**Research Article**

# Nutritional Status of Pulmonary TB Patients in Pakistan– A Cross-Sectional Study from Mardan, Khyber Pakhtunkhwa

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**Abstract** | The main objective of the current study was to investigate the association between albumin, body mass index (BMI), and sputum conversion (SC) in TB patients in Pakistan. A cross-sectional study was conducted at the Baghdada TB Center, Mardan, Khyber Pakhtunkhwa province of Pakistan. The study comprised 100 newly diagnosed TB patients who had tested positive for acid-fast bacilli (AFB). Participants underwent TB therapy in accordance with the WHO recommendations. The variables measured included weight, height, BMI, body fat, albumin and sputum test. Subjects with BMI status below normal, normal, and above normal were represented by 23.0%, 58%, and 19%, respectively. Albumin levels were found to be within normal range (3.5 g/dL) in 57% of the individuals. At the two-month follow-up, 75% of patients who had a normal BMI and/or albumin level had SC (p, for all trends 0.05). Based on their body fat composition, these ppatients in the normal weight group (n=58) were further divided into two sub-groups. Interestingly, all those patients of normal BMI (n=24) who did not show SC, had a body fat content higher than the normal range. On the other hand, all normal weight patients who showed SC (n=34) had a normal body fa composition. Success of TB treatment is significantly influenced by nutritional status (BMI) and albumin level.

## 1. Introduction

The tuberculosis bacillus (TB) lung disease is primarily caused by Mycobacterium tuberculosis bacillus. Some indicators are in use to assess treatment efficacy. One of these reliable indicators of the efficacy of TB treatment is Sputum Conversion (SC). Sixty to eighty percent of TB patients experience SC by the end of the first month, while nine percent of cases do not convert (Sari *et al.*, 2019; Guo *et al.*, 2022). Some nutritional indicators are also in use to check the progress of treatment. Albumin and the body mass index (BMI) are valuable indicators. These are easy to assess as well low cost.

Patients with positive acid-fast bacilli (AFB-positive) pulmonary TB with undernutrition (BMI < 18.5 kg/m²) had a higher risk to covert sputum positive to negative than those with normal nutritional status (BMI ≥18.5 kg/m²) (Tam *et al.*, 2016). Albumin is a potent indicator, both at the onset of a malnutrition episode and during recovery (Simbolon *et al.*, 2016; Agus *et al.*, 2016). Dropping degrees of all out protein and albumin are much of the time brought about by diminished craving, ailing health, and malabsorption in TB patients (Memon and Naz, 2014; Harsa *et al.*, 2016; Martina, 2012).

To confirm the diagnosis of TB, the existing treatment guidelines endorse isolating Mycobacterium tuberculosis from the culture of sputum (Blumberg *et al.*, 2003). In any case, the study of disease transmission, clinical and/or radiographic findings, and the effects of corrosive quick bacilli-stained sputum should be the foundation for initiating TB treatment. In endemic areas, it is altogether expected to coordinate adversary of TB treatment tentatively impending society results, given the clinical features suggesting pneumonic TB. Despite the fact that this technique intends to control infection transmission better, there are expenses related with it: It is possible to treat patients without aspiratory TB incorrectly with anti-TB medications, resulting in adverse effects and unnecessary costs. One of the most manageable methods for diagnosing patients with pulmonary tuberculosis is sputum AFB staining. Additionally, previous research has addressed the difficulty of distinguishing NTM from TB based on imaging or clinical symptoms. The confinement commonness of NTM has likewise steadily expanded, further entanglement of the issue (Marras et al., 2007).

By improving their nutritional status, TB patients can have better treatment outcomes. Positive treatment outcomes are more likely to occur when nutritional support is included and nutritional status is monitored throughout treatment. While BMI is a good indicator of overall nutritional health, it may be misleading in the case of SC in TB patients. Even if a person has a normal BMI, their body fat may be higher (Zhu *et al.*, 2022). BMI appears to be of little or no importance to doctors in their clinical practice, despite its significance. Even in patients with a normal BMI, those who pay attention are unaware of body fat. Due to a lack of awareness and limited access to resources, the problem becomes even more troubling

in poor environments like the one where we carried out this study.

The major purpose of current investigation was to examine connection between BMI and albumin (nutritional status measures) and sputum culture conversion among Pakistani TB patients. There are not enough information and research data on the relationship between SC, BMI, and albumin level. The study also wanted to know if body fat and BMI should be taken into account when determining if sputum culture conversion and BMI are related.

## 2. Materials and Methods

### 2.1 Study design
As part of the doctorate dissertation of the first author, the present investigation is a part of a larger prospective analytic case-control (case-cohort), double-blinded, randomized feeding trial (2012-2021). The study was conducted in district Mardan, KPK Pakistan.

