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EFFECT OF GLOSSOPHARYNGEAL BREATHING AS A PHYSIOTHERAPY INTERVENTION IN PULMONARY TUBERCULOSIS

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Abstract

Objective: *To assess short-term changes in incentive-respirometer inspired volume and airway-clearance symptoms following a three-day glossopharyngeal breathing programme in hospitalized adults with pulmonary tuberculosis.*

Methodology: *This single-group quasi-experimental pretest-posttest study included 80 inpatients aged 18-60 years with drug-sensitive or drug-resistant pulmonary tuberculosis at the Institute of Chest Diseases, Kotri, Pakistan. Participants were recruited by convenience sampling and practised glossopharyngeal breathing for 20 repetitions daily for three days. Inspired volume was measured at baseline and day 3 with an incentive spirometer. Cough frequency was recorded before and after the programme; post-intervention sputum expectoration and chest tightness were assessed using a study-specific questionnaire. Paired-samples t testing was used for the inspired-volume comparison.*

Results: *Mean age was 40.51±14.26 years and 43 (53.8%) participants were male. Inspired volume increased by 430.6 mL (SD of paired difference 326.5 mL; 95% CI 358.0-503.3; $t(79)=11.796$; $p<0.001$; Cohen $dz=1.32$). Cough frequency shifted descriptively toward lower-frequency categories. After the programme, 45 (56.3%) participants reported easy sputum expectoration and 53 (66.3%) reported no or mild chest tightness. All participants reported feasibility and willingness to continue the technique.*

Conclusions: *Three days of glossopharyngeal breathing were associated with increased incentive-spirometer inspired volume and favourable symptom reports. The uncontrolled design, study-specific questionnaire and absence of diagnostic spirometry preclude causal conclusions. Controlled studies with standard pulmonary-function testing and validated airway-clearance outcomes are required.*

INTRODUCTION

Tuberculosis (TB) remains a major global public-health problem. The World Health Organization estimated 10.7 million incident TB cases in 2024, with Pakistan contributing a substantial share of the global burden. [1] Pulmonary TB commonly

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presents with cough and may be accompanied by retained respiratory secretions, impaired ventilation and persistent respiratory morbidity. Cough is also central to symptom burden and transmission. [2] Even after microbiological cure, a considerable proportion of patients experience post-TB lung disease and functional limitation, strengthening the case for appropriately designed respiratory rehabilitation across the TB care continuum. [3,4]

Airway-clearance and lung-expansion interventions aim to improve ventilation and assist secretion mobilisation. Glossopharyngeal breathing (GPB), also called frog breathing, uses coordinated movements of the lips, tongue, pharynx and glottis to deliver successive small boluses of air into the lungs. The technique can augment inspired volume and cough in selected patients, but most published work has involved neuromuscular disorders, cervical spinal cord injury or breath-hold divers rather than active pulmonary TB. [5,7,8,9,10,11,12,13,14,15] Evidence supporting cough-augmentation techniques is condition-specific, and benefits observed in neuromuscular populations cannot automatically be extrapolated to pulmonary TB. [5,6]

Evidence specifically evaluating GPB in adults with active pulmonary TB is limited. Therefore, this study aimed to determine whether a three-day GPB programme was associated with change in incentive-spirometer inspired volume and with short-term changes in cough, sputum expectoration and chest tightness.

METHODOLOGY

Study design and setting

This was a single-group, quasi-experimental pretest-posttest study conducted at the Institute of Chest Diseases, Kotri, affiliated with Bilawal Medical College, Liaquat University of Medical and Health Sciences, Jamshoro, Pakistan. Recruitment and intervention were completed during a six-month study period. The exact calendar dates were not available in the archived study records and should be inserted before journal submission.

Participants and sampling

Hospital census information indicated approximately 100 potentially eligible inpatients during the study period. A sample of 80 participants was selected using non-probability convenience sampling. The sample size was estimated using Raosoft with a 95% confidence level and 5% margin of error.

Adults aged 18-60 years with diagnosed pulmonary TB, including both drug-sensitive and drug-resistant disease, were eligible if they were hospitalized and had intact cranial-nerve function sufficient to perform the manoeuvre. Exclusion criteria were a neurological condition affecting cranial nerves, clinically significant psychological instability that precluded participation, mechanical ventilation, intubation or chest drains, temporomandibular joint dysfunction, extrapulmonary TB without pulmonary involvement, outpatient status, rib fracture, haemoptysis, recent thoracentesis, and concurrent major pulmonary conditions such as lung abscess, haemothorax or pneumothorax.

Intervention

Participants received verbal instruction and a researcher-developed video in their native language. GPB was taught as a coordinated oral-pharyngeal air-stacking manoeuvre involving the lips, cheeks, tongue and pharyngeal muscles. According to the study protocol, a cycle involved five sequential air-bolus strokes with a swallowing/pistoning action, and the exercise was repeated 20 times per day for three consecutive days. Practice was performed in the presence of the research team while participants remained on their prescribed medical management for TB.

