Respiratory intervention in children 7-14 years old with autism spectrum disorder, attention-deficit/hyperactivity disorder and down syndrome in special schools in Central Macedonia- Hellas

Respiratory disorders are more likely in children with Autism Spectrum Disorder (ASD), Attention-deficit/hyperactivity disorder (ADHD) and Down syndrome compared to the general population. Children with specific disorders or syndrome often experience bronchitis, bronchial asthma, bronchiectasis, and comorbidity, such as cystic fibrosis. The purpose of this research was to evaluate respiratory physiotherapy techniques for children aged 7-14 years with autism, Down Syndrome, ADHD, and ASDA. Five months of interventions took place in 90 children with ASD, Down Syndrome, ADHD and ADHD/ASD in order to show the beneficial contribution of respiratory physiotherapy. The 90 children were placed in an intervention group (n = 54) and a control group (v = 34). The mean age of the sample was 10.8 years (s.d= 2.3). The intervention program took place three days a week for 5 months. Every month, (1) Somatometric Stability Testing, (2) Oximetry Testing and (3) Spirometer Testing were recorded. The results showed that both spirometry and oximetry produced significant improvement of the children in the intervention group compared to the control group. A detailed analysis of oximetry measurements showed that the intervention brought a significant improvement in saturation and pulses in the group of children with ASD (p <0.05), ADHD (p <0.05), ASD / ADHD (p <0.05) and Down syndrome (p <0.05). Similarly, the intervention was observed to significantly improve FVC, FVC / pred, FEV1, PEF, PEF / Pred and FEF2575 in the group of children with ASD (p <0.05), ADHD (p <0.05), ASD / ADHD (p <0.05) and Down syndrome (p <0.05). The evidence that emerges from the findings of this research is a strong incentive to continue the effort of investigating the usefulness of respiratory physiotherapy in children suffering from Down Syndrome, ADHD, ASDA.

Keywords: Breathing, physiotherapy, autism spectrum disorder, attention-deficit/hyperactivity disorder, down syndrome.

INTRODUCTION

Respiratory physiotherapy is a form of physiotherapy that aims to mobilize and remove secretions from a patient's airways. It is a treatment that is applied to patients with respiratory dysfunction, with chronic lung diseases such as cystic fibrosis, bronchitis etc (Hristara - Papadopoulou et al., 2008). It includes a set of techniques that are applied to
Physiotherapeutic respiratory techniques are integral aspects of children’s daily routines, as they help eliminate secretions and mucous membranes, thus improving airways and lung function. These techniques aim to relax respiratory muscles, maintain controlled breathing, avoid controlled cough, and perform breathing exercises. Physiotherapeutic breathing techniques or exercises should be adapted to the needs and age of each patient and are suitable for children with respiratory problems (JaniChaitisi et al., 2014).

Children with conditions such as ASD and ADHD are likely to experience problems associated with lung function and respiratory dysfunction, which affect their mental health and behavior (Mody and Belliveau, 2013; Guy et al., 2014; Hussein, 2017; Dalthro et al., 2016; Deger et al., 2017). Respiratory disorders are more likely in children with ADHD, ASD, and Down syndrome compared to the general population. Children with these disorders or syndromes often develop colitis, bronchitis, bronchial asthma, bronchiectasis, and co-morbidities such as cystic fibrosis. These are diseases caused by ineffective lung function, causing immune system dysfunction and a tendency for infections, mainly caused by changes in cytokine levels (Becker et al., 2010; Zheng et al., 2016). Children with Down Syndrome have the physical characteristics of hypotension, ligament laxity, and reduced muscle strength. Over the years, deterioration and musculoskeletal abnormalities affecting muscle strength can also cause problems (Reis and Ladjewig, 2013). In addition, people with Down Syndrome are prone to respiratory complications due to obstruction of the upper airways, lower airway diseases, pulmonary hypertension, pulmonary hypoplasia, congenital heart disease, obstructive apnea, hypnosis, obstructive sleep apnea; aggravated by the general weakness of the trunk and limb muscles (Biasoli and Machado, 2006). The above problems, identified in Down syndrome children, are the causes of respiratory dysfunction.

