

The Readiness for Implementation of Tuberculosis Prevention Therapy Services for Latent TB Infections in Children at Surabaya City Public Health Centre

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Abstract. Tuberculosis preventive therapy (TPT) aims to prevent latent TB infection (LTBI) from progressing to active tuberculosis. The WHO recommends TPT for children under five who are exposed to TB patients. In Surabaya City, TPT coverage among child contacts of TB patients was very low, at 1.7% (2020), 4.8% (2021), and 2.6% (2022). This study assesses the readiness of TPT services for children with LTBI living in the same household as TB patients. An observational study with a cross-sectional design was conducted in 30 public health centers in Surabaya, analyzing service readiness across four variables: investigation, examination, therapy, and information-education-communication (IEC). Results showed that active contact investigation was frequently conducted (50%), while LTBI investigation for children who had not started treatment was only occasional (27.59%), and most of those who discontinued treatment were not investigated (55.17%). Clinical symptom examinations were often performed (86.67%), but chest X-rays were infrequent (36.67%). Therapy according to LTBI protocols was commonly provided (70%), though handling of missed doses was still lacking (46.67%). IEC was most frequently conducted when patients received TB test results (70%), but was less common at the end of TPT (63.33%). The overall readiness index of TPT services in Surabaya was moderately ready (75.18%), with the highest score in IEC (83.47%) and the lowest in investigation (64.17%). Pakis Public Health Center showed the highest readiness (93.75%), and Jemursari Public Health Center the lowest (38.25%).

1 Introduction

Tuberculosis (TB) is the leading cause of death from infectious diseases globally. In 2021, there were approximately 10.6 million new TB cases, including 1.2 million among children

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aged 0–14 years. Each year, more than 15 million children are exposed to TB, approximately 7.5 million develop latent TB infection (LTBI), and 1.0–1.2 million progress to active TB, over half of whom are under five years old. Despite these numbers, between 2018 and 2021 only 1.9 million children (54%) received appropriate treatment, and 1.6 million (40%) of child contacts under five years received Tuberculosis Preventive Therapy (TPT) [1]. In Indonesia, specific data on the prevalence of pediatric LTBI remains limited. However, estimates indicate that approximately 2.8 million children have had contact with active TB cases. In 2019, an estimated 1.7 million cases of LTBI occurred in children who had been in contact with TB patients and other high-risk populations [2].

TPT is an essential component of the National TB Control Program, as outlined in Ministry of Health Regulation No. 67 of 2016. Initially, this program targeted children under five years old and people living with HIV/AIDS (PLWHA). In 2020, the national strategy was expanded to include household contacts over the age of five and other high-risk groups. However, coverage for TPT among children under five who had household contact with TB patients remained significantly below the national target of 90%. In 2016, TPT coverage was only 2.1%, increasing to 7.7% in 2018, but then declining to 6.2% in 2019, 1.6% in 2020, and 1.9% in 2021. In Surabaya, the coverage of TPT administration has increased, but remains low compared to the number of children in close contact with TB patients, 1.7% in 2020, 4.8% in 2021, and declining to 2.6% in 2022 [3].

The primary goal of diagnosing and treating LTBI in children is to prevent future active TB cases. A systematic review of 11 studies in Southeast Asia found that 24.4% to 69.2% of children under 15 who had contact with TB patients had LTBI, with 3.3% to 5.5% at risk of progressing to active TB. The World Health Organization (WHO) recommends TPT for all children under five years who are household contacts of TB or HIV-positive patients. TPT must not be implemented in isolation but should be integrated comprehensively into TB care, where household contacts especially children are treated as an integral part of TB management services [4].

