Effect of Thoracic Kinesiotape on Pulmonary Function in Children with Pneumonia

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ABSTRACT

Background: Pneumonia represents an inflammatory lung disease that mostly affects the small air sacs called alveoli. Viruses, bacteria, and other types of microorganisms, certain medications, and medical disorders (including autoimmune diseases) are the most common causes. **Patients and Methods:** Thirty children suffering from pneumonia from both sexes and aged from 4 to 7 years took-part in this study. The patients were distributed into two equal groups (study and control groups), control group was given selected chest physical therapy exercise such as postural drainage, vibration, coughing, huffing and percussion. Study group was given the same selected physiotherapy program provided to control group as well as thoracic kinesiotape three days per week for two weeks. Lung infiltrates were assessed using X-ray, respiratory function was assessed by digital spirometer, oxygen saturation was assessed by pulse oximeter, and respiratory distress presentations was assessed by Clinical Respiratory Score. All outcome measures were evaluated at baseline and post treatment.

Results: Within group analysis revealed that a statistically significant improvements ($P<0.05$) were detected in respiratory rate, O_2 saturation, clinical respiratory score, and pulmonary functions. Between groups analysis showed no significant improvements in all measured variables ($P>0.05$).

Conclusion: In children with pneumonia, combining traditional chest physiotherapy with thoracic kinesiotaping had no impact, even though both groups improved after treatment compared to baseline values.

Keywords: Children; Kinesiotape; Pneumonia; Pulmonary Function; Thoracic.

INTRODUCTION

Pneumonia represents an inflammatory lung disease that mostly affects the small air sacs called alveoli. Viruses, bacteria, and other types of microorganisms, certain medications, and medical disorders (including autoimmune diseases) are the most common causes [(1)]. Common symptoms of pneumonia include shortness of breath, coughing, fever, along with pain in the chest. Sputum culture and X-rays are diagnostic tools. There are vaccines that can protect against specific kinds of pneumonia. The root cause determines the course of treatment. When physicians suspect bacterial pneumonia, they prescribe antibiotics. The patient is typically admitted to the hospital if the pneumonia is considered serious [(2)].

Around 450 million people suffer from pneumonia every year, and it may be found anywhere on Earth. It accounts for 4 million deaths each year, or 7% of the world total, and is a leading death across all age groups [(3)]. In low-income nations, it is the primary cause of death for children. The newborn period accounts for a large portion of these deaths [(3,4)]. One out of every three neonatal infant deaths is attributed to pneumonia, based on the World Health Organization [(5)]. There is a vaccine that can effectively prevent around half of these deaths because they are brought on by bacteria. In 2011, among children and infants admitted to hospitals in the United States following visits to emergency departments, pneumonia ranked first [(6)].Kinesiotaping (KT) is a method for treating a wide range of physical disorders and musculoskeletal conditions using thin elastic tapes made of cotton and without latex [(7)]. Stretching tape to a length of up to 140 percent of its initial diameter releases elastic energy [(8)]. Activation of muscles, realignment of joints, blood and lymph circulation, and pain have all been suggested as potential benefits of KT in some previous studies [(7,8)].

Studies has demonstrated that KT enhances lymphatic and blood circulation, reduces pain, realigns joints, and reduces muscular tension. Although KT's impact on pain is not yet fully understood, it is possible that KT's afferent inputs enhance pain inhibition systems and reduce pain [(9)]. Applying KT to the thorax may have positive outcomes for restoring respiratory muscle function and minimize hyperinflation, which could lead to better functional capacity for individuals with Chronic obstructive pulmonary disease (COPD), based on the proposed effects [(10)]. However, more rigorous studies are necessary to establish the definitive effectiveness of kinesiotaping in this context [(7)].

AIM OF THE STUDY

This study was done to examine the effect of thoracic kinesiotape on pulmonary functions, time to clinical resolution and respiratory rate in addition to arterial oxygen saturation in children suffering from pneumonia.

