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The Effect of COVID-19 on Tuberculosis Notification in Adamawa and Taraba States, North Eastern, Nigeria

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Abstract

Tuberculosis control is dependent on early case detection and timely notification to health facilities to ensure appropriate treatment of cases and screening of contacts. This study considers the effect of COVID-19 on tuberculosis notification. Records on all TB cases were retrieved from six selected local government areas (LGAs) in Adamawa and Taraba States, with three from each State, the data cover a period of five years, 2017-2021. A total of 9877 cases consisting of 3764 (38.1%) from Adamawa and 6113 (61.9%) from Taraba State were retrieved. The data was analysed at both the bivariate and multivariate levels. The results were interpreted using the odds ratio (OR), and variable and interactions were deemed significant if the P-value associated with the odds ratio is < 0.05. The results revealed that TB notification increased by about 49.7% and 47.4% in Adamawa and Taraba States respectively in year 2021. Furthermore, the results showed, HIV positive patients accounted for 1298 (13.1%), HIV negative patients accounted for 7476 (75.7%), while 1103 (11.2%) of all the patients did not have their HIV status recorded. Also, across age groups, cases notification are more likely in younger age groups than older patients, particularly, childhood TB is more likely with; ages 0-4 (OR=4.228, 3.601, 2.362 and 3.968) respectively, for year 2017, 2018, 2019 and 2021, ages 4-15 (OR= 1.066,1.950, 1.1020) respectively, for year 2017, 2018 and 2021. This study recommends that governments at all levels should ensure continuity of essential health services during and after outbreak and/or emergencies, also, that the incidences of childhood TB need to be investigated.

Keywords: Tuberculosis, COVID-19, Case notification, Odds ratio, North Eastern Nigeria

Introduction

Tuberculosis (TB) is the 13th leading cause of death and the second leading infectious killer after COVID-19 (above HIV/AIDS), a total of 1.5 million people died from TB in 2020

(including 214 000 people with HIV). With an estimated 10 million people infected with tuberculosis (TB) worldwide: 5.6 million men, 3.3 million women and 1.1 million children. Ending the TB epidemic by 2030 is among the health targets of the United Nations Sustainable Development Goals (SDGs) of the World Health Organization (WHO) (Amiri *et al.*, 2021; WHO, 2021a). Prompt notification to the public health facility is an important component of the surveillance process and achieves the following objectives; it identifies people needing follow-up to ensure that treatment is completed, and enables contact tracing and screening of close contacts. It also provides data to measure disease burden, monitor epidemiological trends, detect outbreaks, plan and target preventive and treatment services.

The national TB control activities in Nigeria are coordinated by the National Tuberculosis and Leprosy Control Programme (NTBLCP) which was launched in 1989 under the department of public health in the Federal Ministry of Health (FMOH). Its basic disease control strategy is the provision of free services to all patients identified with TB and its operations are guided by Directly Observed Therapy, Short-course (DOTS) strategies and STOP TB Partnership initiatives (Mirchaulum, 2017). National tuberculosis (TB) programmes globally rely heavily on case finding for detecting TB in the community as advocated by the World Health Organization (WHOb). COVID-19 pandemic has disruptive tendencies on routine health services and progress towards Sustainable Development Goals (SDGs). For TB in particular, The Stop TB Partnership observed, that, lockdowns on society are already showing signs of severely curtailing diagnosis and notifications. Choosing to ignore TB in the face of the imminent COVID-19 pandemic would erase at least half a decade of hard-earned progress against the world's most deadly infection and make millions more people sick" (Stop TB Partnership, 2020). This research is aimed at assessing the effect of COVID-19 on tuberculosis notification in Adamawa and Taraba States, Northeast Nigeria.

Lo *et al*. (2011) noted that a small proportion of TB cases were not notified and a substantial proportion of notified TB cases had delayed reporting, findings with implication for strengthening surveillance of tuberculosis in Taiwan. They concluded that, countries where the completeness and timeliness of TB notification have not yet been evaluated should take similar action to strengthen surveillance of TB. Gelaw *et al*. (2019) noted that TB notification is associated with weather conditions, ecological factors, socioeconomic and individual factors such as ethnicity, place of residence, drug use, alcohol consumption, homelessness, human immunodeficiency virus infection/acquired immune deficiency syndrome, age, and sex. In their work. Codlin *et al*. (2011) revealed that TB case notification rates have increased, potentially because of intensified case detection efforts in both Pakistan and India during the 10-year window that was examined; however, the gender patterns in notification rates remained consistent over time. Regardless of the year examined, in Pakistan, the rates of notification are higher in females compared with males in the young age groups (aged < 45 years), whereas the rates in those aged e" 45 years are higher in males. In India, rates of TB are higher in males in both the young and old age groups.