TB case finding in Indonesia uses a dual approach: “passive with active promotive” and “family and community based active intensive” strategies. Contact investigation aims to trace household members of bacteriologically confirmed TB patients to identify both active TB and LTBI cases. Individuals identified through this process are referred to primary healthcare centers for further evaluation using the nationally standardized diagnostic algorithm, including clinical evaluation, Tuberculin Skin Testing (TST), chest X-ray, and molecular rapid testing (MRT). The diagnostic outcome determines the treatment pathway: individuals with active TB are treated with anti-TB drugs (ATDs), while those with LTBI are recommended for TPT. In the case of children under five with household contact, TPT may be initiated with or without prior diagnostic testing [5].

Public health centers (Puskesmas) serve as the frontline of LTBI control in Indonesia by conducting systematic contact investigations, initiating and monitoring TPT, and ensuring accurate program documentation and reporting. Furthermore, they are mandated to coordinate public–private health service networks through the Public Private Mix (PPM) approach, thereby reinforcing the implementation of national policies aimed at accelerating tuberculosis elimination [5]. Health service readiness reflects the capability of healthcare facilities to provide quality services. Accurate and up-to-date information on health service readiness is critical for planning, monitoring, and evaluating the healthcare system [6]. This study aims to assess the readiness of TB program implementation, particularly the delivery of TPT in accordance with national technical guidelines for LTBI in Indonesia. Key aspects examined include contact investigation, diagnostic evaluation, treatment, and information-education-communication (IEC) services. As the primary entry point to health services, public health center plays a strategic role in LTBI treatment due to its accessibility to high-risk populations. Therefore, this research specifically analyzes the readiness of TPT service

implementation for children with LTBI who have had household contact with TB patients in public health centers in Surabaya City.

2 Methods

2.1 Research Design

This study is an observational research with a cross-sectional design conducted at 30 public health centers in Surabaya City in 2024. The units of analysis are the public health centers. The sample size was determined using the formula for estimating a correlation coefficient with the following parameters: $\alpha = 0.05$; $\beta = 0.2$; $r = 0.5$. From a total of 63 public health centers in Surabaya, a sample size of 30 public health centers was obtained using simple random sampling

$$n \geq \left[\frac{Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}}{\frac{1}{2} \log_e \frac{1+r}{1-r}} \right]^2 + 3$$

Data were collected through structured interviews using a standardized questionnaire to assess the readiness of public health centers in implementing TPT services for children with LTBI who have had household contact with bacteriologically confirmed TB patients. The respondents were the TB program officers at each public health center.

2.2 Research Variable

The readiness to implement TPT services was assessed based on four main variables: investigation, examination, therapy, and information-education-communication (IEC), each comprising several indicators. All variables were assigned equal weight based on the assumption that each contributes equally to service readiness. The selection of indicators was based on the national technical guidelines for LTBI management in Indonesia.

The research variables and their indicators were as follows: 1. Investigation: 1) Active contact investigation, 2) Passive contact investigation, 3) Investigation of LTBI children who have not started treatment, 4) Investigation of LTBI children who did not complete treatment; 2. Examination: 1) Clinical symptoms, 2) Tuberculin Skin Test (TST), 3) Molecular Rapid Test (MRT), 4) Sputum smear microscopy, 5) Chest X-ray examination; 3. Therapy: 1) Compliance with the national LTBI treatment guidelines, 2) Management of missed doses; 3) Monitoring and management of TPT side effects, 4) Assessment of adherence and consistency in TPT medication intake; 5. IEC (Information-Education-Communication): 1) IEC for TB suspects or household contacts, 2) IEC during TB test result delivery, 3) IEC at TPT initiation, 4) IEC during TPT, 5) IEC at TPT completion.

Each indicator was scored based on the frequency of TPT service implementation according to the performance targets set by the District Health Office. The scoring scale was as follows: 1 = Never, 2 = Rarely (<25% of the target), 3 = Occasionally (25%–50%), 4 = Often (50%–75%), and 5 = Always (>75%). Scores were assigned based on respondents' answers regarding the extent to which these activities were carried out by the public health center or TB officers.

