Effect of Buteyko Breathing Technique versus Diaphragmatic Breathing on Clinical Outcomes for Children with Lower Respiratory Tract Infection

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Abstract

Background: Lower Respiratory tract infection is the main cause of utilizing health services by children. Complementary therapies as buteyko and diaphragmatic breathing technique are used to improve clinical outcomes. **The current study was aimed to** evaluate the effect of buteyko breathing technique versus diaphragmatic breathing on clinical outcomes for children with lower respiratory tract infection. **Research hypotheses**:1-Children who are applying diaphragmatic breathing technique are expected to improve their breathing than control group. 2- Children who are applying buteyko breathing technique are expected to improve their breathing than control group. 3-Children clinical outcomes are expected to be improved lower respiratory tract infection as heart and respiratory rate, oxygen saturation. **Subjects and Method**: A convenience sampling of ninety children with lower respiratory tract infection participated in the study. The study was conducted at pediatric medical departments of Tanta Main University Hospital . **Five Tools were used to collect data**: Structured Interview Schedule, Control Pause Breathing Test, Physiological Measurement and Oxygen Saturation , Peak Expiratory Flow Rate, Children Clinical Outcomes. **The results :** Statistical significant differences were found regarding decreasing respiratory rate, increasing oxygen saturations after application of buteyko and diaphragmatic breathing technique. **Conclusion:** Both buteyko and diaphragmatic breathing had a positive effect on improve clinical outcomes as decreasing respiratory rate, increasing oxygen but buteyko breathing technique was more effective in improve clinical outcomes as on decreasing heart rate and improving peak expiratory flow rate than diaphragmatic technique for children with lower respiratory tract infections. **Recommendation:** Implementation of buteyko and diaphragmatic breathing technique should to be endorsed as a part of the routine care for children with lower respiratory tract infection to improve their clinical outcomes.

Keywords: Buteyko , Diaphragmatic, Breathing, Technique, Outcomes ,Children, LowerRespiratory, Infection .

Introduction

Respiratory system is most susceptible to infection from the external environment as a result of its frequent exposure to airborne particles, chemicals and infectious organisms, most common types of lower respiratory tract infections include pneumonia, asthma, bronchitis, bronchiolitis, tracheitis and tracheobronchitis, which are transmitted by inhaling airborne droplets.(1)

Lower respiratory tract infection is classified into acute or chronic respiratory tract infection. Acute lower respiratory tract infection as pneumonia, bronchitis and bronchiolitis may show signs of impaired in gas exchange and raised respiratory rate and chest retractions.(2)

Chronic lower respiratory disease is a group of conditions that affect the lungs; it is a serious illness influencing a large number of children as chronic bronchitis, emphysema, and bronchial asthma that are all characterized by shortness of breath caused by airway obstruction. (3,4)

Breathing exercises are helpful for reducing breathing difficulty, which allow children to be able to relax quickly during facing stressful situations. Breathing exercises have an important role in airway clearance and parenchyma expansion by improve the effectiveness of respiratory muscles as pursed lip breathing exercise, deep breathing exercise, diaphragmatic and buteyko breathing exercise.(5)

Several previous researches illustrate the effect of breathing exercise on the clinical outcomes for children with respiratory problems as asthma and pneumonia , it found that after implementation of buteyko breathing technique , there was an increase in the value of the peak expiratory flow rate and oxygen saturation compared to the previous pre-test. Other research on buteyko breathing techniques in controlling asthma, which means a difference between controlling respiratory manifestations after implementing buteyko breathing.(6)

Buteyko breathing technique is a type breathing exercise which utilizes breath control and breath-holding exercises to treat a wide range of medical issue associated with hyperventilation and low carbon dioxide. The technique aims to diminish hyperventilation by teaching child a method to hold their breath and assimilate shallow breathing technique with relaxation.(7)

Diaphragmatic breathing is slow and deep breathing technique through the nose utilizing using the diaphragm with a minimum chest movement. Diaphragmatic breathing is an important therapeutic strategy for children in different lower respiratory tract infection conditions to enhance the child ventilation and decrease the work of breathing and improve oxygenation and gas exchange.(8)

Nurses have an important role in managing children with lower respiratory tract infection, which includes the following: provide rest, fluids, good oral hygiene, change position frequently, suction and use humidified oxygen. Pharmacotherapy alone has limited role in improving the respiratory function, therefore the complementary and alternative approaches that can use for lower respiratory tract infection management as breathing exercise which make breathing more efficient. (9)

Significance of the study

Lower respiratory tract infections are a leading cause of morbidity and mortality for children. Lower respiratory tract infections represented around 11.9 million of young children hospitalized worldwide. Whereas applying breathing exercises have an important role in improving the efficiency of respiratory muscles. So the nurses should be applying breathing exercises to promote lower respiratory infection management for those children.(10)

Aim of the study

The study was conducted to evaluate the effect of buteyko breathing technique versus diaphragmatic breathing on clinical outcomes for children with lower respiratory tract infection.

