



A COMPARATIVE STUDY OF ABDOMINAL BREATHING AND PURSED-LIP BREATHING ON OXYGEN SATURATION AND QUALITY OF LIFE AMONG PULMONARY TUBERCULOSIS PATIENTS

Dr. Ramiza Khalid^{1*}, Areeb Fatima² Huzaifa Usman³ Maryam Razazaq⁴ Rumaisa⁵

^{1*,2,3,4,5} College of Physical Therapy, Government College University, Faisalabad

***Corresponding Author:** Dr. Ramiza Khalid

*(College of physical therapy, Government College University Faisalabad) Contact email: drramizakhalid@gcuf.edu.pk

Abstract:

Background: Mycobacterium tuberculosis, the causative agent of tuberculosis (TB), is transmitted through airborne droplets and primarily affects the lungs. Pulmonary TB often results in mucus accumulation, leading to secondary infections, atelectasis, reduced lung capacity, respiratory muscle weakness, and potential respiratory failure. Breathing exercises, particularly abdominal breathing and pursed-lip breathing (PLB), may improve pulmonary outcomes by enhancing oxygenation and reducing respiratory distress.

Objective: This study aimed to compare the effects of DB and PLB, combined with the Active Cycle of Breathing Technique (ACBT), on oxygen saturation and quality of life in patients with pulmonary TB.

Methods:

A quasi-experimental study was conducted on 60 patients with active pulmonary TB, aged 25–65 years, recruited through convenience sampling from Allied Hospital II, Faisalabad. Participants were randomly assigned to two groups: abdominal breathing+ ACBT (n = 30) and PLB + ACBT (n = 30). Oxygen saturation and quality of life (measured using the Quality of Life for Respiratory Illness Questionnaire, QOLRIQ) were assessed at baseline, and at the 2nd, 4th, and 6th weeks. Data were analyzed using SPSS with descriptive statistics and repeated measures ANOVA.

Results:

Both interventions significantly improved oxygen saturation over time ($p < .001$). PLB yielded a slightly greater mean increase (+0.60, SD = 0.516, $p = .005$) compared to abdominal breathing (+0.56, SD = 0.527, $p = .013$). Quality of life improved significantly in both groups, with abdominal breathing showing greater improvement (+8.00, SD = 3.972, $p < .001$) than PLB (+6.30, SD = 3.199, $p < .001$).

Conclusion:

Both DB and PLB, when combined with ACBT, effectively enhanced oxygen saturation and quality of life in pulmonary TB patients. PLB was slightly more effective in improving oxygenation, while abdominal breathing showed superior effects on quality of life.

Key words: Active Cycle of Breathing Technique, Diaphragmatic Breathing, Pursed-lip Breathing, Pulmonary Tuberculosis, Respiratory Physical Therapy

Introduction:

Respiration, the fundamental process by which living organisms extract energy from nutrients, is of paramount importance to humankind. The respiratory system serves as a vital conduit between the human body and the external environment, orchestrating the exchange of gases essential for sustaining life. This intricate network facilitates the delivery of oxygen crucial for metabolic processes while efficiently expelling carbon dioxide. However, this pivotal physiological system is vulnerable to various individual and environmental factors, leading to a range of respiratory disorders.(1)

Respiratory conditions include acute infections and chronic diseases. Asthma and COPD are the most prevalent chronic respiratory diseases, impacting nearly half a billion individuals worldwide and causing almost 4 million deaths annually, with over 1 million of these deaths occurring prematurely in people under 70.(2) The global burden also includes infectious diseases such as tuberculosis and COVID-19. The COVID-19 pandemic caused unprecedented disruption, with the WHO reporting over 287 million confirmed cases and 5.4 million deaths by the end of 2021.(3)

Tuberculosis (TB), caused by *Mycobacterium tuberculosis*, remains a significant global health issue. Two billion people, or a quarter of the world's population, are at risk of TB infection, and 10.6 million people are infected annually. Despite being preventable and treatable, TB causes 1.3 million deaths each year, with 3,500 people dying daily. Pakistan ranks fifth among TB high-burden countries, with 510,000 new TB cases and 15,000 drug-resistant TB patients annually, and it has the fourth-highest incidence of multidrug-resistant TB worldwide.(4)

TB primarily affects the lungs, causing granulomas, caseous necrosis, and cavity formation(5). Advanced TB significantly reduces lung function, leading to complications such as thin-walled cavities, bronchiectasis, bronchial stenosis, pleural effusion, and pneumothorax.(6) Effective TB treatment not only benefits the patient but also the community, emphasizing the need for a multidisciplinary approach. The four basic first-line antituberculosis drugs are isoniazid, rifampicin, pyrazinamide, and ethambutol. However, treatment outcomes are poorer in cases of drug-resistant TB(7).