### 2.2 Study participants
The participants in this study were TB patients with lung sputum positivity. Patients were recruited from the local clinics mainly those run by government administration. Patients who had a new AFB-positive pulmonary diagnosis and were taking their usual medications were eligible. TB Patients with other diseases (diabetes, heart diseases, kidney problems etc.) and TB category II patients (No disease Positive reaction to tuberculin skin test) were all excluded. Women did not prefer to participate due to social reasons, although the study was open to all patients without gender discrimination.

### 2.3 Data collection
Body weight was measured using TANITA scale (HA-552; Tanita Japan). Height was measured with an ordinary non-stretchable tap. Weight (Kg) was divided by height (meter squared) to calculate BMI. Bio-impedance analysis (BIA) was used for body fat measurement. This was assessed by Quadscan 4000 (UK). This technique is an alternative to radioisotope dilution and underwater weighing for fluid assessment and Body Composition analysis like the Bodystat (R), body composition using Quadscan 4000 is a quick, simple, cost-effective, and non-invasive method. The frequency that is used is what determines the basic idea behind measuring the body's impedance,

or the flow of current through it. The current will primarily travel through the extracellular space at low frequencies because it is unable to cross the cell membrane. At higher frequencies infiltration of the cell layer happens and the flow is led by both the extra-cell water (ECW) and intra-cell water (ICW).

SC information for patients was gathered from patient cards. A blood sample of 3 ml was drawn for the albumin analysis. The bromcresol green (BCG) method was used to quantify albumin. The principle of the method is that BCG can join albumin at pH 4.0-4.2 to form a yellowish-green albumin-BCG complex. The grouping of albumin is conversely corresponding to the profundity of the yellowish-green. The optical thickness (OD) esteem at 628 nm can be utilized to decide the serum album fixation. Albumin (ALB) Colorimetric Examine Unit (Bromocresol Green Strategy: Cat. The evaluation was conducted with the No.: E-BC-K057-S).

### 2.4 Statistical analysis
The mean (standard deviation) of the data were presented for statistical analysis. Chi-square test was utilized to look at number and rates, while understudy t test was utilized to analyze implies. Participants were classified as obese, overweight, or of normal weight using WHO-established BMI criteria. According to the WHO's recommendation, body fat was deemed normal (less than 20% of body weight) or high (more than 20%). Comparison was considered significant at $p < 0.05$. The SPSS ("Statistical Package for the Social Sciences") (version 15.0.1;) was used for the statistical analysis and calculations. Chicago, IL, USA).

## 3. Results and Discussion

### 3.1 Baseline characteristics
Baseline mean (SD) age was 36.9 (12.8) years and mean (SD) weight for all patients was 53.28. (9.8) Kg. Patients' mean (SD) BMI of 18.1 (3.2) indicated that they were primarily underweight. Patients had a low nutritional status at baseline, according to the nutritional and biochemical data. Table 1 shows the socio-demographics of the study participants at baseline.

### 3.2 BMI and SC relationship
The relationship between BMI and SC is shown in Table 2. Out of 53 patients, who had SC, the majority (81.1%) were of normal weight. Also, the majority of

46 patients who did not have SC were normal weight (52.2%), underweight (39.1%) or obese (30.4%). Patients in the normal weight group (n=67) were further divided into two sub-groups based on their body fat composition. Interestingly, all those patients of normal BMI who did not show SC (n=24) had a body fat content higher than the normal range (38% body fat). On the other hand, all normal weight patients who showed SC (n= 43) had a normal body fa composition (18% body fat).

**Table 1: Selected baseline characteristics of patients.**

| Parameters | Mean (SD) | Maximum | Minimum |
|---|---|---|---|
| **Continuous variables** | | | |
| Age (years) | 35.7 (12.8) | 23 | 40 |
| Weight (Kgs) | 53.2 (8.8) | 45.9 | 55.8 |
| BMI (Kg/m2) | 18.1 (5.2) | 17.4 | 18.2 |

**Table 2: BMI and sputum conversion association.**

| Sputum | Body massindex (n, %) | | | | | Total | | p value |
|---|---|---|---|---|---|---|---|---|
| | Under-weight | | Normal weight | | Obese | | | |
| Conversion | 5 | 9.4 | 43 | 81.1 | 5 | 9.4 | 53 53.5 | 0.01 |
| No-conversion | 18 | 39.1 | 24 | 52.2 | 4 | 8.7 | 46 46.5 | |
| Total | 23 | 23.2 | 67 | 67.7 | 9 | 9.1 | 99 100.0 | |

Chi-square test was used for comparison; p significant at <0.05

### 3.3 Albumin levels and SC relationship
Table 3 shows that out of 53 TB patients who had SC, larger part (84.9%) patients had albumin levels ≥ 3.50 g/dL. Out of as many as 46 patients, who didn't encounter SC, most (89.0%) had albumin levels < 3.5 g/dL.

