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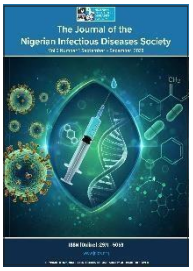

Original Article

Pattern and Treatment Outcomes of Childhood Tuberculosis in Rivers State University Teaching Hospital – A 5-year Review

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ABSTRACT:

Background: Tuberculosis (TB), although preventable and curable, remains a significant infectious cause of illness and death among children in Sub- Saharan Africa. The patterns and treatment outcomes vary based on the availability of effective screening and diagnostic methods, which should be documented if not previously reported.

Aim: To describe the pattern and treatment outcomes of tuberculosis among children (below 16 years) in the Rivers State University Teaching Hospital, Nigeria.

Method: This retrospective review was conducted from January 2018 to January 2023 using records of the Directly Observed Treatment Short Course Centre and all TB-related paediatric in-patient admissions. Appropriate data were retrieved and analysed.

Results: Of the 325 children seen, 170 (52.3%) were females with M: F = 1:1.1 and mean age: 6.4 ± 5.7 years. About half, 162 (49.8%) were under five years. All were new TB cases. Bacteriological diagnosis was confirmed in 177 (54.5%) using GeneXpert. A total of 311cases (95.7%) had pulmonary TB, and 10 (3.07%) had TB meningitis. TB/HIV co-infection rate was 16.9%; The treatment success rate was 81.6% with children under five having higher treatment success rates (93.2% Vs 68.5%; p= 0.0001). Overall, 193(63.3%) completed treatment, 53(17.3%) were cured and 8(2.6%) died. The predictors for successful treatment were young age [AOR= 0.086, CI: 0.038 – 0.198] and bacteriological diagnosis [AOR= 0. 307, CI: 0. 178 – 0.641].

Conclusion: Pulmonary TB was the predominant type seen and treatment outcomes were largely successful. Early screening and prompt treatment are vital in achieving successful treatment outcomes for Paediatric tuberculosis.

Keywords: Childhood, GeneXpert, Outcomes, Pattern, Tuberculosis, Treatment

INTRODUCTION:

Tuberculosis (TB) is a chronic multi-systemic disease of infectious origin.[1] The severe forms of it can easily be prevented by neonatal immunization.[2] However, due to the limited knowledge in resource-constrained countries, it continues to be a major contributor to paediatric morbidity and mortality.[3] In 2022, TB was the second leading infectious disease worldwide after COVID-19.[4]

According to WHO consolidated guidelines on the treatment of tuberculosis published in 2022, 11% of people living with tuberculosis were under the age of 15 years.[4] Over one million of these children were suffering from tuberculosis and 225,000 of them succumbed to the illness.[3] A total of 17 out of the 30 countries with the highest burden of tuberculosis are situated in Africa.[3] Over 300,000 African children aged 0-15 years are infected with TB of which 75% of them remain undiagnosed or are under-reported.[3]

The incidence of TB in Nigeria was 338 per 100,000 in 2012 and 418,000 in 2017.[4,5] This places Nigeria among the countries with a high burden of TB in the world. In addition to drug-sensitive TB (DS-TB), drug-resistant TB (DR-TB) and HIV/AIDS are also prevalent in Nigeria. HIV infection is the most significant risk factor for developing TB, and the morbidity and mortality due to TB in HIV patients is substantial.[6]

A recent ten-year spatial-temporal survey of tuberculosis infections in Rivers State between 2009-2018 found an upward trend with high clusters of TB infections especially in areas of Rivers State, Obio/Akpor, and Port Harcourt, inclusive. The authors suggested targeted interventions in these Local Government Areas to help reduce the spread of Tuberculosis.[7]

Since children have reduced immunities and take a longer time to demonstrate clinical features suggestive of TB – a high index of suspicion is needed by attending health workers who care for children.

Furthermore, although TB is treatable, the outcome in children is poorer than in adults due to their young age and HIV co-infectivity.[8,9] It has also been noted by the Centre for Disease Control and Prevention that young children usually have the more severe forms of TB due to their reduced immunity.[10] Before this, there had been no study to determine the pattern and outcome of TB in our facility. This study will help to assess the strength of our services as well as evaluate the pattern and outcome of tuberculosis in the Rivers State University Teaching Hospital.