Subjects and Method

A quasi-experimental research design will be used in the present study. The study was conducted at Pediatric Medical Departments of Tanta Main University Hospital which is affiliated to the Ministry of Highly Education and Scientific Research .

Sample

The total number of children with lower respiratory tract infection in the age between 6-12 years was 255 child/ last year at Pediatric Medical Departments of Tanta Main University Hospital . The sample size was calculated using Epi-info software statistical package and the calculation was based on type 1 error 0.05and confidence level 95%. A convenience sampling of 90 children with lower respiratory tract infection was collected from above previously mentioned setting. The sample was selected randomly.

They were divided into three equal groups:

1-**Study Group (I):** Thirty children who implemented buteyko breathing technique.

2- **Study Group (II):** Thirty children who implemented diaphragmatic breathing technique.

3-**Control group (III):** Thirty children who were received routine day hospital care.

Inclusion criteria of children: both sexes, aged from 6-12 years, children with lower respiratory tract infection (asthma, pneumonia, bronchitis-bronchiolitis).

The researcher started to implement the study, with buteyko group then, diaphragmatic group and finally control group who were received routine day hospital care .

Five tools were used in the current study as follow.

Tool I: Structured interview Schedule: It was developed by the researchers to collect the required information and it includes the following two parts:-

Part (1): Socio demographic characteristics of the studied children: as age, sex, educational level, residence, date and duration of admission.

Part (2): Medical History of the child related to lower respiratory tract infection: prescribed medication, history of the disease, triggering factors for symptoms, duration, treatment, complications, duration of last admission.

Tool II: **Control Pause Breathing Test.** It was adapted from (Buteyko International, 2014).[11] Buteyko breathing exercise used to assess the depth of breathing and consequent retention of carbon dioxide, result oxygenation and health by using special breathing hold manner, it was used before and immediately after the technique by using stopwatch .

Scoring system of children breathe holding time: -Control Pause (40 to 60 seconds): It indicated a normal, healthy breathing pattern and excellent physical endurance of children.

-Control Pause (20 to 40 seconds): It indicated mild impairment in breathing of children, most symptoms are not there, but may occur following triggering event.

- **From 10 to 20 seconds**: It indicated impairment of breathing and weak tolerance to physical exercise; inhalation and exhalation training and modifications of life were encouraged. Along with symptoms, such as blocked nose, snoring, insomnia, and coughing, short breath.

- **Under 10 seconds**: It indicated the vigorous impairment of breathing, very slow exercise tolerance, health is severely affected.

Tool III: Physiological measurement and oxygen saturation. Part (1): Basic physiologic measurement

as measuring temperature, heart and respiratory rate.

Part (2): Measurement of oxygen saturation using pulse oximeter. Scoring system of children oxygen saturation:

96-100% normal oxygen saturation
91-95% Mild desaturation .
85 -90% Moderate desaturation .
51-85% Hypoxic.

- **Tool IV: Peak expiratory flow rate:** It measured with mini wright peak flow meter device to display child capacity to expire out air through the bronchi, the meter test the ability to force out of the lung. [12,13] **It categorized into three zones of depth:** green, yellow and red zone.

-Green zone: Peak flow result was between **80-100%** of child predicated value, this was the all clear zone.

-Yellow zone**:** peak flow result **50%-79%** of child, predicted value. This was the caution zone.

- Red zone: Peak flow results less than **50%** of child predicted value this was crisis.

Tool V: Children clinical outcomes: it was used to assess clinical outcome for both study groups (I, II) and control group (III) at pre and immediately after technique procedure it included:

- **Physiological measurement:** Improved temperature, respiratory, pulse rate.

-**Oxygen saturation:** Using pulse oximeter , higher oxygen indicated good breathing and prognosis .

-**Peak expiratory flow rate:** improvement in child capacity to expire out air through the bronchi.

Method

An official permission to conduct the study was obtained from the responsible authorities of the Pediatric Medical departments of Tanta Main University Hospital to obtain their approval and cooperation to conduct the study. Nature of the study would not cause any harm or pain to the entire subject, oral consents were obtained from parents and their children to participate in the study after explaining the aim of the study, they have the right to withdraw at any time from the study, children and their parents were informed about the confidentiality of their information and it was used only for the purpose of the study, study tools was developed &modified based on review of related literature: five tools was developed. A pilot study was carried out on nine children (10%) of the sample to test clarity, visibility and applicability of the study tools and the necessary modification was done, those children were excluded from total sample of the study.

