

Performance of Active Tuberculosis Screening across the TB Care Cascade in KNCV-Supported Sites in Plateau State, Nigeria: Lessons from the KNCV Nigeria TB LON Project

Patience Opara¹, Gift Lawrence², Rimamtswab Kifasi², Omotayo Salau³, Mamman Bajehson⁴, Chidubem Ogbudebe⁴, Ogoamaka Chukwuogo⁴, Sani Useni⁴, Bethrand Odume⁴, Maxwell Jubilick⁵, Elias Aniwade⁶

¹Programs, Knowledge Network for Disease Control and Vigilance (KNCV) Nigeria, Jos, Nigeria

²Strategic Information, Knowledge Network for Disease Control and Vigilance (KNCV) Nigeria, Jos, Nigeria

³Strategic Information, Knowledge Network for Disease Control and Vigilance (KNCV) Nigeria, Lafia, Nigeria

⁴Programs, Knowledge Network for Disease Control and Vigilance (KNCV) Nigeria, Abuja FCT, Nigeria

⁵Strategic Information, Knowledge Network for Disease Control and Vigilance (KNCV) Nigeria, Abuja FCT, Nigeria

⁶Program, Plateau State Tuberculosis, Buruli Ulcer and Leprosy Control Program (STBLCP), Jos, Nigeria

Email: popara@kncvnigeria.org

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Abstract

Introduction: Tuberculosis persists as a public health concern and the leading infectious killer worldwide. Active screening for TB is the best strategy for early diagnosis of TB to curb the spread in communities and ultimately control TB. This study assessed TB screening and treatment cascade performances associated with active tuberculosis case finding in KNCV-supported sites in Plateau State, Nigeria. **Methods:** The study was conducted in Plateau State, North-Central Nigeria. A prospective study design was used to study all clients irrespective of their age and gender. A proforma was used to extract data from the general facility register and the active case finding (ACF) screening booklets. Data were summarized using absolute numbers and percentages. They were presented using tables and charts. Ethical consideration was duly observed. **Result:** Over the three years, 1,716,744 clients were studied, out of which 1,707,481 clients were screened (99.5%). The number of clients screened fluctuated, reaching the highest numbers in the period in 2023. Except for the year 2021, females consistently recorded slightly fewer presumptive TB than males over the years (approximately 15,726 - 25,805 among females compared to 14,908 - 28,748 among males), despite a higher number of females being screened. Evaluated presumptive TB showed an upward trend, approximately 14,908 - 15,726 for

the year 2021 to 25,805 - 28,748 in the year 2023. TB case detection or yield ranged from 691 to 1894 per sex per year. Of the total 7823 TB cases diagnosed, almost all diagnosed cases were enrolled for treatment. 7514 (96.1%) were enrolled in treatment over the three years. **Conclusion:** The program demonstrated strong TB screening and treatment cascade performances over the three years, with high screening, evaluation, and treatment initiation rates. Active TB case finding in KNCV-supported sites in Plateau State contributed to improved TB case detection and linkage to care. Further strengthening of targeted screening and community engagement may improve program performance.

Keywords

Impact, Active Tuberculosis Screening, Health Systems, Nigeria

1. Introduction

Globally, Tuberculosis (TB) remains a public health threat despite available vaccines and efficient drugs for treatment. It is the leading cause of morbidity and mortality worldwide [1]. In 2023, TB affected an estimated 10.8 million people and resulted in 1.3 million deaths [1]. Noteworthy is that 90% - 95% of these deaths were found in low and middle-income countries (LMICs) [2] [3]. In addition, more than 87% of global TB cases were reported in 30 high-burden countries for TB, including Nigeria [4].

In Africa, TB ranks eighth among the top ten leading causes of death, accounting for 23% of new cases and 31% of TB-related deaths [1]. Nationally, the TB burden is growing along with its population. For example, Nigeria has the sixth-highest TB burden globally, with an estimated 4.3 percent multidrug resistance in new cases [5]. In the country, 268 people die from TB every day [5]. In 2022, annual TB incidence in Plateau State, Nigeria, was estimated at 10,330, but only 3669 were diagnosed and notified, leaving a gap of 6661 undetected TB cases [6].