PATIENTS AND METHODS

Study design

This randomized controlled experimental trial, was caried out in the period from September of 2023 and May of 2024. The children were recruited from Tala General Hospital in Menoufia Governorate, Egypt.

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Ethical approval

The research was given approval from the Ethics Committee of Cairo University's Faculty of Physical Therapy (No: P.T.REC/012/004544). This study was registered with the number NCT06573047. To ensure full satisfaction, each parent of the children signed a written informed consent form after obtaining information about the study's objective, methods, potential benefits, privacy, as well as data usage. The Helsinki Declaration was followed throughout the study's conduct.

Participants

Thirty children with pneumonia were recruited and randomly distributed into 2 groups utilizing the random generator (www.randomization.com). A research assistant who was not participating in the study was responsible for creating the random list.

Inclusion and exclusion criteria

To be included in the study, subjects were evaluated using the following criteria: Age ranges between 4-7 years from both genders, children hospitalized with pneumonia and they assembled all the clinical and radiological criteria for pneumonia, children with normal thoracic spine, children with stable hemodynamic status, and children with no previous history of surgery or deformities in the thoracic region, rib fracture or any disorder that restricts the KT's application. Children were excluded from participating in the study if they suffered from any of the following conditions: a chest draining, hemodynamic dysfunction, rib fractures or fragile nature, kyphosis or scoliosis in the thoracic vertebrae, a history of thoracic surgery, thoracic deformities, or any other condition that would make KT application difficult. Exclusion criteria also included children who had a history of skin reactions to adhesive wrappings, plasters, or other similar materials, as well as those who were placed on a ventilator.

Sample size calculation

The G*power software (3.1.9; G power software version 3.1, Heinrich-Heine-University, Düsseldorf, Germany) was used to determine the study's sample size. The effect size utilized to calculate the sample size was taken from prior investigations ([11,12]).

The sample size for a study utilizing F tests (MANOVA) was calculated to be 30 participants across 4 main outcomes, with the following specifications: - Type I error rate (α) = 0.05 - Desired power (1 - α error probability) = 0.90 - Pillai V = 0.538 - Effect size f^2 (V) = 0.3679891 to compare 2 independent groups. Taking into account a 15% drop out rate, the minimum number of individuals needed for this study was 36, with at least 18 individuals in each group.

