Unmasking the Effects of the COVID-19 Pandemic on Tuberculosis Diagnosis and Care in Bungoma County, Kenya

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Abstract

INTRODUCTION

After the declaration of COVID-19 as a pandemic by the World Health Organization (WHO) in March 2020, the global focus solely shifted to fighting the pandemic. Tuberculosis (TB) services were affected in that the number of newly diagnosed tuberculosis patients decreased from 7.1 million in 2019 to 5.8 million in 2020. This study investigated the effects of COVID-19 on the diagnosis of tuberculosis patients and their treatment outcomes in Bungoma County, Kenya

MATERIALS AND METHODS

A retrospective cohort study was conducted using TB data from all health facilities in Bungoma County. A total of 5,981 TB patient records were collected, 3337 before COVID-19 and 2644 during COVID-19. An interrupted time series analysis was done to assess the impact of COVID-19 on TB case notification, comparing the period before COVID-19 (April 2018–March 2020) and during the pandemic (April 2020–March 2022). TB cases diagnosed were defined as the number of clinically diagnosed and bacteriologically confirmed TB treatment patients. Treatment outcomes were assigned to patients at the end of treatment according to WHO guideline. Data analysis on proportions was done using Epi Info 7 software.

RESULTS

The number of new patients diagnosed during the pandemic dropped compared to the period before the pandemic. The cure rate among the bacteriologically confirmed patients decreased from 86.9% before COVID-19 to 66.9% during COVID-19. The death rate among the patients increased during the COVID-19 pandemic to 10.8%, compared to 9.3% before the pandemic.

CONCLUSIONS AND RECOMMENDATIONS

COVID-19 not only negatively impacted the number of TB patients diagnosed in Bungoma County but also led to an increase in unfavorable TB patient outcomes. Bungoma County should invest in strategies to safeguard the health system in the future against similar pandemics.

Keywords: *Pandemics, COVID-19, Retrospective Studies, Kenya, Tuberculosis, World Health Organization*

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Background

The World Health Organization (WHO) declared the outbreak of COVID-19 as a global pandemic in March 2020**.** Until the COVID-19 pandemic, tuberculosis (TB) was the leading cause of death from a single infectious agent, ranking above HIV/AIDS (1). In 2021, approximately 10.6 million individuals worldwide contracted TB, an increase from the

10.1 million cases reported in 2020. Africa as a region accounts for 23% of the estimated global TB burden and over 33% of global TB deaths (2). The global focus on COVID-19 led to the newly diagnosed population decreasing from 7.1 million in 2019 to 5.8 million in 2020 (3) Kenya is among the top 30 high-burden TB countries that contribute to 80% of the incidence globally, with a documented incidence of 251 per 100,000 people in 2021 (4). Bungoma is among the high TB-burden counties in Kenya, with a tuberculosis notification of 96/100,000 people (5).

COVID-19 prevention measures that included quarantine, isolation, movement restrictions, school and church closures, and lockdowns had effects on TB care in Kenya. Patients faced substantial difficulties in accessing high-quality TB diagnostic services due to delays in diagnosis. Furthermore, TB molecular testing sites in Kenya were primarily allocated to COVID-19 diagnosis (6). The persistent challenges in accessing essential TB services led to a decline in newly diagnosed tuberculosis patients (7). These reductions in reported tuberculosis cases suggested there could be several undiagnosed TB cases. Additionally, it suggested that there might have been more TB-related deaths, more community transmission, and consequently more cases of TB. A global variance in response to COVID-19 was noted, with services including TB diagnosis having a decline (8,9). Effort was required from national TB programs to evaluate the impact of the COVID-19 pandemic. However, many governments made limited efforts to fully comprehend the severity of the COVID-19 pandemic. The devastating effects of COVID-19 on TB patients were inadequately assessed (10).

The effect of COVID-19 on TB diagnosis and care, in Bungoma County, remains unknown. Evaluating the effects of the COVID-19 pandemic was to provide insights into the performance of TB service indicators in the county. Furthermore, as COVID-19 transitioned to an endemic state, there was a need to understand how to integrate tuberculosis and COVID-19 care management programs. In particular were screening, laboratory diagnosis, contact tracing, and infection prevention and control measures (11). This was to be within both the healthcare facilities and the community's setup. We sought to assess the trends of tuberculosis diagnosis during the COVID-19 pandemic and evaluate the tuberculosis treatment outcomes before and during the COVID-19 pandemic in Bungoma County.

