A COMPARATIVE STUDY OF THE EFFECTS OF INCENTIVE SPIROMETRY AND DIAPHRAGMATIC RESISTANCE TRAINING ON SELECTED CARDIOPULMONARY PARAMETERS IN PATIENTS WITH ASTHMA

STUDIU COMPARATIV PRIVIND EFICIENȚA SPIROMETRIEI STIMULATORII ȘI A ANTRENAMENTULUI DE REZISTENȚĂ A DIAFRAGMULUI ASUPRA PARAMETRILOR CARDIOPULMONARI SELECTAȚI, LA PACIENȚII CU ASTM

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Keywords: Asthma, Incentive spirometry, Diaphragmatic resistance training, Aerobic exercises

Abstract

Background: The primary goal of asthma management is to achieve and maintain control of the disease in order to prevent exacerbations. Evidence suggests that moderate intensity aerobic exercise training programme as well as incentive spirometry (IS) and diaphragmatic resistance training (DRT) improve asthma control and lung function. There is however no clear consensus regarding the comparative efficacy of DRT and IS on the cardiopulmonary parameters of patients with asthma.

Aim. This study was therefore aimed at comparing the effects of incentive spirometry and diaphragmatic resistance training on selected cardiopulmonary parameters in patients with asthma.

Methods: Forty-five (45) participants between the ages of 21 and 65 years diagnosed with asthma by physicians were recruited from the out-patient respiratory clinic of the Lagos State University Teaching Hospital (LASUTH), Ikeja, Lagos State, Nigeria and randomly assigned to three (3) groups (A, B and C) Group A received aerobic exercises and IS, Group B received aerobic exercise and DRT and Group C (control group) received only aerobic exercise for 6 weeks; 3 times a week.

Results: There were significant changes post-intervention in all the pulmonary parameters ($p<0.05$) of the three groups while there were no significant changes in any of the cardiovascular parameters ($p>0.05$). A comparison of the mean values of the cardiopulmonary parameters across the three groups 6th week post intervention show significant differences for FEV_1 and PEFR (*p=0.016* and *p=0.030* respectively) while no significant differences existed in FVC and the cardiovascular variables (SBP and DBP) (p= 0.100, p= 0.739, p= 0.874 respectively).

On post hoc analysis using the least significant difference (LSD), the significant difference observed in FEV1 was found between Groups B&C and A&B. Furthermore, the significant difference observed in PEFR was found between Group B&C.

Conclusion: Our findings show that the use of IS and DRT ha beneficial effects in improving selected pulmonary parameters (FE\ FVC, PEFR). However, the use of DRT is clinically more benefic and is thus recommended to be a part of the intervention for patier with asthma.

Cuvinte cheie: astm, spirometrie stimulatorie, antrenament de rezistență diapfragmatică, exerciții aerobe

Rezumat

Introducere: Scopul primar al managementului bolii astmatice este de a obține și menține controlul afecțiunii, pentru a preveni exacerbările. Studiile sugerează că programele de exerciții cu intensitate moderată, precum și spirometria stimulatorie (IS) și antrenamentul de rezistență a diafragmului (DRT) îmbunătățesc controlul astmului și funcția pulmonară. Nu există totuși un consens clar referitor la compararea eficienței DRT și IS asupra parametrilor cardiopulmonari la pacienții cu astm.

Scop. Acest studiu dorește să realizeze o comparație între efectul spirometriei stimulatorii și a antrenamentului de rezistență a diafragmului asupra parametrilor cardiopulmonary selectați, la pacienții cu astm.

Metode: Patruzeci și cinci (45) de participanți cu vârste cuprinse între 21 și 65 de ani, diagnosticați cu astm, din clinica ambulatorie respiratorie a spitalului Lagos State University Teaching Hospital (LASUTH), Ikeja, Lagos State, Nigeria au fost recrutați și distribuiți aleator în trei (3) grupuri (A, B și C). Grupul A a urmat un program de execiții aerobice și IS, groupul B a urmat exerciții aerobice și DRT și grupul C (de control) a urmat doar exerciții aerobice timp de 6 săptămâni; de 3 ori/ săptămână.

