will be used to measure the RBP following standardised procedures. Athletes will be seated comfortably and the arm at heart level after five minutes of rest. Three readings will be taken at 1-2-minute intervals, and the average value will be recorded. Normal RBP is defined as systolic BP <120 mmHg and diastolic BP <80 mmHg [20].

Steps	Instructions	Duration	Repetition	Frequency
Step 1	Participants will take a gentle inhalation through the nose for approximately 2 seconds, followed by a gentle exhalation for 3 seconds, then hold their breath by pinching the nose at the end of exhalation with comfortably empty lungs. Participants will silently count the seconds until the first urge to breathe, then release the breath and inhale calmly through the nose.	5 minutes	Twice/day	5 sessions/week
Step 2	Participants will be instructed to sit upright in a relaxed posture, and will be asked to place a finger just below the nostrils to monitor and become aware of nasal airflow. Breathing should be gentle and quiet through the nose; throughout the procedure, participants will be encouraged to maintain a state of light air hunger.	5 minutes	Twice/day	5 sessions\week
Step 3	Each session will begin with an initial control pause, following the procedure of gentle nasal inhale (2 seconds), exhale (3 seconds) and breath- hold until the first urge to breathe. This will be followed by 4 minutes of reduced (shallow) nasal breathing, aiming to maintain light air hunger while staying relaxed. Participants will then undergo a 2-minute rest period with normal breathing before the CP measurement. This cycle of reduced breathing, rest and CP will be repeated three more times.	5 minutes	Twice/day	5 sessions/week

[Table/Fig-2]: Buteyko Breathing (BB) protocol.
CP: Control pause

Strength training program					
Weeks	**Exercise name**	**Reps/set**	**Interval**	**Intensity**	**Frequency**
1-2 weeks	Standard push-up, Cat cow, Russian twist, Crunch, Lunges.	10-12-15/ 3-4-5	10-20 seconds	Low to moderate	3 times/week
3-4 weeks	Elbow to hand plank lift, Twisting crunch with dumbbell, Lunges with dumbbell, Triceps dips, Mountain climber.	10-12-15/ 3-4-5	10-20 seconds	Low to moderate	3 times/week
5-6 weeks	Resistance band push-up, Dumbbell sit-up press, Resistance band squat, Dumbbell ,Russian twist, Dumbbell squat thrust.	10-12-15/ 3-4-5	10-20 seconds	Low to moderate	3 times/week

Endurance training protocol				
Week	**Exercises**	**Intensity**	**Duration**	**Rhythm**
1-2	Running	70% Maximum heart rate	30 minutes/day	Low to moderate
3-4	Sprint	90% of MHR	40 minutes/day	Moderate to fast
5-6	Small side 4×4 field	90%-95%-100% MHR	4 minutes	Fast

[Table/Fig-3]: Functional training protocol.
Reps: Repetitions; MHR: Maximal heart rate; EMOM: Every minute on the minute; AMRAP: As many rounds as possible

3. **Resting Heart Rate (HR)** will be measured by a pulse oximeter (Dr Trust USA Signature Series 201), which is a standard calibration device. The device will be applied to the participant's fingertip after adequate rest, and normal resting pulse rate ranges from 60 to 100 beats per minute [21].

The primary researcher or first author will administer the above tests and provide the intervention. All the outcome measures will be assessed at baseline and post-6-week intervention.

STATISTICAL ANALYSIS

The data will be analysed using IBM Statistical Package for Social Sciences (SPSS) Statistics 27.0.1. Paired and unpaired t-tests will be used for within-group and between-group analysis, respectively, and descriptive statistics will be reported as mean±SD for all Variables. If the data are found to be not normally distributed, the Wilcoxon signed-rank test will be used for within-group analysis, and descriptive statistics will be reported as median for all variables. Effect sizes (Cohen's d) and 95% confidence intervals will be reported. Statistical significance will be set at "$p<0.05$".

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