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Changes in spirometric parameters following a swimming intervention in children with bronchial asthma

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ABSTRACT

Background

It has been transpired that childhood asthma is one of the major distressing respiratory system disorder that has taken a toll on the life of over 13,000 children annually accounting to the death of at least 1 in 12 children over the past decade. With the advancement in the field of medicine, newer form of drug therapies and other adjunctive interventions are available; however the potential adversities resulting from the same cannot be ignored. Hence swimming is considered as an upcoming, recreational yet a relatively safer form of intervention for the management of asthmatic children presenting with poor lung function parameters.

Objectives

To review the current state of evidence in order to determine the changes in spirometric parameters following an intervention of swimming training in children suffering from bronchial asthma.

Methodology

Pub Med, Science direct, PEDro, Cochrane, J gate, were the databases which were searched. 202 articles were retrieved based on PICO format and considering the inclusion and exclusion criteria 6 studies were found to be eligible for this review that consisted of one systematic review with meta-analysis, one systematic review and four RCTs.

Conclusion

A significant difference was observed in at least one of the spirometric parameters following the intervention based on which it was concluded that swimming can be recommended as an effective physical activity for children suffering from bronchial asthma.

Keywords: 'Swimming', 'Asthma', 'Spirometric parameters', 'PFT parameters', 'PEF'

INTRODUCTION

According to WHO around 100 to150 million people around the globe suffer from asthma and this number is on the rise. World-wide, deaths from this condition have reached over 180,000 annually. As per the survey conducted by The International Study of Asthma and Allergies in Childhood (ISAAC) it was found that about 14% of the world's children were likely to have had asthmatic symptoms, and the prevalence of childhood asthma

varied widely between countries where the prevalence in India was found to be around 10-15%.These conclusions resulted from ISAAC's survey of a representative sample of 798,685 children aged 13-14 years in 233 centres in 97 countries [1].

As per the Global Initiative of Asthma (GINA) guidelines, Asthma is defined as a heterogeneous disease characterized by chronic airway inflammation. Asthma usually manifests as episodes of coughing, shortness of breath, wheezing, chest tightness that vary over time and intensity along with variable expiratory airflow limitation [2].

The three major components of the disease are i) airway obstruction ii) airway hyper-responsiveness iii) airway inflammation. Individuals with asthma have airways which are hyper-responsive to various intrinsic stimuli such as stress, weather changes, cigarette smoke, polluted air, strenuous exercises, acid reflux, strong odours, drugs like salicylates, fragrances and extrinsic stimuli which include allergens like pollen, animal dander, dust mites and certain foods. Airway inflammation is characterized by increasing number of eosinophils, mast cells, T cells in the airway mucosa. Recurrent inflammation is associated with remodeling of the airway walls as a result of epithelialization, smooth muscle hypertrophy, sub-epithelial fibrosis and proliferation of mucus glands. Also airflow is limited by smooth muscle constriction, mucosal edema and accumulation of secretions.

Spirometric parameters play a great role in the diagnosis, monitoring of symptoms and also serve as an excellent outcome measure for the prognosis of asthma. The commonly measured spirometric parameters include Forced expiratory volume in 1 second (FEV1), Forced vital capacity (FVC), FEV1/FVC ratio and Peak expiratory flow (PEF) [3]. Both FVC and FEV1 indicate the severity of airflow obstruction while the FEV1/FVC ratio with a value of less than 0.8 is indicative of high lung resistance which is characteristic of asthma. Monitoring of PEF is essential to assess response to treatment, identify the triggers that could lead to exacerbation of symptoms or to establish a baseline for action plan. Spirometric studies reveal that individuals with asthma have a reduced FEV1 while the FEV1/FVC ratio is also significantly reduced. Additionally a diurnal variability in PEF of >13% is observed in asthmatic children [2].

