Indonesian Journal of Global Health Research
Volume 6 Number 5, October 2024
e-ISSN 2715-1972; p-ISSN 2714-9749
http://jurnal.globalhealthsciencegroup.com/index.php/IJGHR

EFFECTIVENESS OF CYCLIC SIGHING ON RESPIRATORY RATE AND FUNCTION IN PATIENTS WITH PNEUMONIA

Asni Hasaini*, Muhlisoh, Martini Nur Sukmawaty
Depart of Nursing, Sekolah Tinggi Ilmu Kesehatan Intan Martapura, Jl. Samadi No.1, Jawa, Martapura, Banjar, Kalimantan Selatan 71213, Indonesia
*asnihasaini87@gmail.com

ABSTRACT
Pneumonia is a major cause of morbidity and mortality worldwide, occurring not only in those aged >65 years but also in adults with comorbid conditions. The prognostic factor of pneumonia is closely related to respiratory frequency so it is included in standardized prognostic tools. Cyclic sighing (CS) is a method of sighing that affects the dynamics of respiratory control. Objective : to analyze the effectiveness of cyclic sighing on respiratory frequency and pulmonary function in patients with pneumonia at RSD Idaman Banjarbaru. Method : research design Pretest-Posttest Control Group Design. The sample of this study was 20 respondents with purposive sampling divided into 2 groups, the first group was the intervention group which was given cyclic sighing treatment for 6 consecutive days with the implementation of 5 times per day for 5 minutes and the second group was the control group which received therapy according to the hospital with purposive sampling. The research instrument was an observation sheet. Bivariate data analysis using wilcoxon and mann withney tests. Result : There was a significant difference in the intervention group with the control after being given cyclic sighing on the frequency of breathing with an effectiveness value of 98.6%, but there was no difference in the intervention group with the control after being given cyclic sighing on lung function. Conclusions : It is recommended that the intervention of giving cyclic sighing can be used as one of the nursing interventions with pnemonia as a management action for complaints of tightness.

Keywords: cyclic sighing; lung function; respiration rate; pneumonia

How to cite (in APA style)
Hasaini, A., Muhlisoh, M., & Sukmawaty, M. N. (2024). Effectiveness of Cyclic Sighing on Respiratory Rate and Function in Patients with Pneumonia. Indonesian Journal of Global Health Research, 6(5), 3083-3092. https://doi.org/10.37287/ijghr.v6i5.4034.

INTRODUCTION

Pneumonia is a disease caused by infection of the lung tissue with signs and symptoms including cough, shortness of breath, and fever. Pneumonia is divided into several classifications namely community-acquired pneumonia, hospital-acquired pneumonia, healthcare-acquired pneumonia, ventilator-associated pneumonia (Hinkle, et al, 2022) Community-acquired pneumonia is a major cause of morbidity and mortality worldwide. In the adult population, pneumonia not only occurs in individuals aged >65 years who frequently experience pneumonia but also in adults with comorbid medical conditions, who often experience high rates of hospitalization and mortality. Smoking status, alcohol consumption, comorbidities, and exposure to air pollution are important risk factors that contribute to the prognosis of pneumonia (Fagerli, K, et al, 2022). According to Indonesia's 2018 Riskesdas data, pneumonia patients increased with age. In the 55- 64 age group it reached 2.5%, in the 65-74 age group it was 3.0% and in the 75 and over age group it reached 2.9% (Hatim, F, 2022). Data obtained through preliminary studies of pneumonia cases at Ansari Saleh Hospital was 409 people in 2022, which was the most common disease in Idaman Banjarbaru Hospital. Pneumonia is characterized by clinical conditions including dyspnea, fever, chest pain, and productive cough. Dyspnea is a frequent symptom in patients with acute pneumonia, but is generally not the main complaint. Dyspnea may be the chief complaint in some patients

with diffuse pneumonia, especially when the pneumonia is of nonbacterial origin (Bass JB JR, 1990).