Adejumo *et al.* (2017) assessed trends of tuberculosis (TB) case notification rate (CNR) and treatment outcomes between 2011 and 2015 in Lagos State, Nigeria. They conducted a retrospective review of TB notification data of the Lagos State Tuberculosis and Leprosy Control Programme (LSTBLCP) between 1 January 2011 and 31 December 2015 and found that a total of 44,516 TB cases were notified during the study period, representing 9.4% of the national figure. They concluded that the CNR declined in Lagos State despite an increasing trend in DOTS and microscopy site expansions between 2013 and 2015. A cross-sectional study by Barry *et al*. (2012) revealed that, there was evidence of seasonal variation in TB notifications over an 8-year period, and that the concentration was highest in January through March and lowest in July through September.

Pembi *et al.* (2020) assessed the impact of political conflict (Boko Haram) on tuberculosis (TB) case notiûcations in Adamawa State in North-east Nigeria by designing a retrospective analysis of TB case notifications from TB registers (2010–2016) to describe changes in TB notification, sex and age ratios by the degree of conflict by local government area with 21076 TB cases notification and found out that TB case notifications decreased in conflict areas and increased in areas without conflict.

In their work, Tadolini *et al*. (2020) raised two important issues, namely the possible association between tuberculosis (TB) and coronavirus disease 2019 (COVID-19); whether infection by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) can re-activate TB, and the effects of TB on early mortality in co-infected patients. Boffan *et al.* (2020) noted that regardless of HIV status, people with undiagnosed pulmonary TB (PTB), those with drug-resistant TB or complex presentations such as disseminated forms, and those who have only just begun PTB treatment may be at increased risk for severe responses if they become infected with COVID-19.

Before the emergence of COVID-19 as a public health emergency of international concern, coinfection with tuberculosis was probably the priority for HIV/AIDS control efforts in Africa (Adepoju, 2020), Boffan *et al*. (2020) posited that patients with PTB treatment may be at increased risk for severe responses if they become infected with COVID-19.Studies are still ongoing to verify the evidence of interaction between tuberculosis (TB) and COVID-19 (Visca *et al.,* 2021).

Izudi *et al*. (2020) constructed a retrospective cohort of persons with BC-PTB from a routine tuberculosis clinic database in eastern Uganda and performed bivariate and multivariate analysis at the 5% level of significance. The results revealed that out of the 1,123 records retrieved, 81.1% of the 987 persons with BC-PTB that had treatment outcome, were successfully treated. Successful treatment of tuberculosis was less likely to occur among those with HIV infection. They concluded that Treatment success rate among adult persons with BC-PTB in rural eastern Uganda is suboptimal and mortality rate is high. HIV infection and older age reduce chances of treatment success, and increase mortality rate. Older and HIV infected persons with BC-PTB will require special consideration to optimize treatment success rate and reduce mortality rate.

Disruption across nations due to COVID-19 affected the aspects of health service including TB management (Jain *et al*., 2020; Udwadia *et al*., 2020; Cilloni *et al*., 2020), and potential consequences of delayed or missed diagnoses (Louie *et al*., 2020; Liu *et al*., 2020; Togun *et al*., 2020).

Nath *et al.* (2021) examined the effect of COVID-19 pandemic on tuberculosis notification in India. To understand the potential effect of the COVID-19 response on TB epidemiology, they indicated that modelling studies published by Stop TB Partnership showed that for every month of Lockdown, 232,665 excess Cases and 71,290 Deaths were added in India. They submitted that the first decline in TB notification was in 2020 during the lockdown across the country due to COVID-19.

According to Kant and Tyagi (2021), the outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) from a seafood market in Wuhan, China, has ushered in a new era, that with global focus on fighting this unpredictable fight with this new virus, the biggest chronic infectious killer, mycobacterium tuberculosis (M. tb), was hugely affected from this shift in attention. Furthermore, that due to certain similarities in the behaviour of the two infectious agents, there have been inevitable consequences. On one hand, administrative measures to contain SARS-CoV-2 have simultaneously led to a breaking in the chain of tuberculosis (TB) management. On the other hand, the same measures and heightened hygiene awareness have helped to decrease the spread of the TB bacilli.

Soko *et al.* (2021), analysed the effect of coronavirus disease pandemic on tuberculosis notification in Blantyre, Malawi using an interrupted time series analysis.