METHODS:

Study design and duration of study: This retrospective study spanned from January 2018 to January 2023 and a review was conducted in January 2023.

Study Area and Population: The study was conducted among children who presented either to the Directly Observed Treatment Short- Course (DOTS) clinic and all in-hospital admissions of children with a confirmed diagnosis of any type of tuberculosis of the Rivers State University Teaching Hospital (RSUTH), Nigeria. Rivers State University Teaching Hospital is a 350-bed tertiary referral facility with subspecialty services and offers services to Rivers State and neighbouring states in the Niger Delta region. It is an accredited centre for Infectious disease prevention and control and has a dedicated centre for infant diagnosis services. The center also provides TB care services to all ages. All children who are suspected of TB based on a high clinical index of suspicion according to the WHO TB case definition criteria, either present to the Paediatric outpatient clinic or Family Medicine department are sent to the DOTS clinic for confirmatory diagnosis and subsequent commencement of anti- TB medications. However, if the diagnosis is suggestive of severe TB disease like meningitis, they are admitted to the quarantined ward until suitable for discharge.

This review included all children between the ages of 0 to 15 years whose information was in the DOTS clinic or Paediatric ward and had either clinical, radiological or bacteriological diagnosis–using GeneXpert (stool/sputum) confirmed diagnosis of tuberculosis. All children with incomplete data or beyond the age of 15 years were excluded.

Study procedure and operational definitions: Relevant information including patients' sex, age, method of TB diagnosis (clinical, GeneXpert, radiological or bacteriological), HIV status, type of TB and treatment outcomes - completed treatment, cured, defaulted, still on treatment, lost to follow-up , transferred out and deaths were retrieved from the National TB registers and case notes of the patients in the RSUTH DOTS centre.

Clinical diagnosis was made in children who met the WHO clinical case definition for suspected TB and was confirmed using suggestive chest radiograph findings with or without a tuberculin skin test (since the latter was no longer routinely performed).

Bacteriological diagnosis was confirmed by a positive gene Xpert from either stool or sputum Xpert MTB/RIF test which also detected resistance to Rifampicin. Samples that were Xpert positive, but MTB/RIF negative were Drug Sensitive (DS) and those reported as Xpert positive, but MTB/RIF detected were Drug-Resistant (DR). In this facility, children < 9 years are requested to have stool Xpert and those above 9 years who can produce sputum have sputum Xpert requested. Acid-fast bacilli (AFB) sputum microbiology gram stain is performed more often during follow-up to verify treatment response.

TB treatment outcomes were classified as - completed treatment, cured, defaulted, lost to follow-up, still on treatment, transferred out and deaths following the WHO and National TB and Leprosy Control Programme (NTLCP) recommended guidelines.

Tuberculosis treatment outcome was assessed according to WHO[11] and National Tuberculosis and Leprosy Control Program (NTLCP) guidelines.[12] Tuberculosis treatment outcomes were classified as follows:

Cured: Children with confirmed pulmonary TB at the start of treatment, completed treatment and tested negative for TB on two occasions, with at least 30 days between tests. One of the negative results should be within the last month of treatment.

Treatment completed: TB child who finished treatment but without evidence of cure or failure; either because the necessary tests were not conducted, or the results were not available.

Died: TB child who succumbed for any reason during treatment.

Lost to follow-up (LTFU): TB child who interrupted treatment for 2 consecutive months or longer.

Treatment failure: Patients with bacteriologically diagnosed TB whose sputum smear or culture remains positive at 5 months or later after starting treatment, or who interrupted treatment for more than 2 months after completing 1 month of therapy, returned to treatment, and were found to be smeared or culture positive.

Transferred out: Children who moved out of the health facility catchment area.

Successful treatment: The sum of cases that were cured and those that completed treatment.

Unsuccessful treatment: The sum of cases that were lost to follow-up, died or failed treatment.

Measurements

Dependent Variables: Outcome variables were categorized as successful (cured and treatment completed) or unsuccessful (died, treatment failure or lost to follow-up (LTFU)). Treatment outcomes categories (cured, treatment completed, died, treatment failure, lost to follow- up, and not evaluated) were assigned based on NTLCP/ WHO guidelines. [12] Patients were followed up using laboratory or clinical evaluations at regular intervals: first, third, fifth, and sixth months during chemotherapy.