Outcome measures

The primary outcome was the change in inspired volume displayed by an incentive spirometer from baseline to day 3. The original study records labelled this measure as “vital capacity”; however, because measurement was performed with an incentive spirometer rather than diagnostic spirometry, the endpoint is reported here as incentive-spirometer inspired volume. The manufacturer, model, calibration status and

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detailed measurement protocol were not available in the archived study records.

Secondary outcomes were obtained using a study-specific interviewer-administered questionnaire. Cough frequency was classified as none, rare, occasional, frequent or almost constant before and after the programme. Post-intervention ease of sputum expectoration was classified as no sputum, easy, somewhat difficult, very difficult or impossible. Chest tightness/discomfort was classified as none, mild, moderate, marked or severe. Participants were also asked whether GPB was feasible and whether they were willing to continue the practice. No validation data for the questionnaire were reported.

Statistical analysis

Data were analysed in IBM SPSS Statistics version 24. Categorical variables were summarised as frequencies and percentages, and continuous variables as mean and standard deviation. The pre-post inspired-volume difference was analysed with a paired-samples t test at a two-sided significance level of 0.05. For this manuscript, the 95% confidence interval and within-participant effect size (Cohen dz) were derived from the paired-difference statistics reported in the thesis. Because participant-level paired cross-tabulations for the ordinal symptom items were unavailable, the symptom outcomes are presented descriptively without inferential testing.

Ethical considerations

Written informed consent was obtained from participants before data collection. The archived study records supplied for manuscript preparation did not include the name of the approving ethics committee, approval number or approval date. These details must be inserted from the original institutional record before submission to a journal.

RESULTS

Eighty hospitalized adults with pulmonary TB were included in the analysis. Their mean age was 40.51±14.26 years. Forty-three (53.8%) were male and 37 (46.3%) were female. Twenty-one (26.3%) had drug-resistant TB and 59 (73.8%) had drug-sensitive TB (Table 1).

Table 1. Participant characteristics (n=80)

Characteristic	Category/summary	Value
Age, years	Mean ± SD	40.51 ± 14.26
Sex	Male	43 (53.8%)
	Female	37 (46.3%)
TB drug-sensitivity status	Drug-resistant	21 (26.3%)
	Drug-sensitive	59 (73.8%)

Change in inspired volume

The reported paired difference (baseline minus post-intervention) was -430.625 mL, indicating a mean increase of 430.6 mL after the three-day GPB programme. The SD of the paired difference was 326.5 mL and the standard error was 36.5 mL. The mean increase was statistically significant (95% CI 358.0-503.3 mL; $t(79)=11.796$; $p<0.001$) with a large within-participant effect size (Cohen $dz=1.32$) (Table 2). Only paired-change statistics were available in the archived analysis output; absolute pre-intervention and post-intervention group means could not be reconstructed without the original participant-level dataset.

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Table 2. Change in incentive-spirometer inspired volume after the three-day GPB programme

Mean increase (mL)	SD of paired difference (mL)	95% CI for mean increase (mL)	t	df	p-value
430.6	326.5	358.0 to 503.3	11.796	79	<0.001

Note: Cohen dz=1.32, calculated as the mean paired increase divided by the SD of the paired difference. GPB, glossopharyngeal breathing; CI, confidence interval.

Cough frequency

The cough-frequency distribution shifted descriptively toward lower-frequency categories after the intervention. The proportion reporting no or rare cough increased from 42.5% before the programme to 51.3% after it, while the proportion reporting frequent or almost constant cough decreased from 27.5% to 22.5%. No paired inferential test was performed because participant-level paired ordinal data were not available (Table 3).

Table 3. Distribution of cough frequency before and after the GPB programme

Cough-frequency category	Before GPB, n (%)	After GPB, n (%)
None	15 (18.8)	23 (28.8)
Rare	19 (23.8)	18 (22.5)
Occasional	24 (30.0)	21 (26.3)
Frequent	18 (22.5)	16 (20.0)
Almost constant	4 (5.0)	2 (2.5)
Total	80 (100)	80 (100)

Sputum expectoration, chest tightness and feasibility

After the programme, 45 (56.3%) participants reported that sputum was easy to expectorate, 18 (22.5%) reported some difficulty, four (5.0%) reported very difficult expectoration, 13 (16.3%) reported no sputum and none reported that expectoration was impossible. Chest tightness was absent in 19 (23.8%), mild in 34 (42.5%), moderate in 24 (30.0%), marked in three (3.8%) and severe in none. All 80 participants reported that GPB was feasible and that they were willing to continue it (Table 4).

