

Asthma – A Disease of How We Breathe: Role of Breathing Exercises and Pranayam

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Abstract To describe the role of breathing exercises or yoga and/or pranayama in the management of childhood asthma. We conducted an updated literature search and retrieved relevant literature on the role of breathing exercises or yoga and/or pranayama in the management of childhood asthma. We found that the breathing exercises or yoga and/or pranayama are generally multi-component packaged interventions, and are described as follows: Papworth technique, Buteyko technique, Yoga and/or Pranayam. These techniques primarily modify the pattern of breathing to reduce hyperventilation resulting in normalisation of CO₂ level, reduction of bronchospasm and resulting breathlessness. In addition they also change the behaviour, decrease anxiety, improve immunological parameters, and improve endurance of the respiratory muscles that may ultimately help asthmatic children. We found 10 clinical trials conducted in children with asthma of varying severity, and found to benefit children with chronic (mild and moderate) and uncontrolled asthma, but not acute severe asthma. Breathing exercises or yoga and/or pranayama may benefit children with chronic (mild and moderate) and uncontrolled asthma, but not acute severe asthma. Before these techniques can be incorporated into the standard care of asthmatic children, important outcomes like quality of life,

medication use, and patient reported outcomes need to be evaluated in future clinical trials.

Keywords Pediatric · Asthma · Yoga · Pranayam · Breathing exercise · Lung function · Allergy · Quality of life

Introduction

Bronchial asthma is a complex disease with several phenotypic expressions. It is a multifactorial disease resulting from an interaction between genetically determined predisposition to allergic diseases and environmental factors that serve to enhance inflammation [1]. Environmental factors include microbial products, food and allergens, stress and infections. Because of the variegated predisposing factors, many therapeutic and preventive approaches to asthma have been promoted [2–5].

The classic treatment of childhood asthma includes pharmacological agents, allergen avoidance, lifestyle modification, anti-IgE antibodies, and sometimes alternative or complementary medicines or non-pharmacological methods (including breathing exercise, yoga, pranayam, and inspiratory muscle training). The goal of treatment is to control symptoms, non-restriction of daily physical activity, achievement of near normal or normal lung function, less use of drugs/medications with no minimal side-effects. However, these goals may not always be achieved with a single treatment modality and there may be increased risk of adverse events. Besides these, some parents prefer to give alternative medicines as an addition or substitution to asthma medications because of concerns about asthma medications [6, 7].

Of late, a number of non-pharmacologic methods are getting popular in the management of asthma in adults as well as in children [3]. Of these, breathing exercises or yoga and/or pranayam are the popular ones, as yoga is being increasingly

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accepted worldwide for well-being of humans. These methods basically act by reducing hyperventilation (through end expiration breath-holding/pause, shallow nasal breathing, and minimizing over-breathing), impose resistance on both phases of respiration or prolongation of expiratory phase, and enhancement of abdominal or diaphragmatic breathing [8].

Types of Breathing Techniques

Breathing exercises for asthma are divided into 3 broad groups: breathing retraining (manipulation of breathing pattern); respiratory muscle training (to increase the strength of respiratory muscles); and musculoskeletal training (to increase the flexibility of thoracic cage) [9]. Of these, the focus is on breathing retraining exercises in recent years. This has been frequently investigated in studies either as physiotherapist-administered breathing exercises or Buteyko breathing method or Papworth method or yoga and/or pranayam technique [10–20]. For the purpose of the review authors would be discussing only the various breathing retraining exercises with special emphasis on Pranayam and/or yoga.

Physiology and Rationale

In 1950's it was proposed that hidden hyperventilation which is due to dysfunctional breathing leads to hypocapnia which is the basis for the development of inflammatory and structural changes characteristic of asthma [21]. Airway smooth muscle (ASM) is the major end effector of acute airway narrowing in asthma. Possible mechanisms for hypocapnia inducing bronchoconstriction include: neural reflexes, increasing blood vessel caliber, provocation of mediator release or direct effect on ASM. There is *in vitro* animal evidence as well as experience from human studies that suggest low alveolar PCO_2 causing bronchoconstriction and increasing airway resistance [22, 23]. Thus, if one has to prevent bronchoconstriction, breathing rate and pattern has to be controlled so as to avoid hyperventilation and hypocapnia.