Pulmonary rehabilitation is essential for patients with chronic respiratory diseases, improving exercise capacity, reducing dyspnea, enhancing quality of life, and decreasing hospitalizations(8). Physical therapy, including general conditioning and chest-specific techniques, focuses on controlling phlegm retention, volume loss, tidal volumes, and respiratory failure(9). Various breathing techniques, such as diaphragmatic breathing and pursed-lip breathing, play a crucial role in rehabilitation, improving oxygen saturation, reducing fatigue, and lowering anxiety.

Diaphragmatic breathing, which facilitates outward abdominal movement and reduces upward ribcage movement during inspiration, is beneficial for conditions like hypoxia, tachypnea, and atelectasis. It helps reduce anxiety, increase oxygen saturation, and mobilize secretions(6, 10). Pursed-lip breathing, involving inhaling through the nose and exhaling through pursed lips, regulates oxygenation and ventilation, alleviating shortness of breath and improving gas exchange(11). It also enhances patients' quality of life by allowing them to manage breathlessness and relax more effectively(12).

The Active Cycle of Breathing Techniques (ACBT), consisting of three respiratory cycles performed in sequence—breathing control (BC), thoracic expansion exercises (TEE), and forced expiration technique (FET)—is associated with increased sputum production and fewer exacerbations in pulmonary patients due to improved secretion clearance(13).

In conclusion, addressing respiratory health through a combination of medical treatment and physical therapy is essential for managing both chronic and infectious respiratory diseases. Incorporating breathing techniques and rehabilitation can significantly improve patient outcomes and quality of life.

Methods:

Research design:

This was a quasi-experimental study in which participants were selected after meeting the selection criteria and by signing the consent form. 60 participants were recruited in the study and into two groups. Intervention group I (n=10) was given abdominal breathing technique and intervention group II (n=10) was given pursed lip breathing technique. Active cycle of breathing technique was given as baseline treatment to both intervention groups. Patients' oxygen saturation was measured with pulse oximeter and quality of life was measured with (QOL-RIQ) questionnaire. Follow ups were taken from both groups at 2ND 4TH and 6TH week.

Patient population and recruitment:

This study was conducted in Allied Hospital II (DHQ) Faisalabad. Already diagnosed patients were recruited in study. Consent form was filled by the patients willing to participate in study. Selection criteria were as follows:

Inclusion criteria:

- Patients diagnosed with Pulmonary TB and having active infection.
- Male and female gender
- Age: 25 -65 years old
- Oxygen saturation less than 90%
- Pulmonary TB either Drug sensitive or Drug resistance

Exclusion criteria:

- Patients with TB of any other region of body (extrapulmonary TB)
- Patients with neurological condition including cranial nerve involvement
- Patient on ventilation, any intubation or drain.
- Patients with rib fracture
- Unconscious patient.
- Patients who are unable to follow instructions.
- Agitated or confused
- Psychologically ill patients

Results:

Statistical analysis was performed using SPSS, employing descriptive statistics and mean comparisons. Demographic data was analyzed by using the descriptive analysis.

Table 1 is indicating the distribution of patients by the interventional group. Half of the patients (50.0%) were allocated to the PLB group, while the remaining half (50.0%) belonged to the abdominal breathing group, ensuring equal distribution across the two intervention arms.