As asthma is a chronic condition, it requires continuous medical care. Medically it is treated with long term therapy of anti-inflammatory drugs or short acting beta2-agonists. However there are several drawbacks which include the drug-related side-effects like hoarseness of voice, gastric irritation, long-term drug dependency, poor compliance along with cost related burden. Apart from the drug therapy it is also equally important to avoid asthma triggers-stimuli that irritate and inflame the airways [3]. Non-pharmacological methods of treatment such as relaxation and certain Yogic breathing techniques may help prevent asthma symptoms and improve the overall well-being; however these techniques provide only temporary symptomatic relief [2].

Swimming elicits higher elevations of heart rate, blood pressure and Maximal oxygen uptake during exercise (VO_{2max}) and thereby can improve the cardiovascular fitness. Additionally the buoyancy of water provides the person with relative weightlessness and joint unloading thereby easing the motions. The resistance provided by the water aids in muscle strengthening. The hydrostatic pressure exerted by the water assists in venous return and helps in centralizing the blood flow. Due to relatively higher humidity above the water surface it is less likely to trigger bronchoconstriction. Swimming is known to be a stress buster as it is a relaxing and a peaceful form of exercise [4].

Several forms of therapies are available for management of asthma. However owing to the various benefits of swimming, it could be a cheaper yet effective non-pharmacological intervention to control the symptoms of asthma in children thereby reducing their drug dependency and enhancing their overall quality of life as well serve as an excellent recreational activity. Hence the main purpose of this project is to determine the changes in spirometric parameters and asthma symptoms following a program of swimming as an intervention for children suffering from asthma.

MATERIALS AND METHODS

Design- Literature review. An extensive literature review was done on various electronic handprint databases which included PEDro,

Pubmed, Science direct, J gate and Cochrane. A total of 6 articles were reviewed and reported based on eligibility criteria, which includes 1 systematic review, 1 meta-analysis, 3 randomised controlled trials and 1 clinical study. Inclusion criteria: Articles in English language, Articles published from 2008-2018. Exclusion criteria: Articles whose full text was not retrieved. Literature search was conducted in the above mentioned databases using search strategies and key words and 202 articles were retrieved. The articles were screened based on the three step approach- title, abstract, full text. Based on the title, 25 articles were obtained. Using eligibility criteria, 17 articles were obtained based on the abstract. Using eligibility criteria, 6 articles were selected based on full free text and were used for the literature review.

