INCENTIVE SPIROMETER TRAINING VERSUS LOWER-LIMB ANAEROBIC EXERCISE ON THE PULMONARY FUNCTIONS IN ASTHMATIC CHILDREN.

Reham A.A. Abouelkheir, Ph.D¹, Mohamed E. Khalil, Ph.D².

¹ Lecturer, Department of Physical Therapy for Pediatrics and its surgery, College of Physical Therapy, Misr University for Science & Technology, Egypt.
² Assistant Professor, Department of Physical Therapy, College of Medical Rehabilitation, Qassim University, Saudi Arabia.

ABSTRACT

Objective: This study was conducted to assess the effectiveness of the incentive spirometer training versus lower-limb anaerobic exercise on the pulmonary functions in asthmatic children.

Methods: Forty children (of both sexes) with asthma implicated in this study ranges between 9 and 12 years old. The patients were randomly divided into two groups with the same number. Discovery diagnostic spirometer was used to measure the pulmonary functions: Forced Vital Capacity (FVC), Forced Expiratory Volume (FEV1) and Peak Expiratory Flow Rate (PEFR). (Group A) received incentive spirometer training. (Group B) received lower-limb anaerobic exercise.

Results: The results of the study show that: the pre-remediation data showed no considerable differences between the both groups in any of the measured parameters, the post-remediation results revealed a significant improvement in both groups' pulmonary function (FVC, FEV1 and PEFR).

Conclusion: The incentive spirometer training technique and lower-limb anaerobic exercise program which included in our research can be considered as a valuable rehabilitation program for children with asthma for improvement of their pulmonary functions.

Keywords: Incentive Spirometer, Asthma, Anaerobic Exercise, Pulmonary Functions.

I. INTRODUCTION

Asthma is a major health issue that affects people all over the world. This chronic airway condition affects people of all ages in countries all over the world, and if left untreated, it can severely restrict everyday life and even be fatal. Asthma is becoming more common in most countries, especially among children. [1]. Asthma impairs pulmonary functions, resulting in a decline in functional ability and quality of life, and this disorder is affected by the patient's age, disease length, and severity. [2]. Asthma is resulted from a complicated combination between genetic predisposition and environmental conditions. Despite improved medical care and living conditions, its prevalence has increased in industrialized countries over the last several decades. Environmental pollution, cigarette smoke in the environment, and a decrease in breast feeding are all etiologic causes. [3] Due to alterations of the mechanical properties of airway walls, asthmatic airways could be hyper-responsive, for instance the bronchial wall may be less compatible and therefore reflective constriction rather than dilatation during deep inhalation. [4] In asthma, vascular obstruction and airway edema occurred due leaky bronchial vessels which also play a role, the contraction of airway smooth muscle causes airway narrowing in asthma, vascular obstruction and airway edema occurred due leaky bronchial vessels which also play a role and hypertrophy and fibrosis of the smooth muscles cause irreversible airway constriction. [5] The mechanisms underlying airway hyperresponsiveness are unknown, but they are likely to include excess mediator release from inflammatory cells especially mast cells[6]. Pulmonary function tests are used to evaluate and control diseases affecting the heart and lung function, for monitoring the effects of environmental, occupational and medicinal exposures as well as for assessing the risk of surgery and the effects of pulmonary exposures. Spirometry measures air movement in and
out of the lungs through various respiratory maneuvers.[7]Incentive spirometer stimulate deep respiratory pattern with an inspiratory hold for subjects who find difficult in control their breathing pattern.[8]Physical activity is a crucial component of a child's normal psychosocial growth and self-image.[9]Aerobic and strength training are essential components of a respiratory therapy program because they enhance the functional and physiological condition of the patient. [10]

II. METHODS

Study design:

Single blind, randomized, clinical trial was carried out at The National institute of Neuromotor System, Giza, Egypt

Randomization:

55 children with mild asthma were selected for this study; 10 children did not achieved the inclusion criteria, and 5 children's parents rejected to implicated in this trial. Following the baseline measurements, Eligible children were allocated randomly to either group A or group B. Children were consecutively assigned a number from 1 to 40. Then online graph pad software was used to randomly assign 20 children to each group.

