

Exploring Acapella Therapy for Enhancing Pulmonary Parameters in Bronchiectasis patients: A Scoping Review

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ABSTRACT

Objective: To investigate the impact of acapella therapy on pulmonary function, sputum volume, and health-related quality of life (HRQOL) in individuals with bronchiectasis, supported by evidence-based research.

Methods: This systematic review was conducted in alignment with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The databases searched included PubMed, PEDro, and the Cochrane Library (Controlled Trials and Systematic Reviews). After screening, relevant data were extracted, charted, and presented through figures, tables, and narrative synthesis. Only randomized controlled trials examining the effects of acapella or PEP devices in individuals with bronchiectasis were included.

Results: This analysis, which included 255 patients from four studies, revealed diverse findings regarding respiratory interventions. The first study found no significant difference in sputum wet weight between bubble-PEP and ACBT during the intervention; however, bubble-PEP demonstrated greater sputum clearance 60 minutes post-session. The second study showed that patients in the OPEP group experienced fewer and later-onset exacerbations compared to those in the CCPT group, along with improvements in health-related quality of life, comfort, and well-being. In the third study, both ELTGOL and Positive Expiratory Pressure techniques led to significant improvements in pulmonary function, with ELTGOL producing superior outcomes. Lastly, the fourth study reported no significant baseline differences in FVC, FEV1, or FEV1/FVC between groups A and B, but both groups showed considerable post-treatment improvements, emphasizing the effectiveness of these interventions in improving respiratory function.

Conclusion: These studies highlight that all interventions contribute positively to pulmonary function and quality of life, with techniques like ELTGOL and OPEP showing distinct advantages in areas such as reducing exacerbation frequency and improving long-term sputum clearance. Further research is needed to explore these variations, assess long-term effects, and customize interventions to meet the specific needs of patients with chronic respiratory conditions.

Keywords: Acapella, Bronchiectasis, Pulmonary functions, Quality of life.

1. INTRODUCTION

Bronchiectasis is a lung condition that causes permanent bronchial dilatation and severe inflammation, as well as a persistent cough and recurrent infections. Bronchiectasis is a pathologic process that involves inflammation, recurrent infection, and bronchial-wall destruction. [Weycker, D., et al 2005]

It is a global health problem reported to affect up to 566 per 100 000 adults in the UK, [Quint, J. K., et al (2016)] 701 per 100 000 Medicare recipients in the USA [Henkle, E., et al (2018)] and over 1000 per 100 000 adults aged >40 years in China. [Zhou, Y. M., et al (2013)] Although it can be caused by a wide range of infectious, inflammatory, autoimmune and genetic

conditions, severe infections such as tuberculosis (TB) and pneumonia are believed to be the leading causes of bronchiectasis worldwide. [Dhar, R., et al (2019)] The greatest burden of bronchiectasis is therefore likely to be identified in countries with a high incidence of TB and respiratory infections. The initial report of baseline data from EMBARC-India identified that the characteristics of patients in India were markedly different to those in Europe or the USA. [Chalmers, J. D., et al (2016)] Patients in India were younger, more likely to be male, and had more severe bronchiectasis reflected in both multidimensional severity scores and radiological severity. [Dhar, R., et al (2019)] Bronchiectasis can be caused by a variety of factors, including post-infection (e.g., childhood whooping cough or tuberculosis), airway insult (e.g., aspiration of gastric contents or smoke inhalation), immune system impairment (e.g., primary ciliary dyskinesia or common variable immune deficiency), and exaggerated immune response (e.g., allergic bronchopulmonary aspergill). A considerable proportion of patients have no known cause. [Shoemark, A., et al (2007)] Previously, the emphasis has been on the involvement of external causes, including paediatric respiratory illnesses (pneumonia, pertussis, severe measles, and tuberculosis), in causing irreversible bronchial damage. Early immunization and broad antibiotic usage in childhood are expected to make postinfectious harm less relevant. The focus has shifted to the study of intrinsic abnormalities or non-infectious extrinsic insults that predispose to bronchial inflammation or infection. These include congenital abnormalities, mucociliary clearance problems, irritating aspiration, and allergic bronchopulmonary aspergillosis. Bronchiectasis can be caused by a primary immunodeficiency. In addition to panhypogammaglobulinemia, other modest humoral system problems such as antibody subclass deficit and antibody manufacturing deficiencies have been linked to pulmonary sepsis. Defects in neutrophil adhesion, respiratory burst, and chemotaxis are rare but well-known causes of bronchial sepsis and bronchiectasis, [Bogomolski-Yahalom, V., et al (1995)] which can appear in adulthood. [Schapiro, B. L., et al (1991)] Bronchial inflammation may be linked to illnesses like rheumatoid arthritis, connective tissue disorders, ulcerative colitis, and α 1-antitrypsin deficiency. Identifying the underlying etiology of bronchiectasis can have a significant impact on management. [Pasteur, M. C., et al (2000)]

