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Effectiveness Of Airway Clearance Techniques (Act) On Clinical Parameters Among Clients With Respiratory Disorders In Selected Hospitals Of Ambala Haryana

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) and Tuberculosis (TB) are major causes of chronic respiratory conditions with COPD affecting 55.1% of men and 54.8% of women globally.

Objective: The study aims to assess the effectiveness of Airway Clearance Techniques (ACT) on clinical parameters and satisfaction among clients with COPD and TB.

Research methodology: A Quasi-experimental study with a non-equivalent control group interrupted time series was used on fifty clients (25experimental, 25conventional group) from MMIMSR & Hospital, Mullana, Haryana using purposive sampling technique. The data was collected using biophysiological methods, Dyspnea scale with inter reliability k=0.8 (Cohen's kappa), and a satisfaction questionnaire with reliability=0.9 (Cronbach's alpha) before and after receiving (ACT) twice daily for three consecutive days, while the conventional group received routine care. The interventions provided to the experimental group include: percussion for 9-10 minutes, vibration for 9-10 minutes, coughing for 4-5 minutes and huffing for 4-5 minutes. Data were analyzed using SPSS version 20.

Results: The results revealed statistical significant difference between experimental and conventional groups in terms of clinical parameters: oxygen therapy (Z=2.29, p=0.02), oxygen saturation (Z=4.22,p=0.001), respiratory rate (Z=2.19,p=0.02), dyspnea (Z=3.74, p=0.001), and adventitious breath sounds (crepts:Z=2.29,p=0.02; rhonchi:Z=2.80,p=0.001). There was a significant associations of respiratory rate with age (p=0.04) and routine physiotherapy (p=0.001), adventitious breath sounds (crepts) with consistency of secretions (p=0.04, rhonchi with duration of hospital stay (p=0.02), and wheezing was associated with the presence of co-morbid illness (p=0.05) in the experimental group.

Conclusions: ACT effectively stabilizes clinical parameters in clients with respiratory disorders, demonstrating its beneficial impact on respiratory function.

Keywords: *Airway Clearance Techniques, Clinical parameters, COPD, Client with respiratory disorders, Tuberculosis.*

1. INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) and tuberculosis (TB) are major contributors to the global burden of chronic respiratory diseases. According to the Global Burden of Disease Study 2017, 544.9 million people were affected by chronic respiratory diseases, with 65 million experiencing moderate to severe airway disease. [i] In 2022, TB was the second leading infectious cause of death globally, responsible for 1.3 million fatalities, including 167,000 among individuals living with HIV. Despite being both preventable and treatable, 10.6 million people were infected worldwide, comprising 5.8 million men, 3.5 million women, and 1.3 million children. .[ii]

India has a significant TB burden, with the Global TB Report 2021 estimating an incidence rate of 188 per 100,000 population in 2020. TB notifications in the country increased by 19% in 2021, reaching 19,33,381 cases compared to 2020. WHO's dynamic country-specific models for 16 nations observed a 93% decline in TB notifications from 2019 to 2020. [iii]

Chronic respiratory diseases accounted for 10.9% of deaths in India in 2016, with northern states reporting the highest prevalence. Globally, COPD affected 65 million people and caused 5% of deaths in 2017. In Haryana, acute respiratory infections decreased from 1.06 million cases in 2018 to 0.95 million in 2019. [iv]

Airway clearance techniques (ACTs) play a vital role in managing respiratory conditions such as COPD and TB by enhancing the removal of secretions, improving gas exchange, and preventing complications. Methods like chest physiotherapy, hydration, and humidifiers significantly alleviate symptoms, reduce dyspnea, and promote lung expansion. [v]

COPD is a chronic lung condition that restricts airflow due to lung damage or mucus buildup. Symptoms include cough (with or without phlegm), difficulty breathing, wheezing, and fatigue. Smoking is a primary cause, though one in four individuals with COPD has never smoked. .[vi] A study involving participants aged 40 to 64 found that 45% of smokers also reported excessive alcohol consumption, suggesting that alcohol might contribute to COPD development, often diagnosed after age 45. [vii]

An anonymous online survey conducted with 142 critical care nursing professionals at the University of Newcastle, Australia, revealed that most nurses have used chest physiotherapy techniques in clinical practice and consider them integral to their role.[viii] While physiotherapists are primarily responsible for these techniques, nurses are uniquely positioned to contribute due to their continuous involvement in patient care. The increasing role of nurses in managing chronic diseases emphasizes the importance of continuity of care.[ix]

This study aims to evaluate the effectiveness of traditional airway clearance techniques (ACTs) implemented by nurses, focusing on clinical parameters in clients with respiratory disorders.