Participants:

40 children with mild asthma (22 boys and 18 girls) of both gender ranging in age from 9 to 12 years; they could understand and follow instructions. If a child had any of the following conditions, they were not allowed to participate: 1- Exercise-induced asthma. 2- Taking part in any form of sport. 3- Asthma, moderate to serious. Before collecting the data, the objectives, proceedings and advantages are fully elucidated to the parents of the participated patients. Parents were given informed consents to have their children participated in the study. This study was carried out in accordance with declaration of Helsinki guidelines for studies involving humans. The ethical approval of this study was cleared by the Ethics Review Committee of the Faculty of Physical Therapy, Cairo University.

Outcome measures:

Discovery Spirometer:

Forced vital capacity "FVC", Forced expiratory volume after 1 second "FEV1" and Peak Expiratory Flow Rate "PEFR " were assessed by Discovery Spirometer pre and post application of treatment for 3 times per week for 10 successive weeks to measure the pulmonary functions.

Weight and Height Scale:

It was employed to record the child's weight (in Kg) and height (in cm), these results are essential to fed the “Discovery spirometer“

Interventions:

Group A received Incentive Spirometer training; Group B received Resistance training protocol as follow:

Group A:

The subjects sat in a relaxed posture in the chair, keeping the incentive spirometer upright. They were instructed to exhale softly, tightly close their lips around a mouthpiece, and inhale quietly and mightily till the spirometer ball rose. (As you inhale, the spirometer balls rise, and when you exhale, they fall.) Then, they were told to hold their breath for as long as they could and then slowly exhale. The therapy sessions were provided to all of the children: 45 minutes- 3 times /week for 10 successive weeks

Group B:

The strength training consisted of 4 exercises conducted in 3 sets of 10 repetitions, with a 60 seconds rest between sets and 3 minutes rest between exercises. All exercises with weights around the ankle and it were in form of: quadruped hip extension, straight leg raise exercise, lying leg curl, and calf raise. The first 3 sessions...
were used to adjust to exercises with light weights, and the weights used after that was determined by monitoring the subjects' abilities to do 10 exercise repetitions. The weight was gradually increased as the subjects' abilities to complete three sets of 10 complete repetitions improved.

For both groups: Warm up for 5 min, prior starting the processes and cool down for 5 min, after ending the processes: The warm up and cool down stages comprised of stretching exercises for upper and lower extremities.

Data analysis and statistical design

An unpaired T-test was employed in comparison between pre and post treatment for both study groups to assess the significance of the findings. After discussing and interpreting the results, a final conclusion and collection of recommendations were presented. The computer program SPSS (IBM SPSS, Chicago, IL, USA) version 20 was employed to implement all statistical calculations.

III. RESULTS

Subject characteristics:

As present in Table (1), there were no significant differences in demographic information between the two groups (p > 0.05).

The pretreatment results of this investigation cleared that there were no significant differences (p > 0.05) in all recorded criteria among both groups of patients in the pulmonary functions as indicated in Table (2) which demonstrated that at the beginning of the research, both groups were similar in the measured data and pulmonary functions. (FVC, FEV1 and PEFR) were under these patients' expected values regarding their ages, weights and heights. The post-treatment findings of this research showed that the pulmonary function of the 2 groups A and B improved. “FVC, FEV1 and PEFR” show significant differences in pulmonary function before and after treatment for 10 weeks as represented in Table (3) (p < 0.005).