- **Phases of the study:** The study was conducted through four phases:

1. Assessment Phase

It was done by the researcher for all studied subjects to assess children who met the inclusion criteria. The researcher firstly met chest nurses and resident doctors to explain the purpose of the study to gain their cooperation. Children and their parent were interviewed by the researcher. The parents were asked about socio demographic and medical data of their children to complete questions of (Tool I).

2. Planning Phase

Setting objectives of the buteyko and diaphragmatic breathing technique, preparation of the content (booklet, video), the duration of data collection was done within six month.

3. Implementation Phase

The researcher attended two day/ week from 9.00pm to 2.00 am , buteyko and diaphragmatic breathing technique was conduct in four sessions two day/ week , the first two sessions for group I and the second two sessions for group II, each group taught breathing technique in 2 sessions and the time of each session took about 30-45 minutes.

For (group I and II)

- The researcher measured the duration that a child could comfortably hold breathing before breathing technique (Tool II).
- The researcher recorded the physiological measurements of children (Tool III) included:
  - measure temperature, heart rate and respiratory rate. Measured oxygen saturation by instrument (pulse oximeter) before implementation breathing technique .
- The researcher measured peak expiratory flow rate by instrument(peak flow meter) before implementation breathing technique (Tool IV).
- The researcher initially implemented the procedure by herself, after completing data collection and then taught it to children and caregivers who volunteered to perform it by themselves under the researcher supervision.

After teaching the procedure

After 5consecutive days the researcher measured the following:

- Duration that a child can comfortably hold breathing immediately after breathing techniques (Tool II).
- Recorded physiological measurements and oxygen saturation of children immediately after breathing techniques using (Tool III).

The researcher measured peak expiratory flow rate of children after breathing technique using (Tool IV).

- The researcher recorded children clinical outcomes for both study groups (I, II) immediately after procedure technique (Tool V).
- Control group received hospital routine care provided to child and clinical outcome was measured and recorded before and immediately after routine care (Tool V).

4. Evaluation Phase

It was done to children to evaluate the clinical outcomes for both study groups (I, II) and control group (III) was done before and immediately after five days of teaching the procedure technique

- Comparison between the three groups was done.

Statistical analysis

The data collected were organized, tabulated and statistically analyzed using SPSS software (Statistical Package for the Social Sciences, version 26, SPSS Inc. Chicago, IL, USA). For quantitative data, the range, mean and standard deviation were calculated. For qualitative data, a comparison between two groups and more was done using Chi-square test ($\chi 2$). For comparison between means of two related groups (before and after data) of parametric data, paired t-test was used.[14]

Results

Figure (1): It was evident that 53.3% , 46.7% and 40% were between 6-8 years respectively in buteyko, diaphragmatic and control group.

Figure (2): It was observed that 43.3%,46.7 % and 53.3% of children have pneumonia respectively in buteyko, diaphragmatic and control group.

Figure (3): It was observed that the mean Score of control pause breathing before procedure was 17.8 which increased to 42.3.6 after procedure in buteyko group. Regarding diaphragmatic group, the mean Score of control pause breathing before procedure was 19.8 which increased to 32.64after procedure . Regarding control group, it was evident that the mean Score of control pause breathing before procedure was 19.8 which increased to 28.6 after procedure.

Table (1): Shows percentage distribution of the studied children regarding heart rate measurement before and after procedure. It was observed that after procedure, there were statistically significant differences in buteyko group (χ^2=5.711, p=0.017) where there were no statistically significant differences among the studied children (χ^2=2.443, p=0.118) (χ^2=0.000, p=1.000) respectively in diaphragmatic and control group .

Table (2) Shows percentage distribution of the studied children regarding respiratory rate measurement before and after procedure .It was found that after procedure, there were highly statistically significant differences (χ^2 =27.778 , P =0.0001) (χ^2 =20.317 ,P =0.0001) among the studied children respectively in buteyko and diaphragmatic group .On the other hand , there were no statistically significant differences (χ^2 =1.071, P = 0.301) in control group .

Table (3) illustrates percentage distribution of the studied children regarding measurement of oxygen saturation after procedure. It was noticed that after procedure, there were highly statistically significant differences where (χ^2 =24.093,P=0.0001), (χ^2 =9.600,P= 0.002) among the studied children respectively in buteyko and diaphragmatic group.

Table(4) Illustrates percentage distribution of the studied children regarding peak expiratory flow rate before and after procedure. Regarding level of peak expiratory flow rate, it was noticed that there were a highly statistically significant differences among children in buteyko group. (χ^2 =10.553,P=0.005) after buteyko technique .Where there were no statistically significant differences among studied children in diaphragmatic and control groups (χ^2 =4.903,P= 0.086)and (χ^2 =2.373, P =0.305) after procedure respectively in diaphragmatic and control group.