Table 4. Post-intervention airway-clearance symptoms and feasibility (n=80)

Outcome	Category	n (%)
Ease of sputum expectoration	No sputum	13 (16.3)
	Easy	45 (56.3)
	Somewhat difficult	18 (22.5)
	Very difficult	4 (5.0)
	Impossible	0 (0.0)
Chest tightness/discomfort	None	19 (23.8)

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Outcome	Category	n (%)
	Mild	34 (42.5)
	Moderate	24 (30.0)
	Marked	3 (3.8)
	Severe	0 (0.0)
Feasibility	GPB feasible	80 (100)
Continuation preference	Willing to continue GPB	80 (100)

DISCUSSION

This study found that three days of GPB were associated with a mean increase of 430.6 mL in incentive-spirometer inspired volume among hospitalized adults with pulmonary TB. The within-participant effect size was large. Descriptively, the cough-frequency distribution shifted toward lower-frequency categories, more than half of participants reported easy sputum expectoration, and two-thirds reported no or only mild chest tightness after the programme. The intervention was reported as feasible by all participants. These findings suggest short-term physiological and symptom signals that justify further study, but they should not be interpreted as proof of efficacy because there was no concurrent control group.

A plausible mechanism for the increase in inspired volume is the air-stacking effect of GPB. Successive oral-pharyngeal boluses can increase lung inflation beyond a spontaneous inspiratory effort and may improve cough mechanics in people with impaired respiratory-muscle performance. [5,8,9,10,12,13,14,15] However, the strongest historical and contemporary evidence for GPB comes from neuromuscular disease, spinal cord injury and specialised breath-hold settings. [7,8,9,10,13,14,15] The present TB population is pathophysiologically different; therefore, the observed pre-post change should be viewed as hypothesis-generating rather than as direct confirmation that mechanisms established in neuromuscular cohorts operate identically in active pulmonary TB.

The symptom findings also require cautious interpretation. Cough in pulmonary TB is influenced by airway inflammation, cavitation, secretion load, treatment stage and medication exposure. [2] A reduction in reported cough frequency over three days could reflect airway clearance, natural fluctuation, concurrent anti-TB treatment, antitussive medication or response-category effects. The study did not quantify sputum volume or weight, peak cough flow, oxygenation, dyspnoea with a validated scale, or microbiological outcomes. Likewise, "easy expectoration" and chest tightness were measured only after the intervention, so improvement from a true baseline cannot be established for those variables.

The broader respiratory-rehabilitation literature supports structured rehabilitation and airway-clearance approaches for chronic respiratory impairment and post-TB lung disease, although the optimal intervention depends on the clinical phenotype. [3,4,16,17,18] Recent rehabilitation studies in TB-related lung impairment have reported improvements in functional and respiratory outcomes with multimodal programmes, but these findings do not establish GPB-specific efficacy. [17,18] Similarly, evidence for cough-augmentation techniques remains heterogeneous and, in some populations, of low certainty. [5,6] Future TB-specific studies should compare GPB with standard respiratory physiotherapy or usual care and should identify whether any benefit differs by drug-sensitivity status, radiological disease burden or baseline pulmonary impairment.

The primary physiological endpoint should be interpreted specifically as incentive-spirometer inspired volume, not diagnostic vital capacity. An incentive spirometer is a therapeutic inspiratory-volume feedback device and is not equivalent to

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full diagnostic spirometry. A definitive trial should use calibrated spirometry for forced and slow vital capacity, document device make and model, standardise repeated manoeuvres, and report absolute baseline and post-intervention means alongside change scores.

LIMITATIONS

This study has several important limitations. First, the single-group pretest-posttest design cannot separate the effect of GPB from concurrent anti-TB treatment, regression to the mean, spontaneous day-to-day variation, attention effects or other co-interventions. Second, convenience sampling at one hospital limits external validity. Third, the primary outcome was recorded with an incentive spirometer; device model, calibration details and full measurement standardisation were not reported, and absolute pre- and post-intervention group means were unavailable in the archived analysis output. Fourth, the symptom questionnaire was study-specific and no reliability or validity evidence was reported. Fifth, post-intervention sputum ease and chest tightness lacked corresponding baseline measurements suitable for direct change analysis, and paired participant-level data for cough categories were unavailable. Sixth, the assumptions underlying the paired t test, formal adverse-event surveillance, adherence beyond supervised sessions and medication use that might affect cough were not documented. These limitations substantially restrict causal interpretation.

CONCLUSION

In hospitalized adults with pulmonary TB, a three-day GPB programme was associated with a large short-term increase in incentive-spirometer inspired volume and favourable descriptive reports of cough, sputum expectoration and chest tightness. The findings support further investigation rather than routine adoption as an evidence-proven TB intervention. A controlled, adequately powered trial using standard spirometry, validated symptom measures, objective airway-clearance outcomes and detailed safety monitoring is required to determine clinical efficacy and identify which patients are most likely to benefit.

DECLARATIONS

Ethical approval: Written informed consent was documented, but the archived study records supplied for manuscript preparation did not include the ethics committee name, approval number or approval date. These details must be inserted from the original institutional approval before submission.

Informed consent: Written informed consent was obtained from all participants before enrolment.

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