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(CASE REPORT)

The effect of respiratory physical therapy on the control of the respiratory pattern in a child with bronchial asthma: A case study

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Abstract

Introduction: Bronchial Asthma is a frequent disease in children and young adults, characterized by airway obstruction caused by bronchial hyperresponsiveness. The condition can be cured with the use of bronchodilators or can be treated naturally, by applying Respiratory Physical Therapy (PT) in both cases.

The purpose of this study is to evaluate the effect of Respiratory Physical Therapy, through the training of nasal and diaphragmatic breathing through activities.

Method: A 5-year-old boy of Greek origin was treated with Respiratory PT, to reduce symptoms of Bronchial Asthma. Evaluation measurements were carried out before and after the end of the physiotherapeutic Intervention. Questionnaires were used to check asthma exacerbation and body posture. Spirometry was performed to estimate pulmonary volumes and capacities, abdomen and chest circumference were also measured during inhalation and exhalation phases. 24 sessions, lasting 60 minutes each, were performed during 8 weeks period, through training diaphragmatic and controlled nasal breathing, and Relaxation Techniques. The child and caregiver were trained to apply these techniques at home in a self-treatment form.

Results: Forced Expiratory Volume (FEV) and Peak Expiratory Flow Rate reduced, Forced Vital Capacity slightly increased after treatment, however, spirometry volumes are not considered as statistically significant ($p>0.1$). Abdominal breathing circumference while inhaling, increased by 9.75% (mobility of diaphragm increased). Asthma symptom control improved and fatigue during activity reduced.

Conclusion: Respiratory Physical Therapy (PT) focused on Diaphragmatic Breathing Training, when combined with breathing exercises performed at home, contributes to overall improvement of asthma symptoms. However, research should be conducted in a larger population sample to consolidate findings on the effectiveness of Respiratory Physical Therapy.

Keywords: Case Study; Respiratory Physical Therapy; Child Bronchial Asthma; Diaphragmatic Breathing; Buteyko Nasal Breathing

1. Introduction

As a disease, Bronchial Asthma (BA) occurs frequently in children and adolescents, with the prevalence fluctuating 7-10%, while the condition may regress or persisting into adulthood (The Global Asthma Report, 2018; Ukena et al., 2008).

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Symptoms include coughing, shortness of breath and expiratory wheezing (wheezing) that occurs during exacerbation's acute phase, tachypnea or feeling pressure in the chest area. The shallow breathing pattern increases inefficient pulmonary ventilation, resulting in obstruction of the respiratory tract by mucus hypersecretion and smooth bronchial muscle contraction, a phenomenon called bronchospasm (Macêdo et al., 2016; (Ukena et al., 2008; (Bateman et al., 2008). Lower pulmonary function in BA can affect children's activity, learning experiences and communication with peers, since the priority is given to managing asthmatic symptoms (Bunlam et al., 2024; Ukena et al., 2008). In addition, it is a factor of concern for the child's family, since BA treatment requires financial resources expenditure (Hristara-Papadopoulou and Papadopoulou et al., 2014; Eisner et al., 2012; Kallistratos, 2009; Bateman et al., 2008).

The exacerbation and remission of Childhood Bronchial Asthma is affected by weather conditions (humidity, seasonal allergies); from exposure to upper respiratory tract infections or allergens (pollen, smoke, dust); or from thermal stimuli (hot or cold air). Intense exercise, or intense psychological pressure (anxiety, stress, depression) can also affect the way in which Bronchial Asthma manifests. Medication actively contributes to reducing the symptoms of Childhood Bronchial Asthma, while Respiratory Physical Therapy (PT) has become a popular and effective adjunctive therapy in respiratory diseases management, based on recent guidelines from GINA (Global Initiative for Asthma). Physical activity also contributes to improved pulmonary elastic recoil and lung capacity (GINA, 2022; Zhang et al., 2020). The meta-analyses of Zhou and Xu (2023) and Zhang et al. (2020), recorded improvement in Forced Vital Capacity and Forced Expiratory Volume indicators, while also describing a boost in immune system function, after prolonged mild to moderate exercise, for 40-60 minutes and continuous training of the diaphragm, chest muscles and upper limb muscles in children with asthma. Macêdo et al. (2016) reviewing 3 studies with a total sample of 112 asthmatic children, with a mild to severe condition, described reduction of disease symptoms through Respiratory Physical Therapy (PT) techniques (chest vibration and percussion, Forced expiratory breathing or coughing technique, Relaxation exercises or Jacobson Technique, rhythmic mobilization exercises), although the breathing exercises they are usually part of a treatment program, without a basic guideline for the way or dosage of their application.