Results: S-au înregistrat modificări semnificative după intervenții, la toți parametrii pulmonari ($p<0.05$) la toate cele trei grupuri, și nu s-au înegistrat modificări semnificative ale parametrilor cardiovasculari ($p>0.05$). Compararea valorilor medii are parametrilor cardiopulmonari între cele trei grupuri în a șasea săptămână post intervenție, ademonstrat diferențe semnificative pentru FEV_1 și PEFR (*p=0.016* și respectiv *p=0.030*), în vreme ce nu s-au inregistrat diferențe semnificative ale FVC și variabilele cardiovasculare (SBP and DBP) (p= 0.100, p= 0.739, respectiv p= 0.874).

La analiza posthoc, folosind cea mai mica diferență semnificativă (LSD), s-a demonstrate o diferență semnificativă la FEV1, între grupurile B&C și A&B. Mai mult, diferența semnificativă observată la PEFR a fost între grupurile B&C.

Concluzii: Rezultatele demonsterază că folosirea IS și DRT are efete benefice în îmbunătățirea parametrilor pulmonari selectați (FEV_1, FVC, PEFR). Totuși, folosirea DRT este mult mia benefică din punct de vedere clinic, fiind de aceea recomandat a face parte din programul de intervenție la pacientul astmatic.

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Introduction

The incidence of asthma with its associated high healthcare cost has increased over the last three decades, especially in industrialized countries. [1] The rising morbidity and mortality from asthma despite major advances in the understanding of the disease process can be attributed to inadequate attention given to the management of asthma by improving bronchial asthma control. [2] Though clinical control of asthma can be achieved with proper pharmacological treatment, studies have shown that the use of oral steroid medications to control inflammation in asthma causes weakness of the inspiratory muscles which can impair lung function. [3-6] Prior studies had suggested that pulmonary rehabilitation and inspiratory muscle training may be beneficial in improving functional capacity and reducing dyspnoea, thereby resulting in a reduction in the use of health care services by patients with asthma. [7,8] Evidence suggests that decreased physical activity may play a role in asthma development while aerobic exercises have been known to improve cardiopulmonary endurance, reduce dyspnoea and improve ventilatory capacity.[9, 10] A study carried out by Boyd *et al* [11] and Aweto *et al*[12] showed that moderate intensity aerobic exercise training programme improve asthma control and fitness level without causing asthma deterioration in adult patients with asthma.

Aside from aerobic exercises, studies have shown that lung function can also be improved by respiratory muscle training using incentive spirometry and diaphragmatic resistance training. [1314]

Incentive spirometer (IS) is a portable device whose main purpose is to promote deep, slow inhalation, up to maximal inspiratory capacity, by providing patients with a visual feedback signaling that the desired flow or volume has been reached. It is simple to use and its use results in a prolonged phase of effective inspiration, more controlled flow and greater enthusiasm to practice. [15]There are no known side effects with the use of IS and it is affordable while patients do not require supervision once trained in their use [16]. Incentive spirometry is used to prevent post-operative decrease in lung function following bariatric surgery, prevention of atelectasis following upper-abdominal surgery or after coronary artery bypasses graft surgery and is widely used clinically as an adjunct to chest physiotherapy.

Diaphragmatic resistance training (DRT) also known as inspiratory muscle training (IMT) works by providing a threshold of inspiratory resistance that the patient inhales against to strengthen the diaphragm. This type of training is marked by expansion of the abdomen rather than the chest when breathing. It is considered to be a useful form of complementary and alternative treatment to the pharmacological approach in the management of asthma.[17] The use of DRT is commonly practiced, especially in those patients with cardiopulmonary disease, to improve a variety of factors such as pulmonary function, cardiorespiratory fitness, posture, respiratory muscle length and respiratory muscle strength.[18-21]. Specifically, DRT is essential to patients with asthma since breathing in these patients is of the thoracic type which is associated with decreased chest expansion and chest deformity as a result of a shortened diaphragm, intercostals and accessory muscles.[19] It has also been demonstrated that placing a load on the diaphragm during contraction increases strength in the muscle, causing a meaningful reduction in breathlessness.[22]

Purpose

There is no clear consensus regarding the comparative efficacy of diaphragmatic resistance training and incentive spirometry on the cardiopulmonary parameters of patients with asthma. This study is therefore aimed at comparing the effects of incentive spirometry and diaphragmatic resistance training on selected cardiopulmonary parameters in patients with asthma.