Table (5) Explains the correlation between socio demographic data and peak expiratory flow rate for studied children before and after the procedure .It was found that there was a positive non-significant correlation between age, sex, level of education of children in three groups and their peak expiratory flow rate among children of buteyko ,diaphragmatic and control groups before and after the procedure.

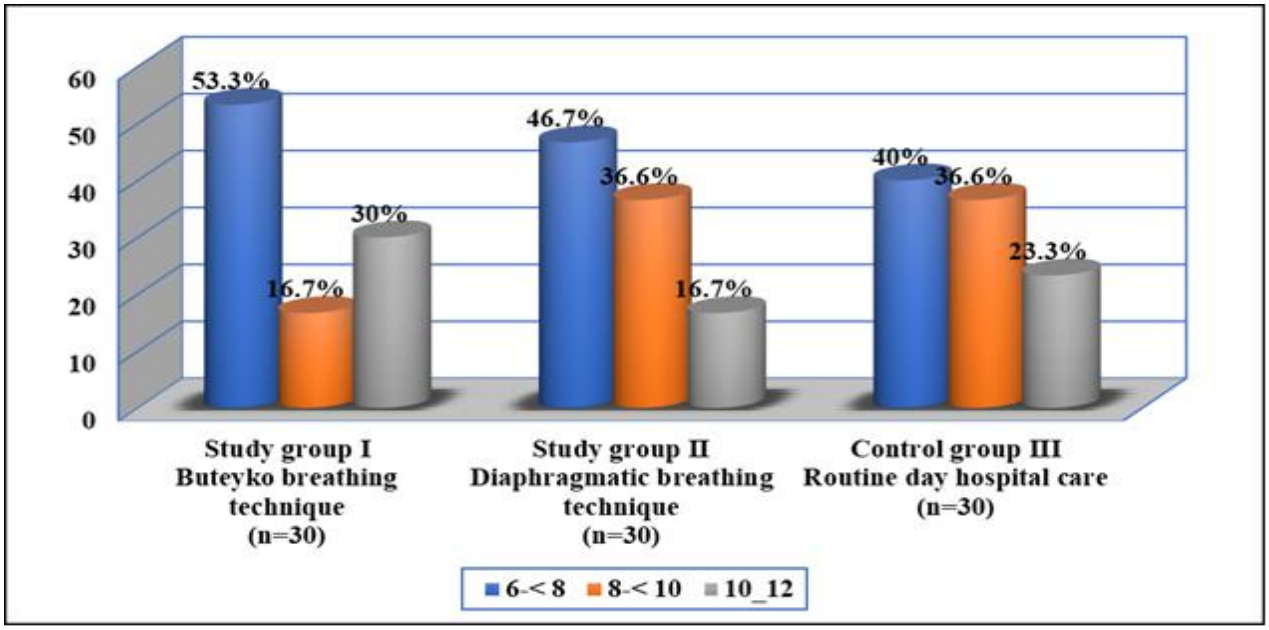

Figure (1): Age (years) of the studied children.

