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Review

The value of exercise therapy to asthmatic patients as an adjunct treatment

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Asthma is a chronic respiratory disease that adversely influences the quality of life of many South Africans. The medical management of asthma includes identification, education, medical and pharmaceutical treatment. Literature has inequitably demonstrated that habitual structured exercise therapy can be a beneficial adjunct to general medical and pharmaceutical management strategies. This clinical commentary aims to increase awareness regarding the salutogenic effect of structured exercise on asthma. There is need for asthmatic management strategies that are not influenced by financial cost, and which, consequently, have the ability to reach more patients. This study recommends the adoption of regular structured exercise rehabilitation as an adjunct to popular asthmatic treatment protocols.

Key words: Asthma, benefits, exercise, risks

INTRODUCTION

In 2010, there were 119 million asthmatics in Africa, of which 49 million were children under the age of 15 years (Adeloye et al., 2013). The prevalence of asthma in South Africa is estimated to be between 5.1 and 7.1% of the total population, making asthma one of the most rampant childhood diseases (Ellapen and Swanepoel, 2017), and being suggestive of an opportunity for the adoption of exercise therapy as an adjunct to normal prescribed treatment (Evans et al., 2016). Evans et al., (2016) reported that the cost of exercise is far less than that of medication. This is a significant consideration given both the exorbitant annual financial cost borne by the South African National Healthcare budget in dispensing chronic medication, and the fact that, despite the onerous cost, not all patients are properly treated or receive the correct medication. Literature has reported that structured habitual physical activity and exercise serves as a successful adjunct to medical management strategies (Durstine et al., 2009; Dishman et al., 2013). Furthermore, the adjunct of structured exercise therapy is a cheaper supplement, and has the potential to reach more South Africans if promoted in public schools, medical clinics, and hospitals (Evans et al., 2016). The objective of this paper is to increase awareness regarding the adjacent value of exercise therapy in the management of asthma and discredit the myth that exercise therapy is dangerous to asthmatics, thereby improving their quality of life.

AETIOLOGY OF ASTHMA

Asthma is a chronic obstructive respiratory disorder that negatively affects normal ventilation, and is characterized

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by variable obstructed airflow, chronic inflammation, and airway hyperactivity (Avallone and McLeish, 2013). The triggers of asthma are environmental and immunological factors (McArdle and Katch, 2015) and symptoms include tightness of chest, wheezing, dyspnea, rapid ventilation, and coughing (McArdle et al*.,* 2015). The respiratory pathological conditions of exercise-induced-asthma (EIA) and exercise-induced bronchoconstriction (EIB) are used interchangeably, which is incorrect (Van der Westhuizen, 2009). Exercise-induced-asthma occurs among patients who have an underlying history of asthma, whilst EIB befalls patients who do not have a history of asthma but experience bronchospasm at an exercise intensity equal to/or more than 75% of their maximum heart rate (Hermansen, 2004). Exercise-induced asthma is the narrowing of respiratory airways as a result of the inflammatory response instigated by hyperventilation (Van der Westhuizen, 2009) whereas exercise-induced bronchoconstriction is a self-limiting physiological mechanism, which limits pulmonary function, and may persist from 30 to 60 min, thereafter resuming normal ventilation. A further distinction can be made regarding antigen induced asthma which requires medication in order to neutralize the asthmatic attack and restore normal ventilation (Gotshall, 2002; Van der Westhuizen, 2009).

There are two popular theories concerning the pathophysiology of exercise-induced asthma, the first being the *hyperosmolarity theory* and the second being the *airway re-warming theory* (Van der Westhuizen, 2009).

i) The *hyperosmolarity theory* suggests that water is lost from the surface of bronchi due to hyperventilation during exercise (Van der Westhuizen, 2009). The water loss triggers hypertonicity (excessive muscle tension or tone), changes in pH and temperature, and hyperosmolarity (abnormally high osmolarity) within the airway cells, stimulating the release of mediators (histamine, prostaglandins, and leukotrienes) (Constantinou and Derman, 2004; Van der Westhuizen, 2009). It is the action of these mediators that produces bronchoconstriction (Constantinou and Derman, 2004). Water loss occurring among chronic asthmatics with underlying airway inflammation may trigger the post-exercise bronchospasm (Storms, 2005; Van der Westhuizen, 2009). Exercise-induced-asthma produces a temporary airway obstruction that may persist from five to 30 min post-activity (Morton and Fitch, 2011).