Materials and Methods

Subjects

Fifty (50) consecutively referred patients with asthma from the out-patient respiratory clinic of Lagos State University Teaching Hospital (LASUTH), Ikeja, Lagos State, Nigeria were screened for eligibility based on the inclusion and exclusion criteria. Five (5) were excluded from the study. The remaining forty-five (45) were randomly assigned to three (3) groups (A, B and C) using computer generated random number sequence with 15 participants in each group.

Three participants withdrew from the study due to illness, transportation problem and travel respectively. Finally, 42 of them (22 males and 20 females) completed the study. Group A received aerobic exercise and Incentive spirometry, Group B received aerobic exercise and diaphragmatic resistance training and Group C (control group) received only aerobic exercise.
The participants were people between the ages of 21 and 65 years diagnosed with asthma by physicians and who had not been on any form of structured exercises in the previous six months ; score ≤ 3 on the Rapid Assessment of Physical Activity (RAPA) questionnaire. Also included were participants with uncontrolled asthma with a score of 19 and below according to the Asthma Control Test (ACT). Excluded were participants with asthma who had influenza-like or respiratory infection symptoms 2-3 weeks prior to evaluation, those on asthma medications and participants with other lung diseases.

Prior to the commencement of this study, ethical approval was sought and obtained from the Health Research and Ethics Committee of the Lagos University Teaching Hospital (LUTH) and Health Research and Ethics Committee of the Lagos State University Teaching Hospital (LASUTH). Written informed consent was also obtained from the participants prior to the commencement of the study.

Materials

Incentive spirometry

Airlife volumetric type IS was used in this study. It is a portable device that encourages the patient, through a visual feedback, to maintain slow sustained inspirations and hence promote lung expansion. Incentive spirometry helps in improving lung function and respiratory muscle strength. [15,23,24]

Spirometry

Contec spirometer SP10 (manufactured in China) was used in this study. It is a handheld calibrated device for measuring pulmonary function tests. It is a battery operated device with a display screen of 128x 48 pixel, measuring 162x49x32mm and weighing 180grams. Spirometry is a method of assessing lung function by measuring the volume of air the patient can expel from the lungs after a maximal inspiration.

It is the most common of the pulmonary function tests (PFTs), measuring lung function, specifically the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled. Spirometry is an important tool used for generating pneumotachographs, which are helpful in assessing conditions such as asthma, pulmonary fibrosis, cystic fibrosis, and chronic obstructive pulmonary disease (COPD). The Pulmonary parameters evaluated included Forced Vital capacity (FVC), forced expiratory volume in the first second (FEV1) and peak expiratory flow rate (PEFR).[25]

Diaphragmatic Resistance Training

POWERbreathe (medic) diaphragmatic resistance trainer (POWERbreathe International Ltd, Warwickshire, UK) was used in this study. It is a hand-held inspiratory muscle trainer offering excellent improvement on breathing and performance. It uses the basic principles of resistance training and significantly improves breathing efficiency. POWERbreathe diaphragmatic resistance trainer uses the principles of resistance training to 'load' the inspiratory muscles, improving their strength, power and endurance. [22]

Bicycle ergometer

This is a stationary bicycle, also known as cycle ergometer. This is a device with saddle, pedals, and some form of handlebars arranged as on a bicycle, but used as exercise equipment rather than transportation. It helps to improve cardiopulmonary endurance.

Asthma control test (ACT)

This is a reliable, valid and practicable instrument for asthma control assessment.[26]. It is a set of five questions designed to help patients with asthma describe how the condition affects them. Each response to the 5 ACT questions has a point value of 1 to 5. ACT is scored by adding up the point values for each response to all five questions. Score point value of 19 and below indicates uncontrolled asthma. [27,28]

Methods

Pre-Intervention Assessment

The nature of the study, effect and benefits were explained to the participants.

Explanation of the procedure and accompanied demonstration of assignments in individual training groups was done. Participants were asked if they had recently taken any medications such as bronchodilators or b-blockers and when they last had a meal (ideal is ≤ 2 hours after meal, as heavy meals can affect performance of the test by causing some restriction).

They were advised not to wear tight or restrictive clothing that could interfere with the test.