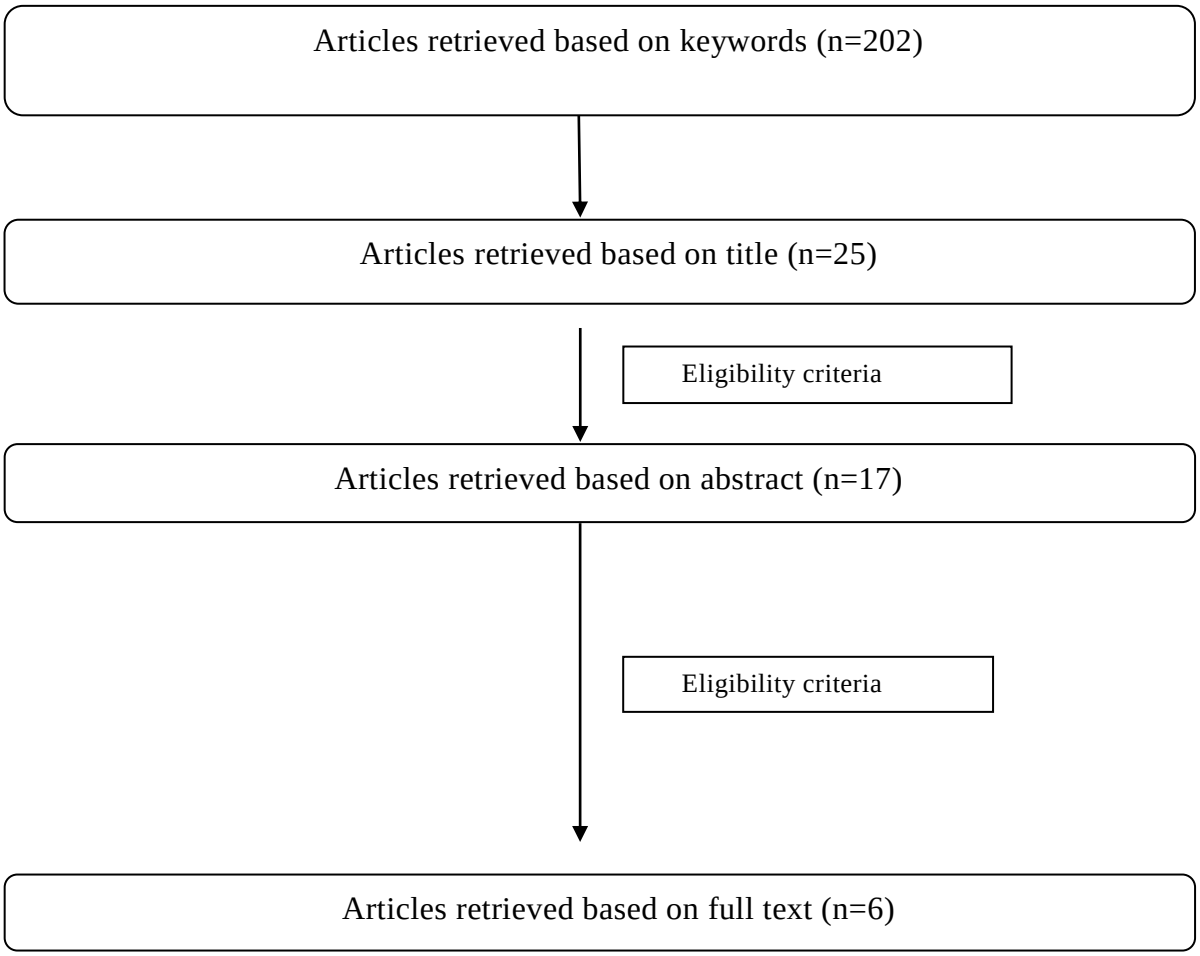

Figure 1- Flowchart of data extraction

RESULTS AND DISCUSSION

Table 1 - Summary

TITLE/ AUTHOR/ YEAR OF STUDY	STUDY DESIGN	SAMPLE SIZE	OUTCOME MEASURES	RESULT
Changes in PEFR following swimming intervention in healthy and asthmatic children Bemanian S et al, 2009	Clinical trial LOE: 3b	Total subjects (n= 76)	Peak expiratory flow rate	Swimming improved the lung mechanics in both healthy and asthmatic children

Effects of swimming intervention in children with Asthma Wang J et al,2009	RCT LOE:1b	Experimental group(n=15) Control group(n=15) Total subjects (n= 30)	PEF, FEV1, FEF50, FEF25 and severity of asthma	Significant improvement in the PEF, FEV1 and Severity of asthma in the experimental group(p value <0.01) when compared to the control group
Effects of swimming training in school children with atopic asthma Wicher I et al, 2010	RCT LOE:1b	Total subjects (n= 61) Experimental group(n=30) Control group(n=31)	FEV1 Metacholine bronchial provocation tests	A significant improvement in FEV1`along with reduction in bronchial hyper-responsiveness was seen in swimming group (p value < 0.001)
A comparative study of the effects of swimming with different forms of exercise in asthmatic children C Carew et al,2018	RCT LOE:1b	Total Subjects (n=41)	FVC, PEF and asthma symptoms diary	The swimming group demonstrated a significant increase in PEF and improvement in symptoms when compared to the other sporting activities and the control (p value = 0.04)
Effects of swimming on asthma frequency and severity Goodman M et al, 2008	Meta-analysis LOE:1a	Total no of studies- 25 2 RCTs and 23 cross sectional designs	Pulmonary function tests Asthma severity diary	Swimming was better tolerated than other sports in children with asthma
Effects of swimming training in children with asthma Beggs S et al,2013	Systematic review LOE: 1a	Total studies = 8 RCTs = 8 Total Subjects(n=262)	Pediatric quality of life questionnaire Asthma symptoms FEV1, FVC, PEF Exercise capacity	Swimming group was associated with significant increase in resting lung function parameters and improved exercise capacity

Total 6 articles were reviewed and reported based on eligibility criteria which includes 1 systematic review, 1 meta-analysis, 3 RCTs and 1 clinical study. The main purpose of this study was to determine the changes in spirometric parameters and asthma symptoms following a program of swimming intervention for children suffering from asthma. Each of these studies demonstrated some positive effects of swimming in asthmatic children which were reflected in the spirometric variables.