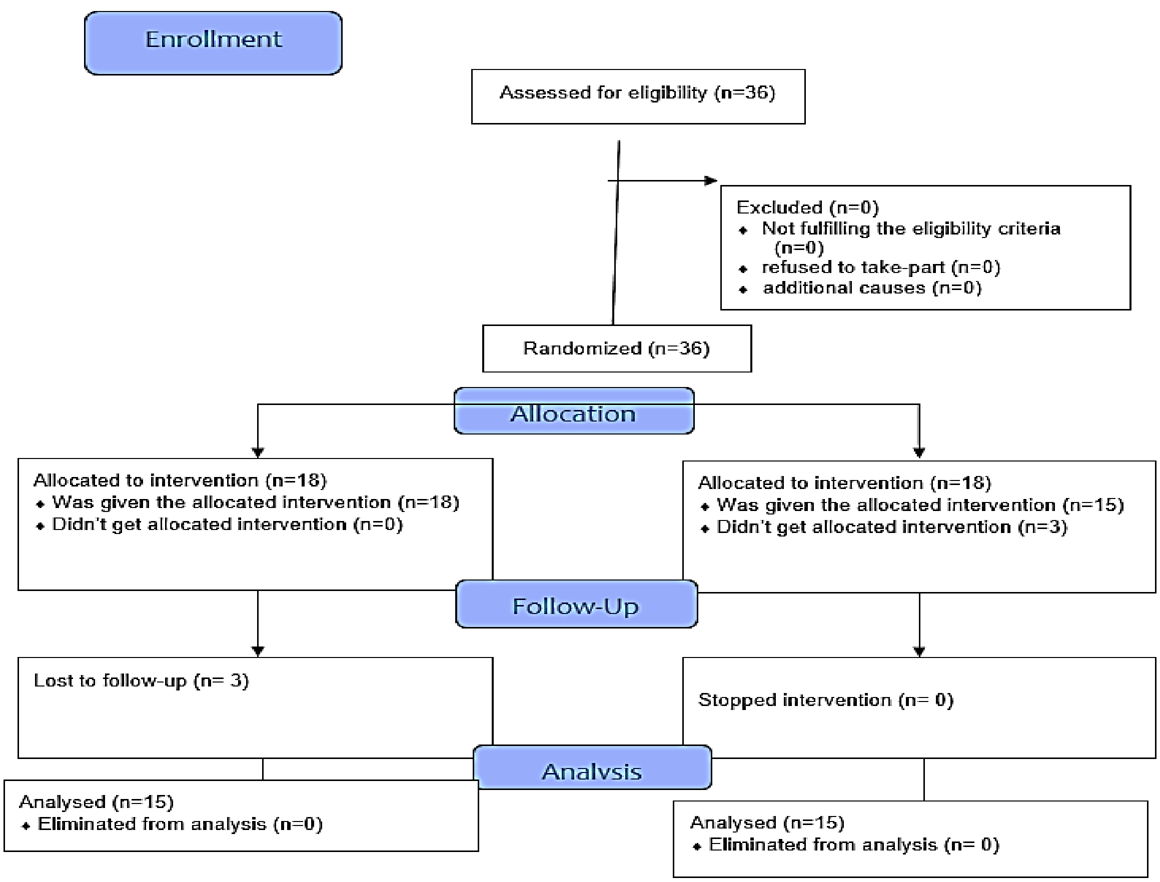

Fig. (1): Flow chart of the patients.

Outcome variables and measures:

Before and after the two-week intervention sessions, children were evaluated for all outcomes. These outcomes included:

X-ray imaging (For Children Selection): (OPERA - 24850- General medical merate-BG-Italy) was used to image the chest for children to check lung infiltrates (white spots) [13]

Digital spirometer: (ZAN 100 flow handy II, ZAN, Oberthulba, Germany) was used to measure (VC-FVC-FEV1-FEV1/FVC ratio-PEF) at baseline and post treatment.

Spirometry is a reliable technique for testing pulmonary functions, which is essential when treating patients suffering from respiratory disorders. They assist diagnosis, monitor therapy response, and can assist taking decisions about additional treatment and interventions. All lung volumes can be measured by spirometry, with the exception of residual volume [14].

Pulse oximeter: This study used (Granzia -pulsox-304 - Genova-Italy). It is a non-invasive tool that is worn over the finger. It calculates the ratio of the present levels of oxygenated hemoglobin to deoxygenated hemoglobin by measuring the wavelengths of light. In healthcare, pulse oximetry is now considered standard practice [15].

The Clinical Respiratory Score (CRS): In the pediatric emergency department (ED) setting located in low as well as middle income countries, it is promising as a means of screening for pulmonary presentations of various causes. Respiratory Score assessed respiratory status in children hospitalized with asthma and bronchitis. The CRS can be used to improve the outcomes for pediatric patients experiencing respiratory distress. It can be integrated into evidence-based protocols beginning with pediatric emergency department triage [14]. When used by all members of the care team, the CRS is a reliable instrument for assessing the severity of asthma attacks in children who present with an acute asthma attack. There was no impact on the CRS's reliability when the color and mental status components were removed, making it simplified [1].