According to the survey, prognostic factors of community-acquired pneumonia are closely related to respiratory frequency and mortality. The mortality rate in this study increased from 0 for respiratory rates below 20/min to 1.7%, 9%, and 16% for respiratory rate values in the ranges of 20 to 29, 30 to 39, and 40 to 49, respectively. The prognostic significance of respiratory rate was confirmed in many studies of acute respiratory infections in different age groups. Therefore, respiratory rate is included in standardized prognostic tools (Strauß R, et al, 2014). During normal breathing, oxygen is transferred to the body through blood circulation. However, in pneumonia with most risk factors in smokers, there is an abnormality where carbon monoxide is transferred more to the body, resulting in respiratory problems such as shortness of breath and cough in the acute stage (Zahra, 2020). Deep breathing exercises can help improve oxygen saturation and lung function by improving inhalation and exhalation. Breathing volume is the amount of air inhaled, exhaled, and stored in the lungs at any given time (Zahra, 2020). Although there is literature regarding the effectiveness of deep breathing exercises on respiratory conditions, the types of deep breathing exercises that have been studied are mostly diapragmatic breathing and pursed lift breathing in pneumonia, no one has examined the effectiveness of cyclic sighing breathing in pneumonia.

Cyclic sighing (CS) is a method of sighing that is one of the elements that affect the dynamics of respiratory control. CS serves as a resetting mechanism to restore optimal breathing regulation when breathing variability deviates from optimal balance "sighing" appears to reset the balance between irregular and regular breathing variability restoring respiratory stability and sensitivity (Vlemincx E, et al, 2013). There is a relationship between breath training methods and lung function and the most cases in Ansari Saleh Hospital are pneumonia, therefore prospective researchers are interested in conducting research on cyclic sighing breath training on respiratory rate and lung function.Based on the results of the preliminary study, it was found that no one knew about non- pharmacological management, namely Cyclic Sighing Breathing, which can normalize respiratory rate and lung function in patients with pneumonia. This study aims to determine the effectiveness of Cyclic Sighing Breathing that can normalise respiratory frequency and lung function in pneumonia patients at Idaman Banjarbaru Hospital so that it can be an alternative intervention in the management of tightness

METHOD

This research design is Pretest-Posttest Control Group Design. The independent variable is Cyclic Sighing Breathing intervention and the dependent variable is respiratory rate and lung function. Counfounding variables are age, gender, comorbidities, smoking history, asthma history, physical activity. The sample size in this study was 20 respondents divided into 2 groups of 10 people each. The first group is the intervention group which is given Cyclic Sighing Breathing treatment which is given for 6 consecutive days with 5 times implementation with one implementation for 5 minutes so that the total duration is 25 minutes and the second group is a control group that is not given treatment but gets therapy according to the hospital with purposive sampling. The instrument used was an observation sheet. The tool needed to measure respiratory rate is a watch and lung function is a peak flow meter. Bivariate data analysis used Paired t-test and Independent t-test. The research has passed ethics at Idaman Regional Hospital, Banjarbaru City Number 025/KEPL-RSDI/II/2024.

RESULTS

Table 1.

Frequency Distribution of Respondent Characteristics in the Intervention Group and Control Group by age of patients with pneumonia (n=20)

Age	Mean	SE	SD	Min.-Max.
Intervention Group	56,50	2,53	8,00	39-65
Control Group	54,50	2,13	6,73	43-63

Based on Table 1, the mean age of the intervention group was 56.50 years old with the youngest age being 39 years old and the oldest being 65 years old. The mean age of the control group was 54.50 years old with the youngest age being 43 years old and the oldest being 63 years old.

Table 2.

Frequency Distribution of Respondent Characteristics in the Intervention Group and Control Group of Patients with Pneumonia (n=20)

Respondent Characteristics	Interventions group		Control group	
	f	%	f	%
Gender				
Male	6	60	5	50
Female	4	40	5	50
Total	10	100	10	100
Comorbidities				
Yes	4	40	8	80
No	6	60	2	20
Total	10	100	10	100
History of Asthma				
Yes	2	20	1	10
No	8	80	9	90
Total	10	100	10	100
Smoking History				
Yes	6	60	4	40
No	4	40	6	60
Total	10	100	10	100
Physical Activity				
Yes	3	30	2	20
No	7	70	8	80
Total	10	100	10	100

Based on table 2, the majority of respondents were male, 60% in the intervention group and50% in the control group. The majority of the control group had comorbidities as much as 80%, while the intervention group was 40%. Respondents did not have a history of asthma as much as 80% in the intervention group, and 90% in the control group. The majority of respondents had a history of smoking, 60% in the intervention group and 40% in the control group. The majorityof respondents who did physical activity were 70% in the intervention group and 80% in the control group.

Table 3.

