International Journal for Multidisciplinary Research (IJFMR)

E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Influence of Respiratory Muscle Training and Balance Exercise in Children with Cerebral Palsy: A Randomized Controlled Trial

Dr. Minhaj Tahir[1], Dr. Manjit Kumar[2]

[1,2]Assistant Professors, Dept of Physiotherapy, Rama University, Kanpur, India

ABSTRACT

The study's objective was to ascertain the effects of inspiratory muscle and balance training on children with hemiplegic cerebral palsy's (CP) pulmonary function, respiratory muscle strength (RMS), functional ability, and balance.

CONTENT AND METHODOLOGY:

This study comprised 30 kids with hemiplegic CP (Gross Motor Function Classification System I-II). The training group's programme (n = 15) contained inspiratory muscle training (IMT) in addition to CPRP for 8 weeks, whereas the control group's programme (n = 15) featured traditional physiotherapy rehabilitation programme (CPRP) that included balance exercises.

RESULTS:

The six-minute walk test (6MWT), RMS measurement, balance tests, and lung function tests served as the outcome measures. Pneumatic function, balance, and 6MWT distance score changes did not differ significantly between groups ($p > .05$), however the training group's maximum inspiratory and expiratory pressures increased even more ($p > .05$).

CONCLUSION:

The rehabilitative strategy for children with CP will benefit considerably from RMS assessment, the identification of kids who require it, and adding IMT to CPRP.

INTRODUCTION:

The term "cerebral palsy" (CP) refers to a set of illnesses characterised by aberrant muscle tone, movement, and posture that resulted from brain injury in the womb, at delivery, or in the early postnatal period.[1] Children with cerebral palsy experience issues with posture, mobility, postural control, and balance as a result of damage to the central nervous system, which also affects the musculoskeletal, neurological, and sensory systems. Cognitive, perceptional, sensory, and behavioral issues are frequently present in conjunction with CP's motor difficulties, as well as secondary musculoskeletal issues, epilepsy, and related impairments (such as vision or hearing loss, intellectual incapacity, or oral-motor issues).[2] Postural control is one of the most significant issues in children with CP.

For children with CP, maintaining the postural control required for performing daily activities is frequently a great challenge. Children with CP who struggle with balance-requiring gross motor tasks like reaching or walking may experience issues due to the compromised postural control.[3, 4] Due to the clinical significance of motor dysfunction in CP, most treatment strategies concentrate on enhancing motor function and physical capacity.[5] However, in addition to the motor issues, children with CP also run the risk of pulmonary abnormalities.

A number of factors, including deformities of the spine and chest wall, reduced airway clearance, repeated aspiration, a poor cough mechanism, and nutritional condition, affect respiratory status in CP.[6] Respiratory issues, which are common in CP, contribute to increased morbidity and death. Children with CP may exhibit abnormal pulmonary function, such as poor airway clearance, weak respiratory muscles, and limited chest motion[.7, 8] When compared to children who are usually developing, children with cerebral palsy (CP) have lower pulmonary function, according to previous research.[9] In a few small trials, children with CP also had respiratory muscle weakness.[10, 11]

Children with cerebral palsy have lower respiratory muscle strength and more severe motor function, which are correlated.[8,12] Children with diplegic CP had weaker respiratory muscles than children with hemiplegic CP. IMT is frequently utilized to enhance lung function and respiratory muscle strength in a variety of conditions. Balance and respiratory muscle strength have been linked in several studies, and IMT has been shown to enhance balance in a variety of conditions.[13-16] To the best of our knowledge, three studies have looked at the results of respiratory muscle training in CP kids using various tools and methods.[17]

When the relationship between the strength of the respiratory muscles and balance is taken into account, improving balance can be accomplished via IMT. On the basis of this data, it is hypothesised that IMT may help children with hemiplegic CP balance and postural stability. In order to evaluate the effects of IMT and balance training on pulmonary function, respiratory muscle strength, functional capacity, postural control, and balance in kids with hemiplegic CP, this study looked at a number of different variables.