Breathing exercises and techniques are usually part of a therapeutic program, but there is no basic guideline for the way or dosage of their application, which in many cases depends on the cooperation of the patient for their application. Taking the aforementioned data into account, we used Respiratory Physical Therapy (PT) techniques such as the focused Nasal Breathing training (Buteyko technique), focused diaphragmatic breathing training and relaxation exercises (Jacobson technique), to improve the condition of a 4-year-old boy with Bronchial Asthma. This study's purpose is also to investigate the effectiveness of Respiratory Physical Therapy elements that can be used to construct an intervention protocol.

2. Case Presentation

A 4-year-old boy, of Greek descent, (height: 107cm, weight: 16.0kg), given the pseudonym "John", for the sake of ease of wording and communication of the Case, came to the "Hippocration General Hospital" of Thessaloniki with a diagnosis of bronchial asthma, after examining his disease state. John belongs to a middle-to-high-income five-member family, with a businessman father and a private employee mother. Both parents are university educated, while he is the third child after his two older brothers, aged 11 and 13 years old. According to the family history, John's parents, siblings and relatives of 2nd and 3d degree, had no signs of respiratory disease.

John's mother reported that no complications or illness occurred during the pregnancy, while taking prescribed low risk conventional drug treatment (probiotics, antacids for indigestion, iron supplements). John's birth weight was 3.2 kg, 50 cm in length. At 10 months old of age (in September), John started cortisone medication and bronchodilators in spray form, after he became ill and was diagnosed with "Obstructive Bronchitis". Symptoms lasted seven days and recurred after a month's remission, where the condition was treated with the same medication. During the recurrence phase, John developed a "dry" cough changed to "productive", three days after the resumption of the medication, where ten days were required for symptoms to subside again. During the same year's winter season (November-February), John manifested the symptoms of bronchitis once every month; taking medication only during the period he was ill.

Until 2 years-of-age, bronchodilators were administered during the evening hours. Clinical presentation of bronchitis was stable at 3 years-of-age and was treated with the same medication (bronchodilators taken at during morning, evening and night hours; cortisone drugs taken only in the by morning and night hours). As soon as John started attending kindergarten, his mother understood that "something did not seem right, because the child was speaking with a weak voice, almost whispering, although the cough appeared with delay during the day". When the cough was provoked, John instantly received the induced medication with bronchodilators and cortisone, to suppress the outbreak. By the age of 4-years-old, John was hospitalized three times during the year, due to frequent outbreaks of Bronchitis and Multifocal Pneumonia. Prescribed medication given three times per day was no longer effective to redeem the

symptoms, while his mother noticed that when John was feeling unwell, "his belly deeply sunk below the height of the ribcage" and he had tachypnea (55-60 breaths/minute), often complaining the “his stomach hurts”. No findings of Cystic Fibrosis were detected by performing the sweet test, with current diagnosis being “Bronchial Asthma”.

During Physical Therapy evaluation, John appeared to have shallow and intense thoracic breathing, in resting state. On inhalation, shoulders were raised and abdomen was retracting, while expiratory wheezing was heard on exhalation. John’s mother reported episodes of dyspnea and tightness when breathing, which also occurred before starting the first Physical Therapy session, while climbing the hospital stairs. This condition manifested in the initial therapeutic sessions (1st to 4th hospital visit), with intense production of sputum secretions at the end of intervention or after an hour, as the caregiver reported.

3. Methods

3.1. Somatomedin Characteristics

John’s somatomedin characteristics were retrieved using an electronic weight scale; a wall measuring tape for height; while Body Mass Index (BMI) was calculated based on the equation: [BMI = Weight in kilograms / Height in meters2]. John's somatomedin characteristics are analyzed in Table 1.

