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ORIGINAL RESEARCH

Correlation between BMI and sputum conversion in sputum positive pulmonary tuberculosis

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ABSTRACT

Aim: The aim of this study is to investigate the correlation between Body Mass Index (BMI) and sputum conversion rates in patients with sputum-positive pulmonary tuberculosis. **Materials and Methods:** A total of 100 patients, diagnosed with sputum-positive pulmonary tuberculosis, were enrolled in the study. The inclusion criteria consisted of patients aged 18 years and older, who were sputum-positive for acid-fast bacilli (AFB) at the start of treatment and initiated on the standard ATT regimen. At baseline, detailed demographic data including age, gender, and residence were recorded. BMI was calculated by measuring the weight (in kilograms) and height (in meters) of each patient at the time of diagnosis and after 3 months of ATT, after 6 month of ATT and After end of the treatment. Sputum samples were collected at baseline and at the end of 3, months, 6 months and end of treatment to assess sputum conversion. **Results:** Underweight patients had the lowest sputum conversion rate at 66.7% (p=0.032), indicating a statistically significant delay in conversion compared to patients in other BMI categories. Normal weight patients had the highest conversion rate (87.5%), followed by overweight patients (75%) and obese patients (100%). The significance in the underweight category underscores the impact of poor nutritional status on treatment efficacy. By this point, conversion rates were high across all BMI categories, with 93.3% of underweight patients, 97.5% of normal weight patients, 95% of overweight patients, and 90% of obese patients achieving sputum-negative status. The p-value for underweight patients (p=0.043) remains statistically significant, emphasizing the challenge faced by underweight patients in achieving full recovery even after a year of treatment. **Conclusion:** The study demonstrated a clear correlation between BMI and sputum conversion rates in pulmonary tuberculosis patients undergoing anti-tubercular treatment. At 3 months, underweight patients showed significantly slower sputum conversion (40%) compared to other BMI groups, indicating early challenges in treatment. By 6 months, conversion rates improved across all groups, but underweight patients still lagged behind (66.7%). At the end of treatment, most patients achieved sputum-negative status, though underweight patients continued to experience a slight delay (93.3%). These findings underscore the critical role of nutritional status in enhancing TB treatment outcomes.

Keywords: BMI, Weight, Pulmonary tuberculosis, anti-tubercular

INTRODUCTION

Pulmonary tuberculosis (TB) remains a major global health challenge, especially in areas with socioeconomic disparities and limited healthcare access.[1] Nutritional status, as indicated by Body Mass Index (BMI), has emerged as an important factor influencing the treatment outcomes of TB patients. Underweight individuals with TB are at a higher risk for poor prognosis due to weakened immune responses and delayed sputum conversion, while overweight and obese patients may face challenges related to drug metabolism and comorbidities like diabetes.[2] The relationship between BMI and sputum conversion is complex, with both low and high BMI impacting TB recovery differently. Understanding the role of BMI in treatment outcomes highlights the importance of integrating nutritional support into TB management to improve patient recovery and reduce transmission risk.[3]

MATERIAL AND METHODS

A prospective observational study was conducted to assess the correlation between Body Mass Index (BMI) and sputum conversion from sputum-positive

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to sputum-negative in pulmonary tuberculosis (TB) patients undergoing anti-tubercular treatment (ATT). A total of 100 patients, diagnosed with sputum-positive pulmonary tuberculosis, were enrolled in the study. The inclusion criteria consisted of patients aged 18 years and older, who were sputum-positive for acid-fast bacilli (AFB) at the start of treatment and initiated on the standard ATT regimen. Patients with multidrug-resistant TB, HIV co-infection, or any severe comorbidities were excluded from the study.

Methodology

At baseline, detailed demographic data including age, gender, and residence were recorded. BMI was calculated by measuring the weight (in kilograms) and height (in meters) of each patient at the time of diagnosis and after 3 months of ATT, after 6 month of ATT and After end of the treatment. Sputum samples were collected at baseline and at the end of 3, months, 6 months and end of treatment to assess sputum conversion.

- **BMI Calculation**: BMI was calculated using the formula:
  BMI=Weight (kg)Height (m)2\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}BMI=Height (m)2Weight (kg) The patients were categorized into underweight (BMI <18.5 kg/m²), normal weight (BMI 18.5–24.9 kg/m²), overweight (BMI 25–29.9 kg/m²), and obese (BMI ≥30 kg/m²).

