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Review Article

Impact of The Covid-19 Pandemic on Tuberculosis Prevalence: A Systematic Review of Regional Trends In Nigeria

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Abstract

Background: The COVID-19 pandemic caused an unprecedented disruption to health systems worldwide, diverting resources and attention from various endemic diseases, including tuberculosis. Among the countries with the highest burden of TB in the world, Nigeria grappled with enormous challenges in TB management during this period, with visible trends of marked regional variations in prevalence.
Objective: The study assessed the effect of the COVID-19 pandemic on trends in TB prevalence in Nigeria, using national and regional trends between the Northern and Southern parts of the country, before and during the pandemic.
Methods: In accordance with PRISMA criteria, this systematic review included research that was published between 2017 to 2023. Boolean operators designed to find pertinent research on the prevalence of tuberculosis in Nigeria were used to obtain peer-reviewed papers from African Journals Online (AJOL), PubMed, ScienceDirect, and Semantic Scholar. Cross-sectional studies documenting the prevalence of tuberculosis in Northern and Southern Nigeria prior to the pandemic (2017–2019) and during the pandemic (2020–2023) were included in the inclusion criteria. Covidence software was used to filter the studies, and the Newcastle-Ottawa Scale was used to evaluate the studies' quality and bias risk. Descriptive statistical techniques were utilised to synthesise and compare the data, which was extracted with an emphasis on research design, demographic characteristics, geographic regions, and TB prevalence rates.
Results: Nationally, TB prevalence increased from 15.8% pre-pandemic to 28.8% during the pandemic, with disruption of healthcare services. In the Northern region, it reduced trivially from 12% to 10%, probably due to decentralization in healthcare facilities and enhanced public health measures, while in the Southern region, there is a remarkable increase from 15% to 40%, driven by high urban density, overload in the healthcare system, and socio-economic adversities.
Conclusion: The pandemic significantly marred TB prevalence in Nigeria, with glaring regional disparities. Whereas the North put up a good fight through community-based interventions, the urban vulnerabilities in the South accelerated TB burden. These findings underline the imperative of equitable health care investment, integrated public health strategies, and socio-economic interventions as ways to mitigate the dual burden of the pandemics and TB.

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1. Introduction

The COVID-19 pandemic, an unprecedented global health crisis, has profoundly disrupted healthcare systems worldwide, redirecting critical resources and attention away from longstanding endemic diseases such as tuberculosis (TB) [1]. TB, caused by Mycobacterium tuberculosis, remains one of the leading infectious diseases globally and represents a significant health burden, particularly in low- and middle-income countries like Nigeria [2]. The disease primarily affects the lungs, though extrapulmonary manifestations involving the brain, spine, or bones can lead to severe complications if untreated [3]. With Nigeria ranking among the top ten countries in TB prevalence, the pandemic has magnified existing vulnerabilities in its healthcare infrastructure, exposing stark regional disparities in disease management and outcomes [4].

The clinical overlap between TB and COVID-19 further complicates the picture. Both diseases primarily target the respiratory system and share symptoms such as cough, fever, fatigue, and shortness of breath [5]. These similarities have compounded diagnostic challenges, misattributions, and delays in care, highlighting systemic healthcare weaknesses [6]. More critically, Nigeria's Northern and Southern regions present distinct socioeconomic and healthcare constraints, underscoring the need for region-specific analysis to understand the pandemic's impact on TB prevalence comprehensively [7].

TB continues to pose a formidable challenge in Nigeria despite government interventions like the National Tuberculosis, Leprosy, and Buruli Ulcer Control Programme (NTBLCP) [8]. The World Health Organization (WHO) estimates Nigeria's TB incidence rate at 219 cases per 100,000 people [9]. However, significant underreporting, referred to as the "missing cases" phenomenon—suggests a graver reality, particularly in Northern Nigeria, where limited healthcare access prevails [10]. Challenges such as stigma, inadequate health infrastructure, and insufficient diagnostic coverage have long hindered progress in TB control efforts [11]. In Southern Nigeria, relatively higher urbanization levels and literacy rates have fostered modest improvements in diagnosis and treatment uptake [12]. However, overcrowded urban settlements continue to perpetuate disease transmission [13]. This regional heterogeneity in TB dynamics demonstrates the need for targeted, region-specific strategies, a reality made more urgent by the disruptions caused by the COVID-19 pandemic [14].