Studies show that even with newer TB diagnostic tools, up to one-third of people living with TB remain undiagnosed [7] [8]. There are also diverse and proven diagnostic options adapted to different settings, but diagnostic gaps persist. It is estimated that 85% - 95% of these deaths could be prevented with early detection, diagnosis, and appropriate treatment. Nevertheless, more than 3 million TB cases are missing annually, and the missed cases are either not diagnosed or diagnosed but not notified [7]. Consequently, the significant risk of transmission is increasing due to the underdiagnosis and under-reporting of TB cases. Of concern is the fact that a person with TB disease can infect 10 to 15 people he or she encounters [9]. This implies that each missed TB case contributes to the current TB burden, thereby compounding the challenge to end TB. Thus, the importance of promptly identifying TB cases and linking them to care cannot be overemphasized.

Low TB case detection remains a major challenge in achieving the End TB targets. The World Health Organization (WHO) emphasized that missed TB cases

are a significant contributor to the continual high prevalence and incidence of TB in low and middle-income countries. It then suggested systematic screening of all clients who come to the health facility [10]. Enhanced TB case finding is crucial to achieve the global reduction targets in TB morbidity and mortality as stipulated in the End TB strategy. Active surveillance or screening is defined as all activities conducted by health care workers in the community and facilities to identify previously undetected active cases of TB. New strategies that consider local contexts are needed in countries with high TB burdens like Nigeria. This calls for more sensitive and specific point-of-care diagnostic tests. Active surveillance for TB is currently identified as the best strategy for early diagnosis of TB to curb the spread in communities [11]. Succinctly, active TB screening of hospital attendees and community dwellers is pivotal in finding missing TB cases.

This study assessed the performance of the TB screening and treatment cascade associated with active tuberculosis screening in KNCV-supported sites in Plateau State, drawing on KNCV Nigeria's experience.

2. Materials and Methods

2.1. Study Setting

The study was conducted across KNCV-supported Directly Observed Treatment Short-course (DOTS) public and private facilities as well as catchment communities under the interventions of active TB screening in Plateau state, North-Central Nigeria. The state is surrounded by Bauchi State to the northeast, Kaduna State to the northwest, Nasarawa State to the southwest, and Taraba State to the southeast. Plateau State consists of seventeen Local Government Areas (LGAs). It has an estimated population of 4.7 million people and over forty ethno-linguistic groups. There are 1470 health facilities spread across the state. Public facilities: 1095 (Tertiary—5, secondary—77, and primary—1013), and private facilities: 375 (secondary—44, and primary—331), government secondary and private secondary healthcare facilities; 77 and 44, respectively, and 5 tertiary healthcare facilities [12]-[14].

2.2. Study Design and Approach

The study was a quality improvement project that employed a prospective study over three years (2021 to 2023). Active tuberculosis (TB) screening was systematically integrated into both facility-based and community-based interventions across KNCV-supported sites in Plateau State. Screening was conducted among all hospital attendees, including accompanying relatives of the patients, household contacts of index TB patients, and community members reached during outreach activities, irrespective of age or sex. Ad-hoc staff and healthcare workers were recruited, trained, and deployed to selected public health facilities and hotspot communities for program implementation, involving conducting symptom-based TB screening among all hospital attendees and relations in various service delivery points within the hospital, additionally, visitations to index TB households for contact investigation and community outreaches using the National Tuberculosis and Leprosy Control Pro-

gramme (NTBLCP) screening algorithm and standardized screening tools. The hub and spoke mapping mechanism facilitated presumptive TB client referrals at facilities without diagnostic capacity, and from the communities.

A presumptive TB was defined as any individual presenting with one or more of the cardinal TB symptoms: cough of two weeks or more, fever, unexplained weight loss, and night sweats or other symptoms consistent with national TB screening guidelines. Identified presumptive cases with productive cough produced sputum samples, which were taken to the laboratory for further diagnostic evaluation by an ad-hoc/healthcare worker either within the same facility with diagnostic capacity or through the established hub-and-spoke referral system in facilities lacking diagnostic capacity. Those unable to produce sputum were referred for chest radiography.

Diagnostic evaluation primarily utilized the molecular WHO-recommended Rapid Diagnostic tests (mWRDs), particularly GeneXpert MTB/RIF, as the first-line diagnostic tool for bacteriological confirmation of TB and detection of rifampicin resistance. Where indicated and available, additional diagnostic procedures such as TB LAMP and Truenat machines, Acid Fast Bacilli (AFB) sputum smear microscopy, chest radiography, and clinical evaluation by a qualified clinician were employed to support diagnosis, especially among clients with strong clinical suspicion but negative bacteriological results.