They established that fewer tuberculosis notifications, on cumulative basis, were received than expected. In particular, women and girls reported 30.7% fewer cases while men and boys reported 20.9% fewer cases. They attributed the following as reasons for fewer people being diagnosed with tuberculosis: momentary facility closures, insufficient personal protective gear, fear of COVID-19 infection, and COVID-19 stigma due to comparable symptoms with tuberculosis.

Aggarwal *et al*. (2022) observed that the notification rates hovered around 200,000 patients per month in 2019, and started deviating from the forecasted rates in March 2020 as a result of social and travel restraints. Due to extensive disruptions in tuberculosis related health services, a reasonable number of patients were missed out by National Tuberculosis Elimination Program (NTEP) who were still able to transmit the disease to the public. They concluded that the decline in recognition of new cases can lead to long-term upsurge in tuberculosis incidence and mortality.

According to Madhukar *et al*. (2022), of the estimated 10 million people who developed tuberculosis in 2020, only 5.8 million cases were diagnosed and reported, representing an 18% decrease from 2019. This decrease was more pronounced in 16 countries with Asian countries accounting for the largest reduction in reported cases. The countries involved all had major COVID-19 outbreaks and healthcare service disruptions.

Kwak *et al*. (2020) opined that 24% reduction TB notification in 2020 in South Korea, suggests the effects of COVID-19 on TB notification, according to the authors, the reason are that, during the COVID-19 outbreak, interventions such as TB contact investigation and preventive therapy may have been deprioritized and delayed, secondly that, patients with newly developed respiratory symptoms could not visit chest clinics easily because those patients were redirected to COVID-19 screening clinics to prevent in-hospital transmission. They concluded that overall healthcare use worsens during outbreaks of communicable diseases, as demonstrated by the 10%–23% decrease in emergency department visits, even for life-threatening conditions, after COVID-19 began, as reported in the United States.

According to Pai *et al*. (2022), though the COVID-19 pandemic has had devastating effects on every aspect of global health, but tuberculosis services have been disproportionately affected. Also, according to the World Health Organization (WHO) Global Tuberculosis Report 2021, case notifications have plummeted because of pandemic-related disruptions in services (WHO, 2021b).

In the United States, reported tuberculosis (TB) disease diagnoses fell 20% in 2020 and remained 13% lower in 2021 than TB disease diagnoses made prior to the COVID-19 pandemic, according to preliminary Centers for Disease Control and Prevention (CDC, 2022) data. The new data suggest that the pandemic has had a substantial effect on TB trends in the United States. Before COVID-19, TB disease diagnoses in the US typically declined between 1% and 2% each year. The 2020 and 2021 declines may be related to factors associated with the COVID-19 pandemic, including a true reduction in incidence as well as delayed or missed TB diagnoses (CDC,2022). This study is unique, in that, it is aimed at assessing tuberculosis notification with wide coverage during a pandemic.

Materials and Methods

Records on all TB cases were retrieved from six local government areas (LGAs) in Adamawa and Taraba States, with three from each State, the data cover a period of five years, 2017-2021; three years before the COVID-19 year, during Covid-19, and a year after COVID-19. The DOTS supervisors of each LGA served as research assistants and contact persons. The independent variables include the following: treatment facility ownership type (private or public health facilities) and LGA where the patients received treatment, gender, age category, site of disease (pulmonary or extrapulmonary), type of drug regimen, HIV status, and availability of a treatment supporter. The

dependent variable is the year of tuberculosis treatment initiation (year of notification).

Data Analysis

The data collected was analysed at three levels; univariate, bivariate, and multivariate levels. In the univariate analysis, frequencies and percentages were employed to elucidate information on the categorical variables. At the bivariate level, the Pearson Chi-square test was employed to measure the association between the dependent variables and the independent variables using *P*-value < 0.05 as the criterion for significance. The multinomial Poisson regression analysis was used to performed multivariate analysis on all statistically significant variables identified at the bivariate level. The results were interpreted using the Odds Ratio (OR), and variable and levels were deemed significant if the *P*-value associated with the Odds Ratio is < 0.05. All statistical analyses were performed on the processed data using IBM SPSS 23.

Results and Discussion

TB notifications retrieved from the two states amounted to a total of 9877 consisting of 3,764 from Adamawa State and 6,113 from Taraba State. The year notification and other variables of the TB patients for Adamawa and Taraba States are presented in Tables 1 and 2 respectively, Table shows the notification by gender and age group, and Table 4 presents the overall significance of the variables for the two states combined.

