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ORIGINAL ARTICLE

# Treatment outcomes and its determinants among the children with tuberculosis in a Tertiary Care Hospital.

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**ABSTRACT… Objective:** To determine tuberculosis (TB) treatment outcomes and identify its determinants. **Study Design:** Analytical, Cross-sectional study. **Setting:** Medical units and TB clinic of National Institute of Child Health (NICH), Karachi, Pakistan. Period: January 2025 to December 2025. **Methods:** A total of 172 children, aged 6 months to 15 years with clinically or bacteriologically diagnosed TB who received anti-TB therapy were analyzed. Management followed National TB Control Program guidelines with a 2-month intensive phase and continuation phase duration based on TB site. Outcomes were analyze applying chi-square of fisher's exact test, while multivariable logistic regression analysis was used to determine predictors of successful treatment outcomes, with adjusted odds ration (aOR), and 95% confidence interval (CI). P<0.05 was taken as statistically significant. **Results:** Among 172 children, 94 (54.7%) were male, and the median age was 4.6 years (IQR 2.0–9.2). Pulmonary TB was diagnosed in 103 (59.9%), and bacteriological confirmation in 64 (37.2%) children. After excluding 23 (13.4%) lost to follow-up, and in remaining 149 children, 131 (87.9%) children achieved treatment success, while 12 (8.1%) died, and 6 (4.0%) failed. Reduced success was associated with previously treated TB aOR 0.31 (95%CI: 0.09–0.98, p=0.047), hypoalbuminemia aOR 0.33 (95%CI: 0.12–0.86, p=0.023), and human immunodeficiency virus (HIV) positivity aOR 0.09 (95%CI: 0.01–0.74, p=0.036). **Conclusion:** Treatment outcomes in children with TB were largely favourable, although death, treatment failure, and loss to follow-up remained clinically important. Prior TB treatment, HIV infection, and low serum albumin were associated with reduced treatment success.

**Key words:** Children, Hypoalbuminemia, Human Immunodeficiency Virus, Treatment Failure, Tuberculosis.

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## INTRODUCTION

Tuberculosis (TB) is one of the significant public health concerns globally. Around 1.3 million children and young adolescents were diagnosed with TB in 2022.[1] Eight countries contribute to 2/3rd total TB burden, while Pakistan ranking 5th on that list with an estimated 264 TB cases per 100,000 per year.[2,3] Timely diagnosis is the biggest challenge in preventing morbidity and mortality from TB especially among children and adolescents.[4]

Among pediatric population, younger age, human immunodeficiency virus (HIV) co-infection, male gender, rural affiliation, protein calorie malnutrition, and hypoalbuminemia are some of the commonly associated factors affecting treatment outcomes.[5-7] Monitoring the treatment outcomes of TB is important in two perspectives i.e. effectiveness and improvement of its intervention and to identify potential barriers for its control.[8,9]

Data on TB treatment outcomes is crucial for developing and implementing contextually relevant interventions for pediatric patients. Results of this study may help address these determinants timely for management and definitely improve outcomes and probably implemented in national TB guidelines. This study aimed to determine the TB treatment outcomes and its determinants.

## METHODS

The analytical, cross-sectional study was conducted at all medical unit and TB clinic of NICH, Karachi, Pakistan, during January 2025 to December 2025, following Institutional Ethical Review Board approval (letter number IERB-32/2023, dated: 15th January, 2025). A sample size of 172 was calculated using online OpenEpi sample size calculator taking treatment success as 67.8%[2], with 7% margin of error, and 95% confidence level.

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Children aged 6 months to 15 years, registered at TB clinics of NICH, diagnosed with TB clinically or bacteriologically and treated with anti-TB drugs were analyzed. Children transferred out to any other healthcare facility, having multidrug resistant TB, unwilling to appear in follow ups, or not agreeing to be the part of this research were excluded. Non-probability consecutive sampling technique was employed.

At the time of enrollment, demographic and clinical information were noted among all eligible children. Treatment of new TB patients consisted of a 2-month intensive phase followed by continuation phase, duration depending upon site of TB. It consist of 4 months in pulmonary, lymph node & abdominal TB, while of 10 months in CNS and bone TB. During the intensive phase, 4 drugs (Rifampicin, Isoniazid, Pyrazinamide and Ethambutol) were advised daily. In the continuation phase, two drugs (Rifampicin and Isoniazid) were advised every day. TB treatment cards of patients were reviewed to collect treatment and outcome related data. Biochemical and hematological data including serum albumin, calcium and hematological profile were also collected. The outcomes of treatment was reported in accordance to National TB Control Program and WHO categorizations.

