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Association of Smoking on Sputum Conversion Rate in Patient with Drug Sensitive Pulmonary Tuberculosis

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ABSTRACT

Background: Pulmonary tuberculosis is a common infectious disease and still a major public health problem in developing countries. Smoking is an important risk factor which impair lung defence and immune response, leading to poor treatment outcomes and delayed recovery in patients. **Objective:** To determine the association of smoking on sputum conversion rate in patients with drug sensitive pulmonary tuberculosis. **Study Design:** Prospective cohort study. **Duration and Place of Study:** This study was conducted from 26th March 2025 to 26th June 2025 at Department of Pulmonology, Lady Reading Hospital, Peshawar. **Methodology:** A total of 144 patients aged 18–60 years were included, with 72 smokers and 72 non-smokers. Diagnosis was made on chest X-ray and microbiological confirmation, and all patients received standard anti-tuberculous therapy. Sputum conversion was assessed after two months of treatment. Data were analysed using SPSS version 26. Chi-square test and Fisher exact test were applied. **Results:** Mean age of smokers was 39.86 ± 12.82 years and non-smokers were 40.46 ± 11.94 years. Sputum conversion was observed in 51 (70.8%) smokers and 60 (83.3%) non-smokers with relative risk 0.85 (95% CI: 0.71–1.02) and p = 0.074. Among males, conversion was significantly lower in smokers 51 (70.8%) compared to non-smokers 34 (97.1%) (p = 0.002). **Conclusion:** Smoking show negative effect on sputum conversion and delay treatment response in pulmonary tuberculosis, although overall association was not statistically significant.

INTRODUCTION

Pulmonary tuberculosis is an infectious illness that is quite common and is caused by Mycobacterium tuberculosis.[1] It is primarily a pulmonary infection. This illness is a public health problem in many developing nations. Overcrowding, malnutrition, and low socioeconomic status are contributing factors.[2] This illness is transmitted when an infected person coughs or sneezes and droplets are expelled into the air. This illness is highly transmissible in closely related communities. In terms of clinical presentation, this illness is characterized by a chronic cough accompanied by fever, night sweats, and weight loss.[3] However, this may vary among individuals. In terms of assessing this illness, sputum and radiographic studies are conducted.[4]

Smoking has been established as a risk factor for tuberculosis, with a strong association with the disease.[5] Smoking compromises the normal defense mechanisms of the respiratory tract. It also compromises the normal functioning of the mucociliary clearing mechanism, thereby making the lungs more susceptible to infection.[6] Smoking compromises the normal functioning of the immune system, making it less effective in combating Mycobacterium tuberculosis.[7] Smoking also increases the severity of the symptoms, making them more widespread in the lungs.[8]

The sputum conversion rate is considered a significant indicator of therapeutic response in drug-susceptible pulmonary tuberculosis patients.[9] It is the change in the sputum test results from positive to negative for acid-fast bacilli following the initiation of therapy. It has been established that smoking has a harmful effect on the sputum conversion rate. Smokers experience delays in sputum conversion in comparison with non-smokers.[10] This delay may be attributed to compromised immunity, chronic inflammation, and reduced effectiveness of anti-tuberculous pharmacotherapy in the smoker's population.[11] Smokers who continue with the habit during the course of therapy may experience increased bacterial loads and reduced clearance of the infection.[12]

There is an urgent need for this research to be conducted in Peshawar because pulmonary tuberculosis remains an important public health problem in this area, evidenced by the significant number of cases being reported in both rural and urban populations. Smoking is also prevalent in this area; however, its effect on sputum conversion rates

has not been clearly evaluated in this particular population. There is considerable variation in socio-economic conditions, crowdedness, and availability of healthcare services in different regions; thus, results from other regions may not be entirely applicable in Peshawar.

METHODOLOGY

This prospective cohort study was carried out at the Department of Pulmonology, Lady Reading Hospital, Peshawar from 26th March 2025 to 26th June 2025. The ethical approval certificate number was Ref. No. 134/LRH/MTI dated 13/03/2025. Sample size was calculated by taking alpha = 5%, power = 80% and confidence level = 95%, using sputum conversion rate after two months as 82.2% in non-smokers and 61.2% in smokers.[13] The estimated sample size was 144, in which 72 patients were placed in exposed group (smoker group) and 72 patients were placed in un-exposed group (non-smoker group).