Materials and methods

Study design, setting and population

This was a retrospective cohort study that abstracted data from the digital TB surveillance database. The study was conducted in Bungoma County, where nearly 14% of COVID-19 cases in Kenya were reported. In 2019, the county had an estimated population of 1.7 million, with the majority being females at 858,389 and males at 812,146. The county has 10 administrative units with over 200 registered health facilities (12). Data for all notified tuberculosis patients were collected from the secondary data sources, for the period between April 2018 and March 2022. The sources included the national TB digital platform (TIBU), a secondary source of all facility TB data. Data variables captured included demographic and clinical variables like age, sex, type of patient, type of TB, HIV status, and distribution by sector. Further data variables captured included the Gene Xpert, Smear microscopy and X-ray. The TB treatment outcomes of patients included treatment success, cured, loss to follow-up, death, failed treatment, or not being evaluated.

Data analysis

All data for notified tuberculosis patients during the study period was analyzed using Epi Info 7 software. Patients' data with incomplete information were excluded. From the analysis the demographic, clinical characteristics and tuberculosis outcomes data was presented as

frequencies and proportions on tables at 95% CI. P-values were presented to evaluate statistical significance on the descriptive data before and during the pandemic. Interrupted time series analysis (ITS) was used to evaluate the effects of COVID-19 on the diagnosis of tuberculosis cases before and during COVID-19. The ITS involved analyzing longitudinal data collected at multiple time points before and after the pandemic. In the case of evaluating the effects of COVID-19, time series data included observations over several time points in the pre-intervention period and post-intervention period (12). The next step was to identify when the COVID-19 pandemic significantly impacted the outcome being studied. Once the intervention point was identified, the impact of COVID-19 on the outcome of interest was estimated by comparing the observed data in the post-intervention period with the counterfactual scenario predicted by the pre-intervention trend. A simple linear regression model was used to estimate the trend in the outcome variable over time before and after the onset of the COVID-19 pandemic. The intervention effect was represented as a step change in the regression equation at the time of the intervention.

Ethical considerations

The ethical clearance for the study was obtained from the Amref ethics review committee (Ref: 0001824). A research license was granted by the National Commission for Science, Technology, and Innovation (License No. 318302). Further approval to use the data was obtained from the Bungoma County Health Department.

Results

A total of 5,981 tuberculosis participants were diagnosed and registered during the entire study period; 3337(55.8%) were diagnosed before COVID-19 and 2644(44.2%) during COVID-19. Males were 61% (n = 3663) of the total participants (P < 0.01).

Table 1:
Demographic and clinical characteristics of study participants in Bungoma County before and during the COVID-19 pandemic, 2018 to 2022 (N=5981)

			Time period		
	Characteristics	**Total n (%)**	**Pre-COVID-19 (April 2018–March 2020) n = 3337**	**COVID (April 2020–March 2022) n = 2644**	**P-Value**
Age Group	0-14	609 (10.0)	339 (10.1)	270 (10.2)	<0.001
	15-24	870 (15.0)	537 (16.1)	333 (12.6)	
	25-34	1131 (19.0)	628 (18.9)	503 (19.0)	
	>35	3371 (56.0)	1833 (54.9)	1538 (58.2)	
Sex	Female	2318 (39.0)	1403 (42.0)	915 (34.6)	<0.001
	Male	3663 (61.0)	1934 (58.0)	1729 (65.4)	
Type of Patient	New	5444 (91.0)	3054 (91.5)	2390 (90.4)	0.02
	Relapse	33 (5.0)	181 (5.4)	150 (5.7)	
	Loss to follow up	171 (2.9)	91 (2.7)	80 (3.0)	
	Failure	14 (0.2)	2 (0.1)	12 (0.5)	
	Others	21 (0.4)	9 (0.3)	12 (0.5)	
Type of TB	Extra Pulmonary	723 (12.0)	435 (13.0)	288 (10.9)	0.01
	Pulmonary	5258 (88.0)	2902 (87.0)	2356 (89.1)	
HIV Status	Positive	1502 (25.0)	844 (25.3)	658 (24.9)	<0.001
	Negative	4344 (73.0)	2448 (73.4)	1896 (71.7)	
	Not Done	135 (2.3)	45 (1.3)	90 (3.4)	
Sector	Public	5171 (87.0)	2835 (85.0)	2336 (88.3)	<0.001
	Private	278 (4.6)	160 (4.8)	118 (4.5)	
	Others	532 (8.9)	342 (10.2)	190 (7.2)	