2.3 Data Analysis

Data were analyzed descriptively. The proportion of each variable was calculated by comparing the total score obtained from implemented indicators to the total possible score. The TPT service readiness index was obtained by calculating the average score of the four variables (investigation, examination, therapy, and IEC). The readiness level for each variable was classified into three categories: Not ready (20–46.66), Moderately ready (46.67–73.33), and Ready (73.34–100). The overall readiness index for TPT service implementation was categorized as follows: Not ready (38–56.75), Moderately ready (56.76–75.26), and Ready (75.27–93.76). The research has obtained ethics approval on health research No: 054/KE.03/SK/03/2024 from the health ethics commission, National Research and Innovation Agency, Republic of Indonesia.

3 Results And Discussion

Table 1 presents the implementation of TPT services for children with LTBI who have had household contact with TB patients across 30 public health centers in Surabaya City. In terms of contact investigation, active contact investigation was more frequently conducted (50%) compared to passive contact investigation (43.3%). Investigation of children who had not initiated treatment was occasionally conducted (27.59%), while investigation of those who did not complete treatment was mostly not performed (55.17%). Regarding LTBI examinations, most were frequently performed, including clinical symptom screening (86.67%), TST (63.3%), MRT (66.7%), and sputum smear microscopy (41.3%). However, chest X-ray examination was mostly conducted only occasionally (36.67%). In terms of TB preventive therapy, the majority of public health centers frequently provided treatment in accordance with LTBI guidelines (70%), monitored TPT side effects (60%), assessed treatment adherence (53.33%), and managed missed doses (46.67%). For IEC services, implementation was also generally frequent. The highest proportions were observed during the delivery of TB test results to patients (70%), to TB suspects or household contacts (66.7%), and at the initiation of TPT (66.67%). Meanwhile, the lowest rates were found during and after TPT (63.33%).

Table 1. Implementation of TPT Services Components for Child LTBI at 30 Public Health Centers in Surabaya City, 2024.

Indicator	Implementation of TPT Services				
	Never (n, %)	Rarely (n, %)	Occasion ally (n, %)	Often (n, %)	Always (n, %)
Investigation					
1. Active contact investigation	0 (0.00)	2 (6.67)	3 (10.00)	10 (33.33)	15 (50.00)
2. Passive contact investigation	1 (3.33)	3 (10.00)	6 (20.00)	7 (23.33)	13 (43.33)
3. Investigation of LTBI children who have not started treatment	6 (20.69)	6 (20.69)	8 (27.59)	6 (20.69)	3 (10.34)
4. Investigation of LTBI children who did not complete treatment	16 (55.17)	6 (20.69)	2 (6.90)	1 (3.45)	4 (13.79)
Examination					
1. Clinical symptoms	0 (0.00)	0 (0.00)	3 (10.00)	1 (3.33)	26 (86.67)
2. Tuberculin Skin Test (TST)	1 (3.33)	1 (3.33)	2 (6.67)	7 (23.33)	19 (63.33)
3. Molecular Rapid Test	4 (13.33)	2 (6.67)	2 (6.67)	2 (6.67)	20 (66.67)

Indicator	Implementation of TPT Services				
	Never (n, %)	Rarely (n, %)	Occasion ally (n, %)	Often (n, %)	Always (n, %)
(MRT)					
4. Sputum smear microscopy	4 (13.79)	5 (17.24)	6 (20.69)	2 (6.90)	12 (41.38)
5. Chest X-ray examination	10 (33.33)	5 (16.67)	11 (36.67)	3 (10.00)	1 (3.33)
Therapy					
1. Compliance with the national LTBI treatment guidelines	5 (16.67)	0 (0.00)	1 (3.33)	3 (10.00)	21 (70.00)
2. Management of missed doses	7 (23.33)	0 (0.00)	5 (16.67)	4 (13.33)	14 (46.67)
3. Monitoring and management of TPT side effects	6 (20.00)	0 (0.00)	1 (3.33)	5 (16.67)	18 (60.00)
4. Assessment of adherence and consistency in TPT medication intake	6 (20.00)	1 (3.33)	3 (10.00)	4 (13.33)	16 (53.33)
IEC					
1. IEC for TB suspects or household contacts	2 (6.67)	1 (3.33)	2 (6.67)	5 (16.67)	20 (66.67)
2. IEC during TB test result delivery	2 (6.67)	1 (3.33)	2 (6.67)	4 (13.33)	21 (70.00)
3. IEC at TPT initiation	4 (13.33)	1 (3.33)	2 (6.67)	3 (10.00)	20 (66.67)
4. IEC during TPT	4 (13.33)	1 (3.33)	4 (13.33)	2 (6.67)	19 (63.33)
5. IEC at TPT completion	5 (16.67)	1 (3.33)	2 (6.67)	3 (10.00)	19 (63.33)