Independent variables: Children were defined as those aged < 16 years, with additional subcategories of younger (< 1 – 4. 99 years) and older (5 – 15years) children. Tuberculosis diagnosis was based on standard WHO/ NTLCP methods, using any sputum microscopy, clinical examination, chest X- ray, and GeneXpert for diagnosis [13] Bacteriologically diagnosed cases included those who were diagnosed using GeneXpert and cure was confirmed using sputum microscopy and repeat GeneXpert for some children.

Other independent variables were gender, anatomical site of TB and presence of TB/HIV co-infection.

Outcome variables: were categorized as primary (rate of successful outcomes) and secondary (proportion of treatment failures or unsuccessful treatment at the end of the expected duration of chemotherapy).

Data Analysis: The data was analysed using IBM SPSS version 25. Descriptive statistics was used to determine the sociodemographic characteristics of the study population. Treatment outcome (successful and treatment failures) variables were compared using the Chi- square test ($\chi 2$ test) and Fisher exact tests as appropriate, with a p-value of 0.05 considered as being statistically significant. Adjusted Odd Ratios (AORs) and the corresponding 95 % confidence intervals were estimated using multinomial logistic regression analysis, with successful outcomes as the dependent variable and age, gender, anatomical site of TB disease, method of diagnosis, and HIV status as the predictor variables. Beyond the descriptive summaries, children who were still undergoing treatment (n = 16) or were not evaluated (n = 4) were excluded from the final analysis.

Ethical Approval was obtained from the RSUTH Research Ethics Committee RSUTH/REC/2023410

RESULTS:

Socio- demographics of children with tuberculosis in RSUTH: Over the study duration, 325 children were registered and all were new TB cases. One hundred and seventy (52. 3%) were females and 155 (47.7%) with M: F = 1: 1.1 and mean age: 6.5 ± 5.7 years (range from 1 month to 15years). Children under age five were in the majority 162 (49. 8%) with further subgroup division shown in Table 1. All enrolled children had a gene xpert test for diagnosis of TB and the TB/HIV co- infection rate was 16.9%. Bacteriological diagnosis was confirmed in 177 (54.5%) using GeneXpert. The lungs was the predominant anatomical site of TB infection accounting for 311 cases (95.7%).

Table I: Baseline characteristics of Childhood TB cases by demographic, laboratory and diagnosis.		
Variables	Frequency (n = 325)	Percent (%)
Demographics		
Age		
< 1 year	50	15.4
1 – 4.99 years	112	34.5
5 – 9.99 years	60	18.5
10 – 15.99 years	103	31.6
Sex		
Females	170	52.3
Males	155	47.7
Laboratory		
HIV status		
Positive	62	19.1
Negative	263	80.9
TB investigations		
CXR	65	21.0
TB diagnosis		
Clinical	148	45.6
Bacteriological(sputum/stool)	177	54.4
Anatomic site of affectation		
• Pulmonary	311	95.7
• Meningitis	10	3.08
• Disseminated	2	0.62
• Adenitis	2	0.62

Comparison of childhood TB cases based on age group category:
When comparison is considered based on age group categories, Table II demonstrates that childhood TB was significantly higher (p=0.0001) among younger children under five, compared to those above five years (53.1% Vs 46.9%; p = 0.0001). There was also a significantly higher clinical diagnosis of childhood TB among children under five years (76.4% Vs 23.5%; p= <0.0001)
Treatment outcomes of childhood TB in RSUTH:

One hundred and ninety-three (59.4%) completed treatment, 53 (16.3%) were cured, 7 (2.2%) defaulted, 16 (4.9%) were still on treatment, 43 (13.2%) were lost to follow-up, 1 (0.3%) was transferred out, 4 (1.2%) were not evaluated and 8 (2.5%) died.

Treatment outcomes of childhood TB cases stratified by sociodemographic and clinical characteristics as seen in Table III demonstrated that among children treated for TB, successful treatment was seen in 81.6% of them. Children under-five years had significantly higher treatment success rates compared to children above five (93.2% Vs 68.5%; p= 0.0001). Similarly, those who completed their course of treatment and were captured as cured, had significantly higher treatment success rates (99.5 Vs 0.5%, 100.05 Vs 0.0%) compared to those who died, defaulted, were LTFU or stopped their medications respectively. Albeit, children who were bacteriologically diagnosed, females, had HIV/TB coinfection and pulmonary TB had higher treatment success rates compared to those that were clinically diagnosed (82.1% vs 79.1%), males (84.0% vs 78.9%), HIV negative (83.9% vs 79.8%) or had extrapulmonary TB. However, these were not statistically significant.

