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Original Research Article (Clinical)

Yogic breathing practices improve lung functions of competitive young swimmers

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ABSTRACT

Background: Resistive breathing practices are known to improve endurance and performance in competitive swimmers. However, the effect of *Pranayama* or Yogic Breathing Practices (YBP) in improving respiratory endurance and performance of competitive swimmers remains un-investigated.
Objectives: To study effects of yogic breathing practices on lung functions of swimmers.
Material and methods: Twenty seven national and international competitive swimmers of the age range 13–20 years, with 8.29 ± 2.9 years of competitive swimming experience and practicing swimming for 9.58 ± 1.81 km everyday, were assigned randomly to either an experimental (YBP) or to wait list control group (no intervention). Outcome measures were taken on day 1 and day 30 and included (1) spirometry to measure lung function, (2) Sport Anxiety Scale-2 (SAS-2) to measure the antecedents and consequences of cognitive and somatic trait anxiety of sport performance and (3) number of strokes per breath to measure performance. The YBP group practiced a prescribed set of Yogic Breathing Practices – Sectional Breathing (*Vibhagiya Pranayama*), Yogic Bellows Breathing (*Bhastrika Pranayama*) and Alternate Nostril Breathing with Voluntary Internal Breath Holding (*Nadi Shodhana* with *Anthar kumbhaka*) for half an hour, five days a week for one month.
Results: There was a significant improvement in the YBP group as compared to control group in maximal voluntary ventilation ($p = 0.038$), forced vital capacity ($p = 0.026$) and number of strokes per breath ($p = 0.001$).
Conclusion: The findings suggest that YBP helps to enhance respiratory endurance in competitive swimmers.

1. Introduction

Swimming as a competitive sport involves propelling one's body in water by pushing against it. The water, because of its greater density, offers more resistance to the swimmers than air in land based sports [1]. Competitive swimmers are expected to have specific anthropometrical features compared to other athletes [2]. Swimming being an activity that requires physical strength and endurance, is often associated with large lung volumes and relatively reduced flow, which may represent a physiological variant of normal pulmonary functions but also can signify an obstructive abnormality [3]. Increased respiratory work in competitive swimming induces respiratory muscle fatigue and in turn reduces swimming endurance, performance and breathing frequency [4,5]. Evidence suggests that serum lactate, a metabolic by product of the glycolytic pathway increases in swimming and contributes to stiffness and soreness [6]. Increased serum lactate levels have been shown to influence stroke rate and distance covered per stroke while swimming [7].

The conventional method used for competitive swimming is inhaling through the mouth in a short time and exhaling the air from the nose while underwater [8,9], thereby reducing the resistance caused by turning the head [10]. However, due to an increase in exhalation, which helps in overcoming the resistance of water, there is a resultant increase in the fatigue of the respiratory muscles [11] and reduction in blood flow and oxygen supply to other exercising muscles [3].

In competitive swimming, strict regulation of breathing is essential [12] to ensure maximum levels of oxygen in a relatively available short time span [13]. Techniques evolved to enhance performance and to overcome the associated complications of

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swimming had focused on keeping well-conditioned lungs, increasing the vital capacity, regulating breathing pattern and strengthening respiratory musculature [4].

Research has indicated the influence of somatic and cognitive anxiety on outcome measures in sports. The process of competitive stress involves the perception of a substantial imbalance between the environmental demand and one's response capabilities. This imbalance is perceived as having important consequences on the outcome [14]. Elevation in sympathetic tone as marked by anxiety and reduced Heart Rate Variability patterns have been shown to be regulated by regulation of breathing [15]. Also, Cognitive Behavioral Therapy (CBT) aimed towards reducing anxiety has been documented to increase performance [16]. The ability to overcome pressure and anxiety is an integral part of sports, particularly among elite athletes [17,18].

Pranayama is more than a simple breathing exercise. It is not merely breath control but is one of the powerful yogic techniques used to regulate the flow of energy, *'prana'* in the body to a higher frequency [19]. Traditional *yogic* literature suggest four important aspects of breathing utilized in Pranayama. They are *Puraka* or inhalation, *Rechaka* or exhalation, *Anthar kumbhaka* or Internal Breath Retention and *Bahir kumbhaka* or External Breath Retention [20]. In the current study three *pranayama* or Yogic Breathing Practices (YBP) have been utilized: Sectional Breathing (*Vibhagiya Pranayama*), Yogic Bellows Breathing *(Bhastrika Pranayama*) and Alternate Nostril Breathing with Voluntary Internal Breath Retention (*Nadi Shodhana Pranayama* with *Anthar kumbhaka*).