ii) The *airway re-warming theory* postulates that exercise-hyperventilation produces cooling of the bronchial airways (Van der Westhuizen, 2009). During post-exercise, rewarming of the bronchial airways occurs, resulting in vessel congestion and fluid exudation into the submucosa of the airway wall, as well as the stimulation of mediator release (histamine, prostaglandins, and leukotrienes) producing bronchoconstriction (Van der Westhuizen, 2009). Many asthmatics avoid physical activity resulting in poor cardiorespiratory fitness, obesity and limited quality of life (Hermansen, 2004; Williams et al*.,* 2014; Avallone and McLeish, 2013). Although physical activity can elicit an asthmatic episode, there is considerable empirical literature recommending that structured physical activity is safe and can assist in reducing the frequency and severity of a potential attack (Satta, 2000; Morton and Fitch, 2011; Avallone and McLeish, 2013).

MANAGEMENT OF ASTHMA

Asthma is predominantly managed through the use of pharmaceutical agents and an asthmatic action plan (Morton and Fitch, 2011). Asthma medications are categorized into controllers, relievers, and preventers (Van der Westhuizen, 2009). Controllers prevent respiratory tract inflammation, averting asthma (Morton and Fitch, 2011). Relievers are rapidly acting inhaled beta-adrenoceptors (IBA) which are effective in relieving bronchoconstriction but should be inhaled in the lowest possible dose only when necessary (Morton and Fitch, 2011). Preventers are rapidly acting IBA which are inhaled before physical activity, thereby allowing the asthmatic to continue their participation for periods exceeding 90 min (Morton and Fitch, 2011). Asthmatics participating in elite sports and who make use of IBA must meet World Anti-Doping Agency standards in order to ensure that their treatment does not constitute an unfair advantage over their fellow competitors (Van der Westhuizen, 2009; Morton and Fitch, 2011). An *"Asthma Action Plan"* (AAP) is a prescribed set of individualized guidelines that assist the patient in identifying deteriorating asthma symptoms and implement the necessary medical action. The asthmatic patient and their family must be familiar with the AAP. A vital component of the AAP is the regular monitoring of lung function through the use of either a peak flow or Forced Expiratory Volume in one second (FEV_1) meter (Morton and Fitch, 2011).

During exercise, the asthmatic patient's peak expiratory flow rate is reduced, while simultaneously the body's oxygen demand is increased. As the person continues to exercise, the contracting muscles need greater volume of oxygen, glucose, amino acids and/or fatty acids to produce energy. The inspired air, rich in oxygen fills the lungs, which is transported to the heart through pulmonary circulatory system. The heart then pumps the oxygenated rich blood to the working muscles (through the systemic circulatory system) to assist in the production of energy. A primary concern of the asthmatic patient is the reduced oxygen level during exercise. The patient should not panic but try to remain calm and use IBA (Morton and Fitch, 2011). Precautions that asthmatic patients should follow to prevent EIA or EIB event include;

(i) do not exercise at an intensity equal to/or more than 75% of their maximum heart rate, (ii) always train with an exercise partner who is familiar with signs and symptoms of EIA and/or EIB, (iii) as well as the aforementioned individual must know the *asthmatic action plan* in case of an emergency. Further, the patient should inhale a controller and/or a reliever type of asthmatic medication to prevent an asthmatic event during exercise.

Benefits of exercise

The prevalence of asthma in South Africa is increasing. In so far as the treatment of asthma is influenced by the cost of medical consultation and medication, traditional medical and pharmaceutical management strategies for the treatment of asthma are only successful for those patients who are able to afford treatment. A cheaper asthma management strategy, with the capacity to reach a broader spectrum of patients, across all socio-economic strata, is thus warranted. Physical activity is an all-encompassing concept, articulated in numerous practises, one being *exercise*, which is a premeditated, repetitive activity designed to enhance or preserve physical fitness (Durstine et al., 2009). In the context of an adjunct treatment for asthma, the value of habitual exercise would be to enhance the asthmatic patient's cardiorespiratory fitness, thereby permitting daily physical activity to be performed at a reduced percentage of their aerobic capacity, and provoking weaker EIB (Morton and Fitch, 2011). The following points explain the value of regular exercise to asthmatics:

i) Swimming is the least asthmogenic exercise, due to greater hydrostatic pressure on the chest that diminishes the expiratory muscle effort, hypoventilation from controlled breathing, peripheral vasoconstriction that augments central blood flow and lower pollen saturation over water (Rosimini, 2003). Exercise heart rates during swimming are 10 to 20 beats per minute lower than land-based exercises, which can assist in keeping the exercise intensity below 75% of the asthmatic's maximal heart rate (McArdle et al., 2015).
ii) The selection of the environment in which the physical activity is conducted influences the onset of an asthmatic episode. Exercising in a humid indoor arena blunts EIB as compared to cold and/or dry outdoor fields. The inhaled humidified air reduces the respiratory effort geared at the humidification of the inhaled air, thus preventing an asthmatic episode. McArdle et al. (2015) reported that EIA is significantly reduced when asthmatics inhaled ambient air that was fully saturated with water. Asthmatics should avoid swimming in chlorinated waters as this may trigger an asthmatic episode (Van der Westhuizen, 2009).
iii) Light, to moderate intensity, warm-up exercises (15-30 min) produce a refractory period that allows subsequent exercise to be performed without precipitating EIB (McArdle et al., 2015). The adequate (intensity) warm-up exercises produce bronchodilation, which enlarges the bronchi facilitating a subsequently lower ventilatory effort (Morton and Fitch, 2011).
iv) Low and moderate-intensity aerobic exercise reduces airway inflammation as demonstrated in the remodelling of the murine asthmatic model (Vieira et al*.,* 2007). The murine asthmatic model relates to animals and demonstrates that low to moderate intensity aerobic exercise lessens airway remodelling by reducing smooth muscle hypertrophy and hyperplasia, leukocyte infiltration, pro-inflammatory cytokine production, adhesion molecule expression and increased regulatory T-cell response (Del Giacca, 2015). Human studies have shown similar findings, reporting reductions in neutrophil, eosinophil and allergen-specific immunoglobulin E (IgE) levels (Del Giacca, 2015). McArdle et al. (2015) support the notion that while exercise does not cure asthma, it nevertheless improves pulmonary airflow reserve and decreases ventilatory effort by potentiating bronchodilation during exercise.
v) Mitochondria are cytoplasmic organelles that accomplish numerous cellular functions, a critical one being free-radical scavenging (Reddy, 2011). Oxidative stress is a major factor associated with the development and progression of asthma, through the formation of free radical oxidative damage. Mitochondrial dysfunction and oxidative stress revealed that mitochondrial oxidative stress is critically involved in asthma and may play a large role in the development of allergic asthma, adversely impacting the person's cardio-respiratory physiology (Reddy, 2011). McArdle et al. (2015) reported that habitual structured aerobic exercises produces mitochondrial hyperplasia (increased number) and hypertrophy (increased size), which may assist with free-radical scavenging, thereby enhancing the asthmatic patient's aerobic capacity (cardio-respiratory capacity). Habitual structured aerobic exercise increases the size and function of the heart and the efficacy of the cardio-respiratory system (cardiac output, stroke volume) (Durstine et al*.,* 2009; McArdle et al*.,* 2015).

Exercise prescription guidelines

There are three realistic goals of habitual exercise; improved exercise tolerance, cardiorespiratory fitness, and musculoskeletal conditioning (Durstine et al., 2009). Attaining improved exercise tolerance provides greater flexibility regarding the fluctuation of exercise intensity.

i) All asthmatics, prior to engaging in an exercise programme, should obtain medical clearance from their pulmonologist and subsequently consult a biokineticist and/or physiotherapist for the prescription of an exercise programme.

ii) The biokineticist and/or physiotherapist should ensure that the patient completes a health screening and risk stratification assessment following the American College of Sports Medicine (ACSM) guidelines in order to determine EIB (Riebe et al*.,* 2018). It is essential that the maximum heart rate threshold precipitating EIB is established. The aerobic test intensity should be at 75% of predicted maximal heart rate, and last 8 min. Airflow measurement should be recorded prior to testing and 8 min post testing. A drop in FEV_1 of 10% from the pre-exercise test and/or 20% in peak flow is confirmation of EIB and EIA (Durstine et al., 2009).

iii) Training exercise intensity should range between 60-70% of maximal heart rate, thereby preventing any EIB episodes (Morton and Fitch, 2011).