Table1: Distribution Of Patients by Interventional Group					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Group I (abdominal breathing)	30	50.0	50.0	100.0
	Group II (PLB)	30	50.0	50.0	50.0
	Total	60	100.0	100.0	

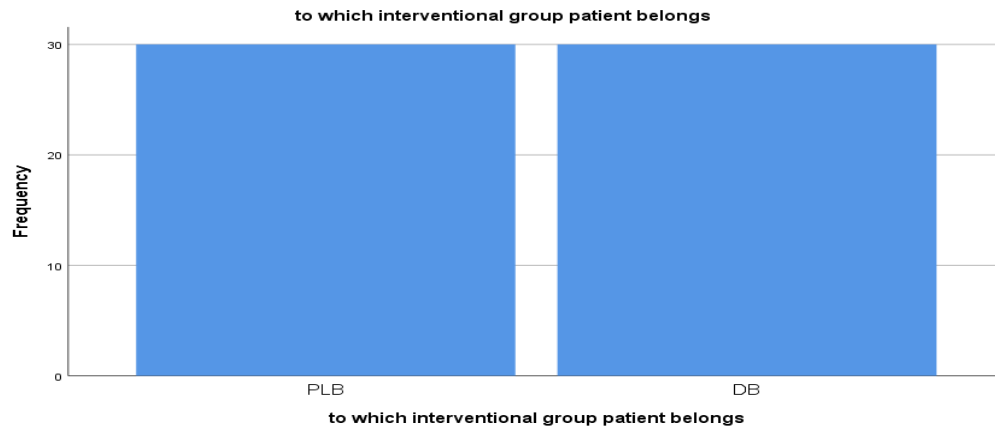


Figure 1: Frequency of pateints in each intervention group.

The table 2 presents the socio-demographic and clinical characteristics of the study participants (N=60). Slightly more than half were female (51.7%), the majority were married (93.3%), and most patients were newly diagnosed with TB (63.3%) rather than relapse cases (36.7%).

Variable	Category	Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
Gender	Female	31	51.7	51.7	51.7
	Male	29	48.3	48.3	100.0
Marital Status	Married	56	93.3	93.3	93.3
	Unmarried	4	6.7	6.7	100.0
Type of TB Disease	New	38	63.3	63.3	63.3
	Relapse TB	22	36.7	36.7	100.0