Breathing Retraining

Breathing retraining is the most commonly used method in research as well as in the therapy of asthma. The aim is to “normalize” pattern of breathing through slowing of respiratory rate by prolonging the expiratory phase and reducing ventilation [24]. Besides these, emphasis is given on the use of abdominal muscles (rather than the thoracic cage muscles) in resting breathing, and on the nasal breathing (rather than mouth breathing). The rationale is based on the abnormal (hyperventilation) or dysfunctional breathing patterns in those with asthma.

The breathing training essentially aims at behavioral change, and is provided in two sessions – instruction session and practice session. The instruction session is delivered either directly (face-to-face) between the therapist and the patient or between the therapist or small groups. Sometimes, alternative indirect/distant methods may be used to deliver the training through the use of video/CD/DVD. The number of instruction sessions required to be effective is presently not known, but is individualized usually as per the need of the asthmatic patient. In some studies, 3–4 sessions over a period of 6 wk is usually effective [9]. The practice session then starts in which the patients are encouraged to practice the techniques learnt in the instruction session on a daily basis followed by gradual introduction or making it a habit in day-to-day life. The number of instruction sessions required to be effective is presently not known, but may vary between patients depending on the asthma severity.

The breathing training is generally a multi-component packaged intervention. Different methods/techniques constitute the core package and are described as follows: Papworth technique, Buteyko technique and Yoga and/or Pranayam. These techniques have some similarities as well as differences. The essential similarity is the modification of breathing pattern, others being the nature and route of breathing, holding of breath, and relaxation/exercise at home. Differences include advice regarding nutrition, medication use, education, aerobic exercise and biofeedback that includes, for example, capnometry.

Control of breathing-pattern includes modification of rate of respiration, depth of respiration, rate or velocity of air-flow, timing (inspiratory and expiratory phase, duration, and pause), rhythm of respiration, and primary area of movement (upper or lower chest, and abdomen). Either single or multiple modifications may be needed to get the desired effect in a case-to-case basis. The primary aim of all these modifications is to reduce the rate of breathing and physiotherapy. Buteyko technique in addition aims to reduce the overall ventilation. Before attempting to control the volume of ventilation, usually it is easier to teach/practice slowing of the respiratory rate. The latter is achieved either through prolongation of the expiratory phase or through the increase of pause times or number of pauses. Majority of the children with controlled or stable asthma usually do not exhibit either expiratory flow limitation or dynamic hyperinflation at rest, but both are common during exercise or stress [25].

Normally, breathing usually occurs either through the nose or the mouth. The physiological role of nasal breathing is to filter, warm, and humidify the inspired air. Any pathology in the nose can impair these physiological processes leading to potential important impact on asthma, based on the “united airways” hypothesis [26]. The latter is supported by the fact that allergic rhinitis is a common accompaniment of asthma, and may affect the ultimate outcome of asthma. It has been seen that mouth breathing is common during acute asthma exacerbation [27], and nose breathing on the other hand is

associated with a reduction in nocturnal symptoms or nocturnal exacerbation [28] as well as decrease in the inspiratory flow rate [29]. So, manipulation or control of mouth and/or nasal breathing is an important component of breathing training.

Breath holding or pause is an important component of breathing training and has potential benefits. These include improved ventilation redistribution in all the lung fields causing the air to get behind the secretions and helping them out of the respiratory tract [30], and desensitization of a patient to hypercarbia and reduced respiratory rate [31]. However, breath holding or pause is not a simple technique as it looks like. There are many variables and there is no clear-cut consensus as to which one is to be manipulated or controlled. These are: phases of pause (inspiratory or expiratory), volume at holding the pause [functional residual capacity (FRC) or maximal inspiration], duration of pause (single or break-points), timing of pause (during rest or activity), and holding of nose or not. The common conception is to use end-expiratory pause (at FRC) with holding of the nose till the point of discomfort, but not for so long that it may be followed by deep breaths afterwards [9].

Yoga and/or Pranayam

These techniques are getting worldwide acceptance as they are firmly believed to cause well-being or feeling of wellness in human beings. They are cost-effective or no cost techniques associated with health benefits in a number of health conditions, particularly for chronic ones. The basic principle is that stress is an important underlying factor for many chronic conditions and yoga and/or pranayam help to reduce stress leading to benefit. Though this is a simpler explanation, there may be more intriguing mechanisms behind the benefit.