Intervention

The children in the control group were given the selected chest physiotherapy exercise in combination with medical treatment three times a week for two weeks, every session lasted around twenty minutes. Each session included the following five exercises. Postural drainage is a technique used to move secretions into the major bronchi by placing the child in a position assisted by gravity. A technique called vibration was used to loosen and remove airway secretions. The therapist flattens their hands and uses isometric alternating contraction of the forearm flexor along with extensor muscles to produce a fast vibratory impulse across the chest wall. This percussion technique involves the therapist using a single or cupped hand, 3 fingers with the middle finger tented, or a facemask using the port covered or blocked by a finger to apply pressure to the area of the bronchopulmonary segment that requires to be drained three times per second. Huffing is a rapid, loud expiration by the patient. Coughing in which the child is asked to cough. Putting the index finger or thumb on the front of the neck along the trachea just above the sternal notch and applying little but persistent inward pressure in a circular manner as the child starts to exhale is a technique known as tracheal stimulation or tickling that can be used with children who are not cooperative or who are small. Lastly, thoracic squeezing is used to elevate intrathoracic pressure, which promotes the usual cough mechanism. The lower portion of the thorax is where the hands are positioned. The next step is for the therapist to apply pressure in order to raise the FEV by 30%. Patients experience fewer episodes of hypoxemia and require less high fraction of inspired oxygen (FiO_2) since the ventilation machine can be left connected during treatment [17,18]. children received the standard medical treatment by the attending pediatrician. The patient was given antibiotics, fluids, and oxygen as needed during treatment.

The children in the study Group (B) were given the same selected program applied to the control group along with kinesiotape 3 sessions a week for two weeks (an overall times of application were 6 times in two weeks). The children sat in a chair. Near the end of their expiration, children were given a bilateral application of 50% tension across the anterior and posterior axillary lines, as well as on the 5th to 6th and 9th to 10th intercostal muscles, transversely. Applying the stimulation approach from the muscle's origin to its insertion while recommending a 25 to 50% stretch is the standard procedure for supporting the muscle's function and stimulating it. The KT was replaced every three days. It was ordered that neither the children nor the caregiver remove the tapes at any time; nevertheless, they were permitted to take showers. Following two weeks of treatment, the researcher noted each patient's results from the post-treatment examinations [19].

Statistical analysis

The data were checked for tests of normality utilizing the Shapiro-Wilk test. Also, no statistically significant difference was noted (P>0.05) when tested for homogeneity of variance utilizing Levene's test. Parametric analysis was performed on data that followed a normal distribution. Software developed by SPSS, Inc. of Chicago, IL, USA, version 25 for Windows, was utilized to do the statistical analysis. The gender distribution was compared both within and across groups using a chi-square test. Mixed design 2x2 multivariate analysis of variance (MANOVA) test was utilized for the

1st outcome measure, which was the tested group, with two levels (study group vs. control group). The 2nd independent variable, which was within the subject factor, was the measurement periods, with two levels (pre-treatment vs. post-treatment). The primary dependent variables, which were the outcomes of the study (respiratory rate, arterial oxygen saturation, as well as pulmonary functions), were considered. When the MANOVA test found a statistically significant F value for one of the examined variables, we utilized the Bonferroni adjustment test to compare the two sets of data within and between the same group. The statistical analyses were all considered significant at the 0.05 level of probability.

RESULTS

The results of clinical general demographic data for pneumonia children (Table 1) showed that no significant differences among study group as well as control group in mean values of pneumonia children age, weight, height, BMI, time of clinical resolution, and gender.

Table 1. Clinical demographic data for pneumonia children in both groups

Items	Groups (Mean ±SD)		*P*-value
	Study group (n=15)	Control group (n=15)	
Age (year)	5.41 ±1.30	5.16 ±1.24	0.602
Weight (kg)	23.87 ±5.91	20.47 ±4.61	0.090
Height (cm)	110.13 ±9.48	105.22 ±6.95	0.117
BMI (kg/m^2)	19.40 ±2.58	18.29 ±2.43	0.238
Time of resolution (Day)	10.33 ±1.23	10.47 ±1.35	0.780
Gender (boys: girls)	13 (86.70%): 2 (13.30%)	9 (60.00%): 6 (40.00%)	0.099

Independent samples t-test was used to analyze the data.