Table (2): Demographic characteristics

<table>
<thead>
<tr>
<th>Demographic characteristics</th>
<th>A</th>
<th>B</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age/year (Mean± SD)</td>
<td>11.4±2.11</td>
<td>11.7 ± 1.23</td>
<td>0.131</td>
</tr>
<tr>
<td>Weight/Kg(Mean± SD)</td>
<td>40.3±8.33</td>
<td>39.7±9.1</td>
<td>0.826</td>
</tr>
<tr>
<td>Height/m(Mean± SD)</td>
<td>1.3±5.74</td>
<td>1.32±7.41</td>
<td>0.438</td>
</tr>
</tbody>
</table>

SD: standard deviation; p-value: level of significance

Table (3): Statistical analysis of the FEV1 (L) and PEFR (L/Min) for both Groups

<table>
<thead>
<tr>
<th>Pretreatment Group A</th>
<th>Pretreatment Group B</th>
<th>Post treatment Group A</th>
<th>Post treatment Group B</th>
<th>Pre vs Post Group A</th>
<th>Pre vs Post Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>P^a value</td>
<td>P^b value</td>
</tr>
<tr>
<td>FVC</td>
<td>1.89±0.273</td>
<td>1.84±0.25</td>
<td>2.03±16.2</td>
<td>0.013</td>
<td>0.044</td>
</tr>
<tr>
<td>FEV1 (L)</td>
<td>1.56±0.273</td>
<td>1.63±0.224</td>
<td>1.8±0.12</td>
<td>0.008</td>
<td>0.075</td>
</tr>
<tr>
<td>PEFR (L/Min)</td>
<td>193.47±13.2</td>
<td>199.22±12.24</td>
<td>205.2±10.35</td>
<td>0.016</td>
<td>0.0563</td>
</tr>
</tbody>
</table>

SD, Standard deviation; p-value, level of significance; a comparison between groups, b comparison within groups.
IV. DISCUSSION

This research compared the effectiveness of the incentive spirometer training versus lower-limb anaerobic exercise on the pulmonary functions in asthmatic children. In this analysis, there were no significant differences in all pre-treatment assessed pulmonary function parameters in both groups of patients. Both groups had similar measured variables and pulmonary functions at the beginning of the study, according to these results, and these patients' pulmonary functions were lower than predicted for their ages, weights, and heights. The results of this study's post-treatment findings revealed that both groups of patients' pulmonary function (FVC, FEV1 and PEF) improved substantially, as shown by a substantial difference between pre-treatment and post-treatment pulmonary functions after 10 weeks of training.

The incentive spirometer used to increase the strength of the inspiratory muscles as well as the expiratory muscles, and lung capability. [11] Incentive spirometry has been shown in several studies to improve respiratory function (PEFR, FVC, FEV1, and MVV) by improve lung magnitude, diminishing air flow impedance and improve deep diaphragmatic respiratory pattern. In addition, the Incentivespirometry provides visible feedback for the subject during exercise. [12] Incentive spirometryenhance cardiopulmonary state, enhance the rate of alveoli perfusion, and keep positive pressure in the airways to improve ventilation.[13] Improved pulmonary functions in group (B) may be attributed to improved lower limbs muscle strength.[14] Anaerobic training enhances the rate and depth of breathing, which can enhance pulmonary functions as well as O2 assimilation and diffusion average. [15]

The body demands more oxygen through endurance and strength exercise, the lungs must enhanced more oxygen, the exchange of carbon dioxide and oxygen becomes more frequent and effective as the depth of breathing increases. [16]

V. CONCLUSION

The incentive spirometer training and lower-limb strength exercise used in this research can be considered as a valuable rehabilitation program for children with mild asthma for improvement of their pulmonary functions.

VI. ACKNOWLEDGMENT

The authors thank all the patients who participated in the study and their parents.

Author Disclosures:

[Authors report no conflict of interest]

No funding was received for this study. The authors certify that they have no financial affiliations or involvement with any commercial organization that has a direct financial interest in any matter or materials discussed in this manuscript.

REFERENCES

5. Anderson SD and Daviskas E. The mechanism of exercise-induced asthma is... J Allergy ClmImmuno 106: 453–459, 2000