**Table 3: Albumin levels and sputum conversion association.**

| Sputum | Albumin level (n, %) | | | | | | p value |
|---|---|---|---|---|---|---|---|
| | ≥ 3.5 g/dL | | < 3.5 g/dL | | Total | | |
| Conversion | 45 | 84.9 | 8 | 15.1 | 53 | 53.5 | 0.002 |
| No-conversion | 6 | 12.9 | 41 | 89.1 | 46 | 46.5 | |
| Total | 51 | 51.5 | 48 | 48.5 | 99 | 100.0 | |

Chi-square test was used for comparison; p significant at <0.05

The findings of this study show that BMI affects pulmonary TB patients' ability to successfully convert acid-fast bacilli (AFB) sputum. Tama *et al*. (2016) reported in a previous study that smear-positive pulmonary TB patients who were underweight (BMI of <18.5) required more time to convert their sputum

compared to patients with a BMI of >18.5 (normal weight). In addition, underweight patients were more likely to experience conversion failure by a factor of 1.32 to 8.86 as compared to patients with normal weight (BMI of >18.5). The majority of pulmonary TB patients with albumin levels below 3.5 g/dL are more likely to convert their sputum, in contrast to the majority of patients with albumin levels above 3.5 g/dL, as shown by our findings.

The way to restricting the spread of TB is positive sputum culture results from patients with pneumonic TB. Malnutrition may be a risk factor for TB mortality. It has been proposed that malnutrition is connected to treatment failure (Tama et al., 2016). The association between poor nutritional status and infectious disease is well-established. BMI, a strong indicator of nutritional status, and TB incidence have been shown to be significantly inversely correlated. This link was especially strong in the underweight population. There is general need of public health initiatives to more aggressively test for TB in the underweight group and help them manage their weight may help to lessen the burden of TB (Cho et al., 2022; Manasa et al., 2022). Also, there is a need not to overlook the importance of body fat with regard to SC. As we demonstrated in this study, a high proportion of even normal weight individual with a normal BMI failed to convert sputum. This finding shows the importance of lean body mass in the rate of recovery of TB patients. In the assessment of the nutritional profile, although it was demonstrated that most individuals had a BMI within normal values, we observed that a large part of the studied population had a fat reserve above adequate value. and, on the other hand, a significant percentage of patients had lean mass values below normal.

When evaluating the composition of the food offered to TB patients, we are of the view that their food may be overestimated in relation to the energy value, a fact that justifies the body composition found. But one may find a deficit in the supply of several micronutrients, which in turn are those most associated with immunocompetence. These facts were beyond the scope of the current study. We recommend that this may be addressed in future studies. Although the nutritional status of the studied population appears to be normal, when comparing tuberculous and non-tuberculous individuals, we may observe a significant difference between the two groups, which maybe a lower value of serum albumin in infected individuals. This alteration may be secondary to body fat composition. Body fat may be responsible for an inversion of the immune response from TH1 to TH2 subsets of CD4 T-cells with connection to cardiovascular health as well (Alam et al., 2022), and which could destabilize a latent infection by Mycobacterium tuberculosis, making the individual susceptible to the appearance of the disease. Pakistan population have previously been shown to have lower immunity profile in general (Alam et al., 2012, 2013, 2019; Almajwal et al., 2020), a fact has a close relation with the disease severity and recovery form TB.

Further investigations to confirm the hypothesis raised here could be of great value in the prophylaxis of infectious diseases such as tuberculosis, as through relatively simple, less costly and far-reaching actions in the area of basic nutrition and nutrition education, we could obtain significant results. in preventing this infection.

## Conclusions and Recommendations

In Pakistani patients with pulmonary TB who tested positive for the AFB, there was a strong association between BMI and albumin levels. Further, even at normal BMI, a significant number of patients may show failure in SC– a fact that emphasizes the importance of body fat assessment along the BMI during assessment and treatment protocols.

TB patients need to be assessed for nutritional health on a regular basis and nutritional advice must be provided by the physician and/or dietitian on importance of albumin level with support of diet that could maintain a healthy level.

## Acknowledgements

## Novelty Statement

This is the first study on TB patients of its type in Khyber Pakhtunkhwa which has highlighted the importance of BMI and body weight in the treatment outcomes of TB patients.

## Author's Contribution

**Muhammad Ashfaq Ur Rahman:** Concept and design of study.
**Muhammad Ashfaq Ur Rahman and Saleem Khan:** Drafting.
**Muhammad Ashfaq Ur Rahman, Saleem Khan, Zia Ud Din:** Data analysis.
**Muhammad Ashfaq Ur Rahman, Saleem Khan, Aurang Zeb, Zia ud Din, Zafar Iqbal:** Revisiting critically.
**Muhammad Ashfaq Ur Rahman, Saleem Khan, Aurang Zeb, Zia ud Din, Zafar Iqbal:** Final approval.

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