Table 1 Somatomedin Characteristics and Questionnaire results

Somatomedin Characteristics	**BEFORE Intervention**	**AFTER Intervention**
Age (year, months)	4 years, 12 months	5 years, 01 months
Height (cm)	107.5 cm	107.7 cm
Weigh (kg)	16.10 kg	16.85 kg
BMI (kg/m2, Percentile Range in %)	13.9 kg/m2 (6%, Near underweight)	14.4 kg/m2 (17%, Healthy weight)
Scaled Evaluation Questionnaires		
ACT (Asthma Control Test):	“11” (Low Quality Control in Asthma Symptoms)	“22” (Good Quality Control in Asthma Symptoms)
TRACE (Trunk Aesthetic Clinical Evaluation):	“0” (Trunk Symmetry)	“0” (Trunk Symmetry)

3.2. Evaluation Questionnaires

To assess the Quality of Asthma Control, we used the Asthma Control Test (ACT) for children aged 4-11 years. The test examines the quality of asthmatic symptoms control, consisting of 7 questions where four of are addressed to the child, aided by the parent or caregiver and the remaining three questions are were addressed specifically to the parent (or caregiver). Each question is was scored from 1 to 5 points according to the given answers, with a total score of ≤19 points indicating low quality in asthma symptoms control, indicating that drug treatment is needed. Body posture was evaluated with the TRACE visual (Trunk Aesthetic Clinical Evaluation), which constitutes a routine tool used for the aesthetic assessment of scoliotic deformity, consisting of a 12-point scale where 0 is assigned to “trunk symmetry” and 3 to severe “trunk asymmetry”. The scale examines four subcategories which include grading the shoulders (0–3), scapulae (0–2), hemi-thorax (0–2) and waist (0–4) (Zaina et al., 2009; Negrini et al., 2007).

3.3. Pulmonary Volumes and Capacities spirometric measurement

An electronic spirometer was used to measure: (a) Forced Vital Capacity (FVC), meaning the total expiratory pulmonary volume after forced exhalation; (b) Forced Expiratory Volume for the first second of the effort (FEV1), meaning the total expiratory volume of air after forced exhalation during the first second; (c) Peak Expiratory Flow Rate (PEF), of the resistance presented in the small bronchioles, for 25%, 50%, 75% of FVC, or for the total FVC range (25-75%) and; (d) The Tiffeneau index, which is calculator using the equation: FEV1 / FVC and is around 80% in people without airway obstruction (Ponce et al., 2024; Stanojevic et al., 2021; Swanney et al., 2008). For spirometry conduction, while standing, John covered his nose and first exhaled the air out of his lungs, then took a deep breath and exhaled forcefully into the mouthpiece of the spirometer. The process was repeated three times and measurement data that appeared on the spirometer screen were recorded in Table 3.

3.4. Thoracic-and Diaphragmatic Circumference measurement

Inspiratory and Expiratory movement of the thoracic cage and the abdominal area was measured around the circumference, without clothing, three hours after John's last meal. Tape measure was placed below the level of the armpit (3rd-4th rib), while standing after exhalation of the subject, where the perimeter of the expiratory movement of the upper thoracic segment was measured. Similarly, the measure was placed at the same height as the xiphoid process (6th-8th rib), to measure the lower thoracic segment. Abdominal motion was measured, placing the measure at the height of the navel, after deep exhalation. (ACSM, 2010) For each measurement procedure John was asked to "take a deep breath", for the circumferential measurement of chest and abdominal expansion at inhaling. Circumference measurement while inhaling, exhaling and percentage alteration before and after Respiratory Physical Therapy (PT) treatment are described in Table 4.

3.5. Intervention

Respiratory Physical Therapy (PT) intervention lasted for 12 weeks, with 60-minute sessions, two times per week, in the hospital and at home. Each session began overviewing the progress of the condition and the diaphragmatic breathing implementation from John and his mother. Intervention focused on (a) shifting breathing pattern from thoracic to diaphragmatic; (b) shifting the pattern from shallow mouth breathing to slow and deep nasal breathing, (c) training in positions facilitating pulmonary drainage. John's mother was present at the sessions to be trained in the Respiratory Physical Therapy (PT) techniques to continue providing therapeutic exercises, at home and also after the end of monitoring. Treatment components used in Physical Therapy sessions were taken from Hristara- Papadopoulou and Papadopoulou, (2014) and are described in Table 2. Figures 1 and 2 show applications performed in the treatment program.