The arrival of COVID-19 in 2020 introduced a parallel health crisis that diverted attention and resources to addressing the novel virus. In Nigeria, healthcare infrastructure strained under the pandemic's demands, resulting in significant disruptions to TB services [15]. Diagnostic facilities, human resources, and funding were largely reallocated to support COVID-19 testing and treatment efforts [16]. This shift had predictable consequences for TB care. Odume et al. [17] documented a 30% reduction in TB case detection rates in Nigeria during the pandemic's first six months [17]. Such a decline parallels trends in other high-burden TB countries like India and South Africa, underscoring the pandemic's global impact on TB control [18]. Reduced case detection not only delayed treatment initiation but also allowed TB to spread unchecked within communities, with potentially devastating implications for future incidence and mortality rates [19].

The fear of seeking healthcare services during the pandemic further exacerbated these challenges. A Nigerian Tuberculosis Epidemiological Review reported that in Northern Nigeria, median delays in TB diagnosis increased from 45 to 75 days [20]. Prolonged diagnostic delays heightened transmission risks within households, particularly under lockdown conditions that forced close interactions [21]. These findings point to the urgent need for nuanced, regionally tailored interventions that address such indirect impacts of COVID-19 [22].

Nigeria's regions have experienced the pandemic's effects on TB prevalence and management differently, reflecting long-standing disparities in healthcare infrastructure and socioeconomic conditions. Northern Nigeria, with its predominantly rural population and fragile health systems, has faced severe setbacks in TB control [23]. Historically, traditional practices, stigma, and low health literacy have hampered access to care [24]. During the pandemic, these pre-existing barriers intensified. A study by Desmon et al. [25] revealed a 40% reduction in TB clinic attendance in Kano State in Northern Nigeria during the lockdown, compared to a 25% decline in Lagos State in the South [25]. Desmon attributed this disparity to better health communication strategies and the adoption of digital tools in Southern Nigeria, which facilitated remote patient monitoring [25, 26]. The findings illustrate the pronounced vulnerability of Northern Nigeria's healthcare system in responding to dual health crises like TB and COVID-19 [27]. In Southern Nigeria, healthcare systems demonstrated relatively greater resilience. However, urban centers such as Lagos and Port Harcourt bore the brunt of overburdened healthcare facilities [28]. Cuffari et al. [29] documented instances of diagnostic misclassification, where TB symptoms were mistakenly attributed to COVID-19, leading to delayed treatment initiation and increased risks of undetected transmission [29]. Moreover, COVID-19 interventions in urban hubs often diverted resources away from peripheral health centers, widening existing inequalities in healthcare access [30].

Another significant consequence of the pandemic has been the exacerbation of drug-resistant TB, including multidrug-resistant TB (MDR-TB) and rifampicin-resistant TB (RR-TB) [31]. MDR-TB, defined as resistance to at least rifampicin and isoniazid, complicates treatment by requiring prolonged and often toxic regimens [32]. Globally, MDR-TB cases increased by 3.1% from 2020 to 2021, a trend largely attributed to healthcare disruptions [33]. In Nigeria, treatment interruptions, medication shortages, and logistical barriers during the pandemic likely fueled the rise of drug-resistant TB [34]. The combination of systemic healthcare vulnerabilities and the socioeconomic impacts of COVID-19 has compounded these challenges, underscoring the urgent need for integrated strategies to address drug resistance within TB care frameworks [35].

The socioeconomic fallout of the pandemic has further shaped TB prevalence trends in Nigeria. COVID-19 containment measures, lockdowns, curfews, and travel restrictions, disrupted livelihoods, disproportionately affecting informal sector workers who constitute a significant portion of Nigeria's workforce [36]. These disruptions have been particularly acute in Northern Nigeria, where poverty rates are higher, further reducing access to nutritious food essential for TB recovery [37]. Anigbo et al. [38] found that malnutrition rates among TB patients in Northern Nigeria rose from 35% to 50% during the pandemic, correlating with poorer treatment outcomes and increased default rates [38]. In Southern Nigeria, urban slums emerged as hotspots for TB transmission due to overcrowding and poor ventilation [39]. Although cities like Lagos implemented contact tracing initiatives, these efforts were overwhelmed by parallel demands of managing COVID-19 [40]. Financial constraints during the pandemic also led to higher out-of-pocket expenditures for TB treatment in private facilities, deterring timely care-seeking behaviors, as reported by [41].

