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Evaluation of Tuberculosis Control Strategy and Challenges in Indonesia After Pandemic COVID-19

Meutya Zahra Eriansyah[1]* , Anggraeni Dian Ciptaningrum[2] , Afifah Thaliah Putri Priyono[3] , Almeria Annisa Putri[4] , Riswandy Wasir[5]

[1] Program Sarjana Kesehatan Masyarakat, Fakultas Ilmu Kesehatan, Universitas Pembangunan Nasional "Veteran" Jakarta; e-mail : 2210713069@mahasiswa.upnvj.ac.id
[2] Program Sarjana Kesehatan Masyarakat, Fakultas Ilmu Kesehatan, Universitas Pembangunan Nasional "Veteran" Jakarta; e-mail : 2210713079@mahasiswa.upnvj.ac.id
[3] Program Sarjana Kesehatan Masyarakat, Fakultas Ilmu Kesehatan, Universitas Pembangunan Nasional "Veteran" Jakarta; e-mail : 2210713122@mahasiswa.upnvj.ac.id
[4] Program Sarjana Kesehatan Masyarakat, Fakultas Ilmu Kesehatan, Universitas Pembangunan Nasional "Veteran" Jakarta; e-mail : 2210713073@mahasiswa.upnvj.ac.id
[5] Program Sarjana Kesehatan Masyarakat, Fakultas Ilmu Kesehatan, Universitas Pembangunan Nasional "Veteran" Jakarta; e-mail : riswandywasir@upnvj.ac.id

* Corresponding Author : Meutya Zahra Eriansyah

Abstract: Prior to the COVID-19 pandemic, Indonesia had made measured progress in addressing its tuberculosis (TB) burden through national strategies such as DOTS and integration into the universal health coverage (UHC) system. However, the pandemic caused substantial disruption to TB control efforts, including declines in case detection, treatment coverage, and continuity of care. This literature review analyzed eight peer-reviewed articles published between 2020 and 2025, selected from the Google Scholar database, to assess post-pandemic TB control strategies and challenges in Indonesia. The findings indicate that digital platforms were increasingly utilized for TB screening, monitoring, and reporting, while community-based education and expanded partnerships with private providers were promoted to maintain service continuity. Despite these adaptations, challenges such as limited infrastructure, inadequate digital literacy, constrained resources, and persistent stigma remain significant barriers. Strengthening the health system's capacity, improving policy coherence between TB programs and insurance schemes, and sustaining innovation through multisectoral collaboration are essential to rebuilding TB services and advancing toward national and global TB elimination goals.

Keywords: Tuberculosis; Strategy; Challenges; Pandemic COVID-19; Indonesia

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1. Introduction

Tuberculosis (TB) remains one of the most pressing public health challenges in Indonesia, a country that consistently ranks among the top three in terms of global TB burden. The high incidence and mortality rates associated with TB have made it a persistent priority within Indonesia's national health agenda (Burhan et al., 2022). Despite the existence of comprehensive control strategies and decades of implementation of the Directly Observed Treatment Short-course (DOTS) strategy, Indonesia continues to struggle with underdiagnosis, treatment dropouts, and the emergence of drug-resistant TB, particularly in vulnerable and marginalized populations [1]. Prior to the COVID-19 pandemic, Indonesia had begun to show encouraging progress in addressing its tuberculosis (TB) crisis. While the improvements have not been rapid, they are moving in a positive direction, with the help of international collaborators including the World Health Organization (WHO), Indonesia is implementing several key strategies [2]. These involved greater community participation in TB education and early detection, expanded access to diagnostic tools like the GeneXpert machine, and stronger surveillance systems to monitor cases [3].