2. METHODS AND CLIENTS

The study was conducted at MMIMSR Hospital, Ambala, Haryana, and involved 50 clients admitted with respiratory conditions such as COPD and TB. Participants were selected through non-probability purposive sampling. Eligible clients were over 18 years of age, diagnosed with COPD or TB, exhibited adventitious breath sounds, understood Hindi or the local language, and were willing to participate. Clients diagnosed with pneumothorax, hydrothorax, haemoptysis, or those discharged during the study period were excluded.

A quasi-experimental research design with a non-equivalent control group and interrupted time series was adopted. Administrative approval was obtained from CEO of MMIMSR & Hospital Mullana. Data collection occurred in February and March 2022.

Data Collection Tools

1. **Demographic Variables Tool**: Captured individual factors such as age, gender, duration of hospital stay, smoking habits, alcohol use, tobacco chewing, and family history of respiratory diseases.
2. **Clinical Variables Tool**: Collected client clinical history through record analysis and included health-related factors from physical examinations and blood investigations.
3. **Clinical Parameters Tool**: Assessed oxygen therapy (O_2), oxygen saturation (SPO_2), respiratory rate (RR), and adventitious breath sounds.
4. **Numerical Dyspnea Scale**: Adapted the Medical Research Council (MRC) scale into a numerical format for precise dyspnea measurement. Inter-rater reliability (k=0.8) was established. The scale ranged from 0 (none) to 4 (unbearable), with simplified terms for client understanding.
5. **Client Satisfaction Tool**: A 5-point Likert scale assessed satisfaction with ACTs performed by the nurse researcher. It included six positive statements (e.g., strongly agree = 5) and four negative statements scored in reverse. Scores ranged from 10 to 50, with higher scores indicating greater satisfaction. Cronbach's Alpha reliability was 0.90.

Procedure

Clients in the experimental and conventional groups (2–3 clients daily for three days) underwent pre-tests assessing O_2, SPO_2, RR, dyspnea, and adventitious breath sounds. The experimental group received ACTs, including percussion, vibration, coughing, and huffing, administered by the nurse researcher. Post-tests measured the same clinical parameters, along with client satisfaction on day 3. The conventional group followed a similar protocol but received routine care instead of ACTs.

Results

Demographic Variables: In the experimental group, 64% were male, compared to 56% in the conventional group. Hospital stays of 5–10 days were reported by 48% of the experimental group, while 68% of the conventional group stayed 0–5 days.

Smoking history was noted in 52% of the experimental group and 36% of the conventional group, with most smokers in both groups using bidis (88% and 87.5%, respectively). Former alcohol use was reported by 40% of the experimental group and 36% of the conventional group. No significant demographic differences existed between groups ($p > 0.05$).

Clinical Variables: Both groups had 60% of clients with COPD and 40% with TB. Hypertension was prevalent in 52.9% of the experimental group and 61.5% of the conventional group. Copious secretions were observed in 60% of the experimental group and 48% of the conventional group. Elevated TLC counts were found in 40% of clients in both groups, while elevated ESR was noted in 36% of the experimental group and 40% of the conventional group. Clinical variables were statistically similar between groups ($p > 0.05$).

Effectiveness of ACTs :

Oxygen Therapy (O_2): The experimental group's median O_2 levels reduced significantly from 2 (2–4) to 1 (0.00–1.00) post-intervention, compared to the conventional group (pre-test: 2 [2–4]; post-test: 2 [0.50–3.00]). Significant differences were observed ($p = 0.02$).

- **Oxygen Saturation (SPO_2)**: Post-test SPO_2 median in the experimental group improved significantly from 92 (91–93) to 95 (93.50–97.50), with no change in the conventional group. Results were statistically significant ($p = 0.001$).
- **Respiratory Rate (RR)**: Median RR in the experimental group decreased significantly from 23 (19–26.50) to 20 (18–21.50) compared to the conventional group. Statistically significant results were noted ($p = 0.02$).
- **Dyspnea**: Experimental group dyspnea scores reduced from 2 (1.50–3) to 1 (1–2), showing significant improvement ($p = 0.001$). The conventional group showed minimal improvement.
- **Adventitious Breath Sounds**: Significant reductions were observed in crepts and rhonchi in the experimental group ($p = 0.001$).