Table 2 presents the readiness of TPT services for children with LTBI at public health centers in Surabaya, including the components of contact investigation, LTBI examination, therapy, and IEC. The readiness for contact investigation ranged from 35% to 95%, with the highest score at Pakis Public Health Center (95%) and the lowest at Gunung Anyar and Tambak Wedi Public Health Centers (35%). LTBI examination readiness ranged from 36% to 100%, with the highest at Gundih Public Health Center (100%) and the lowest at Gunung Anyar Public Health Center (36%). TPT service readiness varied between 20% and 100%, with 12 public health centers achieving 100%, while the lowest score (20%) was recorded at Bulak Banteng, Jemur Sari, Sidotopo Wetan, and Balas Klumprik Public Health Centers. IEC service readiness ranged from 20% to 100%, with 17 public health centers achieving full readiness (100%), and the lowest (20%) observed at Jemur Sari and Balas Klumpik Public Health Centers. The highest overall TPT service readiness index was found at Pakis Public Health Center (93.75%), while the lowest was at Jemur Sari Public Health Center (38.25%). The average TPT service readiness index for LTBI children across Surabaya was 75.18%, with the highest readiness component being IEC (83.47%), followed by therapy (77.50%), examination (75.60%), and the lowest being investigation (64.17%).

Table 2. Proportion of Readiness for TPT Service Implementation for LTBI in Children in Surabaya City by Public Health Center, 2024.

No.	Pueblic Health Center	Components of TPT Service Implementation Readiness (%)"				TPT Service Readiness Index (%)
		Investigation	Examination	Therapy	IEC	
1	Kalirungkut	85.00	84.00	100.00	100.00	92.25
2	Ngagel Rejo	80.00	84.00	100.00	100.00	91.00
3	Morokrembangan	85.00	96.00	95.00	100.00	94.00
4	Tenggilis	55.00	76.00	90.00	100.00	80.25

No.	Pucblic Health Center	Components of TPT Service Implementation Readiness (%)"				TPT Service Readiness Index (%)
		Investigation	Examination	Therapy	IEC	
5	Bulak Banteng	50.00	76.00	20.00	40.00	46.50
6	Kebonsari	75.00	84.00	100.00	100.00	89.75
7	Dukuh Kupang	50.00	88.00	100.00	60.00	74.50
8	Banyu Urip	60.00	84.00	100.00	100.00	86.00
9	Gundih	50.00	100.00	80.00	80.00	77.50
10	Gading	50.00	92.00	75.00	100.00	79.25
11	Kedurus	90.00	84.00	100.00	100.00	93.50
12	Jemursari	45.00	68.00	20.00	20.00	38.25
13	Asemrowo	60.00	76.00	75.00	100.00	77.75
14	Pucang Sewu	80.00	72.00	90.00	100.00	85.50
15	Tanjungsari	60.00	68.00	100.00	92.00	80.00
16	Lidah Kulon	55.00	60.00	60.00	60.00	58.75
17	Sawah Pulo	80.00	80.00	100.00	100.00	90.00
18	Keputih	60.00	76.00	100.00	100.00	84.00
19	Simomulyo	65.00	76.00	100.00	100.00	85.25
20	Perak Timur	70.00	88.00	90.00	96.00	86.00
21	Gunung Anyar	35.00	36.00	65.00	84.00	55.00
22	Balongsari	65.00	68.00	100.00	100.00	83.25
23	Mojo	45.00	60.00	80.00	84.00	67.25
24	Sidotopo Wetan	55.00	76.00	20.00	44.00	48.75
25	Gayungan	60.00	84.00	70.00	72.00	71.50
26	Kedungdoro	80.00	68.00	40.00	52.00	60.00
27	Pakis	95.00	80.00	100.00	100.00	93.75
28	Tambak Wedi	35.00	64.00	40.00	100.00	59.75
29	Rangkah	80.00	60.00	95.00	100.00	83.75
30	Balas Klumprik	70.00	60.00	20.00	20.00	42.50
Surabaya		64.17	75.60	77.50	83.47	75.18