Radiologically, computed tomography (CT) is the most effective way to diagnose bronchiectasis. [Do Amaral, R. H., et al (2015)] Bronchi should have a diameter smaller than the surrounding blood vessel (broncho arterial ratio). [Matsuoka, S., et al (2003)] Bronchiectasis is characterized by an increase in bronchus diameter and a failure to taper normally towards the lung's periphery. Bronchial wall thickening, mucus clogging, tree-in-bud anomalies, air trapping, mosaicism, and emphysema are other radiological findings that may accompany bronchiectasis. [Reiff, D. B., et al (1995)] Neither of these characteristics is essential for diagnosis. Bronchial dilatation can be cylindrical, varicose, or cystic, depending on its severity. [Redondo, M., et al (2016)]

Recurrent aggravations significantly predict morbidity and mortality in bronchiectasis through the progressive impairment of pulmonary function. [McShane, P. J., et al (2013)] In severe bronchiectasis flare-ups, coughing and sputum expectoration increase in addition to sputum viscosity changes. It is critical to remove secretions from patients with bronchiectasis on a daily basis, especially during acute exacerbations. Patients with moderate exacerbations are treated at home with oral medicines for ten to fourteen days. Patients with a mild to severe exacerbation. During an exacerbation, hospitalized patients get IV antibiotics and are part of an aggressive treatment program that involves one to two daily supervised airway clearing techniques (ACTs). [Silverman, E., et al (2003)]

Various devices, such as Acapella, positive expiratory pressure (PEP), and Flutter, have been utilized to control bronchiectasis. [Evans, D. J., et al (2003)]

The Acapella is a handheld device that uses positive expiratory pressure and high-frequency oscillation therapy. According to the producers, acapella may be a better alternative to existing ACTs because it takes less therapist time, can be performed at home, can be utilized in any postural drainage position, and is appropriate for patients with a wide range of pulmonary function. [Patterson, J. E., et al (2007)]

Acapella is made out of a counterweighted plug, a metal strip coupled to a lever, and a magnet. [Senthil, P., et al (2015)] Airflow oscillations occur when the plug's magnetic attraction breaks and reforms, preventing air from moving through the device. The gadget has a frequency/resistance dial that regulates the magnet's proximity to the metal strip, controlling expiratory pressure, amplitude, and frequency of oscillations. During the initial training session, patients were instructed to exhale via the device in a 3- to 4-second interval, with the frequency/resistance dial set to the minimal level. Patients were advised to exhale more or less strongly if their exhalation was too slow or quick. A manometer was added to the circuit, and the frequency/resistance dial was adjusted to maintain an expiratory pressure reading of 10-20 cm H₂O. Acapella was done in two predetermined postural drainage positions. Acapella treatment includes 10 breaths of controlled breathing. Inhale through the Acapella gadget to three-quarters of its maximum breathing capacity, 2-3 s breath hold, active exhalation to functional residual capacity, cough or forceful expiration (huff) in set cycle. [Patterson, J. E., et al (2005)]

In cases of small airway obstruction caused by retained secretions, PEP therapy provides a mechanical advantage to the airways, helping to improve ventilation. When expiratory resistance is high due to a narrowed airway lumen, the resulting airway collapse can lead to ineffective expiration and dynamic hyperinflation, which in turn can increase the work of breathing and reduce the efficiency of gas exchange. [Olsén, M. F. et al (2015)]

PEP therapy aims to mitigate these effects by introducing positive pressure during expiration. This positive pressure creates

a controlled, gradual reduction in expiratory flow, which limits the pressure drop across the airway wall, reducing the risk of airway collapse. The therapy's induced increase in airway pressure shifts the equal pressure point (EPP) to larger, more stable airways, thereby stabilizing the airways and helping to keep them open. This redistribution of pressure effectively reduces the likelihood of airway closure, allowing more complete lung emptying and improving the overall ventilation of the lungs.