Multiple pairwise comparison tests for respiratory rate, O_2 saturation, and clinical respiratory score within each group (Table 2) revealed that there was significant decline in respiratory rate and clinical respiratory score at post-treatment in comparison with baseline values within study group and the control group. In addition, both the study group and the control group showed a significant improvement in O_2 saturation post treatment when compared to baseline values and during treatment. The children with pneumonia who received thoracic kinesiotape program (study group) had more improved respiratory rate (33.85%), O_2 saturation (11.91%), and clinical respiratory score (84.50%) at post-treatment than pneumonia children (30.31, 8.25, and 81.57% respectively) who received the chest physiotherapy exercise program (control group). Multiple pairwise comparison tests for respiratory rate, O_2 saturation, and clinical respiratory score among both groups (Table 2) revealed no significant differences at both of pre-treatment and post-treatment among study group and control group in respiratory rate, O_2 saturation, and clinical respiratory score.

Table 2: Within and between group comparisons for respiratory rate, O_2 saturation, and clinical respiratory score

Variables	Items	Groups (Mean ±SD)		Change	*P*-value^2
		Study group (n=15)	Control group (n=15)		
Respiratory rate	Pre-treatment	42.33 ±3.73	42.00 ±4.56	0.33	0.896
	Post-treatment	28.00 ±2.50	29.27 ±2.76	1.27	0.325
	MD (Change)	14.33	12.73		
	95% CI	11.78 – 16.88	12.18 – 17.28		
	Improvement %	33.85%	30.31%		
	P-value^1	0.0001*	0.0001*		
O_2 saturation	Pre-treatment	86.20 ±2.67	88.67 ±3.37	2.48	0.259
	Post-treatment	96.47 ±1.76	96.00 ±1.69	0.47	0.608
	MD (Change)	10.26	7.33		
	95% CI	8.45 – 12.07	5.52 – 9.14		
	Improvement %	11.91%	8.25%		
	P-value^1	0.0001*	0.0001*		
Clinical respiratory Score	Pre-treatment	6.00 ±1.06	6.13 ±1.12	0.13	0.676
	Post-treatment	0.93 ±0.45	1.13 ±0.64	0.20	0.532
	MD (Change)	5.07	5.00		
	95% CI	4.43 – 5.70	4.36 – 5.63		
	Improvement %	84.50%	81.57%		
	P-value^1	0.0001*	0.0001*		

Abbreviations used in Tables 2 and 3:

MD: Mean Difference, CI: Confidence Interval, P-value1: Within-group comparison, P-value2: Between-group comparison.

Multiple pairwise comparison tests for pulmonary functions within each group (Table 3) indicated that a significant improvement was observed within both the study and control groups in VC, FEV1, FEV1/FVC ratio, as well as PEF at post-treatment in comparison with baseline values.

No statistically significant differences were observed between the pre- and post-FVC interventions in the control group along with the study group. The children with pneumonia received thoracic kinesiotape program (study group) had more improved VC (40.10%), FVC (1.82%), FEV1 (34.62%), FEV1/FVC ratio (29.10%), and PEF (17.68%) at post-treatment than pneumonia children (37.14, 0.90, 28.21, 26.42, and 16.12% respectively) who received the chest physiotherapy exercise program (control group).

At pre-treatment, no significant changes were noted in VC, FVC, FEV1, FEV1/FVC ratio, or PEF among the study group and the control group, according to multiple pairwise comparison tests for pulmonary functions as presented in (Table 3). Furthermore, no statistically significant difference was detected among the control and study groups in terms of VC, FVC, FEV1, FEV1/FVC ratio, and PEF after treatment (Table 3).