Associations with Pre-Test Variables

- Significant associations between SPO_2 and expectorant/mucolytic use ($p = 0.04$) were found in the conventional group.
- Age and routine physiotherapy were significantly associated with RR in the experimental group ($p = 0.04$ and $p = 0.001$, respectively).
- Pre-test crepts were significantly associated with secretion consistency in the experimental group ($p = 0.04$) and hospital stay duration in the conventional group ($p = 0.001$).

Table 1: Demographic Characteristics of Clients with Respiratory Disorders in Experimental and Conventional Groups (N=50)

Variable	Experimental Group (%)	Conventional Group (%)	χ^2 (df)	p-value
Age (years)				
18–40	16.0	16.0		
41–62	48.0	52.0	0.09 (2)	0.95 NS
>62	36.0	32.0		
Gender				
Male	64.0	56.0	0.33 (1)	0.56 NS
Female	36.0	44.0		
Duration of Hospital Stay				
0–5 days	36.0	68.0		
5–10 days	48.0	24.0	5.12 (2)	0.07 NS
>10 days	16.0	8.0		

Variable	Experimental Group (%)	Conventional Group (%)	χ^2 (df) p-value
Smoking Status			
Current	20.0	28.0	
Former	52.0	36.0	0.82 (2) 0.66 ^{NS}
Never	28.0	36.0	
Type of Smoke (n = 17)			
Hukka	0.0	0.0	
Bidis	88.0	87.5	0.00 (1) 0.94 ^{NS}
Cigarettes	12.0	12.5	
Alcohol Consumption			
Current	28.0	25.0	
Former	40.0	36.0	2.84 (2) 0.24 ^{NS}
Never	32.0	52.0	
Tobacco Chewing			
Current	0.0	0.0	
Former	12.0	8.0	0.22 (1) 0.63 ^{NS}
Never	88.0	92.0	
Family History of Respiratory Disease			
Yes	16.0	8.0	0.75 (1) 0.38 ^{NS}
No	84.0	92.0	

χ^2 (1) = 3.84, χ^2 (2) = 5.99. *NS: Not significant ($p \geq 0.05$).*

The results revealed no statistically significant differences between the experimental and conventional groups regarding demographic characteristics ($p > 0.05$), as assessed by the chi-square test. This indicates that both groups were homogenous and comparable in terms of age, gender, duration of hospital stay, smoking habits, alcohol consumption, tobacco chewing, and family history of respiratory disease.

Table 2: Frequency, Percentage Distribution, and Chi-Square Analysis of Clinical Variables in Experimental and Conventional Groups (N=50)

Clinical Variables	Experimental Group (n=25)	Conventional Group (n=25)	χ^2 (df) p -value
Present respiratory diagnosis			
COPD	60.0	60.0	0.00(1) 1.00 ^{NS}
TB	40.0	40.0	
Presence of co-morbid illness			
Yes	68.0	52.0	0.33(1) 0.24 ^{NS}

Clinical Variables	Experimental Group (n=25)	Conventional Group (n=25)	χ^2 (df)	p -value
No	32.0	48.0		
HTN	52.9	61.5		
Diabetes	29.5	30.8	0.64(2)	0.72 NS
Both	17.6	7.7		
Posture (tripod)				
Yes	0.0	0.00	-	-
No	100	100		
Consistency of secretions				
Copious	60.0	48.0	0.72(1)	0.39 NS
Non-copious	40.0	52.0		
Anatomical area involved				
Whole left lung	8.0	0.0		
Whole right lung	0.0	4.0	6.23(8)	0.62 NS
All lobes	4.0	0.0		
TLC count				
Normal (4–10 Thou/mm³)	48.0	56.0		
Elevated (>10 Thou/mm³)	40.0	44.0	3.20(2)	0.20 NS
Record not available	12.0	0.0		
Treatment				
Bronchodilators	96.0	92.0	0.35(1)	0.55 NS
Corticosteroids	96.0	92.0	0.35(1)	0.55 NS
Expectorants/Mucolytics	16.0	32.0	1.75(1)	0.18 NS

χ^2 (1) = 3.84; χ^2 (2) = 5.99; χ^2 (8) = 15.51; NS: Not significant (p≥0.05)

No significant differences were observed in clinical variables between experimental and conventional groups (p > 0.05), indicating homogeneity.