The increased lung capacity observed with PEP therapy occurs as the lungs compensate for expiratory resistance. By allowing a greater inhalation volume, elastic recoil pressure increases enough to help overcome airway resistance. This increase in lung volume results in enhanced gas exchange and, with less air trapped in the lungs, functional residual capacity (FRC) is also reduced. Consequently, the inspiratory muscles operate more efficiently, as they are less hyperinflated and can work with reduced effort. Moreover, as the breathing effort decreases, patients often experience a reduction in dyspnea. The therapeutic effect of PEP on reducing airway collapse leads to a more effective expired volume and better lung emptying, contributing to an overall improvement in ventilation and gas exchange. [Olsén, M. F. et al (2015)]

Objectives

The primary aim of this review was to determine the impact of acapella on pulmonary functions in individuals with bronchiectasis.

Secondary aims included determining the effects of acapella upon sputum volume and health related quality of life (HRQOL) in individuals with bronchiectasis

2. METHODS

2.1 Types of participants

Adults with bronchiectasis of any aetiology, diagnosed according to the investigator's definition including plain-film chest radiograph, bronchography, high-resolution computed tomography (HRCT) or physician diagnosis of bronchiectasis were included. There were no exclusions based on age, gender or physiological status. Participants were considered to have an exacerbation of bronchiectasis if they had an exacerbation of symptoms (dyspnoea, increased cough or sputum production) requiring medical treatment, including hospitalisation. Participants were considered to have stable bronchiectasis if they were free from an exacerbation requiring medical treatment for a period of four weeks (O'Donnell 1998), or as defined by the investigators. It was planned to analyse studies involving participants with acute bronchiectasis separately to studies involving participants with stable bronchiectasis; however, no eligible studies of participants with acute bronchiectasis were identified.

2.2 Types of interventions

Intervention: any PEP device (mainly acapella) used with the primary intent of clearing sputum from the airways was considered. This included, but was not restricted to, 'conventional techniques', breathing exercises, but excluded suctioning. Interventions consisting of a single treatment, short term (less than seven days) and long term (greater than seven days) were included.

Control: this comprised no treatment, conventional or routine physiotherapy.

To be eligible for inclusion, an Acapella (pep device) had to be compared to a control condition. Studies only comparing one ACT to another ACT were not included.

2.3 Types of outcome measures

2.3.1 Primary outcomes

- FEV1,
- FVC,
- FEV1/FVC ratio, and
- PEFR

2.3.2 Secondary outcomes

- HRQOL
- Sputum volume

2.4 Types of studies

Randomised controlled trials (RCTs) of both parallel and cross-over design, in which a prescribed mode of PEP therapy was compared with usual care or routine physiotherapy, individuals with stable or an acute exacerbation of bronchiectasis.

2.5 Search methods for identification of studies

Electronic searches

Trials from the Cochrane Airways Group Specialised Register (CAGR), which is maintained by the information specialist for the Group. The Register contains trial reports identified from several sources:

1. Monthly searches of the Cochrane Central Register of Controlled Trials (CENTRAL), through the Cochrane Register of Studies Online (crso.cochrane.org);
2. Monthly searches of Pubmed
2. Monthly searches of CINAHL (Cumulative Index to Nursing and Allied Health Literature);

We searched all databases from 2019 till 2024 and we imposed restriction on language of publication (only English language articles were included).

2.6 Searching other resources

Reference lists of all primary studies and review articles for additional references were checked.