Data were analyzed using IBM-Statistic, version 26.0. Categorical variables were represented as proportions and percentages (%). Continuous data were described as mean and standard deviations (SD), or median and interquartile range (IQR) Chi-square test or fisher's exact test was used for categorical variables to evaluate associations between dependent and independent variables. The association of predictor variables with the dependent variable was described using logistic regression analysis, taking 95% confidence interval (CI) and adjusted odds ratio (aOR). A p-value < 0.05 was considered statistically significant.

## RESULTS

In a total of 172 children, 94 (54.7%) were males, and 78 (45.3%) females. The median age, and duration of symptoms were 4.6 years (IQR 2.0–9.2), and 5.0 weeks (IQR 3.0–8.0). Urban residence was documented in 96 (55.8%) children. Bacille Calmette-Guérin (BCG) scar was present in 129 (75.0%), while a history of household TB contact was reported in 73 (42.4%). Pulmonary TB was diagnosed in 103 (59.9%), and extrapulmonary TB in 69 (40.1%). Bacteriological confirmation was achieved in 64 (37.2%), whereas 108 (62.8%) were clinically diagnosed. New TB cases accounted for 154 (89.5%), and 18 (10.5%) had a previous treatment history. HIV positivity was documented in 5 (2.9%). Malnutrition was noted in 61 (35.5%), anemia in 79 (45.9%), hypoalbuminemia in 54 (31.4%), and hypocalcemia in 18 (10.5%) children (Table-I).

**TABLE-I**

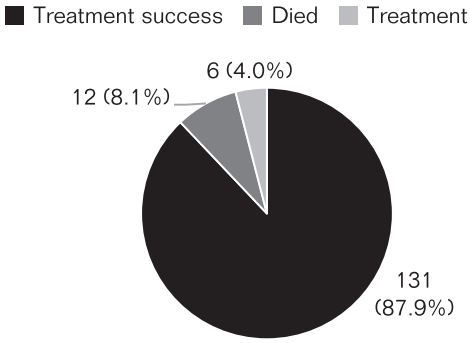
**Characteristics of children (n=172)**

| Characteristics | | Number (%) |
|---|---|---|
| Gender | Male | 94 (54.7%) |
| | Female | 78 (45.3%) |
| Age groups | 6 months to < 5 years | 98 (57.0%) |
| | 5-9 years | 41 (23.8%) |
| | 10-15 years | 33 (19.2%) |
| Residence | Urban | 96 (55.8%) |
| | Rural | 76 (44.2%) |
| BCG scar present | | 129 (75.0%) |
| History of household TB contact | | 73 (42.4%) |
| TB type | Pulmonary | 103 (59.9%) |
| | Extra-pulmonary | 69 (40.1%) |
| Diagnostic category | Bacteriological confirmed | 64 (37.2%) |
| | Clinically diagnosed | 108 (62.8%) |
| TB treatment history | New case | 154 (89.5%) |
| | Previously treated | 18 (10.5%) |
| HIV status positive | | 5 (2.9%) |
| Malnutrition present | | 61 (35.5%) |
| Anemia (Hb < 11 g/dl) | | 79 (45.9%) |
| Hypoalbuminemia (serum albumin < 3.5 g/dl) | | 54 (31.4%) |
| Hypocalcemia (serum calcium < 8.5 mg/dl) | | 18 (10.5%) |

A total of 23 (13.4%) children were lost to follow-up and excluded from the outcome analysis. Among the remaining 149 children with definitive outcomes, treatment success was recorded in 131 (87.9%), treatment failure in 6 (4.0%), and death in 12 (8.1%) children (Figure-1).

**FIGURE-1**

**Treatment outcomes among children with tuberculosis (N=149)**




BCG scar was present in 101 (77.1%) children with treatment success compared with 11 (61.1%) children with unsuccessful treatment (p=0.025). A history of household TB contact was documented in 58 (44.3%) children with treatment success, and 16 (61.1%) children with unsuccessful outcomes (p<0.001). HIV positivity was recorded in 2 (1.5%) children with treatment success and 2 (11.1%) children with unsuccessful outcomes (p=0.018). Bacteriological confirmation was recorded in 52 (39.7%) children with treatment success and 3 (16.7%) children with unsuccessful outcomes (p=0.058). New TB cases accounted for 119 (90.8%) children with treatment success compared with 14 (77.8%) children with unsuccessful outcomes (p=0.093). Anemia was documented in 56 (42.7%) children with treatment success, and 12 (66.7%) children with unsuccessful outcomes (p=0.056). Associations between baseline characteristics and outcomes are presented in Table-II.