Regarding treatment outcomes based on diagnostic method, Table III-B shows that comparing bacteriological vs clinical diagnosis, (81, 51.9% Vs 112, 75.2%) completed TB treatment and (46, 29.5% Vs. 7, 4.7%) were documented as cured. However, there was no significant difference in treatment outcomes based on diagnostic modalities ($\chi 2 = 0.036$; p-value = 0.483).
* Statistically significant $Analysis excluded [cases ongoing treatment and unevaluated = 20]

Predictors of treatment success among children with TB in RSUTH:
The multinomial logistic regression analysis displayed in Table IV was used to identify predictors of successful treatment outcomes among childhood TB in RSUTH. After adjusting for potential confounders, it was found that age below 5 years and a having bacteriological diagnosis of TB were independent predictors for treatment success. Hence, younger age had an 8 % reduced odds of unsuccessful treatment outcome [AOR= 0.086, CI: 0.038 – 0.198)], p=<0.0001. Also, bacteriologically confirmed TB diagnosis was associated with a decreased 30% lower odds of an unsuccessful treatment outcome [AOR= 0. 307, CI: 0. 178 – 0.641], p=<0.002.

This parameter is set to Zero because it is redundant
* statistically significant

Table II: Comparison of childhood TB cases based on age group category

	Variables	Younger (<1 – 4.99 years)	Older (5 -15years)	χ^2	p-value
	Total [n=305]$	162 (53.1%)	143 (46.9%)	305.0	0.0001*
A	Demographics				
	Gender			0.18	0.909
	Female	86 (52.8%)	77 (76.4%)		
	Male	76 (53.5%)	66 (46.5%)		
B	TB Diagnosis type			0.057	0.512
	Pulmonary TB	155 (53.3%)	136 (46.7%)		
	Extrapulmonary TB	7 (50.0%)	7 (50.0%)		
C	Method of diagnosis			64.028	<0.0001*
	Clinical	114 (76.5%)	35 (23.5%)		
	Bacteriological [Xpert]	48 (30.8%)	108 (69.2%)		
D	HIV status			0.348	0.572
	HIV negative	127 (52.3%)	116 (47.7%)		
	HIV positive	35 (56.5)	27 (43.5%)		

* Statistically significant $Analysis excluded [cases ongoing treatment and unevaluated = 20]

Table III-A: Treatment Outcomes of childhood TB cases					
	Variables	Successful	Unsuccessful	χ^2	p-value
A	Primary Outcome [n=305] $	249 (81.6%)	56 (18.4%)		
B	Age Category			30.860	0.0001*
	Younger (< 5 years)	151(93.2%)	11 (6.8%)		
	Older (≥ 5years)	98 (68.5%)	45 (31.5%)		
C	Gender			1.356	0.299
	Female	137 (84.0%)	26 (16.0%)		
	Male	112 (78.9%)	30 (26.1%)		
C	HIV status			0.259	0.381
	HIV negative	197 (81.1%)	46 (18.9%)		
	HIV positive	52 (83.9%)	10 (16.1%)		
D	Diagnostic method			0.036	0.483
	Clinical	121 (81.2%)	28 (18.8%)		
	Bacteriological				
	[Xpert](stool/sputum) Positive	128 (82.1%)	29 (17.9%)		
E	TB Diagnosis type			1.021	0.479
	Pulmonary TB	239 (82.1%)	52 (17.9%)		
	Extra-pulmonary TB	10 (71.4%)	4 (28.6%)		
F	Treatment Outcome			286.927	0.000*
	Completed	192 (99.5%)	1 (0.5%)		
	Cured	53 (100.0%)	0 (0.0%)		
	Dead	0 (0.0%)	8 (100.0%)		
	Defaulters	3 (42.9%)	4 (57.1%)		
	Stopped medications	1 (100.0%)	0 (0.0%)		
	LTFU	0 (0.0%)	42 (100.0%)		

* Statistically significant $Analysis excluded [cases ongoing treatment and unevaluated = 20]