The arrival of COVID-19 in early 2020 significantly disrupted this progress. As national health priorities shifted almost entirely to controlling the spread of the coronavirus, routine TB services were sidelined. Lockdowns, reduced mobility, and fear of visiting healthcare facilities discouraged people from seeking diagnosis or treatment. Additionally, many healthcare workers and resources were diverted to pandemic response efforts, leaving TB programs under-supported and understaffed [4]. This sudden shift led to a sharp decline in TB case reporting. Domestic and global reports show a dramatic decline in new case notifications during 2020 and 2021. In the first year of the pandemic, TB case notifications decreased by 31%, treatment coverage decreased by 7%, and mortality increased by 8% [3]. There was a 45% reduction in the number of patients tested for TB during the pandemic compared with pre-COVID-19

However, this did not reflect a decrease in TB incidence rather, it revealed a breakdown in detection and reporting. Experts have raised concerns that these delays in diagnosis and interruptions in treatment could worsen the spread of TB and increase the risk of the emergence of drug-resistant strains [5]. The fear was that years of public health progress could be quickly undone without a swift and coordinated response. These disruptions are not unique to Indonesia, but their impact in countries with a high TB burden is disproportionately large [3]. Furthermore, the psychosocial and economic impacts of the pandemic have disproportionately affected low-income populations, further increasing their vulnerability to infectious diseases such as TB.

As Indonesia enters a post-pandemic recovery phase, there has been renewed commitment from the government and stakeholders to rebuild and strengthen TB control systems. This includes reintroducing active case finding, launching mobile diagnostic units, promoting digital adherence tools, and scaling up community-based approaches [1]. Despite these efforts, substantial challenges remain. Systemic issues such as underfunding, weak intersectoral coordination, and logistical barriers in rural and remote areas continue to undermine the implementation of TB policies. Additionally, stigma associated with TB persists in many communities, discouraging individuals from seeking diagnosis or disclosing their condition. Health workers also face burnout, limited training opportunities, and inconsistent support, which impact the quality and consistency of TB care [3], [6].

The decentralization of health services in Indonesia further complicates TB control, as there are often significant discrepancies in policy enforcement and service availability across provinces and districts [1]. While national policies may be well-formulated, their implementation into local practice can be fragmented and inconsistent. This raises critical questions about the real-world impact of post-pandemic TB control strategies and the capacity of the system to deliver equitable and effective care across diverse settings.

There are not many studies that discuss how TB management strategies in Indonesia will be after the COVID-19 pandemic and what challenges will be faced, making it necessary to conduct a systematic study.This study aims to thoroughly assess the effectiveness of TB control policies in Indonesia in the post-COVID-19 pandemic period and to identify and analyze the challenges that still exist

2. Preliminaries or Related Work or Literature Review

Tuberculosis (TB) is a contagious infectious disease caused by Mycobacterium tuberculosis, primarily affecting the lungs (pulmonary TB), but it can also involve other organs (extrapulmonary TB)[7]. According to the WHO Global TB Report 2023, Indonesia ranks second after India in the number of TB cases worldwide. The transmission of TB is strongly influenced by social determinants such as poverty, high population density, and limited access to healthcare services[5].

2.1. Tuberculosis Strategy in Indonesia

The high prevalence of TB in Indonesia is closely linked to social determinants such as poverty, overcrowding, and limited access to quality healthcare. To address this, Indonesia adopted the WHO-recommended DOTS (Directly Observed Treatment, Short-course) strategy in the late 1990s, which focuses on political commitment, bacteriological diagnosis, supervised treatment, consistent drug supply, and a robust monitoring system[8].

In 2014, Indonesia transitioned to the End TB Strategy framework, which emphasizes integrated, patient-centered care, supportive health policies, and the promotion of research and innovation. This approach aligns with global targets to reduce TB deaths by 90% and incidence by 80% by the year 2030. As part of the strategy, Indonesia has also implemented

the Public-Private Mix (PPM) approach, involving private healthcare providers in TB case detection, treatment, and mandatory reporting through the national TB Information System (SITB)[9]. The country has also made significant efforts in managing drug-resistant TB (DR-TB) by establishing referral hospitals, introducing shorter treatment regimens, and using newer drugs like bedaquiline. Community engagement has played a vital role through active case finding by community health workers (kader), awareness campaigns such as "TOSS TB," and outreach to high-risk populations. Additionally, TB services are integrated into the national health insurance scheme (JKN), ensuring free diagnosis and treatment, although disparities in service accessibility remain in rural and remote areas [10][7].