Inclusion Criteria

Patients aged 18 to 60 years of either gender having drug sensitive pulmonary tuberculosis were included. Patients who were smoker were placed in exposed group and those who never smoked were placed in un-exposed group.

Exclusion Criteria

Patients having HIV infection, patients with multi-drug resistant tuberculosis or any resistance to first line drugs, and pregnant women during tuberculosis treatment were excluded from study.

Patients were evaluated for drug sensitive pulmonary tuberculosis where diagnosis was made on chest X-ray showing dense homogeneous parenchymal consolidation in any lobe along with positive Mantoux test having induration of ≥10 mm after 48–72 hours. Drug sensitivity was confirmed when Mycobacterium tuberculosis showed suppression with first line anti-tuberculous drugs including rifampin up to 1.0 µg/mL, isoniazid 0.1–0.4 µg/mL, pyrazinamide up to 100 µg/mL and ethambutol up to 5.0 µg/mL on culture using Löwenstein-Jensen medium or MGIT 960 system before start of therapy. A smoker was considered as a person who smoked more than 5 cigarettes per day for at least last 3 years, while non-smoker was taken as person who never smoked. Written informed consent was taken from all patients before data collection and confidentiality was ensured. Basic demographic details were recorded including age, gender, BMI, family socioeconomic status, profession, educational level and residential status.

Detailed history regarding their smoking status, duration of illness, and treatment history was obtained. A clinical examination was carried out. Subsequent to this, all the participants were randomly assigned to two different groups: one consisting of 72 individuals belonging to the smoker group and another group consisting of 72 individuals belonging to the non-smoker group. All patients received standard first-line anti-tubercular medications consisting of rifampin, isoniazid, pyrazinamide, and ethambutol under DOTS. Regular follow-up was carried out to monitor patient compliance and response to treatment. After completion of the intensive phase of treatment, sputum samples were reacquired and subjected to AFB smear and culture. Sputum conversion was assessed after two months of treatment. All information was recorded using a case record form. Sputum conversion was defined as the absence of growth of Mycobacterium tuberculosis in sputum culture after two months of treatment using Löwenstein-Jensen medium or MGIT 960.

All data were analysed using SPSS version 26. Categorical variables such as gender, socioeconomic status, educational level, profession, residential status and sputum conversion rate were presented as frequencies and percentages. Continuous variables like age, BMI were expressed as mean ± standard deviation. Comparison of sputum conversion rate between smoker and non-smoker groups was done by Chi-square test or Fisher exact test, taking p-value ≤ 0.05 as significant. Relative risk with 95% confidence interval was also calculated, and value more than 1 was taken significant. Stratification of sputum conversion was done with respect to age, gender, BMI, socioeconomic status.

RESULTS

In present study regarding the demographic characteristics of both groups, the mean age of smokers was 39.86 ± 12.82 years, whilst the non-smokers had a mean age of 40.46 ± 11.94 years. The mean body mass index (BMI) was recorded as 21.51 ± 2.83 in the smoker's group and 21.08 ± 3.14 in the non-smokers group. With respect to gender distribution, all smokers were male 72 (100.0%), whereas the non-smokers group comprised 35 males (48.6%) and 37 females (51.4%). Concerning place of residence, the majority of smokers were from rural areas 52 (72.2%), with the remaining 20 (27.8%) residing in urban areas; similarly, in the non-smokers group, 48 (66.7%) were from rural areas and 24 (33.3%) from urban areas. In terms of socioeconomic status, low socioeconomic status was predominant in both groups, with 45 (62.5%) smokers and 48 (66.7%) non-smokers belonging to this category, followed by middle status in 22 (30.6%) smokers and 19 (26.4%) non-smokers, and high status in 5 (6.9%) in each group. Educational levels revealed that uneducated participants constituted 26 (36.1%) in each group, primary education was noted in 25 (34.7%) smokers and 19 (26.4%) non-smokers, secondary education in 15 (20.8%) smokers and 19 (26.4%) non-smokers, and higher education in 6 (8.3%) smokers and 8 (11.1%) non-smokers. Regarding profession, smokers were mostly employed in jobs 40 (55.6%), followed by business 21 (29.2%) and housewife 11 (15.3%), whilst non-smokers were predominantly housewives 35 (48.6%), followed by those in jobs 27 (37.5%) and business 10 (13.9%) (Table 1).