All assessments were done with the patient in a sitting position. Pulmonary function parameters; forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC) and peak expiratory flow rate (PEFR) and cardiovascular parameters; systolic blood pressure (SBP) and diastolic blood pressure (DBP) were taken pre-intervention (baseline). Pulmonary parameters were taken by instructing the participants to take the deepest breath they could, and then exhale into the spirometer sensor as hard as possible, for as long as possible, preferably for at least 6 seconds. During the test, soft nose clips were used to prevent air escaping through the nose during exhalation. Disposable filter mouthpieces were also used to prevent the spread of microorganisms. All spirometric assessments were done three times and the best value taken. [29]

The cardiovascular parameters; SBP and DBP Were measured in sitting using a sphygmomanometer and a stethoscope and recorded after the pulmonary function tests were done.

Intervention

The participants completed 6 weeks training at a frequency of 3 times per week and 40 minutes each session. All the participants performed aerobic exercise on the bicycle ergometer at a steady state intensity that achieved 60% of maximum heart rate. Aerobic exercise prescription included 5 minutes warm up (which included arm circles and toe raises), 20 minutes of steady state exercise on the bicycle ergometer and a 5 minutes cool down, thus, a total of 30 minutes per aerobic exercise bout. [11]

Participants in group A were positioned sitting upright with the incentive spirometer held in an upright position. The disposable mouthpiece was placed in their mouth and their lips tightly sealed around it. The participants were instructed to breathe in slowly and as deeply as possible allowing the balls in the device rise. They then held their breath for 3 seconds and removed the device from the mouth, exhaling slowly. They had 5 seconds of rest and repeated the steps nine more times making a total of ten repetitions followed by an additional set, making a total of 20 repetitions of two sets. [24]

For diaphragmatic resistance training (group B), the participants sat upright and held the POWERbreathe by the handle cover with the mouthpiece in the mouth so that the lips covered the outer shield to make a seal. The participants breathed out as hard as they could and then took a fast forceful breath in through the mouth straightening the back and expanding their chest.

They were instructed to breathe out slowly through the mouth with the device still in the mouth until the lungs were empty, letting the muscles in the chest and shoulders relax. They had 5 seconds of rest and then repeated the steps nine more times making a total of ten repetitions followed by an additional set, making a total of 20 repetitions of two sets. [24]

Post- Intervention Assessment

All assessments were done with the patient in a sitting position. Pulmonary function; FEV1, FVC and PEFR, and cardiovascular parameters; SBP and DBP were taken immediately the participants completed their individual group assignment at the end of the 6th week of study.

Data Analysis

` Data was analyzed using the Statistical Package for Social Sciences (SPSS) version 20 (Chicago, II). The result was summarized with descriptive statistics of mean, standard deviation, frequency, percentages, bar chart and pie-chart. Paired t-test was used to determine the effects of each intervention on the selected cardiopulmonary parameters pre- and post-intervention.

Analysis of variance (ANOVA) was used to compare the differences in cardiopulmonary parameters across the three groups post-intervention and post-hoc analysis was used to determine the significant difference between one group and another. Level of significance was set at $p < 0.05$.

Results

The mean age of the participants was 33.24± 14.47 years. At baseline, there was no significant difference in the physical characteristics, pulmonary and cardiovascular variables of the participants in the three groups, which implies that the three groups were homogenous (Table 1).

Table 1: Pre-Intervention Data Showing Homogeneity

Variables	Group A $\bar{X}$±SD	Group B $\bar{X}$±SD	Group C X±SD	F-Value	*p- Value*
Age (years)	38.57± 18.62	31.00± 13.19	30.14± 9.65	1.473	0.242
Height (m)	1.63± 0.09	1.67± 0.08	1.66± 0.09	1.138	0.331
Weight (kg)	71.64± 17.63	73.50± 13.82	79.29± 16.44	0.864	0.429
BMI (kg/m^2)	27.25± 7.61	26.25± 5.06	29.14± 6.78	0.699	0.503
FEV1 (L)	1.39± 0.16	1.30± 0.39	1.29± 0.34	0.404	0.670
FVC (L)	1.92± 0.31	1.70± 0.64	1.76± 0.30	0.887	0.420
PEFR (L)	2.37± 1.03	2.84± 0.93	2.04± 0.85	2.587	0.088
SBP (mmHg)	111.43± 11.67	113.57± 10.82	113.57± 9.29	0.189	0.828
DBP (mmHg)	70.71±8.29	71.43±5.35	70.00±5.55	0.167	0.846

Key

FEV_1= Forced Expiratory Volume in first second | FVC= Forced Vital Capacity

PEFR= Peak Expiratory Flow Rate | SBP= Systolic Blood Pressure

DBP= Diastolic Blood Pressure | Group A= Incentive spirometry group

Group B= Diaphragmatic resistance training group | Group C= Aerobic exercise/Control group

Table 2 shows the changes in the cardiopulmonary variables pre and post-intervention in the three groups. There were significant changes in all the pulmonary parameters ($p<0.05$) of the three groups while there was no significant change in any of the cardiovascular parameters ($p>0.05$) in the three groups.