Table III B: Treatment outcomes based on the mode of diagnosis using Xpert vs Clinical					
	Completed	Cured	Dead	Defaulter	LTFU
Bacteriological (Xpert)	81 (51.9%)	46 (29.5%)	3 (1.9%)	2 (1.3%)	24 (15.4%)
Clinical	112 (75.2%)	7 (4.7%)	5 (3.4%)	5 (3.4%)	18 (12.1%)

Table IV: Predictive Factors associated with successful treatment of TB		
Variable	AOR (95% CI)	P-value
Age		
Below 5 years	0.086 (0.038 – 0.198)	0.0001*
Above 5 years	0[b]	
HIV status		
HIV positive	0.737 (0.329 – 1.650)	0.457
HIV Negative	0[b]	
Method of diagnosis		
Bacteriological [Xpert]	0. 307 (0. 178 – 0.641)	0.002*
Clinical	0[b]	
Gender		
Female	1.673 (0.905 – 3.094)	0.101
Male	0[b]	
TB Anatomic site		
Pulmonary	1.101 (0.277 – 4.367)	0.892
Extrapulmonary	0[b]	

DISCUSSION:

This 5-year review was aimed at describing the pattern, and treatment outcomes of childhood tuberculosis. The study assessed for relationships between demographic/clinical variables and treatment outcome of tuberculosis among children in the Rivers State University Teaching Hospital, Nigeria.

Our study showed that almost two-thirds of the TB cases occurred in children less than five years of age, supporting the findings in previous studies in Nigeria, which reported a high prevalence in children under 5years.[14–16] Childhood TB is said to occur most commonly among infants and young children under five years of age due to their relatively reduced immunity which enhances their early progression from TB infection to TB disease.[8] And many children may not have been immunized against tuberculosis. According to WHO estimates in 2022 Bacillus Calmette Guerin vaccination coverage rate in Nigeria is 74% and this is lower than estimates gotten from Ghana(96%), Benin (88%) and Kenya (97%).[17]

All the cases recruited for this study were new TB cases. Bacteriological confirmation was done in all cases, using either stool or sputum GeneXpert, while clinical confirmations were done in the others, which were GeneXpert negative. This was done with the tuberculosis scoring chart which used clinical presentation, erythrocyte sedimentation rate and a suggestive chest radiograph.[18] The lung was the most common organ affected and this was in keeping with other studies.[13,14,16,19] This is because TB is an airborne infection and the organism transferred in the droplets of an infected person is aerobic and has affinity to the lungs, a well aerated organ.

About one in six children had TB/HIV co-infection and the rate was 16.9% which is relatively similar to Ogbudebe's studies which had 14% co-infection and other studies.[14] The treatment success rate was noted to be 81.6% with children less than five having higher treatment success rates compared to children more than 5 years, this is in keeping with the studies done in Zamfara and Bayelsa.[16,20] However, we found that childhood TB treatment was characterized by relatively poor outcomes. Age and method of diagnosis were associated with treatment outcomes.

Our study revealed a slight female preponderance which was in keeping with other studies.[7,18] In contrast, some studies revealed a male preponderance.[19,22,23] The probable reason for this may be because our study covered more of children under 5years of age, with females having lower immunity. It has also been noted that children of this age are more likely to develop severe forms of the disease like disseminated TB and TB meningitis,[24] and this was observed in our study. The high prevalence could be due to a reduced immunity in this age group. Also, a high preponderance in this age group signifies a high level of transmission in the community as the children are more likely to contract the disease.[25]

The treatment outcome was successful in 80.6% of patients and this is in keeping with studies done by Ogbudebe et al[14] in Nigeria (83%), Mirutse et al[7] in Euthopia (88.7%) and Tilahun et al[26] in Addis Ababa (85.5%). It was noted that having a bacteriological diagnosis was significantly associated with completion and success of treatment. This was probably because parents were more likely to complete the TB treatment of their children when they saw an evidence of bacteriological diagnosis. This was similar to studies done by Adejumo et al also found that treatment success was low in smear negative children.[27] This was in contrast to Ogbudebe et al[14] who observed more success in children aged 5-14 years. The reason could be that the treatment was better monitored in this age group and most of them had a bacteriologic diagnosis. The parents had more confidence in administering the medication when they were certain the disease was present.

In this study, a gene-xpert was done for all the study participants of the study in accordance with the national Tuberculosis and Leprosy control program and 54.5% of the patients had a positive gene-xpert report. This was higher than other studies in which gene xpert was done. The reason for this high level was that stool samples were used for almost all the children especially for those that could not produce sputum.