A TB-positive case was defined as any individual who was either bacteriologically confirmed through mWRD/sputum microscopy or clinically diagnosed with TB by a qualified clinician in accordance with the WHO and NTBLCP guidelines. All diagnosed clients were linked to treatment initiation at designated Directly Observed Treatment Short-course (DOTS) facilities and followed up to confirm treatment initiation and enrollment into care. Presumptive TB referred from spoke facilities or community settings to diagnostic hubs were actively followed up for diagnostic evaluation, and diagnosed cases monitored for treatment completion to guarantee continuity of care and reduce Loss-To-Follow-Up (LTFU). Tracking mechanisms involved collaborating with the TB focal persons known as DOTS officers, follow-up phone calls to patients on treatment, and routine monitoring for sputum conversion through AFB follow-up tests.

2.3. Study Population

Males and females of all ages screened across the above-mentioned intervention areas were included in the study. However, clients screened outside KNCV-supported intervention sites; data from facilities or community activities not supported by KNCV Nigeria under the USAID TB LON project (including non-mapped DOTS facilities or non-programmatic community outreaches), and transferred-in TB Patients; TB patients already diagnosed or initiated on treatment outside the active screening interventions (e.g., transfer-in cases from other states or programs), those with incomplete data or who failed to complete the cascade were excluded to avoid overestimation of screening-attributable outcomes.

2.4. Sample Size Calculation and Sampling

This study employed a total population approach. All eligible hospital attendees and their relations screened for tuberculosis at KNCV-supported public and private DOTS facilities, as well as all household contacts and community members reached through active case-finding interventions in Plateau State between 2021 and 2023, were included. As such, no formal sample size calculation was conducted, since the study analyzed the complete dataset of individuals screened within the defined study period, irrespective of age or sex.

2.5. Data Collection

Data were collected using standardized TB program Recording and Reporting (R & R) tools, including facility TB registers and active case finding screening booklets. A structured data extraction proforma was used to extract data from active case finding (ACF) screening booklets, general facility TB presumptive, and treatment registers, with patients' demographic information deduced from the eligible participants' facility registers (presumptive and treatment registers), and screening booklets. Information collected included: total number seen at the data collection site during the period, numbers screened, number presumptive, number further evaluated, number diagnosed, and number commenced on treatment. Data reporting and preliminary analyses were conducted on a weekly basis. Routine data validation was performed through cross-checking extracted data against source facility registers and ACF screening tools to ensure completeness, consistency, and accuracy before final analysis.

2.6. Data Analysis and Presentation

The target population denominator represented all hospital attendees, accompanying relations, household contacts, and community members reached through KNCV-supported interventions during the study period. Screening coverage above 100% in one subgroup reflected screening of unique persons (accompanying relatives) visiting the hospital who are not captured in the hospital's central register.

Data was entered in Excel for cleaning and validation, then exported and analyzed using IBM SPSS version 25. Descriptive analyses were conducted to assess performance across the TB screening cascade using absolute numbers and proportions. Results were presented using tables and charts. The total population studied was the denominator for the percentage screened. The number screened was the denominator for the percentage of presumptive. The number of presumptive was the denominator for the percentage further evaluated. The number further evaluated was the denominator for the percentage diagnosed. The number diagnosed was the denominator for the percentage commenced on treatment.

2.7. Ethical Consideration

The study was determined to be a non-research programme evaluation. As it re-

quired no direct contact with human subjects (no interview or sample collection) and only de-identified pooled programme data that formed part of standard of care were used, informed consent nor ethical approval was not required.

3. Results

The result summarizes performance across the tuberculosis (TB) screening-to-treatment cascade for a target population for the years 2021 to 2023. It shows how many people were screened, identified as presumptive cases, evaluated, diagnosed, and ultimately started on treatment. Findings show 1,716,744 clients were studied, out of which 1,707,481 clients were screened (99.5%). Clients presumed to have TB were 139,443 (males—72,168; females—67,275), giving an 8.2% yield. All (100%) presumptive TB were further evaluated, of which 7823 (5.6%) were diagnosed as TB positive. TB patients started on treatment were 7514 (96.1%) (**Table 1**, **Table 2**).

Table 1. TB parameters (Overall).

Variables	Number	Percent (100%)
Target population	1,716,744	
Clients screened for TB	1,707,481	
% Screened		99.5%
Clients presumed to have TB	139,443	
% of Screened that were Presumptive		8.2%
Presumptive cases evaluated for TB	139,443	
% Presumptive that were Evaluated		100%
Clients diagnosed with TB	7823	
% Evaluated that had TB		5.6%
TB patients started on treatment	7514	
% Positive Started on Treatment		96.1%

Table 2. TB parameters (Disaggregated by Gender).