Respiratory physiotherapy can be applied to people with some disorders, such as ASD, Down Syndrome, and ADHD. According to the existing literature, respiratory physiotherapy is beneficial for children with autism ASD, which often exhibit cardiac sub-function and respiratory arrhythmia (Ming et al., 2016; Yang et al., 2015) and contributes to both improving motor skills and in the reinforcement of breathing muscles in children with Down syndrome (Deger et al., 2017; Hussein, 2017). In addition, patients with Down syndrome are capable of achieving clearance of airway mucus through respiratory physiotherapy and therefore, patients are not subjected to surgical treatment of airway obstruction (Doshi and Krawiec, 2007). Finally, from the existing literature, respiratory physiotherapy techniques contribute to improvement of the mental health and respiratory function of children with ADHD (Dalthro et al., 2016; Lange et al., 2014). Studies have concluded that children with ASD, Down Syndrome, and ADHD have less respiratory muscle strength than healthy children and were more likely to develop respiratory infections. The researchers also stated that in children with these disorders, the application of respiratory physiotherapy would help both in improving motor skills and in strengthening the breathing muscles. Therefore, respiratory physiotherapy contributes more to improved respiratory function in children with these syndromes than to muscle strengthening exercises.

The literature review revealed that the number of empirical studies which focused on respiratory physiotherapy and the control of its effects on children with ASD, ADHD, ASD and ADHD and Down Syndrome are limited. Additionally, it was observed that previous studies focused on children who had only one of the specific disorders. Furthermore, there was no previous empirical study investigating the effectiveness of respiratory physiotherapy for students with specific disorders in Greece. The research questions of the study are as follows:

1. What is the contribution of respiratory physiotherapy to preventing or reducing the impact of respiratory infections?
2. Is there an improvement in somatometric characteristics, oxygenation, heart rate, and spirometry through respiratory physiotherapy?
3. Does respiratory performance improve through specific techniques for any disorder or syndrome?

**Purpose**

The aim of the present study was to evaluate the respiratory physiotherapy techniques applied to children aged 7 to 14 years with ASD, Down Syndrome, ADHD, ASD/ADHD. In addition, a significant novelty of the research is that it was carried out in special schools and was not limited to the study of children with a single disorder.

**MATERIALS AND METHODS**

**MATERIALS**

In the survey, 90 children (56 in the intervention group and 34 in the control group) participated from five different schools in Northern Greece. The separation of children in the two groups was done randomly using group sampling techniques. The selection of the sample in the context of this research was based on the following criteria: (1) Mentally: children with low index of intelligence were selected; and (2) Behaviorally: children were selected that did not show intense aggression, intense laxity and intense hyperactivity. The distribution of children in both groups for the condition is given in Table 1. It should be noted that...
the mean age of the sample was 10.8 years (standard deviation 2.3 years), but it was slightly lower for the control group at 10.6 years (standard deviation 2.3 years) and for the intervention group it was 11 years (standard deviation 2.2 years). The children were divided into two groups based on their degree of communication and interaction. It should be noted here that throughout the sample there were cases of children with several communication disorders and therefore, it was not possible to split them equally into the two groups. For this reason, the separation was based on qualitative criteria (communicability) rather than quantitative criteria (number of children in each group). The purpose of this separation was to have both children with communication difficulties and no communication difficulties in both groups.