Children with asthma present with hypersensitive airways that are prone for airway obstruction which can significantly hamper the lung function parameters like FVC and FEV1. Pharmacological interventions provide relief at the cost of innumerous adverse-effects that further compromises the quality of life of such individuals [3]. Hence in order to avoid such complications, swimming can be considered as an effective non-pharmacological intervention for asthmatic children.

Various randomized controlled trials and systematic reviews which were chosen for the review supported the hypothesis that swimming can improve the spirometric parameters in asthmatic children through various mechanisms. Swimming is a form of recumbent exercise. It can produce a greater central blood flow than upright exercise, and may also improve gas diffusion and ventilation—perfusion matching. Moreover, minute ventilation in the recumbent position is lower than in the upright position, and may induce lower respiratory heat loss (RHL). Additionally, the peripheral vasoconstriction during immersion increases central blood volume, which may decrease RHL and exercise induced bronchoconstriction [8]. Swimming can be considered as a supreme form of exercise when compared to other forms as it has been associated with lesser attacks of asthma for which several mechanisms have been proposed. Dry air is inspired while a person exercises on land. This dry

inspired air is a major contributor to exercise-induced broncho-constriction (EIB), either by enhancing evaporative cooling or by increasing the osmolarity of airway mucus. On the other hand, the high humidity of inspired air in swimming induces less EIB. Controlled breathing during swimming leads to increased alveolar carbon dioxide levels resulting in less exercise induced bronchoconstriction [10]. Swimming can reverse the inflammatory process and remodeling of the airways [7]. As mentioned earlier, individuals with asthma have airways that show exaggerated responses to several stimuli like pollen, dust, mites which are rarely seen on water surfaces. The high hydrostatic pressure exhibited by the water on the chest wall aims to reduce the expiratory effort and work thereby reducing the chance of a possible asthma attack. Swimming just like any other form of exercise improves the overall self confidence levels and aids in normal physical and psychological development. Swimming can improve muscle tone and general fitness and can be an excellent source of a safe recreational activity for the children [6].

Following a thorough research of all the reviews, certain drawbacks were discovered. All the chosen studies failed to determine the potential harmful effects of chlorine on asthma symptoms thereby the pool chlorine hypothesis could not be justified. In the study conducted by Witcher I et al titled 'Effects of swimming program in school children and adolescent with moderate persistent atopic asthma', the major limiting factor in relation to the improved spirometric variable lied in the fact that the children were in initial stage of swimming program which could have possibly hampered the further improvement and influenced the results [7]. Additionally, in the study conducted by Carew C et al titled 'Effects of different forms of physical exercise on asthma control in children' the smaller sample size chosen for the study was a major drawback implying the need to conduct studies including larger sample sizes [8]. Majority of the randomized controlled studies were carried out in a shortened timeframe and none of them were conducted in India, hence further research could be conducted among the Indian population of asthmatic children with special emphasis on the need to determine the long term effects of a swimming programme.

CONCLUSION

Three studies of level 1b evidence suggested that swimming when performed on a regular basis can significantly improve the spirometric parameters like FEV1, FVC and PEF. One study of level 3b evidence suggested that swimming is beneficial for both normal as well as asthmatic children. Two studies of level 1a evidence suggested that swimming is associated with less asthma attacks and improvement in spirometric variables making it the best tolerated physical activity for asthmatic children. However, since most of the studies were conducted over a short time period with no fixed protocol, there is a need to conduct further studies to investigate the long term effects of swimming on the lung function parameters and also devise a standardized protocol for the same. Additionally, since most of the studies could not establish a link between swimming and asthma frequency with respect to the pool chlorine hypothesis, further research in this regard is recommended.

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