MATERIALS AND METHODS

For a period of 8 weeks, this prospective investigation was carried out as a randomized-controlled trial with a pretest/posttest design. The research was carried out in compliance with Rama University's approved guidelines. All parents provided their consents in writing and with full knowledge.

SUBJECT AND ENVIRONMENT

In order to participate in this study, 245 people with CP were screened. The inclusion criteria were being identified by a child neurology specialist as having hemiplegic CP (one side of the body is afflicted, addressed at the levels of "body function and structure" according to ICF), aged 7 to 16 years old, classed as Gross Motor Function Classification System. (GMFCS) level I or level II (was used to define the key points “activity and participation” according to ICF19) and having sufficient communication skills for understanding of spoken or written language. The exclusion criteria were orthopedic surgery and/or botulinum toxin – an injection in the lower extremity within the past 6 months, severe convulsions that could not be controlled by drugs.

SAMPLE SIZE

6MWT variable, which had the highest standard deviation of all the variables in our investigation, the sample size was determined. An increase of 66 m was attained in 6MWT of children with CP (500 60 m) with IMT, resulting in an effect size of 1.1. According to our calculations, each group needs at least 15 participants in order to detect an improvement in the 6MWT with IMT with a 95% confidence level and an 80% power (1-) in our study.

MEASURES OF EVALUATION AND RESULTS:

DEMOGRAPHIC INFORMATION

The children's age, sex, topographic classification (right or left affected side), birth weight, type of birth, gestational age, auxiliary equipment use (if any), and medication use (if any) were all noted along with their demographic and clinical data. By calculating the body mass index (BMI) for each child, the height and weight were recorded. The GMFCS was used to determine the children's gross motor function levels. The same researcher assessed all of the kids in both groups before treatment and after the 8-week physiotherapy programme on both groups of kids.

BALANCE AND POSTURAL STABILITY

To measure balance and postural stability, the Biodex Balance System was employed.[18] A support handle, a display, a printer, and a platform with either static or dynamic modes (12 levels) make up the BBS. Before the assessment, all of the kids in both groups received a description of the test procedures. The Postural Stability Test (PST), Limits of Stability Test (LoST), and Test of Sensory Integration and Balance (TSIB) were the three BBS tests that were administered to the kids.

THE SIX-MINUTE WALK TEST (6MWT)

The Biodex Balance System (BBS; Biodex Medical Systems, Shirley, NY, USA) was used as a valid and a reliable device to quantify balance and postural stability. The BBS consists of a support handle, a display, a printer and a platform, which has a static mode or dynamic modes (12 levels). Descriptive information about the test steps were given to all children in both groups before the evaluation. Children underwent three tests for BBS: the Postural Stability Test (PST), Limits of Stability Test (LoST), and the Test of Sensory Integration and Balance (TSIB). Prior to the test, the kids relaxed in a chair not far from the starting position for 10 minutes. Blood pressure, oxygen saturation, and heart rate were then recorded both during this time and right after the test was finished. The Modified Borg Scale was used to assess levels of dyspnea and fatigue both before and after the test. The distance in metres was noted after six minutes. The test was conducted during the school day with the kids wearing orthotics when necessary.
PFTs were carried out using a COSMED Pony FX (COSMED; Italy) spirometer in accordance with the recommendations of the American Thoracic Society (ATS) and European Respiratory Society (ERS).[19] Peak expiratory flow (PEF), forced vital capacity (FVC), forced expiratory volume at 1 second (FEV1), and FEV1/FVC were all measured and represented as a percentage of the anticipated values. Each youngster was informed the manoeuvre before the exam, and a visual demonstration of it was also given. Before the test, the kids took a 10-minute break, and the best score from the three tests was accepted as the outcome. The child's unaffected hand was used to hold the device throughout the test.