2.2 Impact the Pandemic COVID-19 on TB Control Strategies

The COVID-19 pandemic has significantly disrupted tuberculosis (TB) control programs globally, including in Indonesia. As healthcare systems redirected their focus and resources toward managing the pandemic, essential TB services—such as case detection, diagnosis, and treatment were deprioritized. According to the WHO Global TB Report, TB case notifications dropped sharply worldwide in 2020, and Indonesia experienced a nearly 45% decline in reported TB cases compared to 2019 [3]. This was largely due to limited access to health facilities, fear of COVID-19 exposure, and mobility restrictions during lockdowns, which led to underdiagnosis and untreated TB cases that continued to transmit the disease within communities[4].

The pandemic also interrupted ongoing TB treatments. Many patients struggled to access medication and follow-up care, particularly due to travel restrictions and the temporary closure or repurposing of healthcare centers. The direct observation model of treatment (DOT), which relies on in-person supervision, became difficult to sustain. These disruptions increased the risk of treatment failure, relapse, and drug resistance. In addition, the reallocation of health workers, diagnostic equipment, and funding to COVID-19 response efforts severely weakened TB program operations[4], [11].

Stigma further compounded these challenges. Because COVID-19 and TB share similar symptoms such as persistent cough and fever many individuals with TB symptoms avoided seeking medical help for fear of being misdiagnosed with COVID-19 or subjected to social isolation [9]. This hesitation delayed diagnoses and further hindered TB control efforts. Moreover, public health campaigns during the pandemic focused almost exclusively on COVID-19, causing TB awareness and community outreach to decline.

3. Proposed Method

This study employed a literature review approach to examine tuberculosis (TB) control strategies and associated challenges in Indonesia after the COVID-19 pandemic. The literature search was conducted through the Google Scholar database, focusing on peer-reviewed articles published between 2020 and 2025. The search used a combination of keywords: "Evaluation," "Post-Pandemic," "COVID-19," "TB Control Policies," "TB Challenges," and "Indonesia," with Boolean operators (AND, OR) to refine the results. A total of 1,240 records were initially retrieved. The screening process involved title and abstract review to assess relevance to post-pandemic TB policy and implementation. Inclusion criteria comprised: (1) full-text availability, (2) publication in English, and (3) discussion of TB policy or program challenges in Indonesia. Exclusion criteria included non-scholarly sources such as conference abstracts, books, news articles, and grey literature. Following the eligibility assessment, eight articles were deemed relevant and included for analysis. Data from the selected studies were synthesized qualitatively to identify key themes and implications for TB control.

4. Results and Discussion

4.1. Result

This study found 8 study as a sample, majority of it was published at 2022 (3 studies). Two studies were published at 2024 and 2025, then 1 study published at 2023. Most of sample using mix method and qualitative as a method (each 3 study), and 2 sample using a quantitative method.

Table 1. Data Extraction

Author (Year)	Title	Method	Result
Caren et al., (2022)	COVID-19 Pandemic Disruption on the Management of Tuberculosis Treatment in Indonesia	Mix Method Study	The COVID-19 pandemic has posed a new challenge for the national TB control program. This study identified several disruptions due to COVID-19 pandemic on TB control management, such as the decrease in government funding for TB treatment; lower quality of care and treatment for TB, MDR-TB, and TB-HIV; decrease in TB case detection and rapid diagnostic services; and lower activities in monitoring, evaluation and surveillance.
Lestari et al., (2022)	Impacts of tuberculosis services strengthening and the COVID-19 pandemic on case detection and treatment outcomes in Mimika District, Papua, Indonesia: 2014–2021	Quantitative study	Activities included decentralization of TB services, training and mentoring of healthcare workers, improved screening for co-morbidities, and introduction and optimisation of Xpert testing in 2018. A total of 11,803 TB cases were notified to the Mimika District Health Office over eight years (2014–21). Between 2015 and 2019, there was a 67% increase in annual case notifications, an 89% increase in bacteriologically confirmed cases and the proportion of TB cases detected in primary care increased from 26% to 46%. In 2020, coinciding with the COVID-19 pandemic, investigation of people with presumptive TB fell by 38%, but the proportion of those tested with Xpert increased. TB case notifications decreased by 19% from 1,796 in 2019 to 1,461 in 2020, but then increased by 17% to 1,716 in 2021. Routine screening for co-morbidities (HIV, diabetes) among TB patients improved over time and was not affected by the pandemic. Treatment success overall was 71% and remained relatively unchanged. Loss to follow-up and death were 18% and 3.7% respectively.
Winardi et al., (2022)	Challenges on tuberculosis care in health care facilities during COVID-19	Qualitative study	TB is one of Indonesia's significant public health burdens in which the COVID-19 pandemic aggravated the effects.