The mortality rate seen in this study was 2.1%, which is higher than 1.1% reported from India[28,29] It is however lower than 3.5% reported from Ethiopia[30] 6.0% reported from Lagos[27] and 28.4% from Kano.[31] The reason for the difference is not known .

CONCLUSION:

The use of DOTS Course Centre in RSUTH during the 5-year period under review recorded some level of success. The treatment success rate was higher in neonates and children under 5years than in children above 5years (with 93.2% Vs 68.5% success; p = 0.00001). The success rate in this study was higher than the world's average of 85-87% success.[32]

From our study, children used in this study were majorly within the ages of 0-5years of age as they were the most affected, the rest were from 6-15years of age. Pulmonary TB was the predominant type seen and treatment outcomes were largely successful. Early screening and prompt treatment are vital in achieving successful treatment outcomes for Paediatric tuberculosis

RECOMMENDATIONS:

The use of Clinical, Radiological (chest X-ray) and Bacteriological (gene expert and sputum microscopy) diagnosis of TB should be sustained, as it was instrumental for the success of the treatments in this study.

Since children less than 5years are the most affected by the TB infection, a campaign awareness and testing should be carried out in communities to test and treat affected adults of Tuberculosis.

Use of Directly Observed Treatment Short-course (DOTS) should be sustained since it was instrumental in this study for the success of treatments.

Childhood TB is significantly higher among neonates and younger children < 5years; due to their relatively reduced immunity. There should be campaigns for the uptake of the BCG (Bacillus Calmette Guerin)[2] Vaccine within the first two weeks of birth.

Declarations

Competing interests: None

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Authors' contributions: Conceptualization, data collection, data analysis, writing of the paper.

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REFERENCES

1. Kliegman RM, Stanton BF, St Geme III JW, Schor NF, Behrman RE. Nelson textbook of pediatrics. 20th ed. Elsevier, editor. Philadelphia; 2015.
2. Dockrell HM, Smith SG. What Have We Learnt about BCG Vaccination in the Last 20 Years? [Internet]. Vol. 8, Frontiers in Immunology. 2017. Available from: https://www.frontiersin.org/articles/10.3389/fimmu.2017.01134
3. Africa W. African Union and WHO urge swift action against childhood tuberculosis 24 August 2022. 2022.
4. WHO consolidated guidelines on tuberculosis: module 5: management of tuberculosis in children and adolescents. 2022.
5. Adejumo AO, Olusola-Faleye B, Adepoju VA, Gidado M, Onoh MO, Adegboye O et al. The pattern of comorbidity and its prevalence among drug-resistant tuberculosis patients at treatment initiation in Lagos Nigeria. Trans R Soc Trop Med Hyg. 2020;114(6):415–423.
6. Glaziou P, Sismanidis C, Zignol M, Floyd K. Methods used by WHO to estimate the global burden of TB disease. Global TB Programme, WHO, Geneva. Glob TB Program WHO, Geneva. 2016;
7. Mirutse G, Fang M, Kahsay AB. Epidemiology of childhood tuberculosis and factors associated with unsuccessful treatment outcomes in Tigray, Ethiopia: a ten-year retrospective cross-sectional study. BMC Public Heal 19. 2019;1367.
8. Narasimhan P, Wood J, MacIntyre CR, Mathai D. Risk Factors for Tuberculosis. Trajman A, editor. Pulm Med. 2013;828939. Available from: https://doi.org/10.1155/2013/828939
9. Shingadia D, Novelli V. Diagnosis and treatment of tuberculosis in children,. Lancet Infect Dis. 2003;3(10):624–32.
10. Evans CA. GeneXpert—A Game-Changer for Tuberculosis Control? PLoS One. 2011;8(7):e1001064.
11. Definitions and reporting framework for Tuberculosis. WHO Geneva. 2013;1.
12. Federal Ministry of Health N. National Tuberculosis and Leprosy control programme: Worker's manual. Fed Minist Heslth, Abuja. 2010;5:1–119.
13. Dodd PJ, Yuen CM, Sismanidis C, Seddon JA, Jenkinshe HE. The global burden of tuberculosis mortality in children: a mathematical modelling study. Lancet. 2017;5(9):E898–906.
14. Ogbudebe C, Adepoju V, Ekerete-Udofia C, Abu E, Egesemba G, Chukwueme N. Childhood Tuberculosis in Nigeria: Disease Presentation and Treatment Outcomes. Heal Serv Insight. 2018;11:1–7.
15. Adejumo OA, Daniel OJ, Abdur-Razzaq HA, Ebunoluwa JO. Trend of childhood TB case notification in Lagos, Nigeria. Int J Mycobacteriology. 2015;4(3):239–44.
16. Ilah G, Sakajiki M, Ibrahim Y, Mafara I, Muhammad A, Tahir Y, Ochapa O. Outcome of Childhood Tuberculosis at a Specialist Hospital in Gusau, Nigeria. Asian J Med Heal. 2018;11(1):1–5.
17. BCG Immunization coverage estimates by country. WHO. 2022. https://apps.who.int/gho/data/view.main.80500?lang=en
18. Pinto LM, Pai M, Dheda K, Schwartzman K, Menzies D, Steingart KR. Scoring system using chest radiographic features forthe diagnosis of pulmonary tuberculosis in adults: a systematic review. Eur Respir J. 2013;42(2):480–94.
19. Alex-Hart BA, Paul NI. Pattern and Outcome of Childhood Tuberculosis Seen at the University of Port Harcourt Teaching Hospital, Nigeria. J Tuberc Res. 2019;7(3):170–83.
20. Jumbo J, Ikuabe PO, Egbi OG. A Ten-year survey of Treatment Outcome in a Tuberculosis and Leprosy Referral Hospital Implementing Direct Observed Therapy Short (DOTS) Course. Int J Innov Sci Res Technol. 2022;7(9):1851– 5.