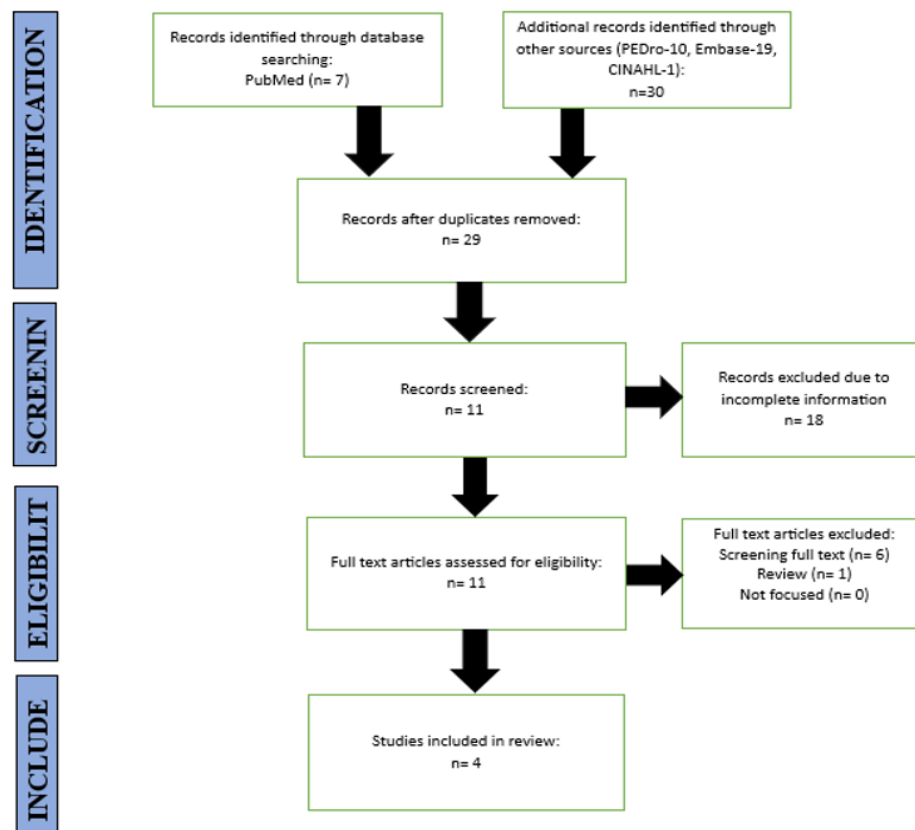
2.7 Data collection and analysis

2.7.1 Selection of studies

The titles and abstracts of all potential studies were screened, identified through the search, categorizing them as either "retrieve" (eligible, potentially eligible, or unclear) or "do not retrieve" (not eligible). We included studies published as full-text, those available only as abstracts, and unpublished data if sufficient information was provided. Full-text reports or publications were retrieved, and a single reviewer independently screened each one, selecting studies for inclusion and recording reasons for exclusion when studies were deemed ineligible. Disagreements were resolved through discussion, or by consulting a second researcher if necessary. Duplicate records were removed, and multiple reports from the same study were collated so that each unique study, rather than individual reports, served as the primary unit for review. We documented the selection process in detail to complete a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram (Figure 1) and a "Characteristics of Excluded Studies" table.

Figure 1. Study flow diagram.

PRISMA CHART



2.7.2 Data extraction

Data extraction was performed. It was carried out utilizing trial characteristics (year, design, duration), participants (age, gender), and intervention (type, duration, exercise dose, follow-up, safety). If the article data was missing or confusing, it was excluded.

2.7.3 Quality assessment of trials

The authors used an 11-point PEDro scale developed to assess the quality of RCTs on the Physiotherapy Evidence Database to identify the methodological quality of the evidence they had gathered. This scale was based on an initial list prepared by Verhagen et al. using the Delphi consensus procedure. The trials' quality was assessed independently. To eliminate ambiguity in responses, each criterion was rated as either yes (score = 1) or no (score = 0). After adding up all the responses (up to a maximum score of 10), the methodological quality of each included study was assigned a total score. Based on the overall ratings received, studies were then rated as poor (score of 4), fair (score of 4 or 5), good (score of 6-8), and excellent (scoring >8).