Table 3: Within and between group comparisons for pulmonary functions

Variables	Items	Groups (Mean ±SD)		Change	*P*-value[2]
		Study group (n=15)	Control group (n=15)		
Vital capacity	Pre-treatment	2.07 ±0.24	2.10 ±0.25	0.03	0.769
	Post-treatment	2.90 ±0.37	2.88 ±0.31	0.02	0.856
	MD (Change)	0.83	0.78		
	95% CI	0.57 – 1.09	0.58 – 0.98		
	Improvement %	40.10%	37.14%		
	P-value[1]	0.0001*	0.0001*		
Forced vital capacity (FVC)	Pre-treatment	1.10 ±0.10	1.11 ±0.09	0.01	0.812
	Post-treatment	1.12 ±0.11	1.12 ±0.12	0.00	1.000
	MD (Change)	0.02	0.01		
	95% CI	-0.10 – 0.05	-0.06 – 0.09		
	Improvement %	1.82%	0.90%		
	P-value[1]	0.558	0.696		
Forced expiratory volume (FEV1)	Pre-treatment	0.78 ±0.08	0.78 ±0.10	0.00	0.850
	Post-treatment	1.05 ±0.12	1.00 ±0.10	0.05	0.645
	MD (Change)	0.27	0.22		
	95% CI	0.18 – 0.34	0.14 – 0.30		
	Improvement %	34.62%	28.21%		
	P-value[1]	0.001*	0.001*		
FEV1/FVC ratio	Pre-treatment	71.03 ±4.65	70.82 ±5.37	0.21	0.897
	Post-treatment	91.70 ±3.59	89.53 ±3.00	2.17	0.169
	MD (Change)	20.67	18.71		
	95% CI	17.56 – 23.78	15.59 – 21.82		
	Improvement %	29.10%	26.42%		
	P-value[1]	0.0001*	0.0001*		
Peak expiratory flow	Pre-treatment	170.80 ±7.48	172.07 ±10.00	1.27	0.698
	Post-treatment	201.00 ±8.23	199.80 ±9.63	1.20	0.713
	MD (Change)	30.20	27.73		
	95% CI	23.69 – 36.70	21.22 – 34.23		
	Improvement %	17.68%	16.12%		
	P-value[1]	0.0001*	0.0001*		

DISCUSSION

This study was carried-out to examine the effect of thoracic KT on pulmonary function in children suffering from pneumonia. Thirty children with pneumonia participated in this study. The outcomes in this study demonstrated that there was improvement in both groups post-treatment in comparison with baseline values, but there was no improvement of pulmonary function in the study group when compared to control group.

Research into KT's effects on pulmonary function as well as ventilator efficiency is limited, and the findings of these studies shown mixed results. Previous research approves the outcomes of this study and found no statistically significant impact of adding KT to traditional physical therapy in children with pneumonia.

A study conducted by **Malehorn *et al.*** [20] corroborated our findings. In this study, healthy individuals were examined to determine gas-exchange threshold (GET), heart rate (HR), as well as (VO_2) during a graded exercise testing. KT was placed to the thorax in this study, but no impact of KT upon exercising respiratory rate or HR was found. Furthermore, no significant differences in the parameters measured while performing the 6MWT were attributed to KT.

Additionally, the purpose of **Ökmen and Ökmen** [12] was to examine the impact of KT upon spirometry-measured respiratory parameters in COPD patients. This study found that when compared to standard medical treatment alone, the addition of kinesiotaping to it improved depression symptoms more than the standard medical treatment alone. When comparing pre- and post-treatment readings, FVC and FVC % did not improve.

Moreover, **Ganesh *et al.*** [21] research compared the effect of thoracic KT techniques upon pulmonary functions, oxygen saturation, in addition to exercise capacity in patients suffering from COPD. This study finding denoted improvements post intervention when compared to the pre intervention values. However, no significant difference was noted in the FEV and FEV/FEV ratio values when compared within experimental group, which received diaphragmatic taping.

These study findings came in agreement with those of **Sari *et al.*** [22], who investigated the impacts of KT on the diaphragm as well as accessory muscles of breathing (sternocleidomastoids, rectus obliquus externus as well as internus). Micro Mouth Pressure Measurement (MPM) was used to assess the maximal inspiratory and expiratory muscle strengths prior to and after taping. This study found no statistically significant relationship between the maximum strength of the respiratory muscles along with the use of kinesiology tape on either the primary or accessory muscles of breathing.