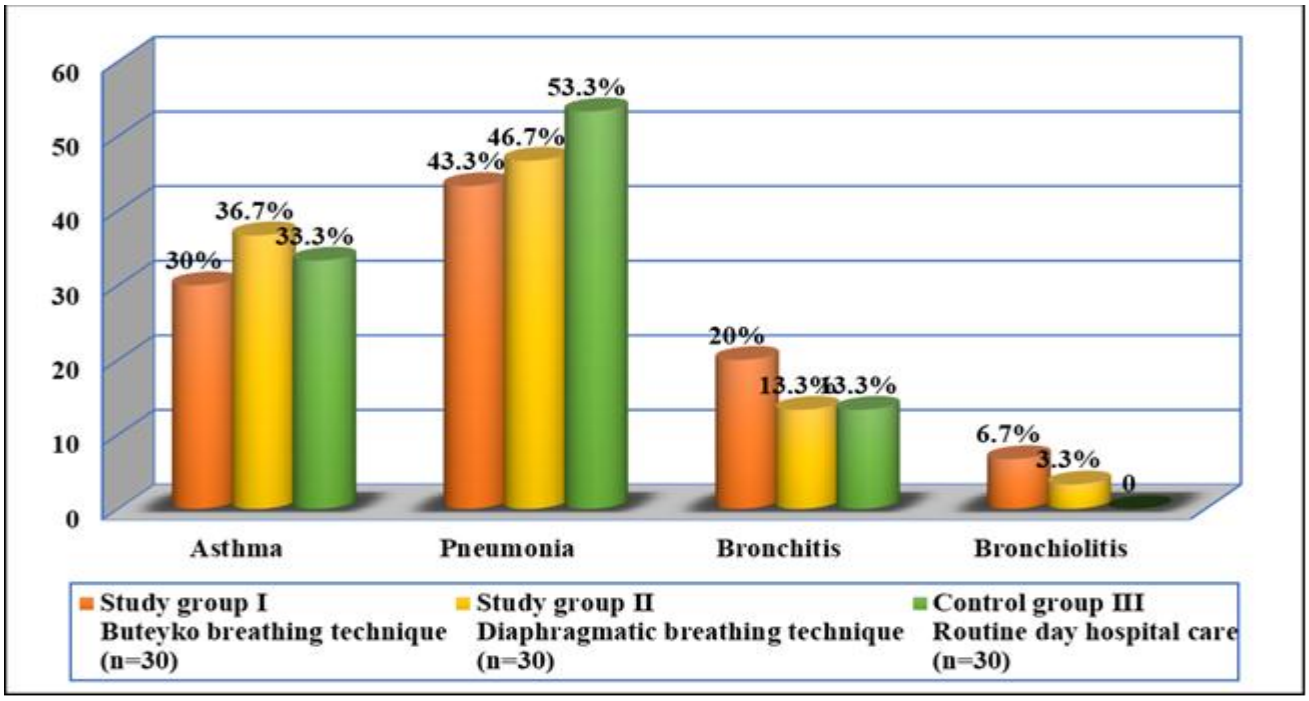

Figure (2): studied children related to types of disease (n=90)

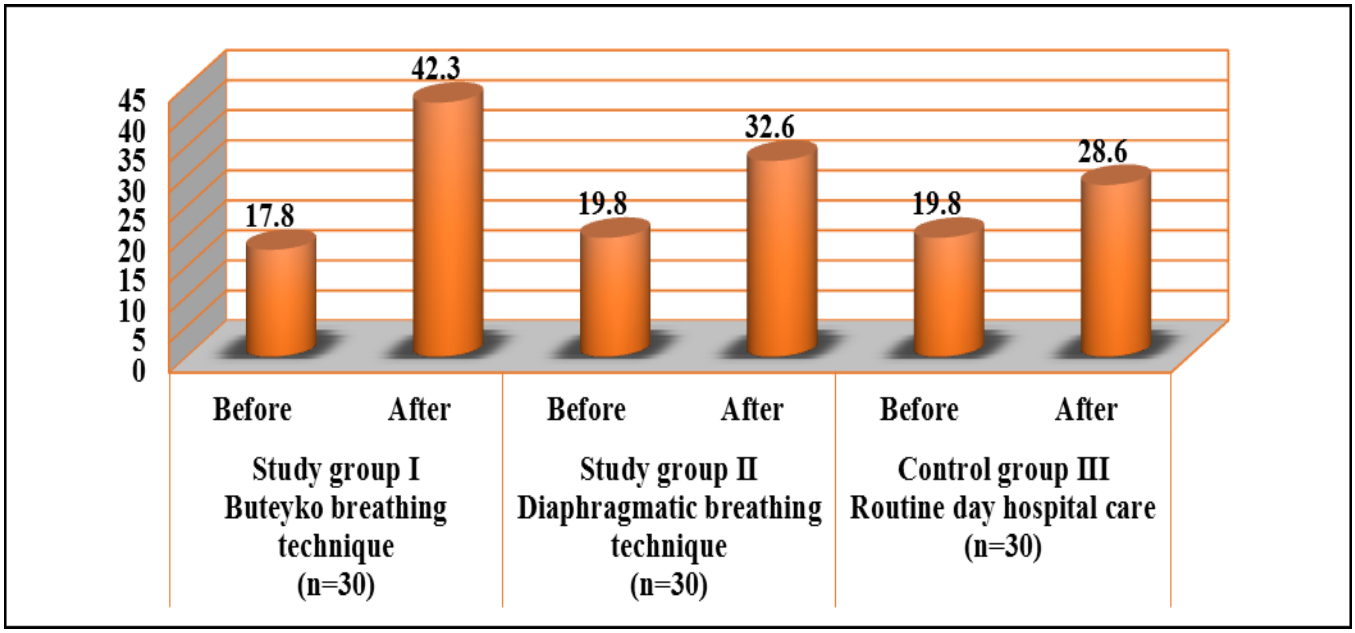

Figure (3): Mean scores of the studied children regarding control pause breathing score before and after procedure (n=90)

Table (1): Percentage distribution of the studied children regarding heart rate measurement before and after procedure.