Table 1: Various researches considered for article on Acapella

S. No.	Author (year & place)	Title	Study design	Sample size	Population	Intervention group	Control group	Outcome	Conclusion
1.	Santos, M. D., et al (2020).	Bubble-positive expiratory pressure device and sputum clearance in bronchiectasis: A randomised cross-over study	prospective, randomised cross-over trial	35	Bronchiectasis patients	G1- Bubble PEP G2- ACBT	No intervention	wet weight of expectorated sputum during 30-min intervention, 60-min post intervention and total wet weight (30 min plus 60 min), forced expiratory volume in 1 s	Sputum wet weight was significantly greater with bubble-PEP than control at all time periods, and greater than ACBT at 60-min-post. Bubble-PEP could be considered an alternative sputum clearance technique to ACBT.
2	Chandrasekar S., et al (2022).	The Efficacy of Oscillating Positive Expiratory Pressure (OPEP) Therapy in Patients with Bronchiectasis - A Prospective Study	A Prospective Study	130	Bronchiectasis	Oscillating Positive Expiratory Pressure (OPEP) therapy using Acapella device	conventional chest physiotherapy	FEV1, sputum, SGRQ	The relatively lower exacerbation rates and their later onset, improvement in health-related quality of life, comfort and wellbeing in patients performing OPEP therapy compared with CCPT supports the use of OPEP therapy for

									airway clearance than other conventional airway clearance techniques in patients with Bronchiectasis .
3	Ashok, C. et al (2023)	Effectiveness of eltgol technique verses positive expiratory pressure technique on pulmonary function and quality of life in subjects with bronchiectasis	Experimental pre-test post-test design, comparative in nature.	60	Bronchiectasis	ELTGOL Technique	PEP therapy	FEV1/FVC ratio and SF36 Questionnaire	This study concludes that ELTGOL Technique along with conventional Physiotherapy are effective when compared to Positive Expiratory Pressure along with conventional Physiotherapy in improving Pulmonary Function and Quality of Life in subjects with Bronchiectasis
4	Abo-Zaid ¹ , S. Y., et al (2024)	Efficacy of Acapella on Spirometer Measures in Patients with Bronchiectasis	Prospective randomized controlled trial	30	Bronchiectasis patients	Acapella with routine physical therapy	Routine physiotherapy program (breathing exercises, postural drainage, Percussion as well as vibration	Spirometer measures forced vital capacity (FVC), forced expiratory volume in the first second (FEV1) as well as FEV1/FVC	Acapella is an effective device for improving spirometer measures as well as pulmonary function in patients experiencing acute exacerbation of bronchiectasis

3. RESULT

3.1 Study characteristics:

Data extraction shows overview of all the studies included for the systematic review. Studies 1 from Kerala, 1 from Egypt, 1 from Australia, 1 from Amalapuram(India) were included. All the studies were published in the year ranging from 2019 to 2024.

Characteristics of Acapella technique: included study followed the below mentioned technique for the intervention

Patients were trained to perform Acapella. For each subject, the frequency/resistance dial (range 1-5) was set to 3. This was the most the participants could bear. Every session lasted 20 to 30 minutes, with patients doing three sets of the following cycle once a day.

(1). The mouthpiece was constantly tightly sealed.

(2). The patients breathed in at 75% of their maximum inspiratory capacity for 10 breaths, held their breath for 3 seconds, and then exhaled at their functional residual capacity.

(3) followed by two or three strong puffs of expiration. [Mandal, P., et al (2012)]

Table 2 describes the findings from four of the systematic review's included research. In this scoping review, the most concerned domains in almost all of the research are FEV1, FVC, FEV1/FVC, PEF, HRQoL, and Sputum volume before and after rehabilitation, which is screened to evaluate the acapella results.

S. NO.	Author (year and place)	Study design	Sample size	Outcome	Intervention	Result	Main findings
1	Santos, M. D., et al (2020).	prospective, randomised cross-over trial	35	wet weight of expectorated sputum during 30-min intervention, 60-min post intervention and total wet weight (30 min plus 60 min), forced expiratory volume in 1 s	G1-Bubble PEP G2-ACBT	There was no significant difference in sputum wet weight between bubble-PEP and ACBT during 30-min intervention. Sputum wet weight was significantly greater in bubble-PEP than ACBT at 60-min post intervention	Bubble-PEP could be considered an alternative ACT in people with bronchiectasis
2	Chandrasekar S., et al (2022).	A Prospective Study	130	FEV1, sputum, SGRQ	Oscillating Positive Expiratory Pressure (OPEP) therapy using Acapella device	The number of exacerbations was significantly less in OPEP group compared to CCPT group and the onset of exacerbations was later in the former group. Health related quality of life, comfort and wellbeing showed improvement in OPEP group.	Relatively lower exacerbation rates and their later onset, improvement in health-related quality of life, comfort and wellbeing
3	Ashok, C. et	Experimental	60	FEV1/FVC	ELTGOL	The results of	Improved