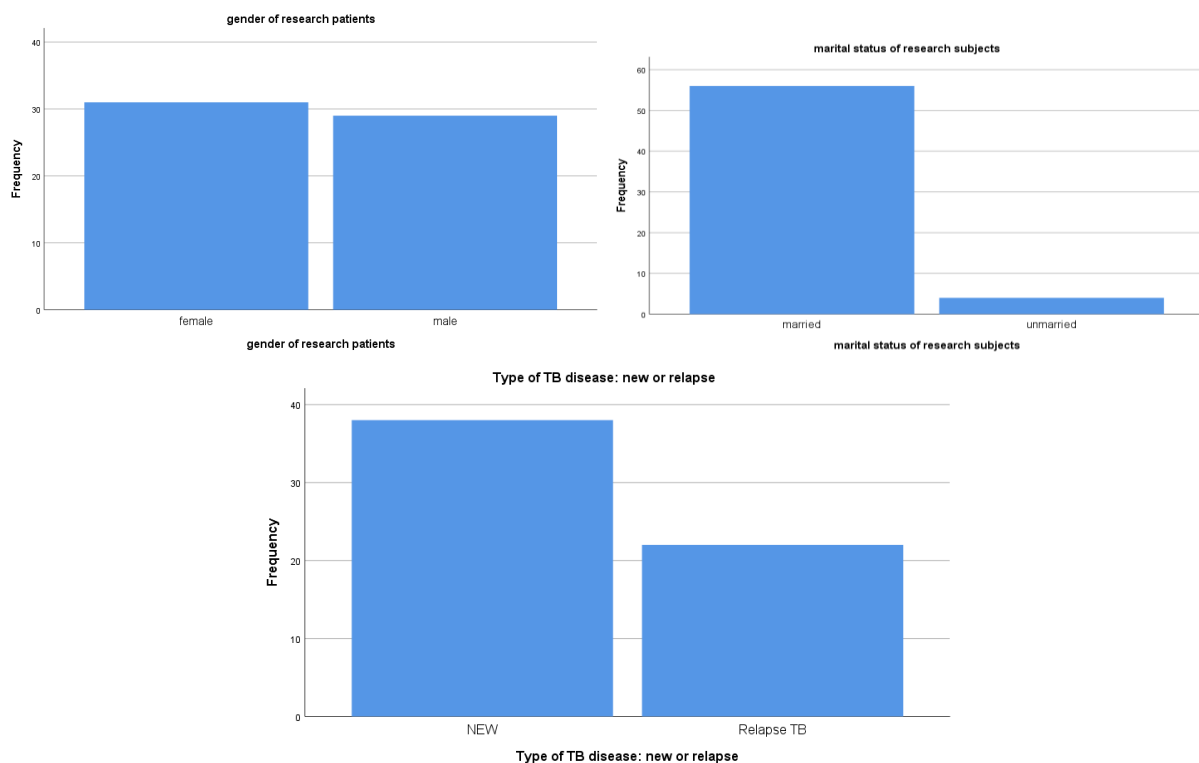


Figure 2: (a) Graph showing the gender of research patients. Slightly more than half patients were female. (b) Graph showing the marital status of research patients. Majority of the patients were married. (c) Graph showing the status of the TB disease. Most patients were newly diagnosed with TB rather than relapse cases.

Table 3 is representing the descriptive statistics of age of research patients. The mean age score of research patients was 2.72 (SD = 1.106), with a median of 3.00 and mode of 4.00. The minimum and maximum recorded values were 1.00 and 4.00, respectively.

Table 3: Descriptive Statistics of Age of Research Patients.	
Mean	2.7167
Median	3.0000
Mode	4.00
Std. Deviation	1.10610
Minimum	1.00
Maximum	4.00

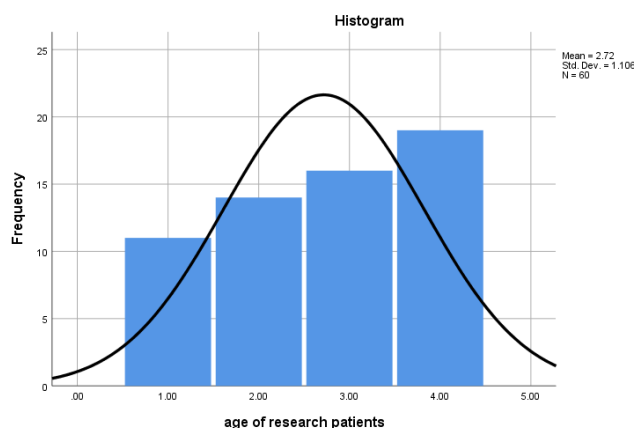


Figure 3: Histogram of Age of Research Patients (N = 60)

The histogram illustrates the distribution of age scores among research patients. The data shows a relatively normal distribution, with most patients clustered around the mid-age categories. The mean age score was 2.72, and the distribution is moderately spread (SD = 1.106).

Table 4 is indicating the descriptive statistics of oxygen saturation levels before and after intervention across groups. The table summarizes oxygen saturation levels among patients in the PLB and DB groups before intervention and at three follow-up assessments. Both groups started with the same mean oxygen saturation (87.8%) prior to intervention. Over time, oxygen saturation improved in both groups, reaching 97.7% in PLB and 97.4% in DB by the third follow-up, with comparable standard deviations, indicating consistent improvement across groups.

Table 4: Descriptive Statistics of Oxygen Saturation Levels Before and After Intervention Across Groups (N = 60)

group patient belongs		Mean	Std. Deviation	N
oxygen saturation level before intervention	PLB	87.8000	1.39951	30
	Abdominal breathing	87.8000	1.91905	30
	Total	87.8000	1.66520	60
oxygen saturation level after first follow-up of intervention	PLB	91.3000	1.98529	30
	Abdominal breathing	90.6000	1.86806	30
	Total	90.9500	1.94348	60
oxygen saturation level after PLB		94.9667	2.34128	30

second follow-up of Abdominal breathing	94.2667	2.18037	30
intervention Total	94.6167	2.27061	60
oxygen saturation level after PLB	97.6667	2.15492	30
third follow-up of Abdominal breathing	97.4000	2.04434	30
intervention Total	97.5333	2.08682	60

The table 5 presents the quality of life (QOLRIQ) scores of patients in the PLB and DB groups before intervention and at three follow-up points. At baseline, mean scores were slightly higher in the DB group (44.3) compared to PLB (42.7). Over the course of the intervention, both groups demonstrated progressive reductions in QOLRIQ scores, indicating improvement in quality of life, with the lowest mean scores observed at the third follow-up (PLB = 17.2; DB = 13.4).