	pandemic: Indonesian perspective		Hospital conversion and health facility closure due to COVID-19 have disrupted TB care in Indonesia. Although medical personnel resources are absorbed into COVID-19 prevention and treatment, treatment monitoring and case finding by picking the appropriate strategy based on local resources and local wisdom should be optimized. Utilizing IT and the community groups might be the option to maintain the treatment monitoring of TB patients. Immediate holistic evaluation of TB care during the COVID-19 pandemic is required to scale the size of the problem.
Surendra et al., (2023)	Impact of the COVID-19 pandemic on tuberculosis control in Indonesia: a nationwide longitudinal analysis of programme data and health system vulnerabilities	Quantitative study	In the first year of the COVID-19 pandemic (2020), tuberculosis (TB) case notifications declined by 31% compared to 2019, while mortality increased by 8% and treatment coverage dropped from 98% to 91%. In the second year (2021), there was a partial recovery in case notifications and a slight decrease in deaths, but treatment coverage remained low at 84%. Declines in TB notifications were linked to higher COVID-19 incidence and fewer GeneXpert machines per capita. Reduced treatment coverage was associated with fewer doctors, while increased TB deaths were linked to fewer health centres, lower domestic health spending, and lower education levels.
Jiang et al., (2024)	Policy gaps in addressing market failures and intervention misalignments in tuberculosis control: prospects for improvement in China, India, and Indonesia	Mix Method study	China, India, and Indonesia have not yet adequately addressed market failures in tuberculosis (TB) control within their current health systems. Misalignment between National TB Programs (NTPs) and national health insurance schemes has hindered access to quality TB care. Though progress has been made through vertical TB programs, a more integrated approach within Universal Health Coverage (UHC) reforms is needed. Addressing policy incoherencies, fostering innovation, and engaging private primary care providers are essential to meeting national TB elimination goals.

			Effective TB control is not only vital for public health but also economically beneficial, and these countries have the potential to learn from one another and serve as models for other high-burden TB nations.
Mashuri et al., (2024)	"I pity the TB patient": a mixed methods study assessing the impact of the COVID-19 pandemic on TB services in two major Indonesian cities and distilling lessons for the future	Mix method study	There was a 45% (21 937/39 962) reduction in the number of patients tested for TB during the pandemic compared with pre-COVID-19, while the proportion of TB tests returning a positive result increased from 12% (4733/39 962) to 50% (10 945/21 937). The proportion of TB patients completing treatment increased by 2.6% during the pandemic, yet the proportion cured and the number of patients successfully treated both decreased (by 7% and 4.4%, respectively). Qualitative interviews highlighted several factors influencing TB service access and delivery, including fear of being diagnosed with COVID-19 during TB-related clinic visits, fear of COVID-19 exposure among patients and health workers, healthcare facilities prioritising COVID-19 over other services, and mandatory mobility restrictions affecting both patients and health workers
Brubacher et al., (2025)	Health and tuberculosis systems resilience, the role of the private sector and pandemic preparedness: insights from a cross-country qualitative study with policymakers in India, Indonesia and Nigeria	Qualitative study	Policy-makers highlighted the crucial role of intersectoral collaboration, effective governance, innovative financing strategies, health workforce reallocation and technological advancements such as virtual consultations and mHealth in strengthening TB service delivery amid the COVID-19 pandemic. India relied on patient–provider support agencies to implement a joint strategy for TB care across sectors and states. Indonesia engaged networks of private provider professional associations to facilitate coordination of the COVID-19 response. Nigeria implemented a pandemic policy for public-private referral for the continuity of TB care.
Vasquez et al., (2025)	COVID-19 policies and tuberculosis	Qualitative study	Results revealed three policy dimensions under costs, access,