Table: 3 Clinical Parameters Comparison between Experimental and Conventional Groups

Clinical Parameters	Mean Rank Experimental	Mean Rank Conventional	U Value	Z Value	P Value
O_2	27.16	23.84	198.50	2.29	0.02*
Oxygen Saturation (SPO_2)	34.16	16.84	96.00	4.22	0.001*
Respiratory Rate (RR)	21.02	29.98	200.50	2.19	0.02*

Clinical Parameters	Mean Rank Experimental	Mean Rank Conventional	U Value	Z Value	P Value
Dyspnea	18.40	32.60	135.00	3.74	0.001*
Adventitious Breath Sounds - Crepts	28.50	22.50	237.50	2.29	0.02*
Adventitious Breath Sounds - Rhonchi	29.50	21.50	212.50	2.80	0.001*
Adventitious Breath Sounds - Wheeze	27.00	24.00	275.00	1.76	0.07 NS

*P<0.05, significant. **NS**: Not significant.

This table shows significant differences in most clinical parameters between experimental and conventional groups, except for wheezing (P=0.07).

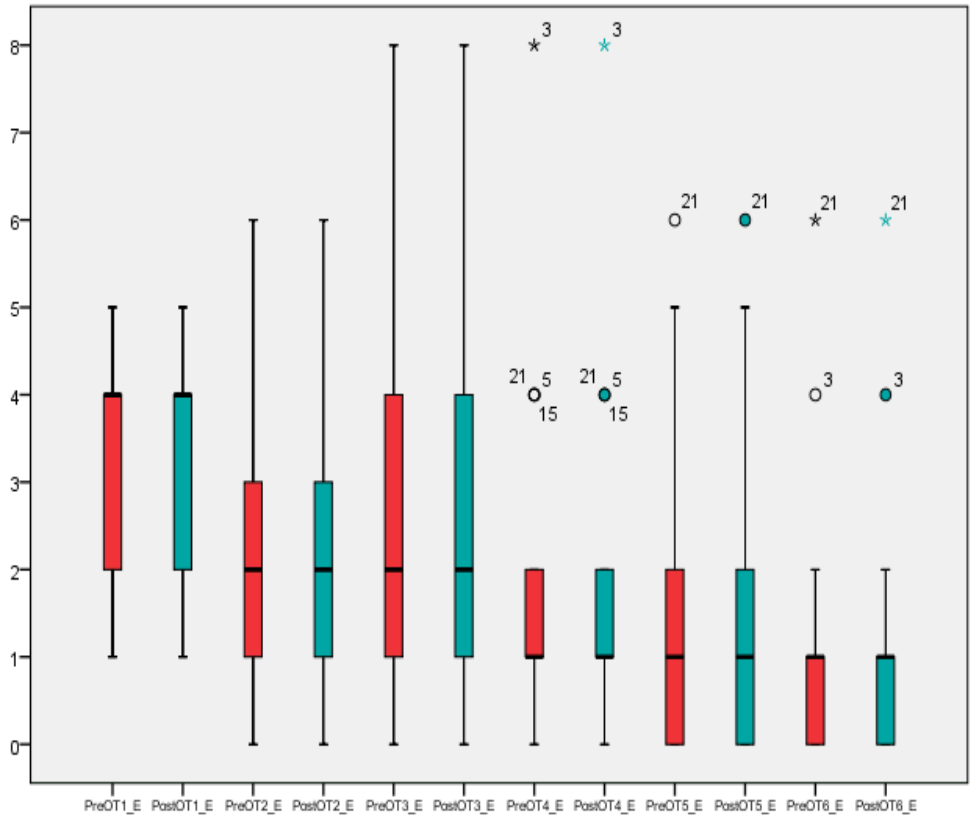

Fig- 1 Comparison of pre (1st of each pair) and post (2nd of each pair) Oxygen therapy (O_2) values in experimental group.