Variables	MALE	FEMALE
	Number	Number
Target population	766,183	950,561
Clients screened for TB	760,757	946,724
% Screened	99.2	99.6
Clients presumed to have TB	72,168	67,275

Continued

% of Screened that were Presumptive	9.5	7.1
Presumptive cases evaluated for TB	72,168	67,275
% Presumptive that were Evaluated	100	100
Clients diagnosed with TB	5146	2677
% Evaluated that had TB	7.1	4.0
TB patients started on treatment	4924	2590
% Positive Started on Treatment	95.7	96.8

Over the three years, the number of clients screened fluctuated. In 2021, the number screened was 225,8191 for males and 300,514 for females. In 2022, screening slightly increased in both sexes and further increased in 2023, reaching the highest numbers in the period, 268,344 for males and 324,052 females (**Table 3** and **Figure 1**).

The presumptive TB remained low as a proportion of those screened, approximately 14,908 - 28,748 for males and 15,726 - 25,805 for females, disaggregated by age over the years. Except for the year 2021, females consistently showed slightly fewer presumptive cases than males, despite more females being screened than males (**Table 3**).

Table 3. TB parameters (Disaggregated by Year and Gender).

Variables	MALE			FEMALE		
	2021	2022	2023	2021	2022	2023
Target population	230,951	266,800	268,432	305,002	322,096	323,463
Clients screened for TB	225,819	266,594	268,344	300,514	322,158	324,052
% Screened	97.8%	99.9%	100.0%	98.5%	100.0%	100.2%
Clients presumed to have TB	14,908	28,512	28,748	15,726	25,744	25,805
% of Screened that were Presumptive	6.6%	10.7%	10.7%	5.2%	8.0%	8.0%
Presumptive cases evaluated for TB	14,908	28,512	28,748	15,726	25,744	25,805
% Presumptive that were Evaluated	100%	100%	100%	100%	100%	100%
Clients diagnosed with TB	1378	1874	1894	691	984	1002
% Evaluated that had TB	9.2%	6.6%	6.6%	4.4%	3.8%	3.9%
TB patients started on treatment	1312	1796	1816	667	953	970
% Positive Started on Treatment	95.2%	95.8%	95.9%	96.5%	96.8%	96.8%

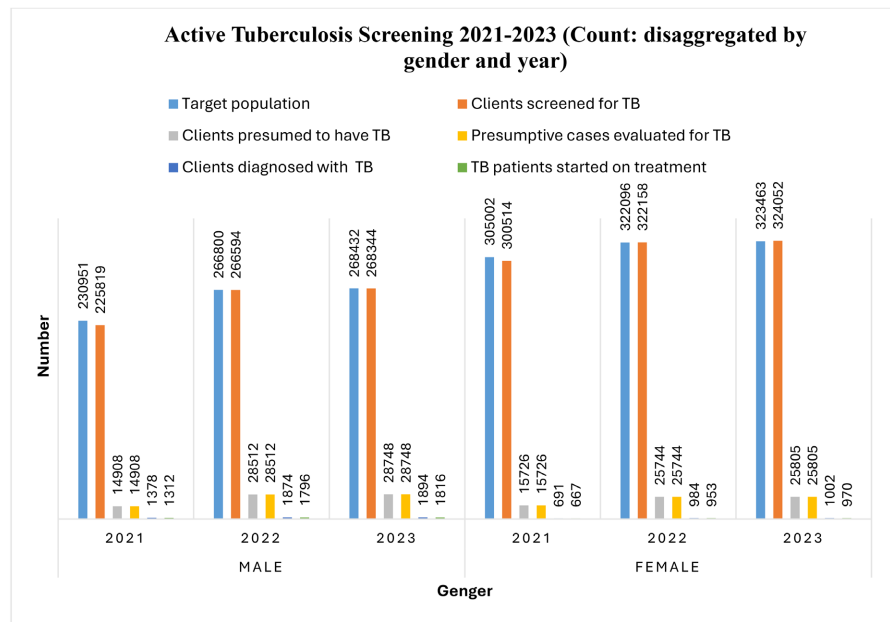


Figure 1. Distribution of active tuberculosis screening 2021-2023 (absolute count).