Heart rate	Study group I Buteyko breathing technique. (n=30)				Study group II Diaphragmatic breathing technique (n=30)				Control group III Routine day hospital care (n=30)			
	Before		After		Before		After		Before		After	
	No	%	No	%	No	%	No	%	No	%	No	%
Normal (75 – 110)	14	46.7	23	76.7	17	56.7	20	66.7	14	46.7	14	46.7
Above normal (> 110)	16	53.3	7	23.3	13	43.3	10	33.3	16	53.3	16	53.3
χ^2, P	**5.711, 0.017***				2.443, 0.118				0.000, 1.000			
Range	94 : 131		90 : 130		92 : 134		85 : 130		91 : 133		90 : 131	
Mean ± SD	113.0±10.8		106.4±8.69		113.9±11.5		109.9±11.3		114.4±14.3		112.5±11.6	
t-test, P	**3.954, 0.0001****				2.048, 0.050				1.002, 0.325			

*** Statistically Significant difference at (P<0.05)**

**** Highly Statistically Significant difference at (P<0.01)**

Table (2): Percentage distribution of the studied children regarding respiratory rate measurement before and after procedure .

Respiratory rate	Study group I Buteyko breathing technique. (n=30)				Study group II Diaphragmatic breathing technique (n=30)				Control group III Routine day hospital care (n=30)			
	Before		After		Before		After		Before		After	
	No	%	No	%	No	%	No	%	No	%	No	%
Normal (18 – 24)	2	6.7	22	73.3	1	3.3	17	56.6	1	3.3	3	10.0
Above normal (> 24)	28	93.3	8	26.7	29	96.7	13	43.3	29	96.7	27	90.0
χ^2, P	**27.778, 0.0001****				**20.317, 0.0001****				1.071, 0.301			
Range	22 : 36		19 :28		24 : 35		20 :32		24 : 34		22 :33	
Mean ± SD	28.7±3.13		23.0±2.38		29.0±3.57		24.8±2.96		29.5±3.01		27.3±2.50	
t-test, P	**9.365, 0.0001****				**8.031, 0.0001****				**4.553, 0.0001****			

*** Statistically Significant difference at (P<0.05)**

**** Highly Statistically Significant difference at (P<0.01)**

Table (3): Percentage distribution of the studied children regarding oxygen saturation measurement before and after procedure.

Oxygen saturation	Study group I Buteyko breathing technique. (n=30)				Study group II Diaphragmatic breathing technique (n=30)				Control group III Routine day hospital care (n=30)			
	Before		After		Before		After		Before		After	
	No	%	No	%	No	%	No	%	No	%	No	%
Normal oxygen saturation (96 - 100%)	6	20.0	25	83.3	9	30.0	21	70.0	7	23.3	14	46.7
Mild Desaturation (91 - 95%)	24	80.0	5	16.7	21	70.0	9	30.0	23	76.7	16	53.3
χ^2, P	**24.093, 0.0001****				**9.600, 0.002****				10.729, 0.001**			
Range	92 : 96		95 : 99		93 : 97		94 : 99		93 : 97		93 : 98	
Mean ± SD	94.6±1.02		96.7±1.14		95.1±1.04		96.2±1.43		94.7±1.04		95.2±1.11	
t-test, P	**9.204, 0.0001****				**3.756, 0.001****				**2.504, 0.018***			

*** Statistically Significant difference at (P<0.05)**

**** Highly Statistically Significant difference at (P<0.01)**

Table (4): Percentage distribution of the studied children regarding peak expiratory flow rate before and after procedure.

Peak expiratory flow rate	Study group I Buteyko breathing technique. (n=30)				Study group II Diaphragmatic breathing technique (n=30)				Control group III Routine day hospital care (n=30)			
	Before		After		Before		After		Before		After	
	No	%	No	%	No	%	No	%	No	%	No	%
Levels of peak expiratory flow rate:												
Green zone (clear zone) 80-100% of child predicated value.	3	10.0	13	43.3	3	10.0	10	33.3	2	6.7	6	20.0
Yellow zone (caution zone) 50%-79% of child, predicted value.	13	43.3	12	40.0	15	50.0	12	40.0	13	43.3	12	40.0
Red zone (crisis) 50% of child predicted value.	14	46.7	5	16.7	12	40.0	8	26.7	15	50.0	12	40.0