Table 1: Case notification variables for Adamawa State patients

VariablesLevel		Year					Total	*P*-value
		2017	2018	2019	2020	2021		
	All cases	721	596	719	692	1036	3764	
		19.2%	15.8%	19.1%	18.4%	27.5%	100.0%	
LGA	Mubi South	247	214	286	262	338	1347	0.000
		18.30%	15.90%	21.20%	19.50%	25.10%	100.00%	
	Yola North	346	265	258	292	429	1590	
		21.80%	16.70%	16.20%	18.40%	27.00%	100.00%	
	Numan	128	117	175	138	269	827	
		15.50%	14.10%	21.20%	16.70%	32.50%	100.00%	
Treatment facility ownership	Public	680	549	693	601	867	3390	0.000
		20.1%	16.2%	20.4%	17.7%	25.6%	100.0%	
	Private	41	47	26	91	169	374	
		11.0%	12.6%	7.0%	24.3%	45.2%	100.0%	
Treatment regimen	6months	700	571	706	679	1027	3683	0.000
		19.00%	15.50%	19.20%	18.40%	27.90%	100.00%	
	12 months	21	25	13	13	9	81	
		25.90%	30.90%	16.00%	16.00%	11.10%	100.00%	
Patient supported	Yes	299	225	198	258	583	1563	0.000
		19.10%	14.40%	12.70%	16.50%	37.30%	100.00%	
	No	422	371	521	434	453	2201	
		19.20%	16.90%	23.70%	19.70%	20.60%	100.00%	
Disease site	Pulmonary	678	560	692	670	1016	3616	0.000
		18.80%	15.50%	19.10%	18.50%	28.10%	100.00%	
	Extra pulmonary	43	36	27	22	20	148	
		29.10%	24.30%	18.20%	14.90%	13.50%	100.00%	

HIV status	Positive	120	97	86	62	99	464	0.000
		25.90%	20.90%	18.50%	13.40%	21.30%	100.00%	
	Negative	518	435	549	550	855	2907	
		17.80%	15.00%	18.90%	18.90%	29.40%	100.00%	
	Not tested	83	64	84	80	82	393	
		21.10%	16.30%	21.40%	20.40%	20.90%	100.00%	
Age group	0-4	14	7	7	3	16	47	0.033
		29.80%	14.90%	14.90%	6.40%	34.00%	100.00%	
	5-14	26	26	13	19	28	112	
		23.20%	23.20%	11.60%	17.00%	25.00%	100.00%	
	15-24	126	85	112	114	180	617	
		20.40%	13.80%	18.20%	18.50%	29.20%	100.00%	
	25-34	326	315	360	340	498	1839	
		17.70%	17.10%	19.60%	18.50%	27.10%	100.00%	
	45-54	95	87	104	97	168	551	
		17.20%	15.80%	18.90%	17.60%	30.50%	100.00%	
	55-64	64	35	65	60	74	298	
		21.50%	11.70%	21.80%	20.10%	24.80%	100.00%	
	>64	70	41	58	59	72	300	
		19.20%	15.80%	19.10%	18.40%	27.50%	100.00%	
Gender	Male	495	382	496	481	735	2589	0.073*
		19.10%	14.80%	19.20%	18.60%	28.40%	100.00%	
	Female	226	214	223	211	301	1175	
		19.20%	18.20%	19.00%	18.00%	25.60%	100.00%	

* No significant difference between the year of notification and gender (male and female) of the patients in Adamawa State

Table 2: Case notification variables for Taraba State patients

Variables	Level	Year						*P*-value
		2017	2018	2019	2020	2021	Total	
	All cases	873	1043	1191	1215	1791	6113	
		14.3%	17.1%	19.5%	19.9%	29.3%	100.0%	
LGA	Jalingo	673	640	815	799	1077	4004	0.000
		16.80%	16.00%	20.40%	20.00%	26.90%	100.00%	
	Gassol	48	275	292	315	604	1534	
		3.10%	17.90%	19.00%	20.50%	39.40%	100.00%	
	Wukari	152	128	84	101	110	575	
		26.40%	22.30%	14.60%	17.60%	19.10%	100.00%	
Treatment facility ownership	Public	828	1012	1152	1115	1456	5563	0.000
		14.9%	18.2%	20.7%	20.0%	26.2%	100.0%	
	Private	45	31	39	100	335	550	
		8.2%	5.6%	7.1%	18.2%	60.9%	100.0%	
Treatment regimen	6months	873	1040	1182	1202	1787	6084	0.001
		14.30%	17.10%	19.40%	19.80%	29.40%	100.00%	
	12 months	0	3	9	13	4	29	