The figure 1 shows, the immediate pre- and post-therapy oxygen values during each session were similar, but there's a gradual decrease in values over the 3 days period. This indicates that while the immediate need for oxygen therapy stayed the same during each session, the overall need of oxygen therapy decreased gradually as the treatment progressed in experimental group.

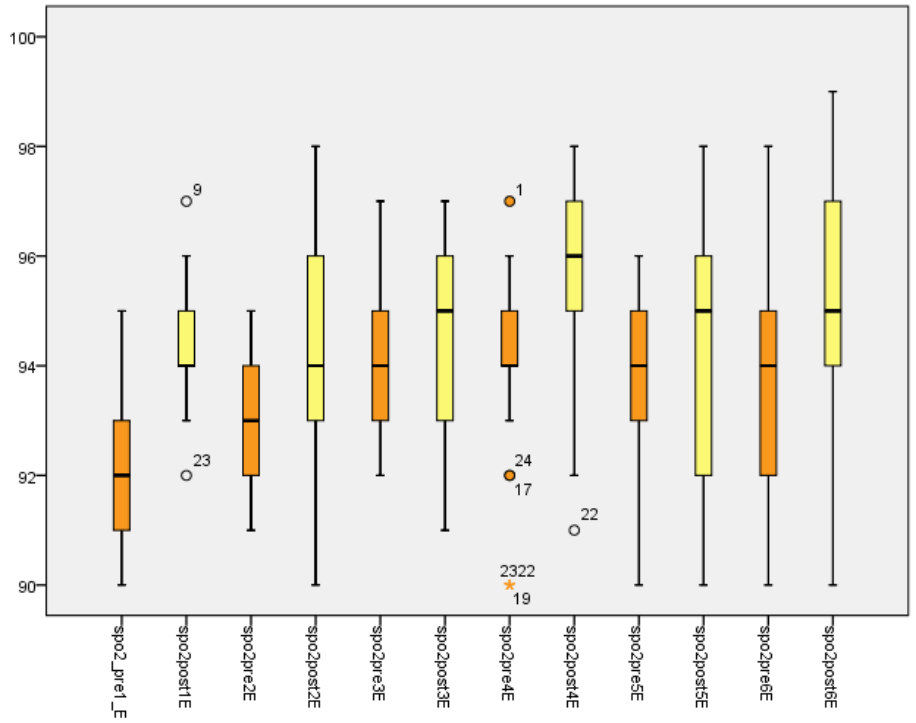

Fig- 2 Comparison of pre (1st of each pair) and post (2nd of each pair) Oxygen saturation values in experimental group.

The figure 2 shows, the immediate post-therapy oxygen saturation values during each session were increased than pre-test values, and also there's a gradual increase in values over the 3 days period. This indicates that while the oxygen saturation improved after each session, also oxygen saturation increased gradually as the treatment progressed in experimental group.