METHODS

There were 34 children in the control group, a physiotherapy intervention program outside the school was not systematically implemented. Also, children who participated in the control group did not show any visible signs of respiratory infection during the measurements. The control team applied in a 30-minute exercise program three times a week, a classical exercise program using a trampoline, static bike, walkway, cone or ring games and sports such as basketball and soccer. A total of 56 children participated in the intervention group, did not show any visible signs of respiratory infection and during the measurements did not participate in any systematic intervention program outside the school. Three-weekly intervention program of respiratory physiotherapy for 30 minutes was applied to the intervention group. The physiotherapist, the educator, the physical education teacher, the occupational therapist, the speech therapist, the psychologist and the social worker of the school units collaborated to apply this program. The physiotherapist received the equipment used during the intervention program, the active breathing cycle was resumed, assisted exertion was performed, which was applied with pressures, shocks and vibrations lasting 5 minutes per iteration with a 2-minute break. Finally, the Pulmo Gain exerciser was used for 5 minutes. On the third day of the intervention week, the children were educated individually and in groups by inflating balloons, blowing napkins, whistling using a whistle or flute, making soap bubbles or bubbles with a straw in water and practicing with specialized toys for breathing exercise. It should be noted that each child received the equipment used during the intervention program. The assessment of respiratory physiotherapy in children is based on a variety of criteria, and was done by a qualified blind physiotherapist and by a blind assessor physiotherapist. For practical reasons, the assessment tests selected in the present study were: (1) Somatometric Stability Testing, (2) Oximetry Testing and (3) Spirometer Testing. The somatometric measures examined in this study include the leaf, height, weight, perimeter of the abdomen and armpit. The oximeter was used to record cardiac pulses and O₂ saturation. The oximeter was used to record blood saturation in oxygen. The spirometer was used to record FVC, FVC / Pred, FEV₁, FEV₁ / Pred, PEF, PEF / Pred, FEV₁%, FEV₁ / Pred, FEF2575, FEF2575 / FEF25, and FEF75. The intervention program lasted 5 months and after the completion of the intervention program, the intervention team and the control group were re-examined and evaluated. In particular, once a month, the height of each child was checked and weight control with an electronic precision balance was recorded. Also, oximetry was performed every month using the Noninoximeter to control O₂ saturation and cardiac pulses. In addition, spirometry was performed at the end of each month to control the above-mentioned sizes.

Statistical Methods

Data analysis was performed in SPSS version 25. A mixed 2x2 variance analysis for comparison between groups (comparison of the intervention and control group) and comparisons within the groups (comparisons between the 5 time points) was used. In addition, interaction conditions were included to investigate whether the behavior of the respiratory function improved significantly over time in the intervention group as compared to the control group. In addition, a control group was compared with each subgroup of the intervention group (ASD, ADHD, Down, ASD/ADHD, DOWN).
Table 2. Gender and age distribution among two groups

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<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>Intervention</th>
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<tr>
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</tr>
<tr>
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<tr>
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<td>26.5%</td>
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<tr>
<td>Age</td>
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<tr>
<td>Mean ±SD</td>
<td>10.6 ±2.32</td>
<td>10.95± 2.22</td>
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Figure 1. Saturation and pulse outcomes of children with ASD in the control group and the intervention group

RESULTS

Demographics

The mean age of children in the control group was 10.6 years (SD=2.32) while the mean age of children in the intervention group was 10.9 years (SD=2.22) (Table 2). The mean age in both groups was equivalent, t(88)=−1.013, p=.314. Moreover, majority of the children in the control group (n=25, 73.5%) and the intervention group (n=40, 71.4%) were boys. Gender distribution in the two groups can be considered equivalent, χ²(1)=0.047, p=.829.

Oximetry results

The results for pulse and saturation measurements for the five months of intervention, both in the control group and in the intervention group for children with ASD, ADHD, ASD / ADHD and Down syndrome are presented in Figures 1-4, respectively. As shown in Figures 1 for children with ASD, the pulses of individuals in the intervention group are about 20% less, and there is a clear tendency to increase the difference over time as the difference in February is about 12 points, while in June it approaches 30 points. It is noteworthy that on average, the difference approaches 23 points in the two groups. Similarly, saturation levels in the intervention group are significantly higher than the control group, as on average there is a difference of 10%. The ANOVA analysis showed that there is a significant interaction of time and group of children with ADF both in saturation, F = 10.981, p < .05 and pulses, F = 11.886, p < .05.