Table 2 Techniques used in Respiratory Physiotherapy Treatment

Techniques:	**Description:**
Performance Evaluation (at the beginning of each session)	Physical-Therapy assessment of respiratory exercise implementation, assigned for completing at home. Breathing Patterns and Asthma Symptoms evaluation.
Training in thoracic and diaphragmatic breathing separation.	Explaining the difference in movement patterns of the thorax upper and lower segment and also the difference in movement between the chest (thoracic breathing) and the abdomen (diaphragmatic breathing). Training and checking slow abdominal (diaphragmatic) breathing pattern, in sitting; semi-sitting and/or in standing position. At the end of each session John was asked to "teach" (to demonstrate the application of respiratory exercises) to his mother how to perform diaphragmatic and abdominal breathing, to also continue practicing at home.
Controlled exhalation breathing training	Controlled retention of exhalation. John was asked to "close his nose with his fingers and hold his breath at the end of the exhalation; then take a deep breath and hold the breath until you feel strongly that you want to inhale, and take a deep breath through the nose slowly and calmly." Repeated for 3-4 times with 40-60 seconds pause in between.
Breathing training using toys and objects.	Deep inhalation and pursed-lip exhalation training: John was asked to exhale forcefully or gently throw a straw in a glass of water, to create large bubbles. The exercise could be modified by blowing soap bubbles, a whistle, pinwheel or a candle. Colored Feathers: A feather was released in mid-air with forced exhalation, as long as possible. Mother and the therapist could also participate through cooperative play to control direction change of the feather. Practicing diaphragmatic breathing through feedback with stuffed toys, to understand the applied technique.
Buteyko Technique (nasal breathing training) and Rhythmic breathing training.	Encouragement of nasal breathing, to normalize respiratory rate and passive exhalation. Encouragement to reduce inhaled volume for short periods. Practice maximum breath retention. Training to maintain rhythmic breathing in combination with walking (e.g. inhale for two steps, exhale for three steps).

Respiratory Exercises at home (*Performed from John and his mother)	Jacobson relaxation exercises (e.g. hold-and-relax for head, trunk upper and lower limb muscles); Upper limb flexion-extension exercises combined with breathing. Application once a day, before bedtime. Controlled slow abdominal breathing exercises, twice a day, while sitting; walking; or during daily activities.
Outdoor Exercise Activities	Stair climbing; gradual increase in speed and while controlling breathing rate; jogging; Walking uphill or downhill with synchronized speed, pace and breath; Encouragement to participate in games of moderate intensity in the kindergarten environment (ball games, chase, hide-and-seek)

3.6. Self-Treatment Advices for Home application

In parallel with the Respiratory Physical Therapy sessions, advice was given for self-treatment implementation, by the child and the caregiver (mother). Advices given were:

- Explaining the difference in upper and lower thorax movement. Maintain Abdominal breathing while walking and during daily activities.
- Demonstration of positions to relieve dyspnea: leaning in a standing position (e.g. against a wall) or in a sitting position (e.g. astride a chair) with the trunk leaning forward.
- Planning respiratory exercises for home: Controlled slow abdominal breathing exercises, 2 times per day; Rhythmic breathing exercises in sitting position to increase reduced pulmonary volume; Daily Relaxation technique application before sleep. Practice in front of a mirror for feedback. (d) Tips for implementing nasal breathing during the day.

3.7. Result Analysis

Data were analyzed using the statistical program SPSS, version 16 (Statistical Package for Social Sciences). ANOVA test was performed to detect homogeneity in spirometry attempts in evaluation before and after intervention phases. Mean ± and Standard Deviation (SD) was calculated for the values between attempts, for the evaluation phases before and after the physical therapy intervention. Paired t-testing data analysis applied accordingly to compare probability value between assessment phases, considered significant at $P \leq 0.05$. We also calculated: (a) percentage alternation of the spirometry indications, as listed on Table 3; (b) percentage alternation of the chest and abdomen region circumference during inhalation and exhalation, as listed on Table_4.

Based on literature reports, observable change of the condition was calculated in the percentage change by over 10% for FVC; FEV1; Tiffenau index and PEF (%) (Stanojevic et al., 2021; Chu et al., 2019). Observable improved thoracic and diaphragmatic mobility set at a percentage change of 3% minimum while inhaling, meaning improvement in pulmonary ventilation, between evaluations (Guy et al., 2023).