Table 5: Descriptive Statistics: Descriptive Statistics of QOLRIQ Scores Before and After Intervention Across Groups (N = 60)

	to which interventional group patient belongs	Mean	Std. Deviation	N
QOLRIQ score before intervention	PLB	42.7333	5.10533	30
	DB	44.3333	10.97123	30
	Total	43.5333	8.52209	60
QOLRIQ score after first follow-up	PLB	32.6000	8.72017	30
	DB	31.7000	7.71094	30
	Total	32.1500	8.17359	60
QOLRIQ score after second follow-up	PLB	24.1000	10.78425	30
	DB	22.1333	8.18634	30
	Total	23.1167	9.54400	60
QOLRIQ score after third follow-up	PLB	17.2333	11.78744	30
	DB	13.4333	8.13966	30
	Total	15.3333	10.22404	60

Table 6 indicates the Repeated Measures ANOVA for oxygen saturation across four time points (Pre, Post1, Post2, Post3) in two groups (PLB and DB). The repeated measures ANOVA revealed a statistically significant effect of time on oxygen saturation in both PLB ($F = 723.94$, $p < .001$) and DB ($F = 777.70$, $p < .001$) groups. This indicates that oxygen saturation levels changed significantly across the four time points.

Table 6: Tests of Within-Subjects Effects for Oxygen Saturation Across Time (N = 60)

Group	Source	df	F	Sig.
PLB	Time (Greenhouse-Geisser corrected)	1.52	723.94	< .001
DB	Time (Greenhouse-Geisser corrected)	1.60	777.70	< .001

Table 7 shows the pairwise comparisons showed that oxygen saturation improved significantly from baseline to each subsequent follow-up in both groups (all $p < .001$). The greatest improvement was observed between baseline and the third follow-up (PLB: +9.9%; abdominal breathing: +9.6%).

Table 7: Pairwise Comparisons of Oxygen Saturation Across Time Points (N = 60)

Group	Comparison	Mean Difference	Sig.
PLB	Pre vs Post1	-3.50	< .001
	Pre vs Post2	-7.17	< .001
	Pre vs Post3	-9.87	< .001
Abdominal breathing	Pre vs Post1	-2.80	< .001
	Pre vs Post2	-6.47	< .001
	Pre vs Post3	-9.60	< .001

Repeated Measure Anova for the Oxygen saturation indicates Mauchly's test of sphericity was significant, so Greenhouse-Geisser correction was used. Oxygen saturation improved consistently and significantly over time in both PLB and abdominal breathing groups. The magnitude of improvement was very similar in both groups, with both reaching ~97% saturation at the third follow-up. This suggests that both interventions were equally effective in improving oxygen saturation over time.

Table 8 indicates the repeated measure ANOVA for QOLRIQ score across four time points (Pre, Post1, Post2, Post3) in two groups (PLB and abdominal breathing). Repeated measures ANOVA showed a statistically significant effect of time on QOLRIQ scores in both PLB ($F = 227.95$, $p < .001$) and DB ($F = 233.64$, $p < .001$) groups, indicating progressive improvement in quality of life across the four time points.

Table 8: Tests of Within-Subjects Effects for QOLRIQ Scores Across Time (N = 60)				
Group	Source	df	F	Sig.
PLB	Time (Greenhouse-Geisser corrected)	1.31	227.95	< .001
DB	Time (Greenhouse-Geisser corrected)	1.41	233.64	< .001

The table 9 indicates Pairwise comparisons, that revealed significant reductions in QOLRIQ scores from baseline to each subsequent follow-up in both groups (all $p < .001$). The greatest improvements were observed between baseline and the third follow-up (PLB: -25.5; DB: -30.9).

Table 9: Pairwise Comparisons of QOLRIQ Scores Across Time Points (N = 60)			
Group	Comparison	Mean Difference	Sig.
PLB	Pre vs Post1	10.13	< .001
	Pre vs Post2	18.63	< .001
	Pre vs Post3	25.50	< .001
Abdominal breathing	Pre vs Post1	12.63	< .001
	Pre vs Post2	22.20	< .001
	Pre vs Post3	30.90	< .001

Both groups (PLB and DB) showed **statistically significant improvement** in quality of life across time. Improvements followed a **linear trend**, with scores decreasing steadily at each follow-up. The **abdominal breathing group showed slightly greater reductions** in QOLRIQ scores compared to PLB, suggesting a stronger effect of this intervention on improving quality of life.