iv) The use of a Borg CR-10 scale to assess breathlessness is effective in maintaining steady aerobic exercise, alleviating asthmatic episodes (Durstine et al., 2009).

v) Asthmatics should initially complete a six-week introductory elementary exercise programme, so as to accustom their bodies to the increased physical demand.

vi) The physicians also develop an "*EIB Action Plan*" in addition to the general AAP (Morton and Fitch, 2011).

vii) The prescription of an intermittent musculoskeletal circuit training programme can serve as the introductory elementary exercise programme. Circuit training programmes alternate upper and lower body exercises with an intermittent mandatory rest period (lowering the average training heart rate). The musculoskeletal programme must aim to increase muscle endurance by adhering to the prescription of high repetitions and low workload.

Exercise precautions

i) Warm-up and cool-down are mandatory in order to prevent the likelihood of an asthmatic episode (Constantinou and Derman, 2004; Durstine et al., 2009; Van der Westhuizen, 2009; Morton and Fitch, 2011).

ii) Exercise testing and training should occur mid to late morning or during the afternoons.

iii) Medication should be taken as per normal.

iv) The patient's bronchodilator should be present during exercise testing and training, ready to contain any potential asthmatic episodes (Van der Westhuizen, 2009).

v) Running is the most asthmogenic activity, therefore patients should commence with walking, progressing to jogging (Morton and Fitch, 2011). Running should only be attempted once the patient has developed a strong aerobic base.

vii) Spirometry assessment is advisable during testing and exercising in order to determine ventilatory complications.

viii) The patient and training partner should be well versed in the EIB action plan.

ix) During musculoskeletal exercise training, the patient must avoid the Valsalva manoeuvre.

x) Many asthmatics have coronary heart disease comorbidities; hence, the biokineticist should monitor ECG activity during testing.

Interprofessional collaboration

The treatment of asthma involves the expertise of a pulmonologist, general practitioner, nurse, pharmacist, dietician and the potential inclusion of a biokineticist (Van der Westhuizen, 2009). Biokinetics profession is an emerging paramedical discipline in comparison to the other longstanding professions of medicine, nursing science, pharmacy and dietetics (whose scope of profession is well recognized within the South African Healthcare fraternity). A biokineticist is a therapeutic exercise scientist specializing in the rehabilitation of musculoskeletal and chronic diseases in the final phase of rehabilitation in the pathogenic healthcare dimension (Ellapen et al*.,* 2018). The pathology of asthma is classified as a chronic respiratory disease. In addition, biokineticists strongly promote health and wellness through physical activity and exercise (Ellapen and Swanepoel, 2017). The need for interprofessional collaboration for the treatment of asthma is imperative in order to ensure a better and more productive quality of life for the patient. Many medical practitioners are unaware of the assistance that other medical practitioners may offer, as they are not necessarily knowledgeable regarding the scope of profession (SoP) that defines the contours of disciplines other than their own (Reeves et al*.,* 2013). Before embarking on interprofessional medical collaboration, a deeper understanding and appreciation of fellow medical specialists' SoP is required. This appreciation can then serve as the launch pad for collaborative interprofessional relationships, ensuring better patient care.

CONCLUSION

Habitual physical activity and exercise have shown to be beneficial to asthmatics. In face of the high cost of medical treatment, controlled exercise may be employed as an adjunct to traditional asthmatic management. The asthmatic patient should be mindful of EIB complications and it would, therefore, be prudent for the patient to gain medical clearance from their medical physician before starting an exercise regime. The consultation of a biokineticist, exercise scientist, or physiotherapist prior to commencing an exercise rehabilitation programme will be beneficial in preventing EIB. Finally, an EIB action plan should also be prescribed and the patient should be well versed in its use should an emergency arise.

RECOMMENDATIONS

1) An interprofessional medical team approach should be adopted to manage asthma, requiring each medical practitioner to be cognizance of fellow practitioners' expertise.
2) Asthmatics should be initially granted medical permission from their pulmonologist to start regular structured exercise therapy.
3) Prior to starting an exercise regime, the asthmatic should consult a biokineticist who completes an initial asthmatic exercise physical work capacity evaluation and subsequently prescribe rehabilitative exercises.
4) Correspondence among the pulmonologist, dietician, nurse, pharmacist and biokineticist is strongly advised to ensure optimal progress of the patient.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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