On multivariable logistic regression analysis, previously treated TB was associated with reduced odds of treatment success with an aOR 0.31 (95%CI: 0.09 to 0.98, p=0.047). Hypoalbuminemia independently reduced the likelihood of treatment success with an aOR 0.33 (95%CI: 0.12 to 0.86, p=0.023). HIV positivity was associated with reduced odds of treatment success with an aOR 0.09 (95%CI: 0.01 to 0.74, p=0.036).

**TABLE-II**

**Association of treatment outcomes with baseline characteristics of children (N=149)**

| Characteristics | | Treatment Success (n=131) | Treatment Unsuccessful (n=18) | P-Value |
|---|---|---|---|---|
| Gender | Male | 72 (55.0%) | 13 (72.2%) | 0.165 |
| | Female | 59 (45.0%) | 5 (27.8%) | |
| Age groups | 6 months to < 5 years | 75 (57.3%) | 10 (55.6%) | 0.892 |
| | 5-15 years | 56 (42.7%) | 8 (44.4%) | |
| Residence | Urban | 84 (64.1%) | 8 (44.4%) | 0.107 |
| | Rural | 47 (35.9%) | 10 (55.6%) | |
| BCG scar present | | 101 (77.1%) | 11 (61.1%) | 0.025 |
| History of household TB contact | | 58 (44.3%) | 16 (61.1%) | <0.001 |
| TB type | Pulmonary | 86 (65.6%) | 8 (44.4%) | 0.080 |
| | Extra-pulmonary | 45 (34.4%) | 10 (55.6%) | |
| Diagnostic category | Bacteriological confirmed | 52 (39.7%) | 3 (16.7%) | 0.058 |
| | Clinically diagnosed | 79 (60.3%) | 15 (83.3%) | |
| TB treatment history | New case | 119 (90.8%) | 14 (77.8%) | 0.093 |
| | Previously treated | 12 (9.2%) | 4 (22.2%) | |
| HIV status positive | | 2 (1.5%) | 2 (11.1%) | 0.018 |
| Malnutrition present | | 43 (32.8%) | 9 (50.0%) | 0.152 |
| Anemia (Hb < 11 g/dl) | | 56 (42.7%) | 12 (66.7%) | 0.056 |
| Hypoalbuminemia (serum albumin < 3.5 g/dl) | | 38 (29.0%) | 8 (44.4%) | 0.184 |
| Hypocalcemia (serum calcium < 8.5 mg/dl) | | 13 (9.9%) | 4 (22.2%) | 0.124 |

**TABLE-III**

**Multivariable logistic regression for predictors of treatment success**

| Predictors | aOR | 95% Confidence interval | P-Value |
|---|---|---|---|
| Extrapulmonary tuberculosis | 0.48 | 0.19-1.19 | 0.112 |
| Clinically diagnosed tuberculosis | 0.39 | 0.14-1.05 | 0.062 |
| Previously treated tuberculosis | 0.31 | 0.09-0.98 | 0.047 |
| Malnutrition present | 0.44 | 0.17-1.10 | 0.079 |
| Hypoalbuminemia | 0.33 | 0.12-0.86 | 0.023 |
| HIV positive | 0.09 | 0.01-0.74 | 0.036 |

Extrapulmonary TB showed lower odds of success with an aOR 0.48 (95%CI: 0.19 to 1.19, p=0.112), and clinically diagnosed TB had an aOR 0.39 (95%CI: 0.14 to 1.05, p=0.062). Malnutrition showed reduced odds of treatment success with an aOR 0.44 (95%CI: 0.17 to 1.10, p=0.079).