		0.00%	10.30%	31.00%	44.80%	13.80%	100.00%	
Patient supported	Yes	784	1042	1190	1213	1789	6018	
		13.00%	17.30%	19.80%	20.20%	29.70%	100.00%	
	No	89	1	1	2	2	95	0.000
		93.70%	1.10%	1.10%	2.10%	2.10%	100.00%	
Disease site	Pulmonary	862	1036	1180	1200	1784	6062	0.000
		14.20%	17.10%	19.50%	19.80%	29.40%	100.00%	
	Extra pulmonary	11	7	11	15	7	51	0.062*
		21.60%	13.70%	21.60%	29.40%	13.70%	100.00%	
HIV status	Positive	243	149	125	140	177	834	
		29.10%	17.90%	15.00%	16.80%	21.20%	100.00%	
	Negative	609	836	866	1006	1252	4569	0.000
		13.30%	18.30%	19.00%	22.00%	27.40%	100.00%	
	Not Tested	21	58	200	69	362	710	
		3.00%	8.20%	28.20%	9.70%	51.00%	100.00%	
Age group	0-4	10	13	17	19	18	77	
		13.00%	16.90%	22.10%	24.70%	23.40%	100.00%	
	5-14	49	64	83	51	62	309	
		15.90%	20.70%	26.90%	16.50%	20.10%	100.00%	
	15-24	118	145	170	189	257	879	
		13.40%	16.50%	19.30%	21.50%	29.20%	100.00%	
	25-34	449	464	530	579	861	2883	0.0
		15.60%	16.10%	18.40%	20.10%	29.90%	100.00%	
	45-54	115	159	179	170	265	888	
		13.00%	17.90%	20.20%	19.10%	29.80%	100.00%	
	55-64	62	91	92	101	169	515	
		12.00%	17.70%	17.90%	19.60%	32.80%	100.00%	
	>64	70	107	120	106	159	562	
		12.50%	19.00%	21.40%	18.90%	28.30%	100.00%	
Gender	Male	533	634	688	729	1133	3717	0.050*
		14.30%	17.10%	18.50%	19.60%	30.50%	100.00%	
	Female	340	409	503	486	658	2396	
		14.20%	17.10%	21.00%	20.30%	27.50%	100.00%	

* No significant difference between the year of notification and gender (male and female) and the site of the treatment (pulmonary and extra pulmonary patients) in Taraba State. That is, no significant association between year and gender and between year and site of the treatment.

Tables 1 and 2 reveal that, Taraba State had more cases of Tuberculosis notification between 2017 and 2021; out of the 9877 retrieved cases, Taraba State accounted for 6,113 (61.9%), while Adamawa State accounted for 3,764 (38.1%). The results revealed that TB notification increased across all the LGAs immediately after the COVID-19 year; a total of 2007 patients in 2020 and 2,827 in 2021, this is attributable to COVID-19 lockdown in 2020, which shows that COVID-19 impacted negatively on TB notification. The Tables further show 8,953 (90.6%) of the patients were treated in public owned facilities, while 924 (9.4%) were attended to at private facilities. Most of the private facilities were often inactive.

From the Tables, 12 months treatment regimen accounted for 110 (1.1%) of all the cases retrieved while the 6 months regimen accounted for 9,767 (98.9%). Thus, very few patients were diagnosed with ETP. Patients who were accompanied by family members accounted for 7,581 (76.8%), patients who

were not accompanied were 2,296 (23.2%). Patients with pulmonary tuberculosis (PTB) accounted for 9,678 (98.0%) of all the cases while extrapulmonary tuberculosis (EPTB) was only 199 (2.0%); Taraba state recorded only 51 (25.6%) of the EPTB while Adamawa had 148 (74.4%). On HIV status of the patients, HIV positive patients accounted for 1,298 (13.1%), HIV negative patients accounted for 7476 (75.7), while 1,103 (11.2%) of all the patients did not have their HIV status recorded. Of those who did not have their HIV status recorded, Taraba state accounted for 710, that is, 11.6% of all TB patients in Taraba State for the period under review, while Adamawa State had 393, that is, 10.4% of all TB patients in Adamawa state.