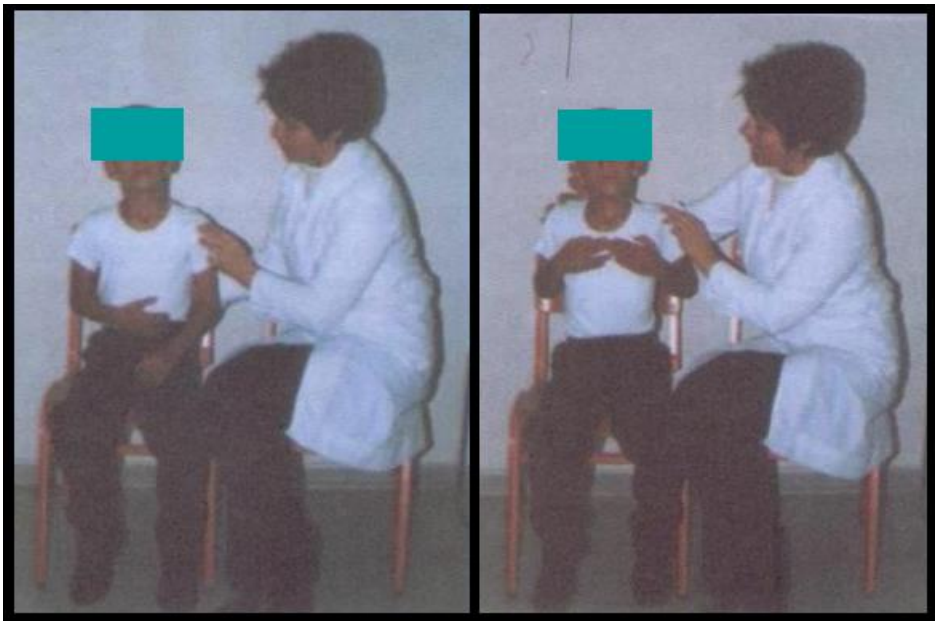

Figure 1 Controled Diaphragmatic (left) and Thoracic (Right) Breathing Training

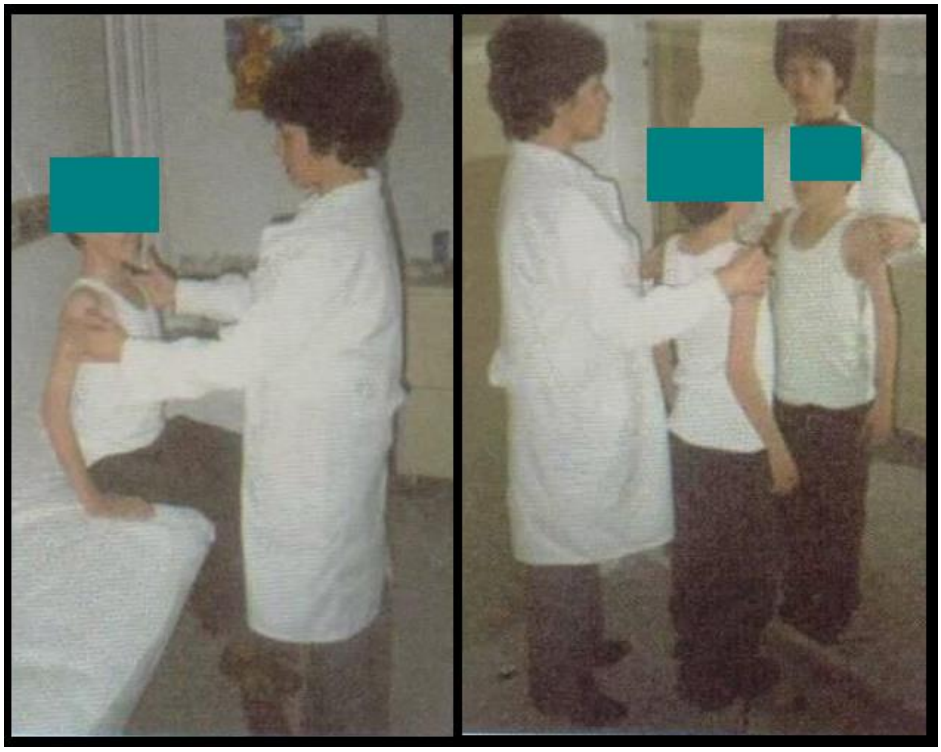

Figure 2 Self-Correcting posture training

Table 3 Spirometry Attempts Before and After Intervention

Assessments	**BEFORE Intervention**					**AFTER Intervention**					**Between Measurements Comparison**	
Spirometry Attempts	1st	2nd	3nd	Mean (SD)	p	1st	2nd	3nd	Mean ± SD	p	Alt (%)	P
FVC (Liters)	0.91	0.91	1.03*	0.95(0.069)	0.002	1.02	1.06	1.07*	1.05(0.026)	0.001	3.88%	0.09*
FEV1 (Liters)	0.78	0.94	1.21*	0.97(0.217)	0.016	0.85	0.92	1.05*	0.94(0.101)	0.004	-13.22%	0.639
FEV1/FVC (%)	85.71	103.29	117.45*	1.02(15.90)	0.008	83.33	85.98	98.13*	80.14(7.89)	0.003	-16.45%	0.135
PEF75 Ltr/sec	2.00	2.15*	1.07	1.74(0.58)	0.036	2.13*	0.79	0.37	1.09(0.91)	0.175	-0.83%	0.274
PEF50 Ltr/sec	1.40	1.75*	1.25	1.46(0.25)	0.01	1.49*	1.09	0.73	1.10(0.33)	0.037	-14.86%	0.255
PEF25 Ltr/sec	0.71	1.17	1.64*	1.17(0.46)	0.049	0.76	0.68	0.90*	0.78(0.11)	0.007	-46.43%	0.234
PEF25-75 Ltr/sec	1.16	1.68*	1.45	1.43(0.26)	0.011	1.24*	0.83	0.67	0.91(0.29)	0.033	-26.19%	0.226

Abbreviations: P: Statistical Significance between evaluation phases; | p: Statistical Significance between attempts (homogeneity checking with ANOVA); | Alt (%): Percentage of Alternation between Maximum Attempts (%) | Standart Deviation: SD | Asterisks meaning (*): Highest Indication in the same Evaluation Phase

Table 4 Thoracic-and Diaphragmatic Circumference measurement

Thoracic-diaphragmatic mobility	**BEFORE Intervention**			**AFTER Intervention**			**Percentage Measurements Comparison (%)**		
Circumference Measurement (cm):	**Exh.**	**Inh.**	**Circ. Diff.**	**Exh.**	**Inh.**	**Circ. Diff.**	**Exh. Alternation (%)**	**Inh. Alternation (%)**	**C.D.Alt**
Upper Thoracic Region	54.2 cm	57.1 cm	2.9 cm	54.1 cm	56.3 cm	2.2 cm	-0.18%	-1.40%	-24.13%
Lower Thoracic Region	48.9 cm	55.4 cm	6.5 cm	49.2 cm	55.9 cm	6.7 cm	0.61%	0.90%	3.07%
Abdominal Area:	47.1 cm	48.2 cm	1.1 cm	47.5 cm	52.6 cm	5.1 cm	0.85%	9.75%*	363,64%