ASSESSMENT OF RESPIRATORY MUSCLE STRENGTH

The ATS/ERS criteria22 were followed for measuring respiratory muscle strength using a portable, electronic pressure transducer (MicroRPM, Micro Medical, UK) with a stiff, plastic, flanged mouthpiece. After maximum inspiration and maximal expiration, respectively, the maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) were measured. The physical therapist described the manoeuvre to each child and gave them a visual demonstration before the measurement. During the evaluation, the kid held the device in their unaffected hand. Children in both groups of this study had their respiratory muscle strength assessed once a week. The most effective rating among the three

STATISTICAL ANALYSIS

Quantitative data are shown as means with standard deviations, whereas qualitative variables are shown as percentages. The SPSS V.20 programme (SPSS Inc., USA) was used to perform the statistical analyses. For the purpose of determining whether the data had a normal distribution, the Kolmogorov-Smirnov test was applied. Using the chi-square test, qualitative data from the two groups' analysis was evaluated. The comparison of pre- and posttest conditions within each group was done using the paired sample t-test. To examine group differences for the outcomes of the BBS, 6MWT, PFT, and respiratory muscular strength, independent samples t-tests were used. For all analyses, p .05 was considered as the significant level. Cohen's d results are 0.8 and represent the effect size (Cohen's d) and 95% confidence interval (lower and upper).

RESULTS:

225 individuals with CP diagnoses were screened for this study (Figure 1). Only 38 of the screened participants had hemiplegic CP, and of the 36 kids who met the inclusion and exclusion requirements, 30 (16 girls and 14 boys) agreed to participate, be randomly assigned, and be evaluated. Table 1 presents the demographic and clinical traits of the two groups, along with comparisons between them. Regarding the children's baseline characteristics, there was no statistically significant difference between the two groups (p >.05). When the mothers of the participants' children were examined during their pregnancies, it was discovered that all of the children were born through spontaneous pregnancies, and none of the moms had used assisted reproductive technologies. There were no discernible differences between the groups (p >.05); however, five children in the CPRP+IMT group and three children in the CPRP group both regularly used anticonvulsant medications.

The intervention programmes had no negative effects on either group during the trial, and the training sessions were highly received. The lung function, respiratory muscle strength, and functional capacity of the two groups' pre- and post-training values, as well as the training's effects, are all significantly different. In terms of lung function, respiratory muscle strength, functional capacity, postural stability, and balance evaluations, there was no difference between them at the start of the trial. The FVC (% predicted), FEV1 (% predicted), and FEV1/FCV% values did not differ substantially between the two groups (p >.05), but the MIP, MEP, PEF (% predicted), and 6MWT values did (p .001). The CPRP +IMT group considerably outperformed the CPRP group in terms of improvements to MIP and MEP values (p .001). Cohen's d values for the effect sizes in MIP and MEP were quite high (3.154 and 2.714, respectively).[20] After the treatment, there were no discernible variations in the PFT and 6MWT findings between the groups (p >.05).

Both groups' pre- and post-training postural stability and balance evaluation results, as well as the effects of the treatment, are clear. With the exception of the post-training postural stability and balance values for the TSIB subgroups "eyes closed firm surface" and "eyes closed foam surface," both groups showed a considerable improvement. Regarding postural stability and balance changes following therapy, there were no statistically significant differences between the two groups.

DISCUSSION:

This study examined the effects of IMT and balance training on pulmonary function, respiratory muscle strength, functional ability, and balance in children with hemiplegic CP.

This is the first study that we are aware of that looked at how balance and IMT training affected balance and postural control in children with CP. This study's most significant discovery was that IMT increased the respiratory muscles' strength in kids with hemiplegic CP. Both groups saw improvements in their respiratory muscle strength, functional capacity, postural stability, and balance following the treatment, but there were no discernible variations in their pulmonary function (aside from PEF). PFT, functional capacity, postural control, and balance parameters did not significantly change between the two groups, however MIP and MEP values considerably increased in favor of the CPRP+IMT group.