Sputum samples were collected and examined using Ziehl-Neelsen staining at baseline (sputum-positive) and after 3 months of treatment, 6 month of treatment and one year or end of the treatment. Conversion to sputum-negative status was determined based on the absence of AFB in the sputum sample after ATT.

Statistical Analysis

Statistical analysis was performed using SPSS software version 25.0. Descriptive statistics were used to summarize the data, and Pearson's correlation test was applied to evaluate the association between BMI and sputum conversion. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1 describes the baseline characteristics of the 100 participants. The majority were male (60%) and 45% were in the 31-50 age group, with the rest split between younger (18-30 years, 20%) and older (>50 years, 35%) age groups. Most participants (70%) were from urban areas. The p-values for gender (p=0.345), age (p=0.112), and residence (p=0.215) suggest that these factors were not statistically significant in this study population, indicating no strong demographic influence on treatment outcomes or BMI distribution.

Table 2 presents the distribution of patients by BMI categories. Forty percent of participants had a normal BMI, while 30% were underweight, 20% were overweight, and 10% were obese. The p-value of 0.047 for underweight patients indicates that BMI significantly influenced the study results, particularly in the underweight group, which may suggest that underweight patients had distinct treatment challenges compared to those with normal or higher BMI.

Table 3 shows sputum conversion rates at various treatment time points. At baseline, no patient had converted to sputum-negative. After 3 months of ATT, 60% of patients achieved sputum conversion, which increased to 80% after 6 months and 95% by the end of treatment. The p-values for each time point (p=0.000, p=0.005, p=0.001, and p=0.000, respectively) indicate that these results are highly statistically significant, highlighting the effectiveness of the ATT regimen over time.

The table 4 demonstrate a clear correlation between Body Mass Index (BMI) and sputum conversion rates at the 3-month mark for patients undergoing anti-tubercular treatment (ATT). Among the different BMI categories, underweight patients (<18.5 kg/m²) showed the lowest sputum conversion rate, with only 40% of patients achieving sputum-negative status by 3 months. This is statistically significant, as indicated by a p-value of 0.045, suggesting that being underweight negatively impacts the rate of sputum conversion early in treatment.

In contrast, patients in the normal BMI category (18.5–24.9 kg/m²) had a higher sputum conversion rate, with 70% achieving sputum-negative status. Overweight patients (25–29.9 kg/m²) had a slightly lower conversion rate at 60%, but this still represents a significant proportion of the cohort. The highest conversion rate was observed in the obese group (≥30 kg/m²), where 80% of patients achieved sputum-negative status by 3 months.

Table 5 details the correlation between BMI and sputum conversion at 6 months. Underweight patients had the lowest sputum conversion rate at 66.7% (p=0.032), indicating a statistically significant delay in conversion compared to patients in other BMI categories. Normal weight patients had the highest conversion rate (87.5%), followed by overweight patients (75%) and obese patients (100%). The significance in the underweight category underscores the impact of poor nutritional status on treatment efficacy.

Table 6 shows the correlation between BMI and sputum conversion at the end of treatment (1 year). By this point, conversion rates were high across all BMI categories, with 93.3% of underweight patients, 97.5% of normal weight patients, 95% of overweight patients, and 90% of obese patients achieving sputum-negative status. The p-value for underweight patients (p=0.043) remains statistically significant, emphasizing the challenge faced by underweight patients in achieving full recovery even after treatment.

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Table 1: Baseline Characteristics of the Study Population (n=100)

Characteristic	Number of Patients (n=100)	Percentage (%)	p-value
Gender			
Male	60	60%	0.345
Female	40	40%	
Age Group (years)			
18-30	20	20%	0.112
31-50	45	45%	
>50	35	35%	
Residence			
Urban	70	70%	0.215
Rural	30	30%	

Table 2: Distribution of Patients by BMI Category (n=100)

BMI Category (kg/m²)	Number of Patients (n=100)	Percentage (%)	p-value
Underweight (<18.5)	30	30%	0.047
Normal (18.5–24.9)	40	40%	
Overweight (25–29.9)	20	20%	
Obese (≥30)	10	10%	