Abbreviations: Exh.: Exhalation | Inh.: Inhalation | Circ. Diff.: Circumference Difference | (C.D.Alt.) Circumference Difference Alternetion: Equals to Perimeter Difference AFTER – BEFORE (%) | Asterisks meaning (*): Highest Indication in the same Evaluation Phase

4. Results

4.1. Evaluation Questionnaires:

Asthma Control Test score was found to be 11 points, interpreted as “poor control of asthma symptoms”. After 24 Respiratory Physical Therapy (PT) sessions, ACT score increased to 22 points, meaning “good control of asthma symptoms”. Total score on the visual TRACE scale was 0 points for all subscales before and after intervention, indicating that John did not exhibit any apparent trunk asymmetry, before and after the physical therapy intervention (Table 1).

4.2. Spirometric measurements:

There was no homogeneity in spirometry measurements from each evaluation phase, investigating the attempts through one-way ANOVA tests ($p<0.05$) (Table 3).

Statistical Significance for Pulmonary Volumes and Expiratory flows was calculated to be $P >0.01$, for the spirometry attempts average (Mean), before and after the intervention, through t-test of dependent variables indicating no statistically significant difference was observed between the two assessment phases. Forced Vital Capacity ($p=0.09$)

percentage change increased by 3.88%, being counted as an non-observable effect in improving the condition (<10% change). Forced Expiratory Volume for the 1st second of effort (p=0.639), decreased by -13.22% (observable change at >10%), between the maximal efforts of the pre- and post-intervention measurements. Tiffeneau index, which represent the proportion of pulmonary vital capacity that can be exhaled in the first second of forced expiration, was also decreased by -16.45% (p=0.135) (Table 3).

Peak Expiratory Flow Rate, had an observable change for 25%, 50% of FVC and the range between 25-75% (all p>0.2), while the absolute value of the percentage changed on the negative by 10%, meaning that Maximal Expiratory Flow Rate decreased. H PEF for the 75% of FVC (p>0.2), decreased by 0.83%, without the change being considered as observable.