The number of presumptive TB further evaluated for TB showed notable progress. 14,908 - 15,726 presumptive TB were reported for the year 2021, in the year 2022, between 25,744 - 28,512 presumptive TB were evaluated, and in the year 2023, between 25,805 - 28,748 presumptive TB were evaluated. Evaluation numbers show an upward trend (Table 3 and Figure 1).

TB case detection was between 691 and 1894, and the yield 3.8% to 9.2%, cases per sex per year. Of the total 7823 TB cases diagnosed, almost all diagnosed were enrolled for treatment, 7514 (96.1%); 4924 males and 2590 females over the three years (Table 3, Figure 2, and Table 1 and Table 2).

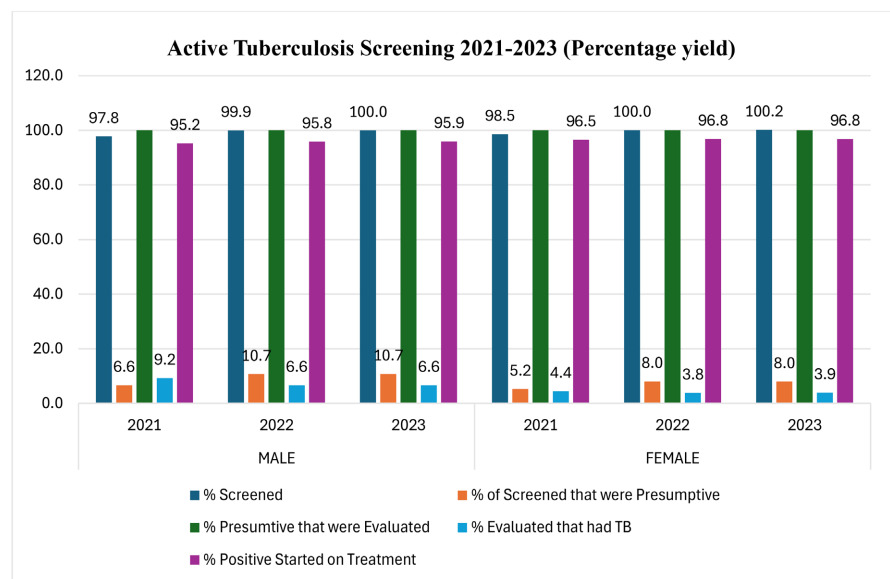


Figure 2. Distribution of active tuberculosis screening 2021-2023 (percentage yields).

In conclusion, there was a steady increase in the number of clients tested, presumed TB found, and TB cases diagnosed between 2021 and 2023. Although causality cannot be shown because the study is observational, these changes may be reasonably explained by expanding facility and community-based treatments, staffing support through trained ad hoc personnel, and routine active TB screening (Table 3 and Figure 3).

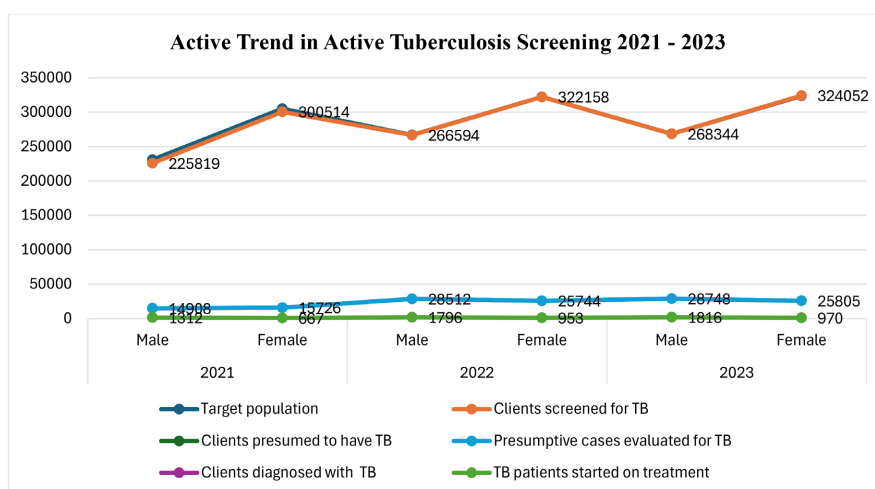


Figure 3. Trend in active tuberculosis screening 2021-2023.