The use of KT for COPD patients did not improve their lung function, according to a meta-analysis by **de Campos *et al.*** [23]. Both diaphragmatic and thoracic approaches were utilized in five studies. There was no significant difference among the control and KT groups regarding forced expiratory volume in the 1st second (FEV1), forced vital capacity (FVC), peak expiratory flow (PEF), as well as the FEV1/FVC ratio.

There are a lot of potential reasons why we didn't see an improvement in respiratory muscle strength. The diaphragm muscle may have a specific shape that makes it difficult to tape in a way that is optimal for the muscle's anatomical and biomechanical characteristics. Muscle fiber orientation and pennation angle, as well as the muscle's origin and insertion, must be taken into account [14].

Furthermore, KT may promote relaxation of accessory respiratory muscles instead of their activation due to its effects on diaphragmatic excursion and local circulation in the scalene as well as upper trapezius muscles. Relaxing these muscles reduces energy expenditure and oxygen consumption, which could explain why other studies have shown improvements in fatigue and dyspnea severity [17].

In contrast to this study results, the researches that find improvement in pulmonary function test can be divided to three categories (normal healthy person, COPD patient and athletes). The improvements in those researches may be due to the added positive well known exercise effect of deep breathing not only in pulmonary function but also to whole body system improvement as improved by **Ravi and Swamy** [24] **and Leelarungrayub *et al.*** [25]**.** In addition, there is natural difference between athlete and non-athlete pulmonary and cardiovascular system performance as proved by **Vignesh *et al.*** [26]**.** The third factor may be the time of KT application**.**

Regarding effect of kinesiotaping in healthy people, a study was performed by **Arslan *et al.*** [27] to identify the immediate impacts of diaphragmatic KT upon the aerobic exercise capacity as well as pulmonary function of 36 participants who had a sedentary life. Aerobic performance as well as submaximal functional capacity were assessed. The rib cage's flexibility was assessed by measuring the subject's chest circumference. A technique called KT muscular facilitation was used upon the diaphragm muscle. Following four days of KT, the study found that pulmonary function test values, including as FEV1, shuttle run test, as well as chest circumference, increased. When compared to a control group that did not get KT, the study found that diaphragm muscle KT had a short-term beneficial effect on aerobic performance in addition to pulmonary functions.

Obaya *et al.* [28] discovered that KT is effective for enhancing vital capacity along with dyspnea in COPD patients. Researchers in this study combined KT with deep breathing exercises. The post-treatment comparison among the two groups indicated that the study group had a significant greater FEV1, FVC, and FEV1/FVC values than the control group. The long-term impacts of KT and the well-known effectiveness of deep breathing exercises may explain why the current study findings was better than the prior studies.

In a study conducted by **Abd Al Raheem *et al.*** [(29)], 60 male soccer players were divided into two equivalent groups to examine the additional impact of KT on inspiratory muscle pressure in conjunction with inspiratory muscle training. A power lung device was used to exercise the inspiratory muscles of the control group. With the addition of KT administered to the inspiratory muscles (diaphragm), the experimental group also got training for these muscles. During forced inspiration after expiration, the maximal inspiratory muscle pressure was recorded, and the maximum distance that could be reached in 12 minutes was determined using a Cooper test. The results revealed that both groups improved significantly, however the experimental group demonstrated an enhancement of 14% in Cooper test distance and a 19% rise in VO2 max. This provides more evidence that KT and inspiratory muscle training should be used together to enhance inspiratory muscle pressure among athletes.

This study might have some limitations. First, the variability in kinesiotaping application might impact the generalization of the results. In addition, because of the young age of patients they were less compliant, which might affect the outcomes.

CONCLUSION

there is no effect of adding thoracic kinesiotaping to traditional chest physiotherapy in children with pneumonia.

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