The primary factor in both morbidity and mortality in CP is respiratory problems. The majority of rehabilitation strategies, however, are concentrated on enhancing motor function and maintaining current physical capacity because the limitation of functional activities brought on by motor dysfunction and the secondary problems linked to the musculoskeletal system are frequent in patients with CP. Clinical symptoms that hinder daily physical activity and stop the development of motor function in CP include poor air clearance, decreased chest wall mobility, and inadequate respiratory muscle function. Studies have shown that children with CP have weaker respiratory muscles than children with normal development, and they also have worse respiratory function.[21] The timing of the contraction of the trunk muscles during the movement of the extremities is correlated with the activation of the respiratory muscles; the regulation of the trunk and the extremities may include interaction with the diaphragm, which is the primary respiratory muscle. Reduced core stability, a prerequisite for good balance and ambulation, may result from impaired respiratory muscle activation.

People with chronic obstructive pulmonary disease have been shown to have less control of mediolateral stability and a higher risk of falling.[22] IMT has been shown to improve movement and balance in people with heart failure, multiple sclerosis, and neuromuscular diseases, according to a number of studies.[23] In this work, we tested the hypothesis that IMT strengthens the scalene muscles and diaphragm, enhancing thoracic stability and enhancing balance and postural control. We are aware of only one study that examined the impact of IMT for six weeks on postural control in CP children. The researchers found that IMT enhanced trunk control, with the exception of static sitting balance, which was measured using the Trunk Control Measurements Scale.

CONCLUSION:

In this study, it was discovered that children with hemiplegic CP had respiratory muscle impairment. The outcomes of this experiment show that IMT training combined with a CPRP may be a secure and beneficial way to increase the respiratory muscle strength in children with CP. Studies on various IMT approaches are required because it is unclear how IMT affects pulmonary function in children with CP. Balance exercises based on NDT can help CP children with their balance and postural control. PEF, respiratory muscle strength, functional capacity, balance, and postural control scores all increased in all children, demonstrating the significant effects balancing training had on these metrics. The association between IMT and particular aspects of balance and postural control in children with CP, such as posture, spasticity, and peripheral muscular strength, has to be further researched.

REFERENCES:

1. Cans C. Surveillance of cerebral palsy in Europe: a collaboration of cerebral palsy surveys and registers. Dev Med Child Neurol. 2000;42(12):816–24. doi:10.1111/j.1469-8749.2000.tb00695.x.
2. Colver A, Fairhurst C, Pharoah PO. Cerebral palsy. Lancet. 2014;383(9924):1240–49. doi:10.1016/S0140-6736(13)61835-8.
3. Woollacott MH, Shumway-cook A. Postural dysfunction during standing and walking in children with cerebral palsy: what are the underlying problems and what new therapies might improve balance? Neural Plast. 2005;12(2–3):211–72. doi:10.1155/NP.2005.211
4. Van Der Heide JC, Begeer C, Fock JM, Otten B, Stremmelaar E, Van Eykern LA, Hadders-Algra M. Postural control during reaching in preterm children with cerebral palsy. Dev Med Child Neurol. 2004;46(4):253–66. doi:10.1017/s0012162204000416.
5. Kwon YH, Lee HY. Differences in respiratory pressure and pulmonary function among children with spastic diplegic and hemiplegic cerebral palsy in comparison with normal controls. J Phys Ther Sci. 2015;27(2):401–03. doi:10.1589/jpts.27.401.
6. Boel L, Pernet K, Toussaint M, Ides K, Leemans G, Haan J, Van Hoorenbecek K, Verhulst S. Respiratory morbidity in children with cerebral palsy: an overview. Dev Med Child Neurol. 2019;91 (6):646–53. doi:10.1111/dmcn.14060.
7. Ersöz M, Selçuk B, Gündüz R, Kurtaran A, Akyüz M. Decreased chest mobility in children with spastic cerebral palsy. Turk J Pediatr. 2006;48:344–50.
8. Kwon YH, Lee HY. Differences of respiratory function according to level of the gross motor function classification system in children with cerebral palsy. J Phys Ther Sci. 2014;26(3):389–91. doi:10.1589/jpts.26.389.
9. with spastic diplegic and hemiplegic cerebral palsy, compared with normally developed children. J Pediatr Rehabil Med. 2013;6 (2):113–17. doi:10.3233/PRM-130246.
10. Keles MN, Elbasan B, Apaydin U, Aribas Z, Bakirtas A, Kokturk N. Effects of inspiratory muscle training in children with cerebral palsy: a randomized controlled trial. Braz J Phys Ther. 2018;22 (6):493–501. doi:10.1016/j.bjpt.2018.03.010.
11. Lee HY, Cha YJ, Kim K. The effect of feedback respiratory training on pulmonary function of children with cerebral palsy: a randomized controlled preliminary report. Clin Rehabil. 2014;28(10):965–71. doi:10.1177/0269215513494876.
12. Lee HY, Kim K. Can walking ability enhance the effectiveness of breathing exercise in children with spastic cerebral palsy? J Phys Ther Sci. 2014;26(4):539–42. doi:10.1589/jpts.26.539.
13. Bosnak-Guclu M, Arikan H, Savci S, Inal-Ince D, Tulumen E, Aytemir K, Tokgözoglu L. Effects of inspiratory muscle training in patients with heart failure. Respir Med. 2011;105(11):1671–81. doi:10.1016/j.rmed.2011.05.001.
14. Oh D, Kim G, Lee W, Shin MM. Effects of inspiratory muscle training on balance ability and abdominal muscle thickness in chronic stroke patients. J Phys Ther Sci. 2016;28(1):107–11. doi:10.1589/jpts.28.107.