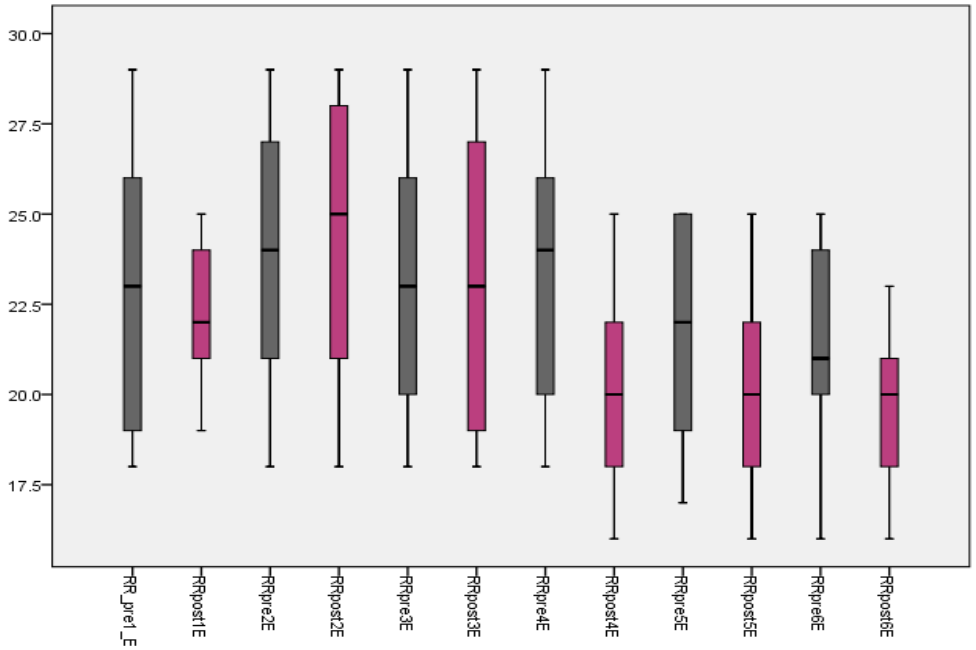

Fig- 3 Comparison of pre (1st of each pair) and post (2nd of each pair) Respiratory Rate values in experimental group.

The figure 3 shows, the post-therapy respiratory rate values during each session are consistently lower than the pre-therapy values, indicating an immediate improvement following therapy. Furthermore, there is a gradual reduction in respiratory rate

values over the 3-day period, as seen from the lower medians and narrower interquartile ranges in later sessions. This suggests that while airway clearance techniques had an immediate effect on reducing respiratory rates, the cumulative effect over time led to sustained improvement in respiratory rate when administered to experimental group.

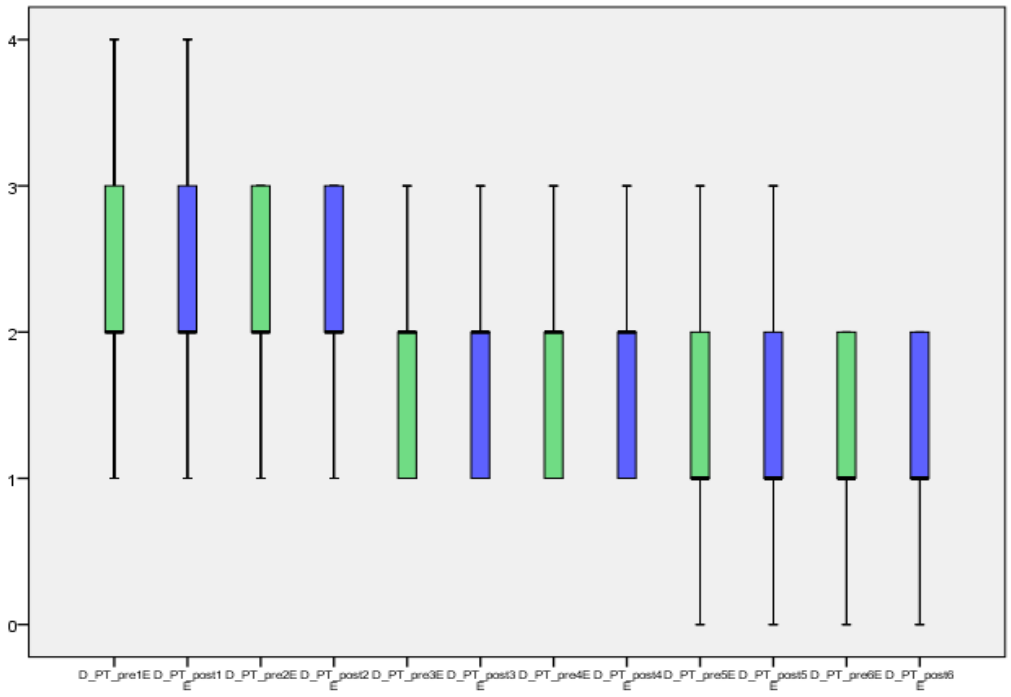

Fig- 4 Comparison of pre (1st of each pair) and post (2nd of each pair) Dyspnea values in experimental group.

The figure 4 shows, the post-therapy dyspnea values during each session are same as the pre-therapy values, indicating no immediate improvement following therapy. However, over the 3-day period, there is a slight reduction in dyspnea values, as reflected by lower medians in later sessions. This indicates the cumulative effect of airway clearance techniques over time led to sustained improvement in dyspnea, when administered to experimental group.