## DISCCUSSION

Treatment success was recorded in 87.9% children with definitive TB outcomes in this study. This level of treatment success aligns with paediatric programmatic cohorts from high burden settings where successful outcomes frequently exceed 85% when treatment is delivered through structured TB services and follow-up is documented. In a large paediatric cohort study, successful treatment outcomes were reported in 94.2% of children, with comparatively lower proportions of death and treatment failure.[10] In contrast, a Pakistan-based cohort analysis that retained loss to follow-up within "unsuccessful" outcomes reported 11.8% overall unsuccessful outcomes, driven largely by 9.3% loss to follow-up, while deaths and failures were lower at 1.6% and 1.0%, respectively.[11] The higher death proportion in the present study among definitively classified outcomes suggests that children reaching tertiary care may represent clinically advanced disease, higher comorbidity burden, or delayed presentation, which can shift the distribution from follow-up attrition toward mortality.

Loss to follow-up remained an important programmatic signal, with 13.4% children lost to follow-up from the baseline cohort. A local study by Hamid and colleagues.[11], reported 9.3% loss to follow-up among children on treatment, indicating that disengagement remains a persistent gap even within organised TB services. In the current setting, the observed follow-up attrition may reflect referral pressure at a tertiary hospital, transitions between inpatient and outpatient care, and competing caregiver priorities, particularly when symptoms improve during intensive phase. From a clinical standpoint, loss to follow-up carries two downstream risks, ongoing transmission risk within households and incomplete mycobacterial clearance with potential for recurrence or drug resistance. The use of harmonised WHO outcome definitions emphasizes loss to follow-up as a key unfavourable outcome category, defined by treatment interruption for at least two consecutive months.[12] Strengthening follow-up systems through patient navigation, phone reminders, decentralized drug refills, and active tracing can shift outcomes toward treatment completion, particularly for families living at distance from tertiary centres.[13]

Previous TB treatment history showed a significant reduced association with treatment success (aOR: 0.31; 95%CI: 0.09 to 0.98, p=0.047). Prior treatment often represents a marker of previous incomplete adherence or delayed diagnosis in earlier illness episodes.[14] This supports early risk stratification at TB registration using prior treatment as a high-risk flag, combined with a low threshold for microbiological confirmation and drug susceptibility assessment when feasible.[15]

HIV positivity showed a strong adverse association with treatment success (aOR: 0.09 95% CI 0.01 to 0.74, p=0.036). Observational studies of HIV and TB co-infected children report mortality in the range of 10% to 20%, especially where ART initiation is delayed or advanced HIV disease is present at TB diagnosis.[16] A recent systematic analysis in African settings reported pooled mortality close to 15.9%

among HIV and TB co-infected children, highlighting the consistent vulnerability of this subgroup across settings.[17] The present results reinforce the clinical importance of early HIV testing in all paediatric TB patients, rapid linkage to ART services, and closer monitoring in the intensive phase. Integrated TB and HIV care pathways can reduce missed opportunities for ART initiation, optimize cotrimoxazole prophylaxis where indicated, and lower inpatient mortality from opportunistic infections and severe respiratory failure.[18]

Hypoalbuminemia also remained independently associated with reduced treatment success (aOR: 0.33; 95%CI: 0.12 to 0.86, p=0.023). Contemporary literature emphasizes hypoalbuminemia as a consistent indicator of morbidity and mortality risk, reflecting underlying processes such as protein energy malnutrition and inflammation, rather than a standalone biochemical abnormality.[19] In paediatric TB, low albumin may reflect chronic illness with poor intake, intestinal malabsorption, or protein-losing states in severe disease.[19,20]

Key limitations relate to this study included important proportion of children loss to follow up which could hamper the statistical evaluations. Constrained regarding bacteriological confirmation rate due to paucibacillary disease and sample collection barriers, restricts the ability to distinguish microbiological failure from clinical non-response. Nutritional status was captured using malnutrition classification and biochemical markers, but detailed anthropometry and socioeconomic variables were not included.

## CONCLUSION

Favourable treatment outcomes can be achieved among children with tuberculosis managed at a tertiary care setting, although a clinically relevant proportion still experience death, treatment failure, or loss to follow-up. Treatment outcomes appear to be influenced by baseline clinical vulnerability, particularly prior TB treatment history, HIV infection, and poor nutritional or biochemical status.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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| AUTHORSHIP AND CONTRIBUTION DECLARATION | |
|---|---|
| 1 | **Mariam Bibi:** Data collection, drafting. |
| 2 | **Mohsina Noor Ibrahim:** Literature review. |
| 3 | **Mashal Khan:** Methodology, critical revision. |
| 4 | **Wajid Hussain:** Conception, design. |