In healthy individuals, Alternate Nostril Breathing has been shown to be effective in improving vital capacity of the lungs as well as cardio-pulmonary functioning [11]. Alternate Nostril Breathing when practiced along with Yogic Bellows Breathing has been shown to improve Maximum Ventilatory Volume along with Vital Capacity of the lungs [21], whereas the same when practiced with Voluntary Internal Breath Retention ensures better oxygen availability to the tissues [21]. Yogic Bellows Breathing when practiced along with other breathing practices showed a better reduction in basal heart rate and respiratory rate suggesting a better cardiac autonomic reactivity and parasympathetic activity [22]. Sectional Breathing practices increased thoraco-pulmonary compliances by more efficient use of diaphragmatic and abdominal muscles, thereby emptying and filling the respiratory apparatus more efficiently and completely. Sectional Breathing involving individual's awareness helps correct the inefficient breathing pattern and increase Vital Capacity of lungs [23]. Having studied individually, the effects of the Yogic Breathing Practices in healthy volunteers, this study aims to utilize these practices to enhance pulmonary function and endurance of the respiratory muscles in competitive swimmers.

Based on the findings from the earlier studies, we hypothesized Alternate Nostril Breathing with Voluntary Internal Breath Retention; Yogic Bellows Breathing and Sectional Breathing are expected to alleviate sport anxiety through reduction of sympathetic arousal, enhance endurance of the respiratory muscles and vital capacity of the lungs thereby reducing fatigue and acute respiratory symptoms.

2. Methodology

2.1. Participants

Twenty seven competitive swimmers from a swimming academy, (thirteen males and fourteen females) of the age range 13–20 years, with 8.29 ± 2.9 years of competitive swimming experience, practicing swimming for 9.58 ± 1.81 km everyday, participated in the study. The project was approved by the Institutional Ethics Committee. A written informed consent was obtained from all the participants above 18 years and for minors below the age of 18 years an informed consent was obtained from the parents or guardians.

Table 1
Demographic data of the initially randomized sample.

Sl No	Baseline characteristics	YBP group n = 14 (Mean ± SD)	Control group n = 15 (Mean ± SD)
1.	Age (in years)	15.23 ± 1.59	15.08 ± 1.26
2.	Height (in cm)	165.69 ± 10.38	163.31 ± 10.28
3.	Weight (in kg)	55 ± 9.66	52.77 ± 10.39
4.	Experience (in years)	8.15 ± 2.96	8.42 ± 2.83
5.	Swimming per day (in km)	9.62 ± 1.89	9.53 ± 1.81
6.	Swimming per week (in km)	48.08 ± 9.47	47.69 ± 9.04

The sample size was estimated from a previous study conducted with an effect size of 0.9 and an estimated sample size of 24. Considering drop outs more swimmers (n=30) were included in the study.

2.2. Experimental design: randomized matched control clinical study

Participants were first stratified according to their age and gender and randomly assigned into one of two, Yogic Breathing Practices (YBP) and wait-list control groups based on a computerized random number generator. Baseline characteristics of the participants in each group are described in Table 1.

2.3. Experimental protocol

The YBP group was administered with Sectional Breathing (*Vibhagiya Pranayama*), Yogic Bellows Breathing (*Bhastrika Pranayama*) and Alternate Nostril Breathing (*Nadi Shodhana*) with Voluntary Internal Breath Retention (*Anthar kumbhaka*) for thirty minutes, five days a week for a period of one month along with their regular practice of swimming and physical training. The control group underwent only physical training practices (Table 2). The practice was administered in a sound attenuated hall as a pre-recorded audio to avoid instructor bias. However, the instructor was available throughout the practice session to clarify the doubts if any. The waitlist control group practiced their regular swimming and physical training protocol.

2.3.1. Description of intervention

2.3.1.1. Sectional Breathing (Vibhagiya Pranayama). Sectional Breathing is a preparatory breathing practice for *pranayama*, which helps to correct the incorrect breathing pattern such as habitual over breathing, breath holding or shallow breathing. Participants were

Table 2
List of Yoga practices

Practice	Duration
Regular physical training undertaken by both the groups	
Running and stretching exercises	20 min
Endurance building exercises	20 min
Swimming drills	6 kick & 3 pull
Practices specific to yoga group	
Sectional Breathing	10 min
Yogic Bellows Breathing (*Bhastrika Pranayama*)	10 min
Alternate Nostril Breathing with Voluntary Internal Breath Retention	10 min