15. Smith MD, Chang AT, Hodges PW. Balance recovery is compromised and trunk muscle activity is increased in chronic obstructive pulmonary disease. Gait Posture. 2016;43:101–07. doi:10.1016/j.gaitpost.2015.09.004.
16. Pfalzer L, Fry D. Effects of a 10-week inspiratory muscle training program on lower-extremity mobility in people with multiple sclerosis. Int J MS Care. 2011;13(1):32–42. doi:10.7224/1537-2073- 13.1.32.
17. El-refaey BH, Mosaad G, Maksoud A, Ibrahim O. Efficacy of feedback respiratory training on respiratory muscle strength and quality of life in children with spastic cerebral palsy: randomized controlled trial. Bull Fac Phys Ther. 2017;22(1):46–52. doi:10.4103/bfpt.bfpt_65_16.
18. Cachupe WJ, Shifflett B, Kahanov L. Reliability of biodex balance system measures. Meas Phys Educ Exerc Sci. 2001;5(2):97–108. doi:10.1207/S15327841MPEE0502_3.
19. Rosenbaum P, Stewart D. The World Health Organization International Classification of Functioning, Disability, and Health: a model to guide clinical thinking, practice and research in the field of cerebral palsy. Semin Pediatr Neurol. 2004;11 (1):5–10. doi:10.1016/j.spen.2004.01.002.20
20. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39(2):175–91. doi:10.3758/bf03193146.
21. Wang HY, Chen CC, Hsiao SF. Relationships between respiratory muscle strength and daily living function in children with cerebral palsy. Res Dev Disabil. 2012;33(4):1176–82. doi:10.1016/j.ridd.2012.02.004.
22. Smith MD, Chang AT, Seale HE, Walsh JR, Hodges PW. Balance is impaired in people with chronic obstructive pulmonary disease. Gait Posture. 2010;31(4):456–60. doi:10.1016/j.gaitpost.2010.01.022.
23. Aslan GK, Gurses HN, Issever H, Kiyan E. Effects of respiratory muscle training on pulmonary functions in patients with slowly progressive neuromuscular disease: a randomized controlled trial. Clin Rehabil. 2014;28(6):573–81. doi:10.1177/02692155135 12215.