Results of *Wilcoxon* Test Analysis of Breath Frequency Before and After *Cyclic Sighing*in the Intervention Group and Control Group in Patients with Pneumonia (n=20)

Intervention Group	Mean	SD	Min.-Max.	ρ value
Before	19,20	1,32	18-22	0.03
After	18,50	0,85	18-20	
Control Group				
Before	22,40	4,08	18-28	0,04
After	21,00	3,56	18-28	

Based on table 3, the mean respiratory frequency before being given *cyclic sighing* in the intervention group was 19.20x/min (SD 1.32 x/min; Min.-Max 18-22 x/min) and after 18.50 (SD1.32 x/min; Min.-Max 18-22 x/min) with a ρ value of 0.03, which means that H_0 is rejected, meaning that there is effectiveness before and after being given *cyclic sighing* on respiratory frequency. The mean frequency of breathing in the control group before was 22.40 x/min (SD 4.08 x/min; Min.-Max. 18-28 x/min) and after was 21.00 (SD 3.56 x/min; Min.-Max. 18-28 x/min) with a Pvalue of 0.04 which means H_0 is rejected, which means there is effectiveness before and after the frequency of breathing in the control group.

Table 4.

Results of *Wilcoxon test* analysis of Lung Function Before and After given to the Intervention Group and Control Group in Patients with Pneumonia at RSD Idaman Banjarbaru (n=20)

Intervention Group	Mean	SD	Min.-Max.	ρ value
Before	285	58,07	150-350	0,48
After	295	59,80	150-350	
Control Group				
Before	305	36,89	250-350	1,00
After	305	36,89	250-350	

Based on table 4, the mean pulmonary function at peak lung flow before being given *cyclic sighing* in the intervention group was 285 L/m (SD 58.07 L/m; Min.-Max 150-350 L/m) and after 295 L/m (SD 59.80 L/m; Min.-Max 150-350 L/m) ρ value>0.05 which means H_0 is accepted, meaning there is no effectiveness before and after being given *cyclic sighing* on lung function. The mean pulmonary function at peak lung flow in the control group before was 305 L/m (SD 36.89 L/m; Min.-Max 250-350 L/m) and after 305 L/m (SD 36.89 L/m; Min.-Max 250-350 L/m) ρ value>0.05 which means H_0 is accepted means there is no effectiveness before and after being given *cyclic sighing* on lung function in the control group.

Table 5.

Results of *Mann-Wittney test* analysis of the difference in mean difference between the intervention group and the control group on breathing frequency and oxygen saturation in patients with COPD at Idaman Banjarbaru Hospital (n=20).

Variables	n	Mean	SD	Min.-Max.	ρ value
Group Breathing FrequencyIntervention - Control	20	19,75	2,82	18-28	0,03
Pulmonary Function GroupIntervention - Control	20	300	48,66	150-350	0,97

Based on table 5, it was found that the mean frequency of breathing after the intervention group with control was 19.75 x/min (SD 2.82 x/min; Min.-Max 18-28 x/min) and the results of the *Mann-Whitney test* analysis were 0.03 (ρ value <0.05) which means that H_0 was rejected, meaning that there was a significant difference in the intervention

group with the control group after being given *cyclic sighing* on breathing frequency.The mean pulmonary function: peak lung flow in the intervention group with control was 300 L/m (SD 48.66 L/m; Min.-Max 150-350 L/m) and the results of the *Mann-Whitney test* analysis were 0.97 (ρ value>0.05) which means H_0 is accepted, meaning that there is no significant difference in the intervention group with the control group after being given *cyclic sighing* on lung function.

Table 6.
Results of Analysis of the Effectiveness of *Cyclic Sighing* on breathing frequency in patients with COPD at Idaman Banjarbaru Hospital (n=20)

		Normal	Increased	Total
Given cyclic *sighing*	10		0	10
		(100%)	(0%)	(100%)
Not given *cyclic sighing*		7	3	10
(according to hospital therapy)		(70%)	(30%)	(100%)

Based on the table 6, to determine the effectiveness, the two groups were evaluated as follows:

Effectiveness = 100 - (1-P1/P2)Description:
P1 = Proportion in the treatment group
P2 = Proportion in Control group
Effectiveness = 100 - (1-P1/P2)
= 100 - (1-0,01/0,7)
= 100 - 0,986
= 98,6%

It can be concluded that the effectiveness of giving *cyclic sighing* to the frequency of breathingis found that the success rate of giving *cyclic sighing* is 98.6%.