Figure 1 illustrates the readiness level of TPT service implementation for children with LTBI across 30 public health centers in Surabaya. For contact investigation readiness, the majority of public health centers were classified as moderately ready (53.3%), followed by ready (33.3%), and not ready (13.3%). Regarding LTBI examination readiness, most public health centers fell into the ready category (63.3%), with 33.3% moderately ready, and only 3.3% not ready. In terms of TPT administration readiness, the majority of public health centers were categorized as ready (70%), while 20% were not ready, and 10% were moderately ready. For IEC readiness, most public health centers were also in the ready category (66.7%), followed by moderately ready (23.3%) and not ready (10%). The overall readiness index for TPT service implementation in children with LTBI showed that most public health centers were classified as ready (66.7%), with 23.3% moderately ready, and 10% not ready. At the city level, the readiness index for Surabaya was categorized as moderately ready, with the components of IEC, TPT administration, and LTBI examination classified as ready, while contact investigation was categorized as moderately ready.

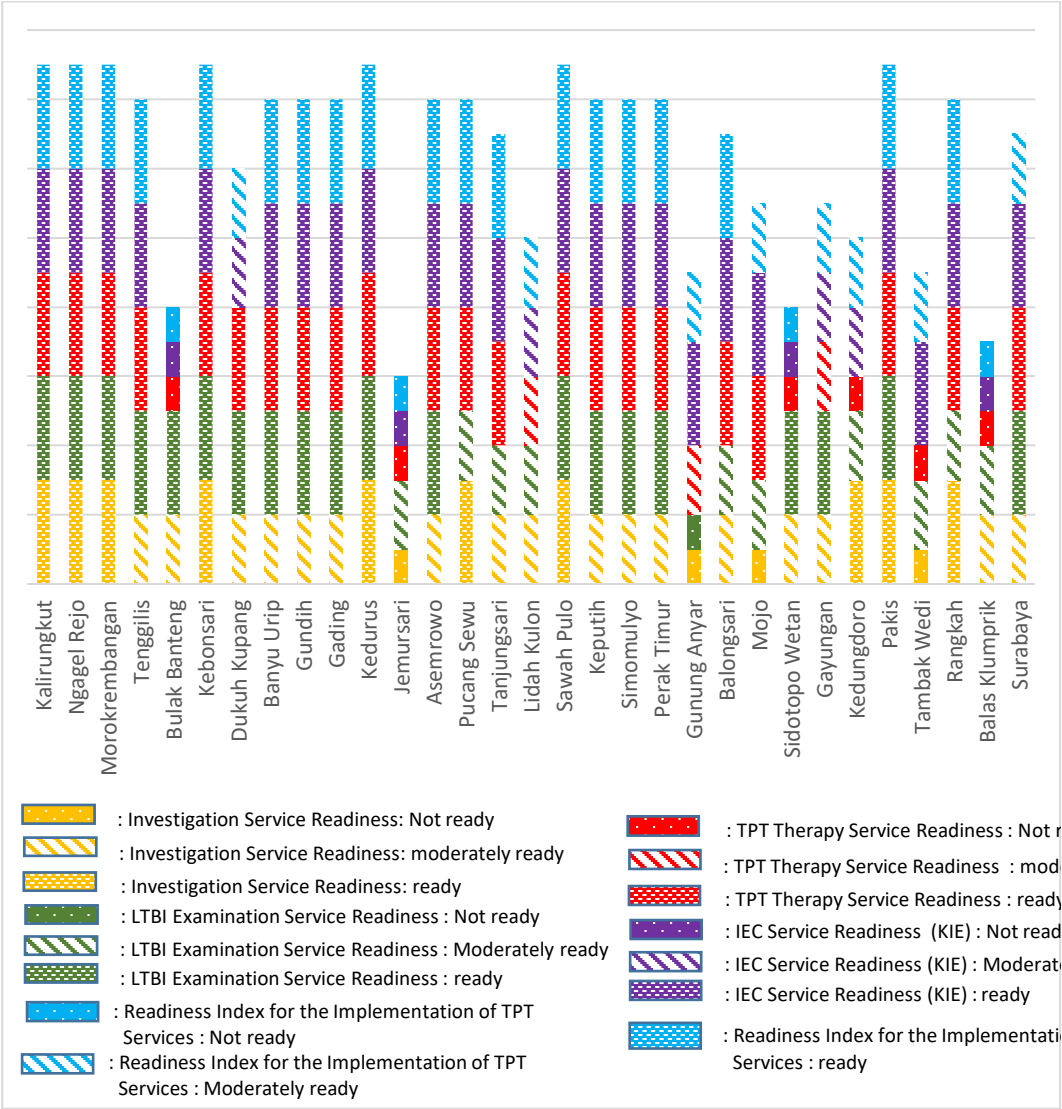


Fig 1. Readiness Level of TPT Services for Children with LTBI in Surabaya City, 2024.

The implementation of Tuberculosis Preventive Therapy (TPT) services for children with latent tuberculosis infection (LTBI) across 30 public health centers in Surabaya reveals a predominance of active contact investigations over passive ones. Active contact investigation entails proactive case finding outside health facilities, engaging community stakeholders, whereas passive contact investigation relies on health facility-based screening, either through health education or intensified case finding via Public-Private Mix (PPM) collaborations [5]. The