3. DISCUSSION

In the present study, 52% of participants in the experimental group were former smokers compared to 36% in the comparison group. Additionally, 68% of the experimental group had comorbid conditions, including hypertension (52.9%) and diabetes (61.5%), compared to 52% in the comparison group, where hypertension (29.5%) and diabetes (30.8%) were prevalent. These findings align with the study by Marina Lampalo et al[x]., which reported that 57.3% of individuals with pulmonary tuberculosis were smokers and 30.4% had diabetes. Similarly, Fernandez-Garcia S. et al[xi]. noted a mean age of nearly 70 years in their sample. However, these results contrast with Rajkumar et al[xii].'s findings, where participants were predominantly above 25 years of age.

A majority of the clients in both the experimental (64%) and comparison groups (56%) were male, consistent with Fernandez-Garcia S. et al[11].'s study, which showed 77% of participants were males. This demographic trend highlights the social and behavioral patterns often linked to chronic respiratory conditions, particularly among males. Furthermore, Fernandez-Garcia's[11] study underscores the social disadvantages faced by women with severe Chronic Obstructive Pulmonary Disease (COPD), particularly those requiring hospitalization in respiratory units.

In this study, the post-treatment median Interquartile Range (IQR) for the need for oxygen (O_2) in the experimental group was 1 (0.00–1.00), significantly lower than the pre-treatment median IQR of 2 (2–4) ($p = 0.00$). This aligns with findings by Anjalatchi et al[xiii]., which demonstrated the efficacy of nebulization combined with chest physiotherapy in improving respiratory status ($p = 0.001$). Similar results were observed in Jindani M.'s [xiv] study, where specific positioning improved oxygenation in patients, with the prone position showing the highest efficacy. Conversely, Berny S[xv]. reported no significant increase in oxygen consumption with physiotherapy or positioning ($p = 0.17$), suggesting variability in outcomes based on patient-specific factors and treatment modalities.

The post-treatment median IQR for SPO_2 in the experimental group was 95 (93.50–97.50), significantly higher than the pre-

treatment median IQR of 92 (91–93) ($p = 0.00$). These findings indicate that Airway Clearance Techniques (ACT) effectively improved oxygen saturation levels, consistent with studies by Manurung et al[xvi]. and Lestari N. et al[xvii]., which demonstrated significant improvements in SPO_2 post-chest physiotherapy ($p = 0.000$). Additionally, Meawad MA et al[xviii]. highlighted the role of chest physiotherapy in elevating oxygen saturation and arterial oxygen pressure ($p = 0.02$ and $p = 0.00$, respectively), leading to reduced ICU duration and healthcare costs.

The post-treatment median IQR for respiratory rate (RR) in the experimental group was 20 (18–21.50), significantly lower than the pre-treatment median IQR of 23 (19–26.50) ($p = 0.00$). This reduction in RR is consistent with Jiandani et al[14].'s study, which demonstrated significant improvements in cardiopulmonary responses following chest physiotherapy ($p < 0.05$). The findings support the efficacy of ACT in enhancing respiratory function and stabilizing clinical parameters.

Finally, the post-treatment median IQR for dyspnea scores in the experimental group was 1 (1–2), significantly lower than the pre-treatment median IQR of 2 (1.50–3) ($p = 0.00$). These results align with Anjalatchi et al[13].'s findings, which demonstrated the combined efficacy of nebulization and chest physiotherapy in alleviating dyspnea and improving respiratory comfort ($p = 0.001$).

In conclusion, the findings of this study underscore the significant impact of Airway Clearance Techniques on improving clinical parameters, such as oxygen therapy, oxygen saturation, respiratory rate, dyspnea and adventitious breath sounds lik crepts and rhonchi, in clients with respiratory disorders.

Conclusion

Based on the findings of the study, it can be concluded that Airway Clearance Techniques was effective in improving the Oxygen therapy, SPO_2, respiratory rate, dyspnea and adventitious breath sounds, performed by nurse researcher. The intervention led to significant improvements across these measures. These findings suggest that ACT can be a valuable tool for improving respiratory function and overall patient outcomes in clinical settings. The effectiveness of ACT highlights its potential for integration into respiratory care protocols. Following the implementation of ACT, a client satisfaction tool revealed that the majority of clients (22 out of 25, or 88%) were satisfied with the intervention. This high level of satisfaction underscores the positive reception of ACT among patients.

Declaration of interest statement

I declare no conflict of interest related to this research article. The study was conducted independently, and no external financial or personal influences affected the research outcomes.

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