	services in private health sectors of India, Indonesia, and Nigeria	and quality. Under healthcare costs, policymakers highlighted resource allocation and diversion of TB resources to COVID response, and increased operational costs for private provider. Under healthcare access, key themes included reduced TB case detection due to fear of COVID-19, disrupted diagnostic services, and adaptations such as extended medicine supplies and tele-consultations. Under healthcare quality, themes included compromised TB diagnostic accuracy due to similar respiratory symptoms with COVID-19, and strain on laboratory infrastructure due to competing demands from both diseases. Policymakers across the three countries pointed to the need for strengthening private–public partnerships (PPP) for healthcare service delivery and continued private sector investment to facilitate the continuity of TB care within a pandemic context.

[1] Data Extraction.

4.1. Discussion

Tuberculosis Control Strategy Amid and After the Pandemic COVID-19

The emergence of the COVID-19 pandemic has significantly disrupted global tuberculosis (TB) control efforts. One of the most striking consequences was the decline in TB case detection and treatment coverage. During the first year of the pandemic, TB case notifications dropped by 31%, while treatment coverage declined by 7%. This decline contributed to an 8% increase in TB-related mortality, reversing years of progress in TB control [1]–[3]

These reductions were driven by multiple intersecting factors. Public health measures to limit the spread of COVID-19, such as lockdowns and mobility restrictions, limited patients' ability to access diagnostic and treatment services. Additionally, widespread fear of contracting COVID-19 within healthcare settings discouraged many individuals from seeking care [2], [4]. At the health system level, critical TB services such as early case detection, rapid diagnostic testing, and patient follow-up were disrupted. The reallocation of healthcare resources, including personnel and funding, toward the COVID-19 response created significant service gaps. These were further exacerbated by shortages of healthcare workers, interruptions in laboratory operations, and unstable supplies of essential TB medications [3], [6], [7].

Strengthening public and private partnerships is a critical component in ensuring the continuity of tuberculosis (TB) services, particularly during times of crisis such as pandemics or natural disasters [11]. Significant collaboration between the government, private healthcare providers, and civil society organizations enhances the health system's ability to respond to service disruptions and maintain access to timely diagnosis and effective treatment [6], [12]. Moreover, achieving TB elimination by 2030 rely on continuous innovation and education. The adoption of advanced diagnostic and treatment technologies, improved public health literacy, and the strengthening of health system capacity including workforce and infrastructure are essential to accelerate early detection, ensure treatment adherence, and

reduce the disease burden [1], [4], [12]. These efforts require an integrated, multisectoral, and sustained approach as part of a comprehensive national TB control strategy.

The integration of digital technologies and telemedicine into tuberculosis (TB) control strategies represents a significant advancement in improving patient detection, monitoring, and management. The use of telemedicine platforms, TB reporting applications, and the incorporation of TB and COVID-19 screening through digital X-ray technology combined with artificial intelligence (AI) are increasingly being adopted to enhance diagnostic accuracy and service accessibility, particularly in remote or underserved areas [4], [11].

In parallel, community-based interventions and strong public–private partnerships play a pivotal role in improving case notification and treatment adherence. Initiatives that involve community education, engagement of civil society, and collaboration with private healthcare providers have shown promise in closing gaps in TB care and strengthening surveillance systems [7], [11], [13]. Furthermore, operational research has made valuable contributions to the development of innovative policies and practices in TB control. However, the impact of such research is often limited in sustainability and scalability unless supported by systematic and long-term implementation frameworks [13]. Together, these approaches underscore the need for integrated, evidence-based strategies to accelerate progress toward TB elimination

Tuberculosis Control Challenges After the COVID-19 Pandemic

Resource limitations remain a critical barrier to effective tuberculosis (TB) control, particularly in regions with inadequate healthcare infrastructure, limited medical personnel, and insufficient diagnostic tools [1]. These constraints have led to significant declines in case notification and treatment coverage, especially during health crises such as the COVID-19 pandemic that further strain existing systems [3].