The pandemic has provided critical lessons for TB control in Nigeria, particularly regarding the importance of resilient healthcare systems. Dual diagnostic platforms like GeneXpert machines, which were utilized for both TB and COVID-19 testing, emerged as an innovative approach to minimize service disruptions. However, the uneven distribution of these technologies has perpetuated existing equity gaps between Northern and Southern regions, exacerbating longstanding challenges in healthcare delivery [41–43].

Despite increasing awareness of the pandemic's impact on TB control, several critical knowledge gaps remain. Current research

Table 1: Search strategy.

Database	Boolen function	Other filters
AJOL	(”tuberculosis” OR ”TB”) AND (”drug-resistant” OR ”MDR” OR ”DR-TB” OR ”XDR”) AND ”Nigeria” (”prevalence” OR ”epidemiology”) AND (”original article” OR ”research article”)	none
PubMed	Prevalence AND drug-resistant TB AND Nigeria	2017-2023
ScienceDirect	Prevalence AND drug-resistant TB AND Nigeria	2017-2023 Original research
Sematic scholar	(”prevalence” OR ”epidemiology”) AND (”tb” OR ”tuberculosis”) AND (”original article” OR ”research article”) AND ”nigeria” -”reviews”	2020-2023

largely focuses on national-level data, providing insufficient insight into the regional disparities that shape TB outcomes in Nigeria [44, 45]. Moreover, the intersection of socioeconomic vulnerabilities, healthcare system disruptions, and the biological interplay of TB and COVID-19 remains underexplored [46]. For instance, disruptions in TB diagnostic and treatment services during the pandemic further fueled drug resistance, as seen globally and within Nigeria [47]. Lockdowns and restrictions affected both patient mobility and supply chain logistics, worsening treatment adherence and creating gaps in healthcare access [48, 49]. Addressing these gaps is imperative for designing targeted interventions that tackle Nigeria’s dual burden of TB and COVID-19 while accounting for regional and socioeconomic heterogeneities.

This systematic review aims to address these gaps by examining trends in TB prevalence Nigeria. Special attention will be given to regional disparities between Northern and Southern Nigeria, synthesizing evidence from both primary and secondary studies. As argue, robust evidence synthesis is vital for understanding the complex interplay of factors driving health outcomes in LMICs [50]. This review will evaluate the impact of the COVID-19 pandemic on TB control efforts and explore the roles of socioeconomic and healthcare system factors in shaping regional TB trends. By offering evidence-based recommendations, the study seeks to inform policies aimed at mitigating the dual burden of TB and COVID-19 in Nigeria. In doing so, this research contributes to the broader understanding of infectious disease dynamics in LMICs during pandemics, providing actionable insights for policymakers and healthcare practitioners. It underscores the importance of addressing healthcare inequalities, enhancing diagnostic capabilities, and improving socioeconomic conditions to achieve sustainable progress in TB control amidst evolving public health challenges.

2. Methodology

This research utilizes a systematic review and meta-analysis methodology, in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines as established in 2015 [51].

Eligibility Criteria

Because the study does not evaluate results of an intervention in which RCTs would be most applicable, this study focuses on the examination of the trends of the pooled prevalence across the periods before and during the COVID-19 pandemic. The eligible papers for this review included cross-sectional studies that addressed the strict epidemiology of TB in both Northern and Southern Nigeria. They had to report data on TB prevalence. It was decided to consider only primary research published in peer-reviewed journals, to ensure that data was reliable, considering that peer review remains a core element of quality control in scientific publishing. The studies ranged from 2017 to 2023, hence encompassing both the pre- and post-COVID-19 eras. Studies conducted between 2017 and 2019 were categorized as the pre-COVID-19 era, while studies conducted from 2020 to 2023 fell under the COVID-19 era.

Despite the highly reduced cases of COVID-19 infection, the socio-economic effects of COVID-19, such as job losses and the closure of businesses, are still very visible throughout Northern and Southern Nigeria. This will hence give a better understanding of the risk factors of tuberculosis from 2020 to 2023. The latest period before the pandemic for which data are available, the years 2017 to 2019 have been considered.

It is also crucial to consider that the year of publication does not necessarily indicate the year a study was conducted. For a study undertaken in 2019 and published in 2021, for example, it would still fall into the pre-COVID-19 timeframe, based on the year the data was collected and not the year the work was published.

On the other hand, it excludes review articles; studies that examined tuberculosis epidemiology outside of Nigeria or those unrelated to the review objectives. For example, a study that deals with treatment adherence alone.