Of the total participants, 56% (n=3371) were adults <35 years of age. Significant differences in age group distribution were noted before and during the pandemic (P-value <0.001, 95% CI). The proportion of new patients was 91.5% before the pandemic and 90.4% during the pandemic. Patients with pulmonary tuberculosis were 89.1% during the pandemic, up from 88.0% before the pandemic at 95% CI. Furthermore, 88% (n=5258) of the participants had pulmonary TB. 87% (n=2902) had pulmonary TB before the pandemic, while 89.1% (n=2356) had this type of TB during the pandemic, representing 2902 (87.0%) and 2356 (89.1%) of the cases respectively, both before (52.1%) and during COVID-19 (61.3%). The number of patients without HIV status was 1.3% before COVID-19 and 3.4% during the pandemic (P < 0.01). Furthermore, participants from the public sector were 88% during COVID-19 compared to 85.7% in the pre-COVID-19 period at 95% CI (Table 1).

A total of 2529 tuberculosis cases were diagnosed by Gene Xpert before and during the pandemic. Before the pandemic, the average number of cases diagnosed by Xpert was increasing by 3.5 TB cases per quarter and culminated at 33 TB cases per quarter before the start of COVID-19 pandemic. During the pandemic this declined by 12.8 TB cases per quarter (Figure 1).

A total of 2271 tuberculosis cases were diagnosed by smear microscopy before and during the pandemic. Before the COVID-19 pandemic the rate of patients diagnosed by smear microscopy was decreasing by -11.9 TB cases per quarter (P-value= 0.006). On the onset of the pandemic this increased to -4.3 TB cases per quarter (P-value = 0.886) and during the pandemic there was further increase in the use of smear microscopy to diagnose TB at a rate of 13 TB cases per quarter (P-value = 0.066) (Figure 2).

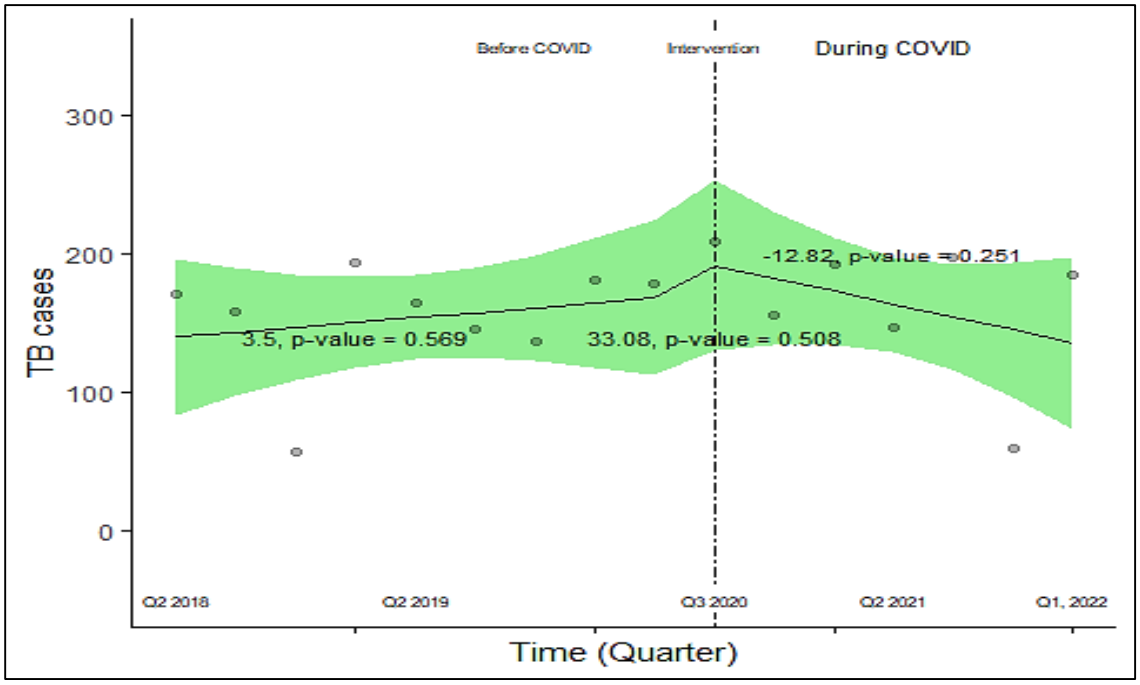

Figure 1:
Trends of tuberculosis cases diagnosed by Gene Xpert before and during the COVID-19 pandemic in Bungoma County, April 2018 to March 2022