	al (2023)	pre-test post-test design, comparative in nature		ratio and SF36 Questionnaire	technique	the study demonstrated significant improvements in both pulmonary function and quality of life for both groups, in addition to conventional physiotherapy. However, it is important to note that the ELTGOL technique showed superior results (P-Value < 0.000) compared to Positive Expiratory Pressure	pulmonary functions and quality of life
4	Abo-Zaid ¹ , S. Y., et al (2024)	Prospective randomized controlled trial	30	Spirometer measures forced vital capacity (FVC), forced expiratory volume in the first second (FEV1) as well as FEV1/FVC	Acapella with routine physical therapy	Nonsignificant differences ($p > 0.05$) were found among groups (A & B) on the pre-treatment mean values regarding FVC, FEV1 and FEV1 / FVC, whereas after treatment, there were statistically substantial variations in all evaluated variables, both within and between the two groups ($p < 0.05$)	Improved spirometer measures as well as pulmonary function

Table 2: Results of Various researches considered for article on Acapella

The first study reported no significant difference in sputum wet weight between bubble-PEP and ACBT during the intervention, but bubble-PEP showed greater sputum clearance 60 minutes after the session. The second study found that the OPEP group had fewer and later-onset exacerbations compared to the CCPT group, with additional improvements in health-related quality of life, comfort, and well-being. The third study indicated significant improvements in pulmonary function for both ELTGOL and Positive Expiratory Pressure techniques, with ELTGOL showing superior results. Finally, the fourth study observed no significant baseline differences in FVC, FEV1, and FEV1/FVC between groups A and B, but both groups showed substantial post-treatment improvements, highlighting the effectiveness of these interventions in enhancing respiratory function.

This review was to deliberate the effectiveness of innovative approach acapella on pulmonary functions in bronchiectasis patients. It has been seen that implementation of acapella technique have shown better results when compared with treatment protocol in terms of improving pulmonary functions (FEV1, FVC, FEV1/FVC, PEFR), HRQOL and sputum volume. Acapella is an upcoming technique which have shown better outcome in treating various respiratory conditions and secondary complications.

3.2 Quality of the trials.

Of the four studies, two are classified as "good," while the other two fall under the "fair" category, as presented in Table 3.

s. n o	Author s	Rand om Allocation	Conce aled allocation	Grou p Simila rity At baseli ne	Partici pant blindin g	Thera pist blindi ng	Ass es sor bli ndi ng	Adeq uate follow -up	Inten tion to treat analy sis	Betwe en group difference s report ed	Point estima tes and variab ility report er	To tal sco re (ou t of 10)	Qua lity
1	Santos, M. D., et al (2020).	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	8	Good
2	Chandra sekar S., et al (2022).	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	5	Fair
3	Ashok, C. et al (2023)	No	No	Yes	No	No	No	Yes	No	Yes	Yes	4	Fair
4	Abo-Zaid ¹ , S. Y., et al (2024)	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	7	Good

Table 3: Quality scoring of randomized controlled trials (n = 4)

4. DISCUSSION

The findings from these studies highlight important considerations for respiratory interventions aimed at improving pulmonary function and quality of life in individuals with compromised respiratory health. While various approaches were compared—including bubble-PEP, ACBT, OPEP, CCPT, and the ELTGOL technique—the results underscore the potential benefits and limitations of each intervention in different aspects of respiratory care.

First, the study comparing bubble-PEP and ACBT found no significant difference in sputum wet weight during the 30-minute intervention, indicating that both techniques are comparably effective in clearing sputum over this timeframe. However, sputum wet weight was significantly higher in the bubble-PEP group 60 minutes post-intervention, suggesting that bubble-PEP may have a prolonged effect on sputum clearance compared to ACBT. This finding could be beneficial for patients requiring extended mucus clearance beyond the intervention period. [Santos, M. D., et al (2020)] Our findings are in agreement with a study by Patterson, J.E. et al., which investigated the impact of Acapella and ACBT on sputum

expectoration. The study reported no significant difference in the weight of sputum expectorated during treatment and in the 30 minutes afterward between the two techniques [Patterson, J. E., et al (2005)].