Information Sources and Search Strategy

Sources of Information and Search Strategy Searches were also performed on electronic databases, targeting coverage comprehensively and inclusively of relevant studies with an emphasis on African research repositories. Such a search was performed in the AJOL library, a host to an immense number of different African journals and publications. With regard to the geography under scrutiny-Nigeria-this database was considered specifically fitting. Other databases that have been searched include PubMed, Science Direct, and Semantic Scholar. The search strategy was then developed using Boolean operators to enhance the results to be in line with the objectives of the review [52].

Data Management

To ensure the systematic review was conducted with precision, Covidence, a reputable software designed for managing reviews, was used throughout the process [53]. This platform streamlined critical stages, including study identification, title and abstract screening, evaluation of full texts, assessment of quality, and data extraction. Covidence is aligned with the PRISMA protocol, which guarantees a methodical approach to systematic reviews. Upon completing the process, the tool generated a detailed PRISMA flowchart that outlined every stage, from the identification of studies to their final inclusion. In addition, End Note, a trusted reference management application, was employed to organize citations from the selected works [54]. All extracted information was exported into Microsoft Excel for further processing and analysis.

Selection Process

The initial step involved transferring the studies identified in the databases into EndNote for citation organization [54]. These references were then exported as XML files into Covidence for systematic screening. Within Covidence, the studies underwent a dual-phase review: titles and abstracts were first evaluated to exclude irrelevant studies based on predetermined criteria. The remaining studies were subjected to an in-depth review of their full texts, allowing for the discovery of critical information not apparent in the abstracts. Only those studies that met the eligibility criteria proceeded to the subsequent stages, including quality evaluation and data extraction. Covidence documented the process by generating a PRISMA flowchart, visually capturing the sequence from study identification to the final selection of studies.

Data Extraction, Quality Assessment, and Risk of Bias

Eligible studies that passed the screening were subjected to data extraction, quality evaluation, and bias assessment. Extracted information included study titles, lead authors, publication years, population characteristics, study designs, study periods, locations and TB prevalence. The Newcastle-Ottawa Scale (NOS) was employed to evaluate the quality and potential biases of the selected studies. This tool assessed critical elements such as sample size adequacy, population representativeness, sampling methodology, outcome evaluation, and statistical analysis to determine the quality and validity of the studies. As the eligible studies were cross-sectional in nature, the NOS was particularly suitable for this purpose, given its endorsement for the assessment of non-randomized studies [55].

Synthesis and Analysis of Data

Data from the reviewed studies were synthesized using descriptive statistical approaches. With the aid of Microsoft Excel, mean proportions were calculated to provide a summary measure of the rates. These figures were then depicted visually, enabling a clear and effective representation of the findings.

Ethical Considerations

This review, by nature, relied entirely on secondary data derived from previously published works. As systematic reviews and meta-analyses do not involve direct research with human or animal subjects, ethical approval was not required. No empirical data collection was conducted, and the study did not entail interventions or experiments. To uphold the principles of academic integrity, all data from the reviewed studies were appropriately cited, ensuring adherence to research ethics and proper acknowledgment of the original authors.

3. Results

PRISMA flowchart figure 1

Table 2: Study characteristics

Studies	Study design	Population	Sample size	State in Nigeria
Studies conducted before 2020 (Pre-COVID-19 era)				
Olabiyi et al., [56]	Cross-sectional	Presumptive TB patients	1203	Ekiti/Ondo
Ibrahim et al., [57]	Cross-sectional	Presumptive TB patients	2451	Maiduguri
Ibadin et al., [58]	Cross-sectional	Presumptive TB patients	276	Edo
Ejeh et a., [59]	Cross-sectional	Presumptive TB patients	425	Benue
Abdulazeez et al., [60]	Cross-sectional	Presumptive TB patients	1610	Kwara
Ugwu et al., [61]	Cross-sectional	Presumptive TB patients	868	Enugu
Mohammad et al., [62]	Cross-sectional	Presumptive TB patients	384	
Ejeh et a., [63]	Cross-sectional	Presumptive TB patients		Benue
Daniel et al., [64]	Cross-sectional	Presumptive TB patients	17334	Ogun
Studies conducted from 2020 (COVID-19 era)				
Obiora et al., [65]	Cross-sectional	Presumptive TB patients	200	Abuja
Ologunde et al., [66]	Cross-sectional	Presumptive TB patients	191	Ekiti
Alex-Wele et al., [67]	Cross-sectional	Presumptive TB patients	260	Rivers
Daniel et al., [68]	Cross-sectional	Presumptive TB patients	24516	Ogun
Maori et al., [69]	Cross-sectional	Presumptive TB patients	130	Gombe