All patients diagnosed with TB who had CXR done on them were assessed. Before the COVID-19 pandemic; the average numbers of cases were increasing by 3.8 cases per quarter. At the onset of the pandemic there was a step change of -43.6 cases, and during the pandemic the value of cases increased by an additional 8.9 cases per quarter at 95% CI (Figure 3).

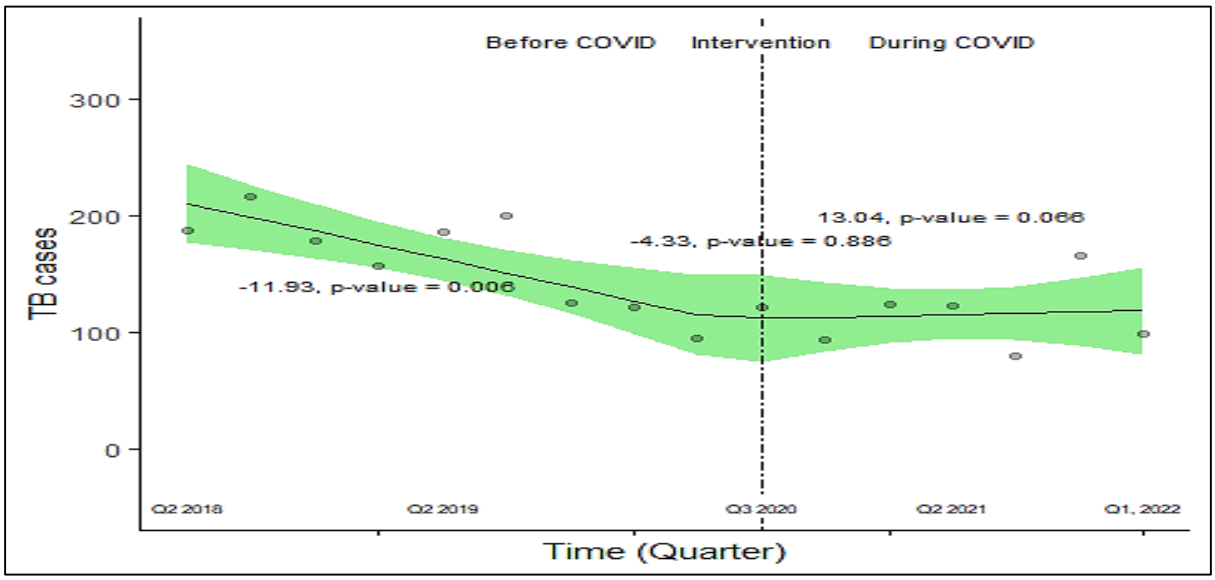

Figure 2:
Trends of tuberculosis cases diagnosed by microscopy before and during COVID-19 pandemic in Bungoma County, April 2018 to March 2022