There are different components of yoga and/or pranayam and these include, but are not limited to different Asanas or Postures (e.g., Ujjayi Pranayama, Nadishodhana, Supta Baddhakonassna, Virassna, Tadassna, Suptassna, Gomukhassna, Makarassna, Bhujangassna, and Shavassna), Micro-exercises (Sukshma Vyayama), Macro-exercises, Pranayam, and Om meditation (Dhama & Dhyana). The time limit of these components may vary from 5 to 20 min. The maximum time (around 20 min) is usually spent in the Asanas or Postures [17, 18]. The typical duration of a yogic session is around 45 min, being practiced 6 d a week for 12 wk or 3 mo [18].

Different mechanisms have been postulated through which yoga and/or pranayam may impart a potential health benefit in children with asthma or other respiratory conditions. These are as follows [32].

- The ‘squeezing and soaking’ process during “asana” – In this process the respiratory organ (lung) is ‘squeezed’ or constricted followed by release, and this

causes the body to ‘soak’ an excess fresh, nutrient rich blood to the organ (lung).

- The diaphragm being the primary muscle of respiration is stretched and massaged during the “asana” leading to improved/normalised breathing.
- Strengthening of the muscles of respiration (both primary and accessory) secondary to regular practice of pranayamic breathing that involves stretching of the above muscles to maximum extent.
- Improved compliance of the chest wall secondary to stretching causes the lung to get inflated near to total lung capacity (TLC) that may lead to release of prostaglandins and/or surfactants into alveolar spaces causing improved lung compliance, decreased airway smooth muscle (ASM) tone and resistance. The improved chest wall compliance and respiratory muscle tone help increase the expiratory flow.
- The neural control of breathing may get altered leading to alteration of the autonomic nervous system favouring the parasympathetic system dominance over the sympathetic ones. The parasympathetic system decreases bronchiolar smooth muscle tone and airway resistance, and has a favourable effect.
- Yoga enables an individual to take slower and deeper breath with full awareness, and essentially controls breathing similar to breathing training (described above).
- Yoga also balances the endocrine system to release cortisol secretion that may affect the immune functioning through the release of various chemical mediators. An abnormal cytokine profile is commonly observed in children with asthma.

Evidence for Breathing Exercises, Yoga and/or Pranayam

Though breathing exercise, yoga and/or pranayam are old age treatments, they have recently gained popularity and been tested in a number of randomized clinical trials (Supplementary appendix 1). Below is the description of these methods in the published clinical trials.

Breathing Exercise

Buteyko Breathing Technique (BBT)

Two trials reported about this technique [10, 11]. One trial was conducted in outpatient department of Australia, and the other in Egypt. One trial [10] included 39 participants of 12–70 y of age (BBT = 19; control = 20) with chronic asthma with mild exacerbation. The BBT was a series of exercises in which subjects reduced the depth and frequency of respiration and

was practised several times a day, administered over seven days with each session lasting about 60–90 min. There was reduced hyperventilation, use of beta 2-agonists, a trend towards reduced inhaled steroid use, and better quality of life observed in the BBT group without objective changes in measures of airway calibre. The other trial [11] included 54 children aged 8–14 y [active cycle breathing technique (ACBT) = 18; Buteyko breathing (BBT) = 18; thoracic lymphatic pump technique (TLPT) or control = 18] with chronic (mild and moderate persistent) asthma over a period of 3 mo. The BBT was found to be better compared with the ACBT in the treatment of children with bronchial asthma (better asthma control and improved ventilator function).

Other Breathing Exercises

Four trials tested different breathing exercises [12–16]. One trial conducted [12] in New Zealand included 34 children aged 6–13 y (chest physiotherapy = 16; control = 18) admitted with acute severe asthma and provided four treatment sessions (each lasted 1 h) over a two-day period (two/day). The chest physiotherapy did not improve the outcome. Another trial from Egypt [13] included 40 children aged 6–13 y with chronic (moderate persistent) asthma and provided breathing exercise (deep breath from the nose moving the lower chest, holding the breath at the end of inspiration for 5 s and then expire slowly through the pursed lips), 15–20 min in sets (each set 5 times with rest periods in-between) over 3 mo (3 sessions/wk) and 36 sessions. The trial found improved ventilator functions in children with asthma. Another trial from Turkey [14] included 28 children with mean age 10.8 ± 2.3 y [pulmonary rehabilitation programme (PRP) = 16; control = 12] having chronic (moderate persistent) asthma and provided PRP (relaxation exercises, endurance exercises, breathing exercises and rhythmic mobilization exercises) over 1 mo. There was improved quality of life and pulmonary function in children with asthma. Another trial from Brazil [15] included 50 children aged 8–12 y (inspiratory muscle training and breathing exercise = 25; control = 25) with uncontrolled asthma and were provided breathing exercises (diaphragmatic breathing, inspiratory patterns and pursed lips) that were repeated 10 times (each session for 25 min) performed before inspiratory muscle training over 1 mo (14 sessions, twice a week). There was increased mechanical efficiency of the respiratory muscles along with improvement in the peak expiratory flow and severity variables in asthmatic children.