In terms of exacerbation rates, the study comparing OPEP and CCPT reported a significantly lower number of exacerbations in the OPEP group, as well as a delayed onset of these exacerbations compared to the CCPT group. This suggests that OPEP may offer more protective benefits in preventing respiratory exacerbations, which could translate into a reduction in the frequency and severity of episodes requiring medical attention. Additionally, health-related quality of life (HRQoL), comfort, and well-being were improved in the OPEP group, supporting OPEP's role in enhancing patient satisfaction and daily functioning [Chandrasekar S., et al (2022)].

Regarding pulmonary function improvements, both groups in another study demonstrated enhanced function and quality of life when combined with conventional physiotherapy, but the ELTGOL technique showed superior results. The significant p-value ($p < 0.000$) indicates a strong effect of the ELTGOL technique on pulmonary function and highlights it as a particularly effective intervention. The data imply that ELTGOL may be more effective in enhancing airway clearance and pulmonary function, especially when integrated into a conventional physiotherapy regimen [Ashok, C. et al (2023)]. Airway clearance techniques are known to improve lung function by facilitating mucus clearance [Khokhawala, A., et al. (2021)]. ELTGOL has proven effective in removing secretions in patients with bronchiectasis and cystic fibrosis. A study by Herrero-Cortina et al. demonstrated the short-term effects of three airway clearance techniques in bronchiectasis, revealing that both autogenic drainage and ELTGOL led to greater sputum expectoration compared to temporary positive pressure. [Herrero-Cortina, B., et al. (2016)] ELTGOL works by compressing the airways to enhance air-liquid interaction in the peripheral airways, thereby promoting the movement of secretions. Its primary aim is to regulate expiratory flow to prevent airway closure and aid mucus clearance, unlike conventional postural drainage, which mainly increases mucus clearance in the dependent, lower-positioned lung. [Khokhawala, A., et al. (2021)]

Furthermore, a final study showed non-significant differences in pre-treatment FVC, FEV1, and FEV1/FVC values between groups A and B (Acapella and routine physical therapy group), but statistically significant improvements in these parameters post-treatment, both within and between groups ($p < 0.05$). This demonstrates that both interventions had a meaningful impact on lung function outcomes. Improvements in these metrics underscore the effectiveness of the respiratory therapies in enhancing forced vital capacity and expiratory volume, which are critical indicators of respiratory health. [Abo-Zaid¹, S. Y., et al (2024)] The results of this study align with the findings of Lu, X., and Qiang, Y., who conducted research in 2021 to examine the impact of Acapella training on respiratory functions. Their study concluded that the differences in FEV1, FVC, and PEF between the two groups following Acapella treatment were statistically significant ($P = .04$, $P = .047$, $P = .047$). [Lu, X., & Qiang, Y. (2021)]

4.1 Limitations and strengths

The study's strengths lie in its comparative approach across multiple respiratory techniques, providing valuable insights into each method's impact on clinical outcomes like sputum clearance, pulmonary function, and quality of life. The use of quantitative, objective measures such as FEV1 and FVC ensures clinical relevance, and the significant results for ELTGOL ($p < 0.000$) underscore its efficacy. The study also highlights prolonged benefits with bubble-PEP and OPEP, which could aid long-term management. Additionally, the focus on health-related quality of life reflects a patient-centered approach, emphasizing both comfort and clinical improvement.

However, the study's small sample size and short follow-up make it hard to see long-term effects and limit how widely the results can apply.

5. CONCLUSIONS

These studies collectively suggest that while all interventions had a positive effect on pulmonary function and quality of life, certain techniques, like ELTGOL and OPEP, may offer superior results in specific aspects, such as reducing exacerbation frequency and enhancing long-term sputum clearance. Future research should focus on further exploring these differences, examining long-term outcomes, and tailoring interventions to the individual needs of patients with chronic respiratory conditions.

5.1 Conflict of interest

There is no conflict of interest among the authors.

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