Table 3: Sputum Conversion Rates at Different Time Points

Time Point	Sputum Conversion (n=100)	Percentage (%)	p-value
Baseline (0 months)	0	0%	0.000
After 3 months of ATT	60	60%	0.005
After 6 months of ATT	80	80%	0.001
End of the treatment of ATT	95	95%	0.000

Table: 4 Correlation Between BMI and Sputum Conversion at 3 Months

BMI Category (kg/m²)	Sputum Conversion (n=100)	Percentage (%)	p-value
Underweight (<18.5)	12/30	40%	0.045
Normal (18.5–24.9)	28/40	70%	-
Overweight (25–29.9)	12/20	60%	-
Obese (≥30)	8/10	80%	

Table 5: Correlation Between BMI and Sputum Conversion at 6 Months

BMI Category (kg/m²)	Sputum Conversion (n=100)	Percentage (%)	p-value
Underweight (<18.5)	20/30	66.7%	0.032
Normal (18.5–24.9)	35/40	87.5%	
Overweight (25–29.9)	15/20	75%	
Obese (≥30)	10/10	100%	

Table 6: Correlation Between BMI and Sputum Conversion at End of Treatment (1 year)

BMI Category (kg/m²)	Sputum Conversion (n=100)	Percentage (%)	p-value
Underweight (<18.5)	28/30	93.3%	0.043
Normal (18.5–24.9)	39/40	97.5%	
Overweight (25–29.9)	19/20	95%	
Obese (≥30)	9/10	90%	

DISCUSSION

The study aimed to investigate the correlation between Body Mass Index (BMI) and sputum conversion rates in pulmonary tuberculosis (TB) patients undergoing anti-tubercular treatment (ATT). The results indicate significant correlations between BMI and treatment outcomes, with lower BMI, particularly underweight patients, being associated with delayed sputum conversion. The study population's demographic characteristics (60% male, 45% in the 31-50 age group, and 70% urban dwellers) show a common distribution seen in TB epidemiology. In comparison, studies like those by Lonnroth et al. (2010) found similar gender distributions, where males are more susceptible to TB due to higher exposure rates and potential social and lifestyle factors.[4] However, the p-values for gender (p=0.345), age (p=0.112), and residence (p=0.215) indicate no significant demographic influence on treatment outcomes or BMI distribution, implying that

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factors like gender or age may not directly influence BMI-related treatment response, consistent with the findings of Murray et al. (2014).[5]This study showed that 30% of patients were underweight, 40% had normal BMI, and 20% were overweight, with 10% obese. Underweight patients had a statistically significant p-value (0.047), highlighting a distinctive challenge in their treatment response compared to those with normal or higher BMI. Similar studies by Cegielski et al. (2012) have demonstrated that malnutrition in TB patients is a critical factor, with underweight individuals showing poorer treatment outcomes due to compromised immune function.[6] This supports the conclusion that lower BMI patients are at a disadvantage in achieving faster sputum conversion.Sputum conversion is a key marker of TB treatment success. In this study, sputum conversion rates progressively improved from 60% at 3 months to 95% by the end of treatment, with significant p-values across all time points (p=0.000, p=0.005, p=0.001, p=0.000). These findings are consistent with the results of a study by Ahmad et al. (2017), which showed a similar trend of high sputum conversion rates in TB patients receiving regular ATT.[7]

At 6 months, sputum conversion rates varied significantly across BMI categories, with underweight patients showing the lowest conversion rate (66.7%) and obese patients having the highest (100%). The p-value for underweight patients (p=0.032) indicates a statistically significant delay in their response to treatment. These findings align with research by Zachariah et al. (2002), who reported that malnourished TB patients take longer to convert to sputum-negative status due to weakened immune responses.[8]

CONCLUSION

The study demonstrated a clear correlation between BMI and sputum conversion rates in pulmonary tuberculosis patients undergoing anti-tubercular treatment. At 3 months, underweight patients showed significantly slower sputum conversion (40%) compared to other BMI groups, indicating early challenges in treatment. By 6 months, conversion rates improved across all groups, but underweight patients still lagged behind (66.7%). At the end of treatment, most patients achieved sputum-negative status, though underweight patients continued to experience a slight delay (93.3%). These findings underscore the critical role of nutritional status in enhancing TB treatment outcomes.

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