On age group and gender of the TB Patients, Tables 1 and 2 revealed that 159 (4.3%) of the notified patients in Adamawa State were childhood TB, that is TB in children aged below 15, while in Taraba State this category of patients consists of 386 (6.4%) of the total patients for the 5 years under consideration. The Tables, further revealed that, there were more cases of childhood TB in year 2021 across the two states compared to the other years. The results also, show that the year 2021 witnessed an increase in the number of notified cases across all age groups. Furthermore, Table 3 shows that the male patients were more in number than the females in the two states: Adamawa, male 2,589 (68.7%), female 1,175(31.1%); Taraba, male 3717 (60.8%) while female 2,396 (39.2%). Further insight revealed in Table 3 that, of all male patients in Adamawa State, 89 (3.4%) had childhood TB and of the female patients, 70 (6.0%) had childhood TB. Of all the patients in Taraba State for the period under study, childhood TB consists of 209 (5.6%) males and 177 (7.4%) females. The results revealed a drop in childhood TB notification across the two states in the year 2020.

There was no significant difference between the year of notification and gender (male and female) of the patients in Adamawa State, also there is no significant difference between the year of notification and gender (male and female) and the site of the treatment (pulmonary and extra pulmonary patients) in Taraba State. That is, no significant association between year and gender and between year and site of the treatment. The combined data from the two states in Table 4 revealed that there is significant difference in TB patients' notification in all patients' variables except for age groups, this is an indication that it is more profiting to run the data on State bases.

Table 3. Case notification by States, Age group, and Gender

State	Gender	Age group						
		0-4	5-14	15-24	25-34	45-54	55-64	>64
Adamawa	Male	31	58	379	1286	418	209	208
		1.20%	2.20%	14.60%	49.70%	16.10%	8.10%	8.00%
	Female	16	54	238	553	133	89	92
		1.40%	4.60%	20.30%	47.10%	11.30%	7.60%	7.80%
Taraba	Male	44	165	473	1783	577	316	359
		1.20%	4.40%	12.70%	48.00%	15.50%	8.50%	9.70%
	Female	33	144	406	1100	311	199	203
		1.40%	6.00%	16.90%	45.91%	13.00%	8.30%	8.50%

Table 4: Overall analysis of the significant difference in patients' characteristics

Variables	*p*-value
States	0.000
LGA	0.000
Treatment facility ownership	0.000
Treatment regimen	0.001
Patient supported	0.000
Disease site	0.000
HIV status	0.000
Age group	0.182*
Gender	0.019

There was significant difference in TB patients' notification in all patients variables except for age groups.

Multivariate Data Analysis

Multinomial regression analysis was employed to perform multivariate analysis for all statistically significant variables identified at the bivariate analysis and reported the results as odds ratios, with year 2020 as the reference year, the results are presented in Tables 5a-6b. Tables 5a and 5b present the multivariate analysis for Adamawa State case notifications, while Tables 6a and 6b present the results for Taraba State case notifications.

Table 5a: Multinomial model fitting information (Adamawa State)

			Likelihood Ratio Tests		
Model	BIC	-2 Log Likelihood	Chi-Square	Df	*P*-value
Intercept	2388.248	1894.254[a]	0.000	0	
LGA	2440.864	2012.736	118.481	8	.000
Health facility ownership	2446.984	1985.922	91.668	4	.000
Treatment regimen	2363.556	1902.495	8.241	4	.083
Patient supported	2559.338	2098.277	204.023	4	.000
Disease site	2362.218	1901.157	6.903	4	.141
HIV Status	2369.212	1941.083	46.829	8	.000
Age Group	2230.111	1933.715	39.461	24	.024

Table 5a shows that Treatment regimen ($p = 0.83$) and Disease site ($p = 0.141$) are not statistically significant. This implies that there was no significant difference in the yearly cases notification with respect to Treatment regimen and Disease sites. Table 5b shows the odds ratio (OR) for the levels of each parameter with their respective significance ($p < 0.05$), the result shows there was an increase in case notifications for Mubi South (OR=1.022) and Yola North (OR=1.493) for year 2017 compared to Numan LGA, similarly, cases notification was more likely in Yola North in year 2017 (OR=1.022), 2018 (OR=1.33) and 2019 (OR=1.034) than in year 2020. Patients were more likely to be treated in public facilities between 2017 and 2019 (OR = 3.411, 2.049, 3.697) with ($p = 0.000$, $p = 0.001$,) respectively, but are less likely to patronise public health facilities (OR=0.871) in year 2021.Six months regimen treated were more likely in 2017 (OR=1.257), 2019 (OR=1.273) and year 2021 (OR=2.407). However, cases were not likely in year 2021 compare to 2020 with odds ratios; Mubi North (OR=0.924), Yola North (OR=0.361) and public health facilities (OR=0.871), also, patients were not likely to be supported to take drugs two years before COVID-19;year 2018 (OR=0.947), 2019 (OR=0.697) but mostly supported in year 2021 (OR=4.144) with (). Furthermore, individuals with HIV complications are more likely compared with those without HIV complications and those with unknown HIV status, also, across age groups, cases notification are more likely in younger age groups than older patients, particularly, childhood TB is more likely with; ages 0-4 (OR=4.228, 3.601, 2.362 and 3.968) respectively, for year 2017,2018, 2019 and 2021, ages 4-15 (OR= 1.066,1.950, 1.1020) respectively, for year 2017, 2018 and 2021.