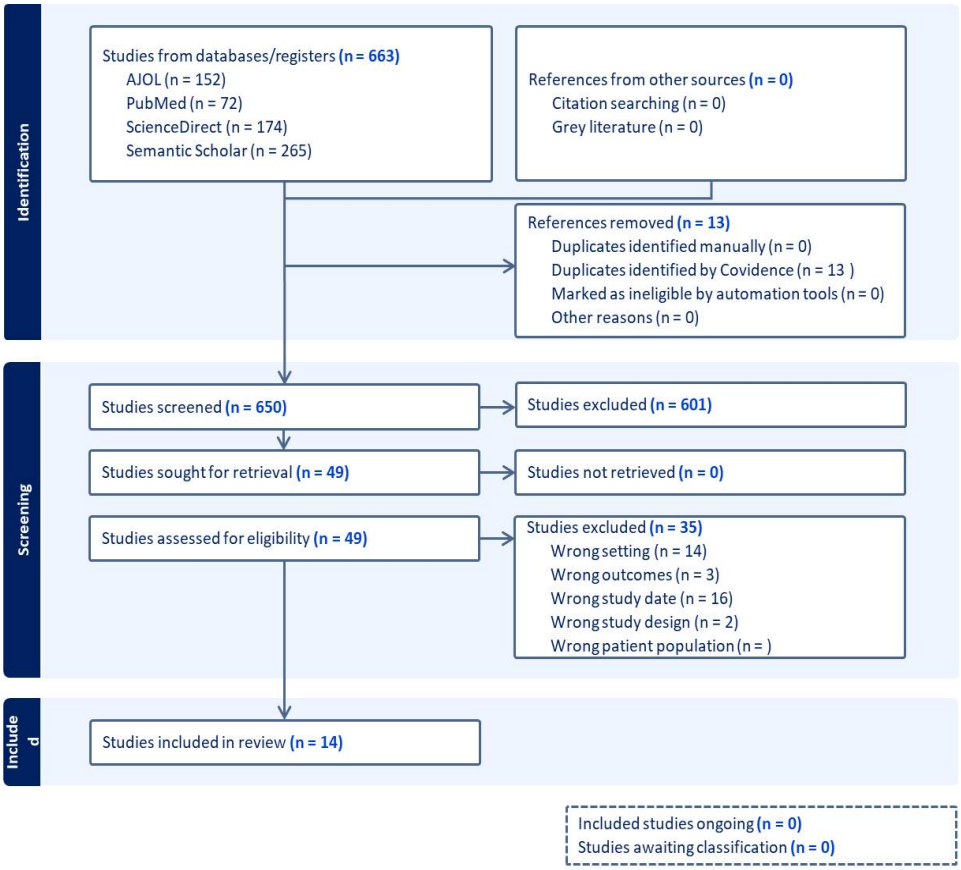

Figure 1: PRISMA Flowchart

In this Table 2 presents the characteristics of studies included in the systematic review, categorized by the period in which they were conducted. The studies are divided into those conducted before 2020 (Pre-COVID-19 era) and those conducted from 2020 onwards (COVID-19 era). The Table details the study design, population, sample size, and the state in Nigeria where each study was conducted.
In Figure 2 bar charts illustrating the mean TB rates across Nigeria, highlighting an increase from 15.8% before the pandemic to 28.8% during the pandemic. The data highlights the significant impact of the COVID-19 pandemic on TB prevalence at the national level.
In Figure 3 bar chart showing the TB rates in the Northern region of Nigeria, with a slight decrease from 12% before the pandemic to 10% during the pandemic.
In Figure 4 presents the TB rates in the Southern region of Nigeria, demonstrating a substantial increase from 15% before the pandemic to 40% during the pandemic.

4. Discussion

The COVID-19 pandemic has severely disrupted health care systems worldwide and has created serious obstacles to the management of infectious diseases hitherto combated. This systematic review comprehensively captures the impact of the pandemic on the prevalence of TB in Nigeria in general, then further divides into the Northern and Southern regions of the country. Incidentally, a wide difference in the trend of TB prevalence between the North and South during the pandemic was observed.