4.3. Thoracic-and Diaphragmatic Circumference alternation

Circumference in Upper and lower thoracic region and in the abdominal area showed a small percentage change in dimensions, while inhaling and exhaling (-2% to 0.9%), for the measurements before and after the intervention (table 4). Abdominal region circumference increased by 9.75% after Respiratory PT intervention, interpreted as pulmonary capacity increase through diaphragmatic inhalation. Perimeter Difference Alternation (in percentage), indicates: (i) Decrease in upper thoracic circumference during breathing (-24.13%), meaning also a reduction of the thoracic breathing pattern; (b) Small increase in lower thoracic region circumference (by 3.07%); (c) Perimeter Difference for the abdominal area during the respiratory process is tripled (364.64%), meaning intensification of diaphragmatic breathing pattern (table 4).

4.4. Caregiver's Observation

John's mother reported that before the Respiratory Physical Therapy (PT) treatment, his endurance in walking short distances or climbing stairs was reduced. After kindergarten, John was exhausted and could not raise his voice to be heard when he spoke. Following Respiratory Physical Therapy (PT) treatment, John could go up and down stairs or walk about 300 meters on an uneven road without stopping; and he was not fatigued after kindergarten activities. John started playing intense activity games like chase, hide and seek with his peers on the playground and in kindergarten gaining courage to participate, in contrast with his previous in-house activity. John's family expressed that

they feel less stressed for his condition after treatment and more confident about his health progress.

5. Discussion

Various researches have been carried out regarding the Physical Therapy treatment of Bronchial Asthma, without a general treatment line being established as Respiratory Physical Therapy (PT) , is usually provided as a supplement to holistic physical treatment programs. Our study aims to provide data related to one child with Bronchial Asthma, since case studies are scarce in this clinical subject; while treatment application, and also the effectiveness of respiratory therapy, heavily depends on the patient's clinical condition's image, habits, family and medical history as well as environmental conditions exposure. In another case studying Bronchial Asthma, published from Pandey and Pandey (2015), an Indian 10-year-old boy with sarcofascial system imbalance, the effectiveness of Respiratory Physical Therapy exercise treatment was examined in the thoracic and diaphragmatic breathing pattern and also in brain activity. Physical treatment included Proprioceptive Neuromuscular Facilitation stretching and Manual Therapy techniques for upper and lower limbs and pelvis, in order to activate respiratory mobility through whole-body movements. In John's case were no neurological disorders, it is important to note that Respiratory Physical Therapy may provide multidimensional benefits beyond Bronchial Asthma treatment.

John's case intervention and results after treatment, share some similarities with the procedure followed by Hepworth et al. (2019), where improvement in ACT for asthma symptoms control was noticeable (≥23 points) after the implementation of Buteyko nasal breathing and Diaphragmatic breathing techniques. However, in both cases high scoring in ACT questionnaire may carries a risk of biased conclusions, since indicators change can also be associated with independent factors which do influence Bronchial Asthma manifestation (e.g. increased stress, seasonal allergies, bronchospasm caused from intense physical activity) (Van Dixhoorn and Folgering, 2015). Amin et al. (2019) described a significant improvement in the quality of bronchial asthma control indices at one-month follow-up, for 30 children trained in Diaphragmatic breathing technique and pursed-lip exhalation exercises. Bunlam et al. (2024) in their Clinical Trial, observed that Maximal Inspiratory and Expiratory Pressure increased after treatment, for 30 children 7-12 years of age with Childhood BA, divided into a Sustained Maximal Inhaling Breathing Group and a Balloon Blowing Breathing Group. Since in this Case, John also actively participated in a similar intervention process, also frequently applying and

Breathing exercises were frequently applied at home, improvement observed in some of the indicators investigated (ACT questionnaire, FVC, Abdominal area after inhalation circumference).

Electromyography of respiratory muscles indicates reduced activity of the scalene muscles, where paradoxical movement of the upper thoracic cage is established, resulting in retraction instead of expanding while inhaling, on asthmatic conditions. Sternum and lower rib cage also retract on inhalation, implying that the diaphragm flattens out on retraction, instead of the physiological normal dome shape (Hoover's Sign). (Binazzi et al., 2008; Garcia-Pachon, and Padilla-Navas, 2006). Relaxation of the abdomen before the contraction (downward movement) of the diaphragm, may account for Hoover's sign, as it does not function as an auxiliary fulcrum for the diaphragmatic dome to rise up (Gosselink, R. 2004; De Troyer and Estenne, 1984). In John's case, abdominal-to-thoracic synchrony was reduced, resulting in paradoxical movement of the ribcage at the start of inspiration, possibly due to lower activity of pectoralis minor and intercostals muscles on upper ribcage (Gosselink, 2004). After Respiratory PT sessions completed, diaphragmatic breathing was not completely established as a natural pattern of respiratory movement pattern, however the thoracic breathing pattern and shoulder shrugs on inspiration were reduced. Respiratory Physical Therapy also benefited John in daily activities, increasing the quality of his performance.