Table 2: Changes in the cardiopulmonary variables Pre and Post-intervention in the study groups

	FEV_1	FVC	PEFR	SBP	DBP
Incentive Spirometry					
Pre Int. X̄±SD	1.39± 0.16	1.92± 0.31	2.37± 1.03	111.43± 11.67	70.71± 8.29
Post Int. X̄±SD	2.08± 0.39	2.44± 0.58	5.27±1.71	110.00± 9.61	70.00± 7.84
t-value	-8.509	-2.908	-7.613	0.806	1.000
p-value	0.001*	0.012*	0.001*	0.435	0.336
Diaphragmatic Resistance					
Pre Int. X̄±SD	1.30± 0.39	1.70± 0.64	2.84± 0.93	113.57± 10.82	71.43± 5.35
Post Int. X̄±SD	2.40± 0.43	2.87± 0.60	6.13± 1.89	111.43± 9.49	70.71± 7.30
t-value	-7.977	-5.423	-5.659	1.883	0.563
p-value	0.001*	0.001*	0.001*	0.082	0.583
Aerobic Exercise					
Pre Int. X̄±SD	1.29± 0.34	1.76± 0.30	2.04± 0.85	113.57± 9.29	70.00± 5.55
Post Int. X̄±SD	2.00± 0.28	2.44± 0.58	4.33± 1.51	112.86± 9.94	71.43± 6.63
t-value	-6.313	-5.314	-4.316	1.000	-1.000
p-value	0.001*	0.001*	0.001*	0.336	0.336

Table 3 shows the comparison of the mean values of cardiopulmonary parameters across the three Groups (A, B & C) at post intervention (6th week) using ANOVA. Significant difference was observed for FEV1 and PEFR were (*p=0.016* and *p=0.030* respectively) while no significant differences existed in FVC and the cardiovascular variables (SBP and DBP) (p= 0.100, p= 0.739, p= 0.874 respectively).

Table 3: Comparison of the Cardiopulmonary Parameters across the Three Groups Post-Intervention (6th Week**)**

Variables	Group A X̄±SD	Group B X̄±SD	Group C X̄±SD	F-value	*p- value*
Pulmonary Variables					
FEV1 (L)	2.08± 0.39	2.40± 0.43	2.00± 0.28	4.589	0.016*
FVC (L)	2.44± 0.58	2.87± 0.60	2.44± 0.58	2.439	0.100
PEFR (L)	5.27± 1.71	6.13± 1.89	4.33± 1.51	3.839	0.030*
Cardiovascular Variables					
SBP (mmHg)	110.00± 9.61	111.43± 9.49	112.86± 9.94	0.305	0.739
DBP(mmHg)	70.00± 7.84	70.71± 7.30	71.43± 6.63	0.135	0.874

*Significant at p<0.05

KEY

FEV_1= Forced Expiratory Volume in first second
FVC= Forced Vital Capacity
PEFR= Peak Expiratory Flow Rate
SBP= Systolic Blood Pressure
DBP= Diastolic Blood Pressure
Group A= Incentive spirometry group
Group B= Diaphragmatic resistance training group
Group C= Aerobic exercise/Control group

On post hoc analysis (least significant difference (LSD), the significant difference observed in FEV1 was found between Groups B&C and A&B. Furthermore, the significant difference observed in PEFR was found between Group B&C.