Nationally, TB prevalence surged from 15.8% before the pandemic to 28.8% during the pandemic. The increase underlines the broader impact of the pandemic on health services globally, as many resources were shifted toward fighting COVID-19, with TB services severely disrupted. It also follows the trend recorded internationally in countries with a high burden of tuberculosis such as India and South Africa, where similar redistributions of diagnostic tools, health workers, and finances saw TB case numbers increase [69, 70]. The disruption of essential health services, coupled with delays in diagnosis, led to the proliferation of undiagnosed and -treated cases of TB, erasing the gains made over decades in reducing the prevalence of the disease. WHO reports confirm the trend; an unprecedented rise in TB cases worldwide, beginning with the year 2019, impelled largely by pandemic-related disruptions [71, 72].

The Northern region's slight decline in TB prevalence, from 12% to 10% during the pandemic, deviates from the national and global trends. While counterintuitive, this reduction can be attributed to limited number of TB studies conducted in the region in the COVID-19 era and specific regional factors. For instance, the relatively rural and less densely populated Northern region experienced slower COVID-19 transmission rates, which likely reduced healthcare system overload [73]. Moreover, community-based TB interventions, which have become an essential part of healthcare delivery in this area, may have lessened the pandemic's effects on TB control initiatives. Research conducted in other rural, resource-limited regions, like certain areas of Sub-Saharan Africa, similarly indicates that TB outcomes remained stable or showed slight improvements during the pandemic [74, 75]. This resilience might partially be linked to steady involvement with community health care systems that rely less on the centralized, hospital-based infrastructure that faced overwhelming challenges in the surges of COVID-19.

Perhaps even more so than the actual economic impact of the pandemic itself, which was severe in the Northern region, the disruption