dominance of active case finding underscores a proactive approach in examining close contacts and reflects the commitment of public health centers to enhancing early detection of both active and latent TB, which is crucial in preventing diagnostic delays and interrupting community transmission.

Empirical evidence supports the efficacy of active case finding in early TB detection, reducing transmission risk, and controlling disease spread. For instance, a study in

Nigeria reported a 183.3% increase in TB notifications following the implementation of active case finding in hard-to-reach areas. This approach facilitates early diagnosis, often before sputum smear positivity, and uncovers hidden cases, particularly among women. Despite its significant contribution, passive case finding still accounts for the majority of TB case detections. Research indicates that combining active and passive methods can enhance detection rates by up to 3.8 times while being more cost-effective [7].

However, investigations into LTBI among children who have not initiated TPT remain limited in many public health centers, especially for those who did not complete treatment, leading to delays in TPT initiation. Consistent with other studies, primary barriers include insufficient personnel for screening, examination, TPT administration, and contact investigation. Additional challenges encompass healthcare workers' skepticism regarding TPT efficacy, concerns about side effects and potential drug resistance, low prioritization of TPT due to resource constraints, and interprofessional perception differences. A lack of training and knowledge among healthcare providers exacerbates these issues [8]. External factors such as low family awareness and support for TPT, fears about side effects and therapy effectiveness, and limited availability of pediatric TPT formulations further hinder program outcomes [9].