Table 4: Post Hoc Analysis of the Pulmonary Variables between the Groups

Variables	Group Status (I)	Group Status (J)	Mean Diff (I-J)	P-Value
FEV1 (L)	Group C	Group A	-0.07671	0.589
		Group B	-0.40143	0.007*
	Group A	Group C	0.07671	0.589
		Group B	-0.32471	0.026*
	Group B	Group C	-0.40143	0.007*
		Group A	0.32471	0.026*
PEFR (L)	Group C	Group A	-0.93071	0.158
		Group B	-1.79143	0.009*
	Group A	Group C	0.93071	0.158
		Group B	-0.86071	0.191
	Group B	Group C	1.79143	0.009*
		Group A	0.86071	0.191

*Significant at p<0.05

KEY

FEV_1= Forced Expiratory Volume in first second

PEFR= Peak Expiratory Flow Rate

Group A= Incentive spirometry

Group B= Diaphragmatic Resistance Training

Group C= Aerobic exercise/ Control

Discussion

The purpose of this study was to compare the effects of incentive spirometry and diaphragmatic resistance training on selected cardiopulmonary parameters in patients with asthma.

The homogeneity of the pre-intervention parameters across the three groups indicates that the results of this study could not have been influenced by any confounding variables of the subjects, or by chance or external factors.

The significant effect of incentive spirometry on pulmonary parameters in this study is in line with previous studies which concluded that there was an improvement in asthma control and quality of life for patients with asthma in addition to a significant difference in maximal respiratory pressures, spirometric variables and oxygen saturation in patients who underwent incentive spirometry after coronary artery bypass grafting. [30] These effects may be due to the fact that it is a form of low-level resistance training that emphasizes sustained maximal inspiration and reduces the resistance to airflow by increasing lung volume, improving deep breathing, expanding collapsed areas in the lungs and preventing alveolar collapse.[31,32] The fact that there was no significant effect of incentive spirometry on cardiovascular parameters in patients with asthma corroborates findings of Basoglu *et al* [33]which reported that incentive spirometry acts majorly on the pulmonary function.

The post-intervention improvement in aerobic exercise (control) group in this study could be due to the fact that aerobic exercises produce a training effect which improves ventilatory functions and increases the capacity to utilize oxygen. Aerobic exercise therefore not only improves the respiratory system but also many other systems which in turn improve the respiratory system. [13,34] This finding is thus a confirmation of previous studies that aerobic exercise could improve pulmonary functions in patients with asthma. Prior studies had also reported that exercise performance improves pulmonary function in patient with chronic obstructive pulmonary disease due to respiratory muscle endurance training. [35,36]

Findings from this study revealed that diaphragmatic resistance training improved pulmonary parameters in patients with asthma. Diaphragmatic resistance training has a higher-level resistive effect than incentive spirometry thus resulting in a strengthening of the respiratory muscles. Strengthened respiratory muscles will likely reduce the perception of breathlessness which consequently will reduce the possibility of exercise-induced asthma. This is consistent with the report of prior studies which showed a reduction in dyspnoea and an increase in the mechanical efficiency of the respiratory muscles with the use of diaphragmatic resistance training.[19,37] In addition, the improvement seen with the use of diaphragmatic resistance training may be due to an increased expansion and mobility of the chest and aeration of collapsed alveoli, thereby allowing collateral ventilation to occur.

The fact that there were significant differences in pulmonary parameters across the three groups post-intervention implies that incentive spirometry, diaphragmatic resistance training and aerobic exercise had impact in improving FEV1 and PEFR. [19,37] Though incentive spirometry and aerobic exercise improved pulmonary parameters, the possible role of diaphragmatic resistance training in augmenting these effects could be seen in the post hoc analysis which shows significant differences between this group and both the groups that had incentive spirometry and aerobic exercise (control) in improving FEV1 and PEFR. Thus, group B (diaphragmatic resistance training + aerobic exercise group) had better improvement than the single-mode training in the control group.

This nonetheless, suggests synergy rather than interference between diaphragmatic resistance training and aerobic exercise, hence, this mode of training might be useful as an adjunct therapy in patients with asthma. [38] These findings are at variance with the study by Silva et al,[39] which showed no significant differences between the diaphragmatic resistance training group and the control group for FEV1 and PEFR and thus attributed their results to inconclusive evidence to support or refute diaphragmatic resistance training. Results from our study however suggest that diaphragmatic resistance training was most effective in improving the pulmonary parameters.

Conclusion

Findings from this study, suggest that the use of incentive spirometry and diaphragmatic resistance training have beneficial effects in improving the selected pulmonary parameters (FEV1, FVC, PEFR). However, the use of diaphragmatic resistance training is clinically more beneficial in the management of asthma. Diaphragmatic resistance training is thus recommended to be part of the intervention in the management of patients with asthma.

Conflict of Interest

The authors report no conflicting interest; financial or otherwise

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