χ^2, P	**10.553, 0.005****		4.903, 0.086		2.373, 0.305	
Score of peak expiratory flow rate						
Range	90 : 370	190 : 380	100 : 330	150 : 360	100 : 320	120 : 340
Mean ± SD	216.6±84.6	311.0±65.3	203.6±74.5	269.6±71.3	191.3±64.7	231.3±66.6
t-test, P	**7.866, 0.0001****		**9.577, 0.0001****		**7.261, 0.0001****	
Changes in peak expiratory flow rate after than before						
Range	10 : 250		10 : 180		0 : 150	
Mean ± SD	94.3±65.6		66.0±37.7		40.0±30.1	
Z value, P	**4.784, 0.0001****		**4.789, 0.0001****		**4.720, 0.0001****	
χ^2 value	**17.835**					
P	**0.0001****					

*** Statistically Significant difference at (P<0.05)**

**** Highly Statistically Significant difference at (P<0.01)**

Table (5): Correlation between sociodemographic data and peak expiratory flow rate for studied children before and after the procedure (n=90)

Socio demographic data	Study group I Buteyko breathing technique. (n=30)				Study group II Diaphragmatic breathing technique (n=30)				Control group III Routine day hospital care (n=30)			
	Before		After		Before		After		Before		After	
	R	P	R	P	R	P	R	P	r	P	R	P
Peak expiratory flow rate												
Age (Years)	0.175	0.354	0.284	0.128	0.143	0.451	0.044	0.819	0.174	0.358	0.097	0.611
Sex	0.286	0.125	0.108	0.570	0.072	0.707	0.138	0.468	0.198	0.295	0.233	0.214
Residence	-0.115	0.545	-0.139	0.463	0.041	0.830	0.033	0.862	0.075	0.694	0.043	0.867
Level of education	0.138	0.466	0.273	0.145	-0.077	0.686	0.071	0.710	0.242	0.198	0.148	0.436
Duration of admission/ length of hospital stay (days)	-0.050	0.792	-0.024	0.900	0.100	0.598	0.117	0.537	-0.081	0.669	0.150	0.430

Discussion

lower respiratory tract infection is one of the most prevalent infectious diseases in children is, it is the fifth reason for mortality worldwide and the most common infectious cause of death in children.[14]

Non-pharmacological interventions have gained attention in the treatment of lower respiratory tract infection as breathing exercises.[15]The current study was conducted to evaluate the effect of buteyko breathing technique versus diaphragmatic breathing on

clinical outcomes for children with lower respiratory tract infection.

It was evident that 53.3% , 46.7% and 40% were between 6-8 years respectively in buteyko, diaphragmatic and control group. The researcher illustrates that the current result may be due to young age children had higher predominance of lower respiratory tract infections . **Rodman (2022)** who in the same direction and reported that during the study period, the mean age of children with lower respiratory tract infection was 7.4 years.(16)

As regard types of lower respiratory infection, the current study showed that pneumonia was the most frequent type of lower respiratory tract infection. The current findings may attributed to pneumonia was the most prevalent infection in children and main reason for pediatric hospitalizations. **Ramesh(2021)** whose results were congruent with the present results and stated that bronchopneumonia was the more common diagnosis for lower respiratory tract infection among children under twelve years.(17)

Regarding control pause breathing score, the present study showed that buteyko breathing technique was more effective in increase mean scores of the studied children regarding control pause breathing score after procedure than diaphragmatic breathing technique.

The researcher illustrates that the current result may be due to the improvement in the post test to the decrease of the body sensitivity to CO_2 level in the blood as buteyko breathing technique involving a period of breath holding interspersed with periods of shallow breathing , which leads to dilatation of smooth muscles of respiratory system, and therefore optimizes ventilation perfusion matching.

This finding was in the same line with **Priyalatha (2018)** who supported the current result and reported that buteyko breathing technique was significantly effective in improving control pause breathing score in children .(18) While **Afshan (2020)** who disagreed with the current findings and stated that there was significant improvement in breath holding time, control pause breathing test of post-cardiac surgery group after using incentive spirometer when compared to the buteyko breathing technique group .(19)

The results of the present study showed that there were statistically significant differences decrease in the mean scores of pulses, respiratory rate after buteyko breathing technique. These findings may be due to that reduction in heart rate may come from the relaxation state in all system of the body that presented by a drop in the heart rate and buteyko exercise is designed to slow down or reduce the lungs' air intake to reduce interference with the respiratory tract in infection after buteyko exercise.

This finding was supported by **Hassan (2022)** who reported that there were highly statistically significant differences regarding decrease of means respiration and heart rates of children who received buteyko breathing technique after the procedure. (20) While **Rai ,Hembrom, Sharma (2018)** who disagreed with these findings and recorded that the heart rate in the post-test was higher than that in the pre-test after practice of buteyko breathing exercise .(21)

Concerning the diaphragmatic group, the current study showed that there was a statistically significant difference in the studied children regarding decrease mean of respiratory rate after diaphragmatic breathing exercise and no statically significant regarding heart rate .