Figures 2 shows that for children with ADHD in the intervention group, there is a significant reduction of pulses over time while there is a significant increase in saturation. The ANOVA analysis showed that there is a significant interaction of time and group of children with ADHD both in saturation, F = 21.345, p < .05 and pulses, F = 19.766, p < .05. From Figures 3, there is a significant reduction in pulses for children with ADHD / ADHD in the intervention team and a significant increase in saturation over time. The
Figure 2. Saturation and pulse outcomes of children with ADHD in the control group and the intervention group

Figure 3. Saturation and pulse outcomes of children with ASD/ADHD in the control group and the intervention group

Figure 4. Saturation and pulse outcomes of children with DOWN syndrome in the control and intervention group
ANOVA analysis showed that there is a significant interaction of time and group of children with ADHD / ADHD both in saturation, $F = 18.892$, $p < 0.05$ and pulses, $F = 23.451$, $p < 0.05$. Finally, the findings from Figures 4, show that children with DOWN syndrome in the intervention group also have a significant reduction in pulses and a significant increase in saturation over time. The ANOVA analysis showed that there was significant interaction of time and group of children with DOWN syndrome both in saturation, $F = 17.676$, $p < 0.05$ and pulses, $F = 19.992$, $p < 0.05$.

**Spirometry results**

Figure 5 shows that there is a significant increase in FVC for children with ASD in the intervention group for FVC, $F = 19.991$, $p < 0.05$, FVC / pre; $F = 18.751$, $p < 0.05$ of FEV1; $F = 18.981$, $p < 0.05$ of PEF; $F = 22.344$, $p < 0.05$ of PEF / Pred; $F = 20.911$, $p < 0.05$ and FEF2575; $F = 18.645$, $p < 0.05$.

Figure 6 shows that for children with ADHD in the
Figure 6. Spirometry results for children with ADHD in the control group and the intervention group.

Intervention group: there is a significant increase in FVC; $F = 18.089, p < 0.05$, FVC / pre; $F = 21.022, p < 0.05$ of FEV1; $F = 17.912, p < 0.05$ of PEF; $F = 19.133, p < 0.05$ of PEF / Pred; $F = 17.615, p < 0.05$ and FEF2575; $F = 19.812, p < 0.05$.

Figure 7 indicates that there is a significant increase in FVC for children with ASD / ADHD in the intervention team for FVC; $F = 21.066, p < 0.05$, FVC / pre; $F = 19.133, p < 0.05$ of PEF / Pred; $F = 16.991, p < 0.05$ and FEF2575; $F = 16.993, p < 0.05$.

Figures 7 indicates that there is a significant increase in FVC for children with ASD / ADHD in the intervention team for FVC; $F = 18.011, p < 0.05$, FVC / pre; $F = 19.901, p < 0.05$ of FEV1; $F = 21.345, p < 0.05$ of PEF / Pred; $F = 17.889, p < 0.05$ and FEF2575; $F = 17.651, p < 0.05$.

Figure 8 indicates that for Down syndrome children in the intervention group, there is a significant increase in FVC; $F = 18.011, p < 0.05$, FVC / pre; $F = 19.901, p < 0.05$ of FEV1; $F = 21.345, p < 0.05$ of PEF / Pred; $F = 17.889, p < 0.05$ and FEF2575; $F = 17.651, p < 0.05$. 
DISCUSSION

Respiratory disorders are more likely in children with ASD, ADHD and Down syndrome compared to the general population. Children with specific disorders or syndrome often experience bronchitis, bronchial asthma, bronchiectasis, and comorbidity, such as cystic fibrosis. Through the five-month intervention in children with the above diseases, an attempt was made to show how beneficial respiratory physiotherapy is. In general, it should be noted that both the results of spirometry and oximetry showed that the results appear to be beneficial in all cases of these diseases. More specifically, children with ASD and those with other disorders found a significant difference in