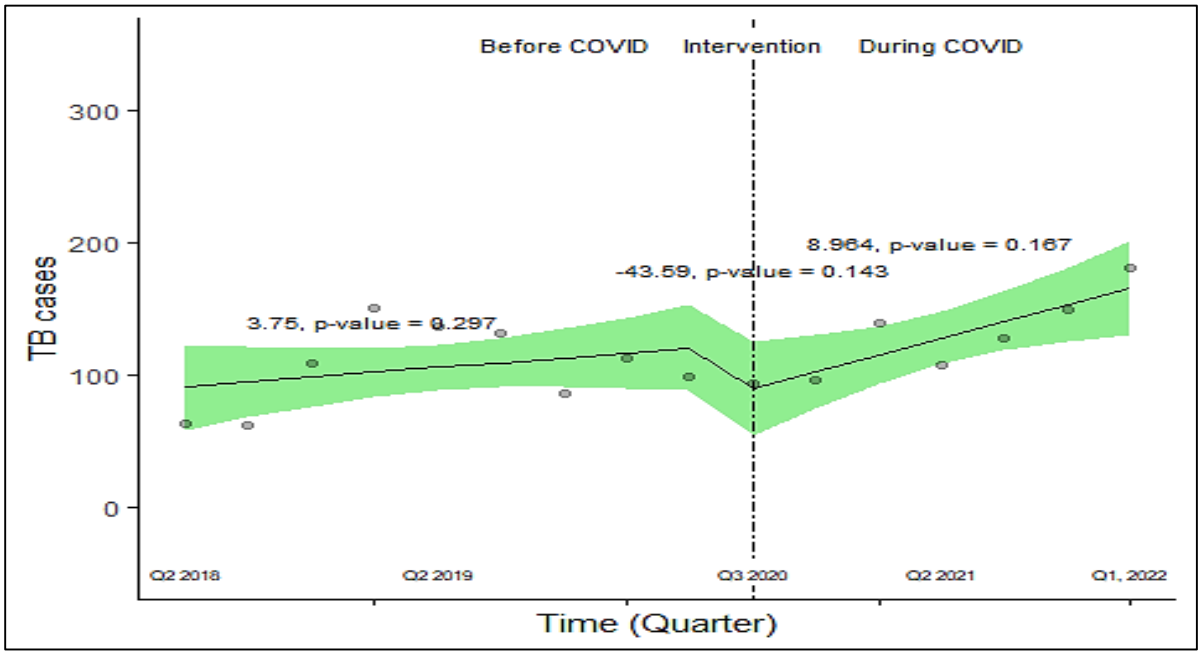

Figure 3:
Trends of tuberculosis cases diagnosed by X-Ray before and during COVID-19 pandemic in Bungoma County, April 2018 to March 2022

There was a decrease in the treatment success rate from 84.3% before to 79.9% during the pandemic at 95% CI. The cure rate among bacteriologically confirmed patients also decreased from 86.9% in the pre-COVID-19 period to 66.9% during COVID-19 at 95% CI. The death rate increased from 9.3% to 10.8% between the two periods, while treatment failure in tuberculosis patients increased by 0.6% during the COVID-19 period at 95% CI (Table 2).

Discussion

The study found that more males had TB relative to females before COVID-19 and during COVID-19, which is consistent with previous studies in Brazil (10). However, studies in Ethiopia and Malawi found more females relative to males (13,14). Tuberculosis was observed to be common in individuals aged over 35 years, a demographic that may be linked to high-risk behaviors and a lack of awareness regarding their susceptibility to infections, ultimately leaving them vulnerable to tuberculosis(6). We found out that pulmonary tuberculosis was the most diagnosed tuberculosis, even amidst the ongoing pandemic. The HIV testing dropped among TB patients. HIV testing disparity can be attributed to inadequate HIV testing commodities due to a shift in government priorities to COVID-19. Some studies identified advanced age, HIV positivity, and the presence of pre-existing medical conditions as factors that were associated with unfavorable treatment outcomes like death, loss to follow up and treatment failure during the pandemic (15,16). This calls for continuous efforts to prevent poor treatment outcomes among those high-risk individuals. Most of the TB patients came from the public sector, consistent with previous observations that associated TB patients are mainly diagnosed in the public sector, thus creating a need to enhance other sector integration in TB case diagnosis in case of a pandemic (11).

Before the pandemic, the number of patients diagnosed was on an increasing trend. This could have been made possible by the rollout of more gene xpert platforms in the county and the emphasis on gene xpert as the first choice of tuberculosis diagnosis, while smear microscopy was primarily for follow-up on patients. In this study, we found a significant drop in tuberculosis case detection in the course of COVID-19. It could be possible that health care workers could have been afraid of handling sputum specimen to avoid infection by COVID-19(17). However, the decrease in tuberculosis case detection might also be due to reduced case finding and public fear of being infected with COVID-19, fewer people would attend health facilities than usual (8,18). Alternatively, there may have been an actual reduction in tuberculosis infections due to public health restrictions. The reduced number of tuberculosis diagnoses could reflect a decrease in its transmission associated with physical distancing and the increased use of face masks (19,20).