The justification of the researcher toward the current results may be due to diaphragmatic breathing requires slow, rhythmic inspiration and expiration with emphasis on the diaphragm muscle moving downward on

inhalation and upward on exhalation. The exhalation phase is prolonged than the inhalation phase leading to a decrease in respiratory rate.

This finding was in the same line with **Mendes (2019)** who noticed that there was a significant decrease in the breathing rate and a significant increase in inspiratory time and expiratory time were observed for diaphragmatic breathing group. [22]

Regarding mean scores of oxygen saturation , the result of the current study revealed that there were statistically significant differences among the studied children of buteyko and diaphragmatic groups after procedure .The current result may be illustrated on the basis that buteyko breathing technique is aimed to reduce pulmonary ventilation which will increase the carbon dioxide levels in human body. The increase of carbon dioxide levels is leading to an increase in the oxygen partial pressure that forces the oxygen to be released from the hemoglobin, it was increase the oxygen delivery into the tissues and cells.

This finding was in the same line with **Sullivan(2019)** who mentioned that buteyko breathing technique assists in balancing the CO_2 levels, causing smooth oxygenation, and can help decrease the occurrence of hypoxia and hyperventilation .[23]

Regarding diaphragmatic breathing exercises have direct effect on the oxygen saturation as ventilation become easy and an child can inhale maximum oxygen after normal expiration .Through diaphragmatic breathing exercise, diaphragm fully expands and more air is inhaled in the lungs which leads toward increase in the stamina and flexibility of the respiratory muscles and improve oxygen saturation. **Russo(2017)** who reached the same result and notified that there diaphragmatic breathing has various physiological effects in humans which decreased alveolar dead space and increasing the arterial oxygen saturation. [24]

Regarding peak expiratory flow rate , the current study revealed that there were a highly statistically significant differences among children in buteyko group. The present results may be explained on the basis that buteyko breathing helps to improve bronchospasm which lead to increase maximize speed of expiration which leads to a significant improvement in peak expiratory flow rate.

This result was supported by **Rajendra (2020)** and **Hassan(2022)** who found that comparison of pre and post values of peak expiratory flow rate were done and it shows the significant improvement in peak expiratory flow rate after the intervention of buteyko breathing exercise.[25,20] On the contrary **Arora (2019)** who mentioned that the there was no statistically significant difference in peak expiratory flow rate and functional capacity suggesting that both conventional physiotherapy and buteyko breathing did not bring about an improvement in peak expiratory flow rate and functional capacity.[26]

It was found that there was a positive non-significant correlation between age, sex and level of education of children in buteyko ,diaphragmatic and control groups and their peak expiratory flow rate before and after the procedure. This result can be explained that socio demographic characteristic of children in three groups was nearly equal and this may reflect buteyko and diaphragmatic breathing technique effect not controlled by age ,sex or educational level, but can give a significant effect for all children .

This result was in agreement with **Mohamed (2019)** who notified that after application of the buteyko breathing exercise, there were no statistically significant correlation amongst among the study group's age, gender and risk factors with asthma control levels.[27] Beside

Perciavalle (2017) whose results was in the same line with the current results who found in his study there were no significant changes were observed in experimental and control group were found between both sex after practice deep diaphragmatic breathing exercise.[28]

On the other hand, **Vaishnav (2020)** whose results also were against the present results as they mentioned that in buteyko group significant relations among level of peak expiratory flow rate before technique and their selected socio-demographic characteristic as level of education, residence, length of illness, age, gender, religion. [29]

Conclusion and Recommendations

Based on the findings of the present study, it can be concluded that that both buteyko and diaphragmatic breathing exercise had a positive effect on improve clinical outcomes than control group as decreasing respiratory rate and increasing oxygen saturations but the buteyko technique was more effective in improve clinical outcomes as on decreasing heart rate and improving peak expiratory flow rate than diaphragmatic technique for children with lower respiratory tract infections .

Recommendations

Based on the findings of the present study, the following recommendations are suggested:

For nurses

1-Continuous in-service educational training programs should be conducted for chest nursing staff about the application of buteyko and diaphragmatic breathing technique and its effect on improve clinical outcomes for children with lower respiratory tract infections.

2- Implementation of betyko and diaphragmatic breathing technique should be endorsed as a part of the routine care for lower respiratory tract infections children to improve clinical outcomes.

For hospital administration

1- Hospital managers are encouraged to include buteyko and diaphragmatic breathing techniques in the training program for chest nurses and recommended to be included in the hospital protocol for the management of lower respiratory tract infections.

For future nursing researches

1- Replication of the study using a larger probability sample from different geographical areas, on various age groups, and on other breathing exercises procedures to attain more generalization of results.

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