21. Panigatti P, Ratageri VH SI, Madhu PK, Shepur TA. Profile and outcome of childhood tuberculosis treatment with DOTS – An observational study. Ind J Paed. 2016;81(1):9–14.
22. Ugwu KO, Agbo MC, Ezeonu IM. Prevalence of tuberculosis, drug-resistant tuberculosis and HIV/TB co-infection in Enugu, Nigeria. African J Infect Dis. 2021;15(2):24–30.
23. Dim CC, Dim NR. Trends of tuberculosis prevalence and treatment outcome in an under-resourced setting: The case of Enugu state, South East Nigeria. Niger Med J. 2013;54(6):392–7.
24. Israni AV, Dave DA, Mandal A, Singh A, Sahi PK, Das RR et al. Tubercular Meningitis in Children: clinical, pathological and radiological profile and factors associated with mortality. J Neurosci Rural Pr. 2016;7(3):400–4.
25. Tuberculosis in Children. Center for Disease Control and Prevention. 2021.
https://www.cdc.gov/tb/about/children.html
26. Tilahun G, Gebre-Selassie S. Treatment outcomes of childhood tuberculosis in Addis Ababa: a five-year retrospective analysis. BMC Public Health. 2016;16(612).
27. Adejumo OA, Daniel OJ, Adebayo BI, Adejumo EN, Jaiyesimi EO, Akang G. Treatment Outcomes of Childhood TB in Lagos, Nigeria. J Trop Pediatr. 2016;62(2):131–8.
28. Nandimath VA, Ukarande AR, Chaithra S. Outcome of paediatric DOTS treatment at city tuberculosis centre, Solapur. Ind J Curr Res. 2015;7(08):19683–5.
29. Bandichhode ST, Nandimath VA. Health profile of paediatric tuberculosis patients on directly observed short course therapy. Ind J Contemp Pediatr. 2016;3(4):1401–4.
30. Daemo MD, Kelbore A. Treatment outcomes and associated factors of childhood tuberculosis: Treated under DOTS program in health centers of Makelle town, Tigray Regional State, Ethiopia. Cent Afr J Pub Hlth. 2016;2(1):11–7.
31. Adamu AZ, Aliyu MH, Galadanci NA, Musa BM, Gadanya MA, Gajida AU et al. Deaths during tuberculosis treatment among paediatric patients in a large tertiary hospital in Nigeria. PLoS. 2017; 12:8.
32. Global Tuberculosis Report. TB Treatment: coverage and Outcomes WHO. 2023. https://www.who.int/teams/global-programme-on-tuberculosis-and-lung-health/tb-reports/global-tuberculosis-report-2023/tb-diagnosis.