Additionally, patient adherence to TB treatment is deeply affected by social stigma, fear of concurrent infections such as COVID-19, and poverty, all of which contribute to delays in seeking care and increased risk of treatment default [14]. Addressing these multifactor challenges requires strengthening health system readiness through sustained investment in healthcare worker training, improving the reliability of medicine supply chains, and adopting user-friendly technologies to support diagnosis, treatment monitoring, and patient engagement [11], [12] . These measures are essential to build a more resilient and responsive health system capable of delivering equitable and continuous TB care, particularly in vulnerable and underserved populations [15].

Private sector engagement remains a persistent challenge in tuberculosis (TB) control efforts, particularly in countries where a significant proportion of patients initially seek care from private healthcare providers [12]. Despite the central role of private practitioners in early patient contact, incentives to encourage their active participation in TB control programs remain limited. Furthermore, regulatory oversight of private sector practices, including the availability and quality of essential diagnostics and medications, is often suboptimal. This has contributed to low levels of TB case reporting from the private sector, which undermines national surveillance and treatment efforts [3], [10].

Compounding this issue is a misalignment between the national TB program's emphasis on outpatient care and the structure of the national health insurance scheme, which primarily reimburses only for inpatient services. This policy discordance can discourage timely diagnosis and outpatient treatment, potentially delaying care and increasing the risk of transmission and disease progression [4], [10]. Addressing these gaps required harmonized policies, targeted incentives, and better integration the private sector into national TB strategies to ensure more comprehensive and effective disease control.

The cumulative effect of these challenges illustrates that the COVID-19 pandemic not only posed a direct global health emergency but also undermined the capacity to manage long-standing infectious diseases. If left unaddressed, these disruptions could result in a sustained setback in global TB control and jeopardize the achievement of international TB elimination targets.

5. Conclusions

The COVID-19 pandemic has substantially disrupted tuberculosis (TB) control efforts in Indonesia by limiting case detection, reducing treatment coverage, and exacerbating existing systemic challenges. These disruptions were primarily driven by shifts in health priorities, constrained resources, and operational limitations in both public and private sectors. While several adaptive measures—such as digital monitoring tools and community-based outreach—have been introduced, their implementation remains uneven across regions. Moving forward, TB control strategies in Indonesia require a more integrated and resilient framework. This includes strengthening intersectoral collaboration, improving the alignment between TB programs and health insurance schemes, and enhancing access to diagnostic and treatment services, particularly in underserved areas. Equally important is the need for sustained investment in digital infrastructure, capacity building, and context-specific operational research. Without these efforts, the progress toward national and global TB elimination targets may remain slow and vulnerable to future public health disruptions.

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References

[1] T. Lestari *et al.*, "Impacts of tuberculosis services strengthening and the COVID-19 pandemic on case detection and treatment outcomes in Mimika District, Papua, Indonesia: 2014–2021," *PLOS Glob. Public Heal.*, vol. 2, no. 10 October, pp. 1–19, 2022, doi: 10.1371/journal.pgph.0001114.

[2] Y. A. Mashuri *et al.*, "' I pity the TB patient ': a mixed methods study assessing the impact of the 19 pandemic on TB services in two major Indonesian cities and distilling lessons for the future," *BMJ Glob. Heal.*, vol. 9, pp. 1–10, 2024, doi: 10.1136/bmjgh-2023-014943.

[3] H. Surendra *et al.*, "Impact of the COVID-19 pandemic on tuberculosis control in Indonesia: a nationwide longitudinal analysis of programme data," *Lancet Glob. Heal.*, vol. 11, no. 9, pp. e1412–e1421, 2023, doi: 10.1016/S2214-109X(23)00312-1.