4. Discussion

Over the three years, both the target population and clients screened for TB show noticeable yearly fluctuations by sex disaggregation but generally trending upward. Despite the large numbers screened (99.5%), the number of presumed (8.2%) and diagnosed (5.6%) remains relatively small despite being a targeted screening program. The observed changes are in line with KNCV's intervention in TB activities over this period in the state. Intervention started about mid-2020, which led to an increase in performance in 2021. The low presumptive and TB yields (8.2% and 5.6%, respectively) could be attributed to reduced ad-hoc staffing strength in 2022, which led to decreases in facility interventions, limiting outreaches to only high-burden LGAs, and contact investigation frequencies. However, in 2023, following ad-hoc staff re-engagement, full contact investigation, and community outreach implementation from January 2023, screening and diagnosis rates rose again. This suggests that improved program reach, consistent program quality, strengthened outreach, improved mobilization, or expanded campaigns are key to success in control of TB. This finding is supported by a previous study in Nigeria, which showed a progressive increase in the number of persons with presumptive TB and those tested following an active search for cases [15].

The presumptive TB remained low as a proportion of those screened. The low presumptive rate is typical in mass screening because most individuals screened are healthy. Females have a larger target population and more screenings. However, males show slightly higher presumptive and diagnosed numbers per popu-

lation unit screened. The consistently higher male presumptive numbers may reflect higher TB risk among males. This is consistent with global trends of the typical TB pattern that show a higher prevalence of TB among males. Male-to-female differences in presumptive and diagnosed cases might warrant examining risk factors or screening location choices.

Previous studies reported that men bear a disproportionately high burden of disease, face greater barriers to diagnosis and treatment, and may experience worse treatment outcomes than women [16]. The study further averred that the impact of these disparities extends beyond men's health and that the transmission from affected men is responsible for most new infections in the community. In support of the finding, in 2021, WHO data showed that among adults notified cases of TB, men and women contributed 56.5% and 32.5% respectively [17]. Also, in Nigeria, a study documented that the TB surveillance system screened more women and diagnosed more men with the disease [15]. This is not a surprise because gender disparities in TB are shaped by biological, socio-behavioral, and structural factors and influenced by underlying gender roles and norms. Globally, alcohol use disorders and smoking are more prevalent among men [18] [19]. Structural determinants of TB, incarceration, and occupational exposures (e.g., in the mining sector) increase men's risk of disease.

The number of presumptive TB that had diagnostic evaluation increased significantly from 2021 to 2023, indicating stronger follow-up systems. High evaluation rates suggest efficient programme activities and/or improved follow-up (referral, specimen collection, and diagnostic capacity). TB case detection remained encouraging. Moderate to high detection could reflect high TB prevalence in the screened population. It indicates that more periodic screenings are necessary. Though the yield of TB cases may seem low relative to screening volume. This could mean a true low prevalence of TB among the population screened. It may be a pointer to intensify screening activities with more focus on high-risk settings (e.g., urban slums, mining, prisons).

Treatment initiation closely mirrors the number diagnosed each year. This indicates strong linkage to care, with nearly all diagnosed patients starting treatment. It suggests minimal loss between diagnosis and treatment initiation. This is encouraging and needs to be sustained to achieve set program targets. by the TB control program towards TB elimination.

The efficiency of the combined strategy used in this intervention is affirmed by previous studies. Adding community-based active case finding (ACF) interventions to facility-based services can increase the number of people diagnosed with tuberculosis [20]-[22]. This implies that the "business-as-usual" approach, which is the passive screening, was insufficient in finding missing TB cases and evinced the need for active case finding (ACF), as many people with TB identified in the interventions were previously undiagnosed. This gives credence for the ACF scale-up in the TB control programme [20].

The strength of the intervention is that there was high and improved screening

coverage over the years, improved evaluation rates, consistently strong linkage to treatment, and stable detection trends, with no major drops or system failures. Consequently, it implies that the continuum of care (presumptive → evaluated → diagnosed → treated) appears strong.

5. Limitations

This study utilized routinely collected program data and may be subject to documentation inaccuracies and possible duplicates. Due to repeated screening contacts, this study may have duplicate counts and documentation errors because it used program data that was routinely collected. Selection bias may have been generated by the exclusion of incomplete records. Furthermore, the lack of a comparison group restricts the attribution of observed benefits to the intervention alone.

6. Conclusion

Over the course of three years, the program showed remarkable TB screening and treatment cascade performance, with high rates of screening, evaluation, and treatment initiation. Improved TB case detection and care linkage may have resulted from active TB case finding in KNCV-supported locations in Plateau State. Male-to-female disparity might warrant examining risk factors or screening location choices, as well as monitoring gender-specific barriers to early care-seeking. Program efficacy may be enhanced by further bolstering focused screening and community involvement.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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