Figure 7. Spirometry results for children with ASD/ADHD in the control group and the intervention group
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Figure 8. Spirometry results for children with Down syndrome in the control group and the intervention group compared to the control group in terms of their pulse drop, which in all cases was in the order of 20%. The results about the positive effect of respiratory physiotherapy augment the conviction of modern scientific research around the beneficial effects of respiratory physiotherapy in both children with autism (Guy et al., 2014), Down syndrome (Deger et al., 2017), and ADHD (Dalto et al., 2016). In addition, saturation reached almost 100 in the intervention group, when the control group clearly ranged at lower levels. With regard to the results obtained from the measurements made with the spirometer, there were significant differences between the individuals who participated in the intervention group and those who
participated in the control group. All measurements showed an improvement in all measured sizes in all conditions, except FEV1% and FEV1% / pred measurements, which showed a higher value for the control group, indicating that the subjects in the intervention group have also improved significantly in this field. What should be noted is that students with Down syndrome have shown a relative lag in improving their performance in relation to students with other conditions, which could be interpreted as an indication of longer time intervention in these people, so that safer conclusions can be drawn. These findings confirm the results obtained in other studies that most children with autism and Down syndrome who experience respiratory dysfunction benefit greatly after respiratory physiotherapy (Ming et al., 2016; Yang et al., 2015; Deger et al., 2017).

CONCLUSION

Respiratory disorders are more likely in children with ADHD, ADHD and Down syndrome than in the general population. Children with these disorders or syndrome often develop colitis, bronchitis, bronchial asthma, bronchiectasis, and co-morbidities such as cystic fibrosis. Through the five-month intervention in children with the above conditions, an attempt was made to demonstrate the effectiveness of respiratory physiotherapy. In general, it should be noted that both the results of spirometry and oximetry appear to be beneficial in all cases of the particular conditions. More specifically, in children with ASD as well as in those suffering from other diseases, a significant difference was found in those in the intervention group compared to those in the control group regarding their heart rate decrease, which in all cases was around 20%. In addition, the saturation reached nearly 100 in the intervention group, while the control group was clearly at lower levels.

Concerning the results obtained from the measurements made with the spirometer, again it should be noted that there were significant differences between the subjects in the intervention group and those in the control group. All measurements showed an improvement in all measured values across all conditions, except FEV1% and FEV1% / pred, which showed a higher value for the control group, indicating that the intervention group also improved significantly in this area. It should be noted that people with Down Syndrome have shown a relative lag in performance improvement compared to people with Down Syndrome, which could be interpreted as an indication for longer-term intervention in these people, in order to draw safer conclusions.

It should also be noted that an attempt was made to test the effects of the gender of those in the intervention group who were suffering from the same disease. It should be noted that no statistically significant differences were found in the results of oximetry in any condition. However, in the spirometry results, boys with ASD and ADHD had lower levels of improvement compared to girls in the sample. This result should be given a special basis, as the relevant literature on this issue is not explicitly mentioned in this result. With regard to the views of responsible teachers on the impact they have on the general behavior of children of such interventions, it should be noted that teachers find significant improvements mainly in the level of children's mobility and social behavior. More analytically, as might be expected, individuals with both ADI and ADHD recorded the least encouraging results in terms of their social and motor behavior. On the other hand, the most significant improvements were seen in people with ADHD and Down syndrome, compared to people with ADHD and ADHD / ADHD. Respiratory physiotherapy has also been shown to contribute to the prevention and reduction of the effects of respiratory infections. Through personal observation and evaluation, no differences were found between students' preferences for breathing exercises and tests. Finally, all of the above conclusions prove the wider benefits of respiratory physiotherapy for the community and the state; through better socialization and integration of these people and, of course, the reduction of government spending on inpatient and outpatient care.

In any case, research in this field should continue and overcome any obstacles that have arisen in the course of this research, which should be noted as the size of the sample and the timing of the intervention. However, the evidence from the findings of this research is a strong incentive for the continued investigation of the usefulness of respiratory physiotherapy in children with chronic illnesses, so that they may be able to reap all the likely benefits.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

REFERENCES

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