Discussion:

The primary aim of this study was to investigate the effects of abdominal breathing and pursed lip breathing (PLB), in combination with active cycle of breathing techniques (ACBT), on oxygen saturation and quality of life in patients with pulmonary tuberculosis (TB). The findings of this study demonstrated significant improvements in both oxygen saturation and quality of life (QOLRIQ scores) across all follow-up periods in both intervention groups. At baseline, mean oxygen saturation levels were identical in both groups (87.8%). Over time, repeated measures ANOVA indicated a significant effect of time in both PLB ($F = 723.94$, $p < .001$) and DB ($F = 777.70$, $p < .001$) groups (Table 6), with significant improvements observed at every follow-up point (all $p < .001$; Table 7). By the third follow-up, mean oxygen saturation increased to 97.7% in the PLB group and 97.4% in the DB group (Table 4), representing the greatest improvements from baseline (+9.9% and +9.6%, respectively). Pairwise comparisons confirmed that each time point was significantly higher than the previous, reflecting consistent improvement over the six-week intervention period.

At baseline, DB patients reported slightly higher QOLRIQ scores (44.3) compared to PLB (42.7) (Table 5). However, both groups showed progressive and significant improvements across time. Repeated measures ANOVA revealed a significant effect of time for both PLB ($F = 227.95$, $p < .001$) and DB ($F = 233.64$, $p < .001$) groups (Table 8). Pairwise comparisons demonstrated significant reductions in QOLRIQ scores from baseline to each follow-up (all $p < .001$; Table 9). By the third follow-up, mean QOLRIQ scores had reduced to 17.2 in the PLB group and 13.4 in the abdominal breathing group, indicating substantial improvements in quality of life, with greater improvements in the DB group (−30.9 vs −25.5).

These findings suggest that both interventions were effective, with PLB producing slightly greater improvements in oxygen saturation, while abdominal breathing resulted in slightly greater improvements in quality of life. This dual effect highlights the clinical utility of combining ACBT with either breathing technique depending on the targeted outcome: oxygenation or quality of life.

The results of this study are consistent with previous findings. A study by Kaur, Masih reported that breathing exercises, including pursed lip and segmental breathing, increased quality of life and reduced dyspnea in pulmonary TB patients, supporting the present findings.(14) While their study combined multiple breathing exercises, our study paired ACBT with either abdominal breathing or PLB, yet demonstrated similar improvements in both oxygenation and QOL. Specifically, our findings indicated that ACBT + abdominal breathing improved oxygen saturation by 0.56 points at the 6th week ($p = .013$), while ACBT + PLB improved oxygen saturation by 0.60 points ($p = .005$). Similarly, ACBT + abdominal breathing improved QOLRIQ by 8.0 points ($p < .001$), compared to a 6.3-point improvement with ACBT + PLB ($p < .001$).

The findings are also aligned with the systematic review by Permana, which concluded that pursed lip breathing and diaphragmatic breathing improve oxygenation in pulmonary TB patients.(15) Likewise, Hariyono and Soedarsono found that pursed lip breathing enhances oxygen saturation and reduces hyperinflation, consistent with the improvements seen in our PLB group.(16) Furthermore, Namuwali reported that breathing exercises reduce physical symptoms and depression while improving pulmonary function and health-related quality of life in TB patients, again supporting our results.(17)

Overall, both abdominal breathing and PLB combined with ACBT were significantly effective in improving oxygen saturation and quality of life in pulmonary TB patients. PLB combined with ACBT was slightly more effective in enhancing oxygen saturation, while abdominal breathing combined with ACBT was slightly more effective in improving quality of life. These findings suggest that both approaches are valuable and may be integrated into pulmonary rehabilitation programs for TB patients, with tailoring based on patient needs and treatment goals.

Conclusion:

Both PLB and abdominal breathing, combined with ACBT, are effective in improving oxygen saturation and quality of life in pulmonary TB patients. PLB shows a slightly higher initial improvement in oxygen saturation, while abdominal breathing shows a greater improvement in quality of life over time. These techniques should be incorporated into clinical practice to enhance outcomes in respiratory conditions like TB.

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