DISCUSSION

Data in Table 1 states that the average age of respondents with pneumonia in the intervention and control groups was 56.50 years and 54.50 years, respectively, with the youngest age being 39 and 43 years. The results of this study are in line with research that states pneumonia disease is related to the older the meal, the more at risk of experiencing the disease. But other studies have also shown an increased risk at a young age with smoking and alcohol abuse (Grau I, et al, 2014).As people with chronic respiratory disease with manifestations of coughing, breathlessness can be intervened with airway clearance techniques but in a less prescribed way is still often done. Although there is a lack of long-term research on airway clearance techniques, it may slow disease progression or reduce health care dependency for people with chronic secretion-producing conditions. (Lewis et al., 2012)

Another risk factor that can trigger pneumonia is smoking. Table 2 shows the results of 60% smokers in the control group and 40% in the control group. Several studies have shown that smoking and alcohol abuse are important risk factors for pneumonia. Active and passive smoking can increase pneumococcal attachment to epithelial cells and increase oropharyngeal colonization and pneumococcal infection (Beatty JA et al, 2016; Vernatter, et al, 2013). The risk of death from pneumonia was shown to decrease as the number of quitters increased. This study provides empirical evidence that smoking cessation can reduce the risk of death from pneumonia (Kihara et al, 2022). For most patients with respiratory diseases, rehabilitation interventions such as education, physical exercise, and breathing exercises are as important as pharmacological treatment for long-term symptom control (Kang et al, 2021). Breathing consists of a variety of different behaviors that are bidirectionally regulated through

autonomic and voluntary mechanisms. One of the behavioral components is the sigh, which has different physiological and psychological roles (Severs et al, 2022).

Tables 4 and 5 show that there is no significant evidence that the cyclic sighing method improves lung function. This is in accordance with the research of Zhong et al (2022) which states that the active cycle of breathing technique performed on respondents with significant pneumonia on day 7 after surgery with a duration of 1 cycle of 15 minutes carried out for three to four cycles (Zhong J et al, 2023). According to the researchers' assumption of no change in lung function due to the already affected lung condition in patients with severe pneumonia or structural damage to the lungs, breathing exercises such as cyclic sighing may not be sufficient to improve lung function parameters such as vital capacity or FEV1 and breathing exercises may need to be performed with a certain intensity and duration to have a significant effect on lung function. If exercises are performed for short periods of time or inconsistently, changes in lung function may not be detected, and the response to breathing exercises may vary based on individual conditions, including disease severity, age, and other comorbid factors.

According to research (Pryor, 2000). Positioning can also be used to improve lung function and matching alveolar ventilation to capillary blood flow to different parts of the lungs. With some of the techniques in use today, e.g. AD, PEP mask and ACBT, positioning the patient to increase airflow to specific parts of the lungs can improve airway clearance by allowing incoming air to track behind secretions. Increased airflow can help mobilise and clear secretions. Ward, et al in (Pryor, 2000) studied several effects of deep breathing: one deep breath, a deep breath held for 5 seconds and multiple deep breaths. They concluded that retained deep breathing was the most efficient way to reduce atelectasis. Tucker and Jenkins' review suggests that the effects of thoracic expansion exercises (deep breathing) may include increasing lung volume, facilitating the removal of excess bronchial secretions and aiding the reexpansion of lung tissue (Tucker & Jenkins, 1996).

In this study, it was found that there were differences in the frequency of breathing in the intervention group respondents before and after cyclic sighing ($p = 0.03$), and in the control group ($p = 0.04$), and there were differences between the intervention group and the control group on the frequency of breathing after treatment ($p = 0.03$). Sighing is considered a deep breath reflex activated by sensory afferents such as lung stretch receptors and responds to decreased lung compliance (Severs et al, 2022). The results also showed that the success rate of cyclic sighing was 98.6% of the breath frequency. The tidal volume of breathing with a sigh, greater than twice that of normal breathing, allows the sigh to redevelop partially collapsed and under-ventilated lung regions, thereby improving lung compliance and restoring the ventilation/perfusion ratio so as to maintain normal lung function (Severs et al, 2022).

Pneumonia is an infection of the lungs and alveoli that causes inflammation and mucus production, with manifestations of difficulty breathing and increased respiratory frequency. One of the goals of breathing exercises such as "cyclic sighing" is to improve alveolar ventilation and increase oxygenation and reduce respiratory workload. Cyclic sighing affects the frequency of breathing because it can increase the vital capacity of the lungs by exercising the respiratory muscles and expanding the alveoli that are often partially collapsed in patients with pneumonia. And along with research that Active cycle breathing technique (ACBT) is effective in increasing the volume of sputum expelled, in reducing the viscoelasticity of secretions and in reducing symptoms such as dyspnea.