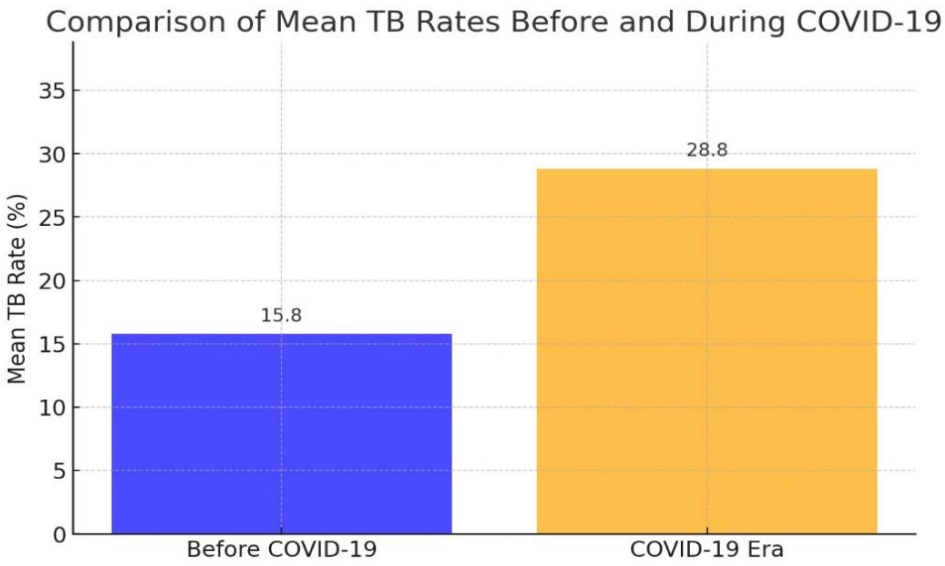

Figure 2: Comparison Of Mean TB rates before and during Covid-19

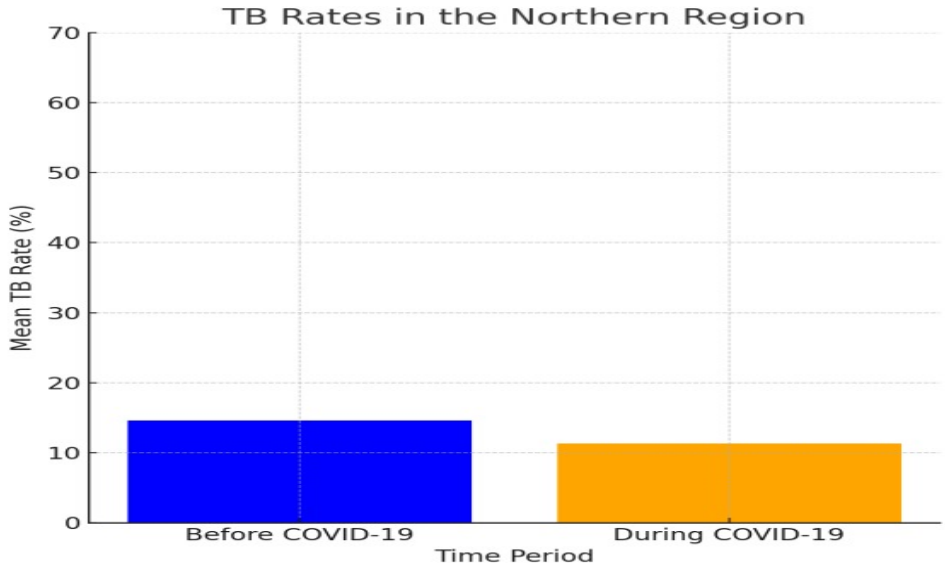

Figure 3: Comparison Of TB rates before and during Covid-19 in the Northern Region

of daily life seems not to have been felt quite as severely as in the urbanized South. Smaller baseline income levels and a more agrarian livelihood may protect against some of the most deleterious economic effects of the pandemic, thus continuing to afford those already in the system access to treatment and care for TB. The general public health measures, like targeted contact tracing and isolation efforts, may have indirectly favored tuberculosis control [38, 76, 77]. These findings go against the usual assumptions that rural areas are faring worse in terms of health crises but instead point to how community-oriented health care can present the potential for ensuring continuity of services.

In sharp contrast, there was an unprecedented surge in the prevalence of TB from 15% to 40% in the Southern region. This steep growth reflects an inability of urban compact populations to cope with dual health crises. The relatively advanced healthcare infrastructure in the South was nonetheless found choking with cases of COVID-19 that finally pushed TB services to the sidelines. Highly congested urban settings, poor ventilation, and socio-economic disparities provided just the right environment for TB infection to spread [38]. The lockdowns were especially harsh on the emergence of tuberculosis in urban slums, where this disease spread mainly in crowded spaces due to the restriction of movement that increased exposure to infected persons. Similar trends are evident in other global metropolises, including Mexico City and São Paulo, where healthcare systems buckled amidst competing epidemics to produce a remarkable surge in tuberculosis burden [76, 78].

Economic hardship amplified these problems. In the South, reliant as it was on informal economies, pandemic job losses were catastrophic in reducing access to healthcare services. It is observed that two of the major risk factors for tuberculosis, namely poverty and malnutrition, continued to rise as many families struggled to make basic needs [79, 80]. Such socioeconomic forces, when interacting with health system failures, create self-reinforcing cycles that accelerate the spread and progression of TB. Comparative studies conducted in Brazil and India reveal strikingly similar dynamics, underscoring the compounded effects of economic hardship and healthcare disruptions on the burden of tuberculosis during the pandemic [81–84].

The diverging patterns present in both the Northern and Southern regions highlight the importance of customized public health strategies based on regional situations. Whereas decentralized healthcare provision and minor economic disruptions helped the North, higher urban

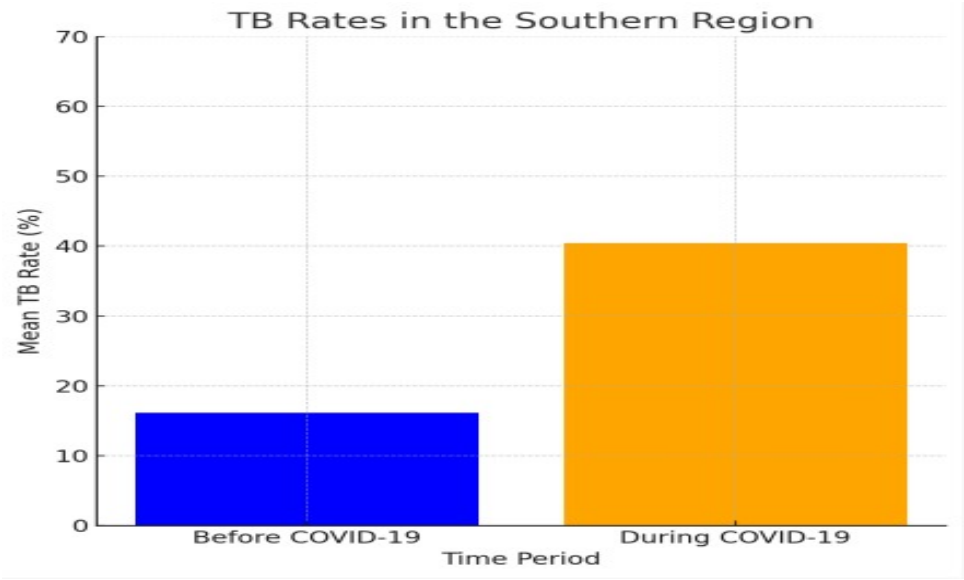

Figure 4: Comparison Of TB rates before and during Covid-19 in the Northern Region