In relation to the overall sputum conversion outcomes, sputum conversion was achieved in 51 (70.8%) smokers compared to 60 (83.3%) non-smokers, with a relative risk (RR) of 0.85 (95% CI: 0.71–1.02) and a p-value of 0.074, which was not statistically significant (Table 2).

In the stratified analyses by demographic variables, amongst participants aged ≤40 years, sputum conversion in the smokers was 25 (71.4%) compared to 24 (77.4%) in the non-smokers, with a RR of 0.92 (95% CI: 0.70–1.22) and p = 0.579. For those aged >40 years, sputum

conversion was observed in 26 (70.3%) smokers and 36 (87.8%) non-smokers, yielding a RR of 0.80 (95% CI: 0.63–1.02) and p = 0.055. When stratified by gender, among males, sputum conversion was seen in 51 (70.8%) smokers versus 34 (97.1%) non-smokers, with a RR of 0.73 (95% CI: 0.62–0.85) and p = 0.002, which was statistically significant. No data were available for female smokers as all smokers in this study were male. With regard to socioeconomic status, among those with low socioeconomic status, sputum conversion was recorded in 33 (73.3%) smokers and 42 (87.5%) non-smokers, with a RR of 0.84 (95% CI: 0.68–1.03) and p = 0.084; among the middle socioeconomic group, 15 (68.2%) smokers and 16 (84.2%) non-smokers achieved sputum conversion, with a RR of 0.81 (95% CI: 0.57–1.14) and p = 0.233; and among the high socioeconomic group, 3 (60.0%) smokers and 2 (40.0%) non-smokers achieved conversion, with a RR of 1.50 (95% CI: 0.41–5.45) and p = 0.527 (Table 3).

Table 1

Patient Demographics in Both Groups (n=144)

Variables	Smokers n=72	Non-Smokers n=72
	Mean ± SD	Mean ± SD
Age (years)	39.86 ± 12.82	40.46 ± 11.94
BMI	21.51 ± 2.83	21.08 ± 3.14
Gender	**n (%)**	**n (%)**
Male	72 (100.0%)	35 (48.6%)
Female	0 (0.0%)	37 (51.4%)
Residence		
Rural	52 (72.2%)	48 (66.7%)
Urban	20 (27.8%)	24 (33.3%)
Socioeconomic Status		
Low	45 (62.5%)	48 (66.7%)
Middle	22 (30.6%)	19 (26.4%)
High	5 (6.9%)	5 (6.9%)
Education		
Uneducated	26 (36.1%)	26 (36.1%)
Primary	25 (34.7%)	19 (26.4%)
Secondary	15 (20.8%)	19 (26.4%)
Higher	6 (8.3%)	8 (11.1%)
Profession		
Job	40 (55.6%)	27 (37.5%)
Housewife	11 (15.3%)	35 (48.6%)
Business	21 (29.2%)	10 (13.9%)

Table 2

Association of Smoking on Sputum Conversion Rate (n=144)

Sputum Conversion	Smokers n=72 n (%)	Non-Smokers n=72 n (%)	RR (95% CI)	P value
Yes	51 (70.8%)	60 (83.3%)	0.85 (0.71 – 1.02)	0.074
No	21 (29.2%)	12 (16.7%)		
Total	72 (100%)	72 (100%)		

Table 3

Association of Smoking with Sputum Conversion Rate by Demographic Variables

Demographic Variables	Subgroup	Group	Sputum Conversion Yes n (%)	Sputum Conversion No n (%)	RR (95% CI)	P value
Age (years)	≤40	Smokers	25 (71.4%)	10 (28.6%)	0.92 (0.70–1.22)	0.579
		Non-Smokers	24 (77.4%)	7 (22.6%)		
	>40	Smokers	26 (70.3%)	11 (29.7%)	0.80 (0.63–1.02)	0.055
		Non-Smokers	36 (87.8%)	5 (12.2%)		
Gender	Male	Smokers	51 (70.8%)	21 (29.2%)	0.73 (0.62–0.85)	0.002
		Non-Smokers	34 (97.1%)	1 (2.9%)		
	Female	Smokers	—	—	—	—
		Non-Smokers	26 (70.3%)	11 (29.7%)		
Socioeconomic Status	Low	Smokers	33 (73.3%)	12 (26.7%)	0.84 (0.68–1.03)	0.084
		Non-Smokers	42 (87.5%)	6 (12.5%)		
	Middle	Smokers	15 (68.2%)	7 (31.8%)	0.81 (0.57–1.14)	0.233
		Non-Smokers	16 (84.2%)	3 (15.8%)		
	High	Smokers	3 (60.0%)	2 (40.0%)	1.50 (0.41–5.45)	0.527
		Non-Smokers	2 (40.0%)	3 (60.0%)		