CONCLUSION

There is a mean difference before and after being given Cyclic sighing in the Intervention Group and Control Group in patients with pneumonia on the frequency of breathing and there is a significant difference in the intervention group with the control group after being given cyclic sighing on the frequency of breathing with an effectiveness value of 98.6% can normalize the frequency of breathing, but there is no significant difference in the intervention group with the control group after being given cyclic sighing on lung function. It is recommended that the intervention of providing cyclic sighing can be used as one of the nursing interventions in patients with pneumonia as a management action for complaints of tightness.

REFERENCES

Alwi, I. (2012). Empirical Criteria in Determining Sample Size', Formative Journal, 2(2), pp. 140-148.

Bass J.B. JR. Dyspnea. In: Walker HK, Hall WD, Hurst JW, editors. (1990). Clinical Methods: The History, Physical, and Laboratory Examinations. 3rd edition. Boston: Butterworths;mChapter 36. Available at: https://www-ncbi-nlm-nih-gov.translate.goog/books/NBK357/

Beatty JA, Majumdar SR, Tyrrell GJ, Marrie TJ, Eurich DT. (2016). Current Smoking and Reduced Mortality in Bacteremic Pneumococcal Pneumonia: A Population-Based Cohort Study. Chest.150(3):652-60. doi: 10.1016/j.chest.2016.04.020. Epub 2016 May 3. PMID: 27151328.

Fagerli K, Ulziibayar M, Suuri B, Luvsantseren D, Narangerel D, Batsaikhan P, Tsolmon B, Gessner BD, Dunne EM, Grobler AC, Nguyen CD, Mungun T, Mulholland EK, von Mollendorf C. (2022). Epidemiology of pneumonia in hospitalized adults ≥18 years old in four districts of Ulaanbaatar, Mongolia, 2015-2019. Lancet Reg Health West Pac. 10;30:100591. doi: 10.1016/j.lanwpc.2022.100591. PMID: 36419739; PMCID: PMC9677069.

Gharib AM, Stern EJ. (2001). Radiology of pneumonia. Med Clin North Am. 85(6):1461- 91

Grau I, Ardanuy C, Calatayud L, Schulze MH, Liñares J, Pallares R. (2014). Smoking and alcohol abuse are the most preventable risk factors for invasive pneumonia and other pneumococcal infections. Int J Infect Dis. 25:59-64. doi: 10.1016/j.ijid.2013.12.013. Epub 2014 May 19. PMID: 24853638.

Hage CA, Knox KS, Wheat LJ. (2012). Endemic mycoses: overlooked causes of community acquired pneumonia. Respir Med. (6):769-76.

Hatim F. (2022) World Pneumonia Day. Ministry of Health Health Services. 2022. Available at https://yankes.kemkes.go.id/view_artikel/1997/world-pneumonia-day-2022.

Hinkle JL, Cheever KH, Overbaugh KJ. (2022). Brunner & Suddarth's Textbook of Medical-Surgical Nursing 15thth edition. Philedelpia: Wolters Kluwer

J. Vernatter, L.A. Pirofski. (2013). Current concepts in host-microbe interaction leading to pneumococcal pneumonia. Curr Opin Infect Dis. 26: 277-283

Jain S, Self WH, Wunderink RG, Fakhran S, Balk R, Bramley AM, Reed C, Grijalva CG, Anderson EJ, Courtney DM, Chappell JD, Qi C, Hart EM, Carroll F, Trabue C, Donnelly HK, Williams DJ, Zhu Y, Arnold SR, Ampofo K, Waterer GW, Levine M, Lindstrom S, Winchell JM, Katz JM, Erdman D, Schneider E, Hicks LA, McCullers JA, Pavia AT, Edwards KM, Finelli L. (2015). CDC EPIC Study Team. Community-Acquired Pneumonia Requiring Hospitalization among U.S. Adults. N Engl J Med. ;373(5):415-27.