density and economic interdependence increased exposure in the South. These observations are consistent with international experience showing that it is socio-economic resilience and the resilience of health systems themselves that have become major determinants of health in the pandemic context. High-income countries like the UK and the USA, for example, experienced relatively stable TB trends during the pandemic, thanks to robust healthcare systems and comprehensive social safety nets [85, 86]. The disparities within Nigeria highlight the urgent need for equity-driven investments in healthcare and socioeconomic infrastructure.

Another dimension which forms part of the discourse is how inequalities in pre-pandemic healthcare formed the pandemic outcomes the countries were subjected to. For example, in the North, traditional practices and health access limitations have always served to hinder TB control; that same constraint may insulate the region from pandemic-related service disruptions. The reverse was true in the South, where the highly centralized health system it depended on was overwhelmed. It speaks volumes about the relevance of decentralized, community-based health care models characterized by accessibility and continuity, especially in times of crisis.

The pandemic has also reignited debates on the sustainability of vertical programmes globally. The shifting of TB-related resources towards COVID-19 responses underlines how vertical approaches to health can be very fragile; disease-specific funding and infrastructure can easily become liabilities when new health threats emerge. Integration allows sharing of resources and infrastructure-for instance, GeneXpert machines are dual-purpose diagnostic tools-and creates a more resilient framework through which concurrent health threats can be managed. Nevertheless, the disproportionate allocation of these resources in Nigeria, wherein urban regions are significantly privileged, highlights underlying systemic disparities that require rectification to guarantee equitable access to healthcare.

This also brings critical questions about the interface of health and socioeconomic policy in its effect on the prevalence of TB. Besides health system resilience, it is impossible to overestimate the part played by poverty, malnutrition, and particularly housing conditions in driving the rate of TB infection. Many of these root causes require cross-sectoral collaboration and sustained investment in social protection programs. The response of Nigeria to the pandemic has secured the place of collaborative approaches which connect health to social services to make sure that no one gets left behind in times of disaster.

5. Conclusion

The COVID-19 pandemic therefore brought considerable inequity to light in the prevalence of TB across Nigeria. This is a very complex interplay, including health care, socio-economic, and infrastructural variables. Whereas the northern part was strong against this pandemic because of decentralized healthcare delivery, vulnerabilities of urban areas in the south strongly exposed critical weakness in the public health system. Such findings emphasize context-specific strategies, equitably distributed resources, and integrated public health approaches. Addressing these will take the country far in building a resilient health infrastructure to deal with multiple health crises happening concurrently, thereby reducing the burden of tuberculosis in post-pandemic times.

Recommendations

Strengthening health resilience will ensure the continuity of health services during the pandemic period. Investing in decentralized, community-based models of health is one way to strengthen systems of health care delivery in rural areas and integrate tuberculosis services into broader health responses to enhance resilience. Resources should be distributed equitably, with targeted investment in the most disadvantaged areas to address systemic inequities in access.

In addition, better access and equitable distribution of dual-purpose diagnostic equipment may reduce disruptions during public health emergencies. Broad-based public health approaches are generally needed to manage the many health risks people face. Integrating approaches that coordinate TB and COVID-19 responses, leveraging shared resources, infrastructure, and training, can greatly improve health system efficiency and effectiveness. Also, root causes of TB-poverty, nutritional status, and poor housing-need to be in place for the reduction of the socioeconomic load of the disease. Expanding social safety nets and targeted economic support programs would enable many of the vulnerable populations to avoid such risks. And finally, with respect to structural determinants of health in the urbanized regions, there is the

need to address crowding and poor ventilation.

This strengthens the nation's public health infrastructure, invests in affordable housing, and helps reduce the risk of TB transmission, particularly in highly congested areas. These form a comprehensive framework for improving TB control and public health outcomes during and beyond pandemics.

Limitations

This review is further limited by the few studies conducted during the COVID-19 period, especially in rural areas. Second, reliance on secondary data may mask specific local-level fluctuations in tuberculosis trends. The absence of qualitative insights from both providers and patients further limits the depth of understanding related to the experiences of people affected by disruptions in services.

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