Self-report questionnaires of 192 asthmatic children, in Brzęk's et al. (2019) survey, described improvement in symptom management, following regular exercise, result also observed in John, after increasing physical activity outside home. Results showed that posture and asthma outcome is influenced by physical activity, contributing to the positioning of the thoracic cage in the Vertebral Column (thoracic kyphosis depth factor). Both in Brzęk et al. (2019) research and in this Case Study, injuries of the musculoskeletal injuries that may affect posture and respiratory function were not listed. Research supports that body posture varies according to individual habits, affecting breathing pattern of the chest, abdomen, or a combination thereof (Pelletier et al., 2015; Gasser et al., 2013).

In relieving asthma symptoms, bronchodilators are an important factor, opening blocked airways to facilitate breathing. Excessive use, however, degrades drug effectiveness, increases the occurrence of bronchospasm and breath shortness. Therefore, appropriate dosage intake and not blind use is strongly recommended. Bronchodilator overuse occurs frequently in patients diagnosed with asthma, often encouraged from the close social circle; friends, colleagues or family members. Drug intake, not prescribed by a pulmonologist, happens to relieve asthma symptoms, such as dyspnea from a stressful situation; to increase lung capacity and endurance, during or after vigorous activity; or even as a preventive application for avoiding respiratory congestion (Boyd et al., 2004; Pratt, 1982). In John's case, it is needed investigation, whether there was misuse of bronchodilators and a medical diagnosis sought afterwards, due to parental stress; or whether the use of medication had been discussed with the physician; as well as whether drug usage determined the asthma outcome. This questioning shall be discussed further, because pre- and post-treatment spirometry showed an apparent percentage improvement, yet the values were close to John's medical records from previous hospital admissions.

6. Conclusion

The aim of this report was to highlight the contribution of Respiratory Physical Therapy in improving pulmonary ventilation quality of patients with Childhood Bronchial Asthma. Physiotherapy intervention combined with medication can reduce symptoms disease and also increase Quality of Life and daily activity.

John, the boy who participated in the research, showed significant improvement in asthma symptom control, through the 8-week Respiratory Physical Therapy intervention, while also increasing endurance for moderate to vigorous activity such as walking, running, climbing stairs or participating in games with his peers. Our research process concerns the study of a single case incident; therefore, the possibility of bias from the results cannot be omitted. Further research is recommended, on the therapeutic effect of diaphragmatic breathing pattern training, in a larger children population sample, to draw valid conclusions about Childhood Bronchial Asthma.

Suggestions for Respiratory Physical Therapy application

Reviewing literature and taking into account the intervention and results of this case study, we quote suggestions to improve Respiratory Physical Therapy, for patients with Childhood Bronchial Asthma:

- It is necessary to explain from the beginning that Respiratory Physical Therapy does not replace, but increases medication effectiveness. Similarly, drugs do not replace the benefit provided by Respiratory Physical Therapy, as the latter focuses on techniques for self-management of breathing capacity by the patient; rather than on the pharmacological mechanisms that relieve asthma symptoms.

- Diaphragmatic breathing retraining, combined with respiratory exercises, can modify the breathing pattern from thoracic to abdominal, improving the quality of pulmonary ventilation.
- It is necessary to continuously ensure the interest of child patients, to adhere to the rehabilitation plan and to the successful outcome of the treatment. Playing games increases the degree of fun derived from rehabilitation.
- Personalized exercise contributes to learning how to apply respiratory rehabilitation, to achieve optimal cooperation with the Physiotherapist and self-treatment at home.
- Implementing Breathing exercises at home by the patient, increase Respiratory Physical Therapy effectiveness while dealing actively with the rehabilitation plan, also reducing the time of clinical condition manifestation.
- Following therapeutic guidelines after the rehabilitation program comes to a closure is essential, as it contributes by increasing the time until recurrence of Bronchial Asthma symptoms reoccurs.

Declarations

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Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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