[4] G. J. Caren, D. Iskandar, D. A. E. Pitaloka, R. Abdulah, and A. A. Suwantika, "COVID-19 Pandemic Disruption on the Management of Tuberculosis Treatment in Indonesia," *J. Multidiscip. Healthc.*, vol. 15, no. January, pp. 175–183, 2022, doi: 10.2147/JMDH.S341130.

[5] A. A. Malik *et al.*, "Tuberculosis control and care in the era of COVID-19," *Health Policy Plan.*, vol. 35, no. 8, pp. 1130–1132, Oct. 2020, doi: 10.1093/heapol/czaa109.

[6] N. A. Vasquez, C. Oga-Omenka, V. Yellappa, B. W. Lestari, and A. Sassi, "COVID-19 policies and tuberculosis services in private health sectors of India, Indonesia, and Nigeria," *J. Clin. Tuberc. Other Mycobact. Dis.*, vol. 38, no. December 2024, p. 100503, 2025, doi: 10.1016/j.jctube.2024.100503.

[7] W. Winardi, H. Wahyuni, M. Hidayat, and A. Wirawan, "Challenges on tuberculosis care in health care facilities during COVID-19 pandemic: Indonesian perspective," *Narra J*, vol. 2019, no. December 2019, pp. 4–9, 2022, doi: doi.org/10.52225/narra.v2i2.80.

[8] B. W. Lestari *et al.*, "Patient pathways and delays to diagnosis and treatment of tuberculosis in an urban setting in Indonesia," *Lancet Reg. Heal. - West. Pacific*, vol. 5, p. 100059, Dec. 2020, doi: 10.1016/j.lanwpc.2020.100059.

[9] D. K. Sunjaya, C. Paskaria, D. M. D. Herawati, M. Pramayanti, R. Riani, and I. Parwati, "Initiating a district-based public–private mix to overcome tuberculosis missing cases in Indonesia: readiness to engage," *BMC Health Serv. Res.*, vol. 22, no. 1, p. 110, Dec. 2022, doi: 10.1186/s12913-022-07506-4.

[10] W. Jiang *et al.*, "Policy gaps in addressing market failures and intervention misalignments in tuberculosis control: prospects for improvement in China, India, and Indonesia," *Lancet Reg. Heal. - West. Pacific*, vol. 46, p. 101045, May 2024, doi: 10.1016/j.lanwpc.2024.101045.

[11] Y. Kurniawan, M. D. Hartanti, and J. Suyanto, "Obstacles and prospects in a holistic approach to tuberculosis eradication : A systematic review," *Malahayati Int. J. Nurs. Heal. Sci.*, vol. 07, no. 9, pp. 1110–1122, 2024.

[12] L. J. Brubacher *et al.*, "Health and tuberculosis systems resilience , the role of the private sector and pandemic preparedness : insights from a cross- - country qualitative study with policymakers in India , Indonesia and Nigeria," *BMJ Glob. Heal.*, vol. 10, pp. 1–10, 2025, doi: 10.1136/bmjgh-2024-016180.

[13] G. Marme, J. Kuzma, P.-A. Zimmerman, N. Harris, and S. Rutherford, "Investigating socio-ecological factors influencing implementation of tuberculosis infection prevention and control in rural Papua New Guinea," *J. Public Health (Bangkok).*, vol. 46, no. 2, pp. 267–276, May 2024, doi: 10.1093/pubmed/fdae018.

[14] F. Makbul and D. Amir, "Incidence of Tuberculosis in Primary Health Care during the COVID-19 Pandemic: A Longitudinal Study and Perspective from Eastern Indonesia," *J. Epidemiol. Public Heal.*, vol. 9, no. 1, pp. 117–128, Jan. 2024, doi: 10.26911/jepublichealth.2024.09.01.11.

[15] L. P. L. Wulandari *et al.*, "Delivering HIV and TB services amidst the COVID-19 pandemic in Indonesia: a qualitative study of challenges and mitigation strategies," *J. Glob. Heal. Reports*, vol. 8, Jun. 2024, doi: 10.29392/001c.117620.