Table 5b: Factors associated with cases notification in Adamawa State

Variable/Level	2017		2018		2019		2021	
	P-value	OR	*P*-value	OR	*P*-value	OR	*P*-value	OR
Intercept	0.078		.482		0.122		0.04	
LGA								
Mubi South	.889	1.022	.932	.987	.201	.831	.572	.924
Yola North	.026	1.493	.149	1.313	.850	1.034	.000	.361
Numan[b]								
Health facility ownership								
Public	0.00	3.411	.001	2.049	.000	3.697	.398	.871
Private[b]								
Treatment regimen								
6 months	.630	1.257	.280	.596	.639	1.273	.115	2.407
12 months[b]								
Patient supported								
Yes	.404	1.137	.734	.946	.343	.697	.000	4.144
No[b]								
Disease site								
Pulmonary	.060	.512	.304	.673	0.183	0.602	.715	1.158
Extra pulmonary[b]								
HIV status								
Positive	.000	2.308	.003	2.081	.346	1.257	.308	1.273
Negative	.746	1.061	.750	1.064	.478	.876	.134	1.311
Not tested[b]								
Age group								
0-4	.030	4.228	.076	3.601	.230	2.362	.037	3.968
5-14	.857	1.066	.069	1.950	.423	.721	.783	1.102
15-24	.760	.934	.664	1.116	.868	.962	.196	1.324
25-34	.192	.773	.209	1.321	.862	1.036	.408	1.174
35-54	.293	.784	.370	1.256	.756	1.076	.161	1.365
55-64	.718	.912	.667	.880	.625	1.136	.929	.978
>64[b]								

Year 2021 is set as the reference category.
b Reference level

Multivariate analysis for the data from Taraba State as presented in Tables 6a and 6b show that all the variables significantly affect notification except Age group. Table 6b presents the factors associated with TB notification, the results show that compared to Wukari LGA, notification was lower in Jalingo in 2017 (OR=0.510), 2018 (OR=0.572), and 2021 (OR=0.963), but more likely 2019 (OR=1.049). In comparison, Gassol LGA recorded more likely cases in 2019 and 2021 than Wukari LGA. On health facilities, the public health facilities were more likely patronised than the private facilities except for the post COVID-19 outbreak year; 2017 (OR= 1.574), 2018 (OR=2.980), 2019 (OR=2.754) and 2021 (OR=0.416). On treatment regimen, the 6 months regimen was more likely across the years except for 2018; the year 2017 has the most likely cases (OR= 4547932.161). The result further revealed that patients were more likely supported to take their medications in the year 2017 (OR=1.674), year 2018 (OR=2.118) and year 2021(OR=1.344) than in 2020. Also, on HIV in TB, HIV positive patients were more likely in the year 2017 (OR=5.318) and 2018 (OR=1.241), but lower in year 2019 (OR=0.322) and 2021 (OR=0.248) compared to those not tested and also compared the to year 2020. Furthermore, Table 6b revealed that Childhood TB is more prominent among children of ages 5-14; (OR=1.392, 1.392, 1.237) for 2017 to 2019 respectively.