Another trial from India [16] included 40 children with asthma (breathing exercise = 20; control = 20) and provided breathing exercise (3 phases – deep breathing, paper strip blowing, and balloon blowing) over 1½ mo. There was improved lung volume and lung function in asthmatic children.

Yoga and/or Pranayam

A total of three trials evaluated these techniques in children with asthma [17, 18, 20]. One trial from India [17] included 150 children (Yoga = 75; control = 75) aged 8–14 y with chronic nasobronchial allergy (asthma and/or allergic rhinitis) and provided Yoga (Nadishodhana and Ujjayi Pranayama and yoga postures like Virasana, Suptasana, Supta addhakonasana, Tadasana, Hujangasana, Gomukhasana, Shavasana and Makarasana) over 1½ mo (every morning for half to one hour). There were improved pulmonary functions in the treated children. Another trial from India [18] included 30 children aged 10–14 y (Yoga = 15; control = 15) with chronic asthma and provided Yoga sessions (Sukshma Vyayama or Micro exercises for 5 min, Macro exercises for 3 min, Asanas or Postures for 22 min, Pranayama for 10 min, Dharna and Dhyana or Om meditation for 5 min) over 3 mo (45 min daily for 6 d a wk). There were improved pulmonary functions in the treated children. Another trial from Turkey [20] included 20 children aged 6–17 y (Yoga = 10; control = 10) with asthma and either positive or negative response to exercise challenge and provided *hatha* yoga technique (a combination of breathing exercises or pranayamas for 10 min, physical postures or asanas for 40 min, and relaxation for 10 min) over a period of 12 wk (1-h sessions twice per week). The pulmonary functions improved in the treated children and the exercise-response-positive asthmatics became exercise response-negative.

Breathing Exercise and Yoga and/or Pranayam

One trial from Egypt [19] compared these two techniques by including 40 children aged 7–12 y (BBT = 20; Yoga = 20) with asthma (mild to moderate) and provided either of the intervention for 3 successive months (15 min twice daily, 3 d/wk). Both the techniques improved pulmonary functions and functional capacity in the treated children, and there was no significant difference between the two groups.

Limitations

All the trials mentioned above did not report the important outcomes normally required to know the actual effectiveness of that intervention in children with asthma. The important outcomes that any trial in childhood asthma should describe include the following: quality of life, asthma symptoms, reduction in medication usage (controller as well as reliever), number of acute exacerbations, physiological measures of lung, school absenteeism, and adverse events. Most of the trials described about lung function by doing lung function tests or spirometry. The breathing exercises used in the trials did not describe or comprise of all the techniques, and trial did not describe the actual technique used [14]. Most of the trials

did not separate breathing exercise component of the intervention, as a result, authors were unsure about the actual intervention or the active component of the intervention the study children received. The clinical asthma phenotype was not uniform in the trials as different severity classes were included: persistent (mild and moderate), uncontrolled, and acute severe asthma. In some trials, children performed the exercise at home without supervision of a professional. The age range of included children also varied among the trials and most of the trials included adolescents. It is well known that changes in the respiratory system occurs throughout childhood and may be different from adolescents or adults. So, the benefit found in the trials may also be different during childhood and adolescent age groups, but none of the trials reported them separately.

Conclusions

Asthma in children is a chronic condition that is amenable to control but not cure. Though pharmacological modalities effectively control the symptoms, there is always a potential for producing adverse events with these agents. Now-a-days different complementary and alternative medicines/techniques are available, of which breathing exercises, and yoga and/or pranayam are gaining popularity and have been tested in a number of clinical trials. In this review, authors have summarized the different techniques from all the published clinical trials and conclude that these techniques unanimously benefit children with chronic (mild and moderate) and uncontrolled asthma, but not acute severe asthma. However, before these techniques can be incorporated into the standard care of asthmatic children, important outcomes like quality of life, medication use, and patient reported outcomes need to be evaluated in future clinical trials. The outcomes should also be reported separately for children as well adolescent age groups.

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Compliance with Ethical Standards

Conflict of Interest None.

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