Table 2:
Treatment outcomes in patients enrolled for tuberculosis treatment before and during COVID-19 in Bungoma County, April 2018 to March 2022

Enrolled for treatment:	Pre-COVID-19 N=3337 (%)	COVID-19 N=2644 (%)	% Difference
Treatment Success (%)	84.3	79.9	↓4.4
Cure rate (%)	86.9	66.9	↓20.0
Loss to Follow-up (%)	5.7	7.1	↑1.4
Died (%)	9.3	10.8	↑1.5
Failed treatment (%	0.1	0.7	↑0.6
Not evaluated (%)	0.1	0.2	↑0.1

Additionally, lockdown measures were put in place to restrict the movement of people. This made it more difficult for people to physically access health services (21). The government should consider this when implementing lockdown policies. In Kenya, 50% of TB-diagnosed patients had difficulties accessing public transport to health facilities during the pandemic (22). Healthcare personnel also experienced stress and anxiety, key predictors of errors and poor quality of diagnosis. Furthermore, some healthcare workers were compelled to undergo quarantine on exposure to index patients, fell ill, or even died, thereby rendering them unavailable for routine health services (23) The increase in patient detection by x-rays could be associated to the county authorities having invested in x-ray machines. Though they were aimed at fighting the pandemic, but x-ray machines might have come in handy to support the tuberculosis services.

Furthermore, the patients had an increased likelihood of encountering adverse tuberculosis treatment results amidst the pandemic. The pandemic led to a significant drop in the success rate of tuberculosis treatment, likely because there was a general rise in the number of patients who were not assessed. This healthcare facility-dependent service could have been severely impacted by economic constraints, restrictions on movement, or patients' apprehension being associated with COVID-19 infection. Other studies have also documented a decline in the effectiveness of TB treatment during the COVID-19 pandemic (13**).** This corresponds with research conducted in Korea, where they observed a decline in the treatment success rate, dropping from 89.4% to 84.5% (20**).** A decline in the success of tuberculosis treatment may heighten the risk of suboptimal treatment outcomes and exacerbate the country's issue of drug-resistant tuberculosis (DRTB**)** (11). Nonetheless, a different study revealed that although TB treatment success initially declined, it subsequently increased to a range of 70% to 80% during the latter months of the COVID-19 period (24**).** We also found out that there was a decline in the cure rate among bacteriologically confirmed patients. This could be attributed to the COVID-19 restrictions that potentially hindered patients from reaching healthcare facilities for re-assessment and sputum monitoring(14). Mortality rates rose during the COVID-19 pandemic in contrast to the pre-COVID era. This increase could be associated with the higher occurrence of undiagnosed COVID-19 among our tuberculosis patients, potentially leading to an upsurge in tuberculosis-related deaths during treatment (25,26).

Limitations

Our study was limited to health facilities in Bungoma County, and therefore may not be representative of Kenya as a whole. The utilization of summarized data meant that understanding of the specific sequence of care for the detection of tuberculosis cases in individual patients wasn't possible.

Conclusion

COVID-19 influenced negatively on fundamental TB service indicators that included diagnosis of cases, care of the identified cases, and treatment success, as by the findings of this study. TB detection and patient management strategies should be strengthened to enhance the diagnosis, treatment, surveillance, and management of TB patients during a pandemic. Furthermore, the TB management policies should be reviewed to include TB patients' management during lockdowns, rapid TB diagnostic tools, digital patient management, and innovative treatment options during pandemics, to adapt them to the challenges that come with pandemics.

Recommendations

To ensure the continuity of TB services amid a pandemic threat, strategies like activating remote treatment support through the use of telemedicine should be enforced. The emphasis

should be on the use of digital platforms for active case finding, treatment, and community-based care. The implementation of phone consultations can be one strategy to cushion TB services during emergency periods in Bungoma County. Community-based care adapted to pandemic situations, can also be used to monitor adherence, ensure that patients with comorbidities are also closely monitored away from the health care system, and prompt referral in the case of emergencies. Additionally, the private sector's role in TB care should be integrated and innovated during pandemics, as should improvements to access to other test services for TB patients, including HIV testing, which are crucial to TB patients during the pandemic period. Lastly, the county needs to create policies that promote bi-directional screening, multi-pathogen tests, and integration of TB and pandemic disease surveillance to avoid diagnostic delays and improve treatment outcomes. In living within a pandemic, we suggest that rather than suspending active case finding, it should be adapted to the pandemic situation while considering infection control measures.

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Availability of data and materials. The Bungoma County TB data on excel for the 2018 to 2022 period analyze for the current is available from the author on reasonable request.

Conflict of Interest. Investigators have no conflict of interest in data collection or the future publication of the study.

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