Table 6a: Multinomial model fitting information (Taraba State)

			Likelihood Ratio Tests		
Model	BIC	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept	2001.978	1513.761[a]	0.000	0	
LGA	2229.315	1810.842	297.082	8	.000
Health facility ownership	2245.249	1791.904	278.143	4	.000
Treatment regimen	1996.571	1543.226	29.465	4	.000
Patient supported	2238.970	1785.625	271.865	4	.000
HIV status	2309.694	1891.222	377.461	8	.000
Age group	1827.953	1548.972	35.211	24	.065

Table 6b: Factors associated with case notification in Taraba State

`	2017		2018		2019		2020	
	P-value	Exp(B)	*P*-value	Exp(B)	*P*-value	Exp(B)	*P*-value	Exp(B)
Intercept	.000		0.04		0.515		0.535	
LGA								
Jalingo	.000	.510	.000	.572	.771	1.049	.807	.963
Gassol	.000	.102	.008	.650	.924	1.017	.025	1.434
Wukari [b]								
Health facility ownership								
Public	.019	1.574	.000	2.980	.000	2.753	.000	.410
Private [b]								
Treatment regimen								
6 months	.000	4547932.161	.004	6.532	.471	1.390	.029	3.620
12 months [b]								
Patient supported								
Yes	.000	.015	.674	1.674	.541	2.118	.768	1.344
No [b]								
HIV status								
Positive	.000	5.318	.319	1.241	.000	.322	.000	.248
Negative	.006	2.079	.788	.951	.000	.299	.000	.237
Not tested [b]								
Age group								
0-4	.373	.683	.228	.627	.455	.763	.616	.835
5-14	.209	1.392	.363	1.237	.234	1.308	.659	.902
15-24	.640	.909	.057	.713	.182	.795	.919	.984
25-34	.958	1.010	.032	.721	.149	.807	.752	1.046
35-54	.773	.942	.415	.865	.734	.943	.524	1.110
55-64	.802	.943	.450	.860	.280	.807	.330	1.195
>64[b]								

Year 2021 is set as the reference category. b Reference level

Findings

The results presented in Tables 1-4 revealed that the males are more infected with TB than the females across age groups, even among children, which implies the male adults as well the children are at higher risk compared to the females. The results further revealed that COVID-19 impacted negatively on TB notification including childhood TB notification. It is pertinent to note that childhood TB was still endemic across States and all LGAs. Childhood TB is a direct reflection of the incidence of adult TB within the community, this represents recent transmission from an infectious adult or adolescent and is considered a sentinel event in public health, there is need to further investigate the cause(s) of Childhood TB, since all children in Nigeria ought to complete their BCG vaccine. The results further revealed that childhood TB is more

likely than in other age groups, though the Adamawa State was more likely than Taraba States.

Childhood TB is an indication that TB transmission is ongoing in the communities, the implication is that the global effort to end TB by 2035which is called "End TB Strategy" needs to be reinvigorated or else the End TB Strategy will be a mirage. On TB in people with HIV, the study revealed that there is a little decrease in the number of HIV/TB coinfection in both States between 2015 to 2020 but there was sudden increase in HIV/TB coinfection in both States in 2021, the year following COVID-19 outbreak. Furthermore, the study revealed that, patients with HIV complications are more likely both in pre and post COVID-19 outbreak but that patients avoid public health facilities, post COVID-19 outbreak. Also, a good number of TB patients were not tested for HIV; 393 in Adamawa State and 710 in Taraba State, this is also detrimental to the effort to the global fight against HIV/AIDS targeted to end HIV by 2030 as stated in SDG 3.3.

Conclusion

The COVID-19 pandemic has had devastating effects on every aspects of global health, the pandemic has revealed the existing gaps in healthcare and offers an opportunity to bridge the gaps (Kant & Tyagi, 2021). This study revealed that, there was an increase of case notifications across states in 2021, based on 2020 figures; 49.7%and 47.4% in Adamawa and Taraba respectively, while, on HIV in people with TB, there was sudden increase in HIV/TB coinfection in both states in 2021; Adamawa State recorded 55.5% while Taraba state had 24.6%increase based on 2020 records, furthermore, 10.4%and 11.6%of the Adamawa and Taraba patients respectively, have no HIV status recorded. The study also revealed that childhood TB is still endemic in the study area, though the children were expected to have completed childhood vaccine against TB and other child killer diseases, hence the incidences of childhood TB need to be investigated. In conclusion, this research revealed that, there was decline in TB cases notification during the COVID-19 outbreak year, and that COVID-19 impacted negatively on TB notification, this is in tandem with other studies (Kwak, *et al*., 2020; WHO, 2021a; Pai *et al*., 2022). This could be because the entire process of TB management came to a halt as a result of the COVID-19 lockdowns.

Human subjects' issues and ethics approval.

This study was reviewed and approved by the Modibbo Adama University, Yola, Research Ethics Committee. The need for patient consent was waived by the ethics committee because data collection involved retrieval of records from large numbers of TB patients, for whom it would have been logistically impractical to reach and seek individual consent. Data were handled confidentially since the names of patients were excluded.

Compliment

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