Jain V, Vashisht R, Yilmaz G, et al. (2023). Pneumonia Pathology. [Updated 2023 Jul 31]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing. Available from: https://www.ncbi.nlm.nih.gov/books/NBK526116/

Kalil AC, Metersky ML, Klompas M, Muscedere J, Sweeney DA, Palmer LB, Napolitano LM, O'Grady NP, Bartlett JG, Carratalà J, El Solh AA, Ewig S, Fey PD, File TM, Restrepo MI, Roberts JA, Waterer GW, Cruse P, Knight SL, Brozek JL. (2016). Executive Summary: Management of Adults With Hospital-acquired and Ventilator-associated Pneumonia: 2016 Clinical Practice Guidelines by the Infectious Diseases Society of America and the American Thoracic Society. Clin Infect Dis. 63(5):575-82.

Kang J, Hong J, Lee YH. (2021). Development and Feasibility Test of a Mouth Contactless Breathing Exercise Solution Using Virtual Reality: A Randomized Crossover Trial. Asian Nurs Res (Korean Soc Nurs Sci). 15(5):345-352. doi: 10.1016/j.anr.2021.12.002. Epub 2021 Dec 14. PMID: 34920173.

Kihara T, Yamagishi K, Iso H, Tamakoshi A; JACC Study Group. (2022). The association of smoking cessation with mortality from pneumonia among middle-aged and elderly community residents: The Japan Collaborative Cohort (JACC) study. Prev Med. 163:107188. doi: 10.1016/j.ypmed.2022.107188. Epub Aug 2022, 9. PMID: 35961622.

Lewis, L. K., Williams, M. T., & Olds, T. S. (2012). The active cycle of breathing technique: A systematic review and meta-analysis. Respiratory Medicine, 106(2), 155–172. https://doi.org/10.1016/j.rmed.2011.10.014

Mackenzie G. (2016). The definition and classification of pneumonia. Pneumonia (Nathan). 8:14. doi: 10.1186/s41479-016-0012-z. PMID: 28702293; PMCID: PMC5471962.

Mandell LA, Wunderink RG, Anzueto A, Bartlett JG, Campbell GD, Dean NC, Dowell SF, File TM, Musher DM, Niederman MS, Torres A, Whitney CG. (2007). Infectious Diseases Society of America. American Thoracic Society. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. Clin Infect Dis. 44 Suppl 2(Suppl 2):S27-72.

Pryor, J. A. (2000). Series "Chest Physiotherapy" Physiotherapy for airway clearance in paediatrics. European Respiratory Journal, 1, 196–204.

Sattar SBA, Sharma S. (2022). Bacterial Pneumonia. StatPearls Publishing; Treasure Island (FL)

Severs LJ, Vlemincx E, Ramirez JM. (2022). The psychophysiology of the sigh: I: The sigh from the physiological perspective. Biol Psychol. 170:108313. doi: 10.1016/j.biopsycho.2022.108313. Epub 2022 Mar 11. PMID: 35288214; PMCID: PMC9204854.

Strauß R, Ewig S, Richter K, König T, Heller G, Bauer TT. (2014). The prognostic significance of respiratory rate in patients with pneumonia: a retrospective analysis of data from 705,928 hospitalized patients in Germany from 2010-2012. Dtsch Arztebl Int.111(29-30):503-8, i-v. doi: 10.3238/arztebl.2014.0503. PMID: 25142073; PMCID: PMC4150027.

Tucker, B., & Jenkins, S. (1996). The effect of breathing exercises with body positioning on regional lung ventilation. Australian Journal of Physiotherapy, 42(3), 219–227. https://doi.org/10.1016/S0004-9514(14)60389-5.

Vlemincx E, Abelson JL, Lehrer PM, Davenport PW, Van Diest I, Van den Bergh O. (2013). Respiratory variability and sighing: a psychophysiological reset model. Biol Psychol. 93(1):24-32. doi: 10.1016/j.biopsycho.2012.12.001. Epub 2012 Dec 20. PMID: 23261937.

Zahra I., Liaqat, M., & Qadeer U. (2020). Effects of Breathing Exercises on Lung Volumes and Capacities Among Smokers. International Islamic Medical Journal.2(1): 35–39. https://doi.org/10.33086/iimj.v2i1.1829

Zhong J, Zhang S, Li C, Hu Y, Wei W, Liu L, Wang M, Hong Z, Long H, Rong T, Yang H, Su X. (2022). Active cycle of breathing technique may reduce pulmonary complications after esophagectomy: A randomized clinical trial. Thorac Cancer. 213(1):76-83. doi: 10.1111/1759-7714.14227. Epub 2021 Nov 12. PMID: 34773384; PMCID: PMC8720618.