DISCUSSION

The study was conducted to assess the relationship between smoking and sputum conversion rate in drug-susceptible pulmonary tuberculosis. From the study, it was evident that sputum conversion was seen in smokers, i.e., 51, 70.8%, whereas in non-smokers, it was seen in 60, 83.3%. There was a lower conversion rate in smokers than in non-smokers. This could be due to a compromised pulmonary defense mechanism in smokers, where ciliary action is impaired, thus allowing tubercular organisms to persist. Similarly, in male patients, a lower conversion rate was seen in smokers, i.e., 51, 70.8%, than in non-smokers, i.e., 34, 97.1%. There was a significant difference in this study. This could be due to a higher exposure of males to cigarette toxins, thus suppressing cell-mediated immunity, especially T-lymphocytes, which are crucial in controlling tubercular infection. Similarly, in individuals above 40, it was seen that in smokers, there was a conversion rate of 26, 70.3%, whereas in non-smokers, it was seen in 36, 87.8%. There was a delay in recovery in smokers. This could be due to a compromised immune system in elderly individuals, thus delaying recovery.

The present findings showed sputum conversion in smokers 51 (70.8%) and non-smokers 60 (83.3%) with no significant association (p=0.074), which is comparable to findings reported by Abal A *et al.* [14] where no significant difference in 2-month conversion was observed (p=0.065), suggesting that effect of smoking may not always reach

statistical threshold despite visible clinical difference. Similar trend of delayed conversion among smokers was reported by Magee M *et al.* [15] (aHR 0.82) and Wang E *et al.* [16] (pOR 1.55), supporting that smoking negatively influence sputum conversion, which is also reflected in lower conversion proportion in smokers in present data.[17] Likewise, Cailleaux-Cezar M *et al.* [13] demonstrated significant delay in culture conversion (RR 3.58; p=0.01), and Siddiqui U *et al.* [18] reported prolonged infectivity (OR 4.42), which is in agreement with reduced conversion rate seen in smokers, possibly due to impaired immune response and higher bacillary load.

In contrast, some studies showed stronger associations than present findings, such as Mahishale V *et al.* [19] and Paik G *et al.* [20] where smoking was clearly linked with delayed conversion and poor outcomes, which may be due to larger sample size, longer follow-up, and inclusion of severity markers like smear grading. Similarly, Mota P *et al.* [21] and Buatong W *et al.* [22] highlighted role of age and bacillary burden as predictors of delayed conversion, which may explain why in present data older age group (>40 years) showed relatively lower conversion in smokers, although not statistically significant. Furthermore, Fitriani L *et al.* [23] and Hassmiller K *et al.* [24] reported worsening disease severity and progression among smokers, which indirectly supports reduced treatment response observed.

The overall preponderance of evidence from a majority of these investigations indicates that tobacco has a negative influence on tuberculosis treatment outcomes. There may be several reasons for this, including possible differences in sample sizes, study designs, study duration, and methods used for assessing smoking exposure. There may be a possibility that inclusion of multidrug-resistant tuberculosis in a study could be a reason for stronger associations in other investigations. Overall, it appears that smokers tend to have a worse sputum conversion when compared to non-smokers, although this may not always be statistically significant.

In this study, it was conducted in a single center, and this could be a limitation in terms of generalizing this study to a wider population. There was a small sample size, and this could be a limitation in terms of assessing the strength of the study. There was a short duration of follow-up, and long-term outcomes such as relapse were not evaluated. Smoking exposure was not well characterized, and this could be a limitation in terms of assessing a dose-response relationship. There was no representation of female smokers in this study, and this could be a limitation in terms of assessing gender-based outcomes.

CONCLUSION

The conclusion from this study is that smoking has a negative effect on sputum conversion in drug-susceptible pulmonary tuberculosis patients. Smokers take longer to respond to treatment compared to non-smokers. The delay in response to treatment in smokers can be attributed to impaired immunity and decreased pulmonary defense capabilities resulting from cigarette smoking. Smoking cessation is an essential factor in tuberculosis treatment.

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