Public health centers in Surabaya frequently conduct LTBI examinations, particularly clinical symptom assessments, TST, and MRT, though sputum and chest X-ray examinations are still limited. According to the Technical Guidelines for LTBI, household contacts under five years old without symptoms can receive TPT directly, with or without additional tests. Children aged five and above require chest X-rays; if suggestive of TB, TCM is conducted, and if not, TST or Interferon-Gamma Release Assays (IGRA) are performed, with TPT administered upon positive results. However, limited X-ray facilities in public health centers mean LTBI screening for household contacts often relies solely on clinical symptoms, TST, and TCM. Sputum tests are primarily for treatment evaluation, while X-rays are conducted in hospitals if TB symptoms appear but TCM results are negative. TCM has been designated as the primary diagnostic tool for TB in Indonesia, as per the Circular Letter of the Director General of Disease Prevention and Control No. HK.02.02/III.I/936/2021 [2].

Research findings indicate that TPT implementation in Surabaya's public health centers largely adhere to guidelines, focusing on monitoring side effects and adherence, though management of missed doses requires improvement. Guideline-compliant TPT prevents latent TB progression, reduces treatment costs, and decreases TB transmission at household and community levels. Public health center staff have been monitoring and providing continuous support to children undergoing TPT, including detecting side effects, educating on the importance of adherence, and addressing issues during treatment. Such monitoring enhances treatment safety, prevents complications, ensures high TPT completion rates, and reduces drug resistance risk. Nevertheless, handling of missed doses remains suboptimal and inadequately documented. Currently, there is insufficient data on managing adherence issues, particularly regarding the number of missed doses that can be compensated by extending treatment duration without compromising therapy effectiveness. A study in Ethiopia demonstrated that community-based approaches through village health posts improved contact screening coverage, treatment, and TPT completion compared to primary health facility implementation [10].

Public health centers in Surabaya have been actively providing information, education, and communication (IEC) services, especially when conveying LTBI examination results and initiating therapy, although IEC during and after therapy needs strengthening. IEC services are essential for the success of the TPT program for children with LTBI, particularly during result delivery and therapy initiation, as they enhance family understanding and build trust in health services. However, limited IEC during and post-therapy reflects a lack of continuous education, risking reduced adherence and treatment success. Studies show that

weak follow-up IEC can increase the progression of LTBI to active TB [11]. Therefore, continuous education strategies through scheduled counseling, digital media, and community engagement are vital to support health literacy and family empowerment.

This study reveals that TPT service readiness for LTBI in Surabaya's public health centers varies across facilities, with most showing readiness in IEC, therapy, and examination aspects, while contact investigation readiness remains moderate. Overall, the TPT service readiness index in Surabaya falls into the moderately ready category. These findings highlight significant readiness variations among public health centers (highest at 93.75%, lowest at 38.25%). Consequently, periodic evaluations of each public health center's needs and obstacles, along with need- and performance-based budget allocations, are necessary, particularly for public health centers with low readiness such as Jemur Sari, Balas Krumpik, and Bulak Banteng.

These findings align with Rogers' (2003) policy implementation theory, emphasizing the importance of internal and external factors like resource availability, training, and inter-staff coordination in determining health system readiness [12]. Other studies indicate that contact investigation implementation still faces various challenges affecting early TB detection program effectiveness, especially among children as a vulnerable group. Key barriers include limited TB staff and time, minimal funding allocation, suboptimal coordination with community health workers, and community resistance. These conditions impact the quality of contact tracing and TB program achievements [13]. The proportion of children identified through tracing is also lower than those already diagnosed with TB, indicating potential missed cases during tracing [14]. Additional factors such as information delivery methods, stigma, and family dynamics also influence participation in clinical visits and follow-ups [15].

The study's findings suggest that while TPT service readiness in Surabaya is generally adequate, improvements in contact investigation aspects are necessary to enhance TPT service effectiveness. Therefore, it is recommended to improve TPT service effectiveness through better coordination between healthcare workers and the community, increased human resource capacity via technical training, and more optimal funding allocation. Community involvement in contact investigation can enhance case identification accuracy, strengthen TB screening and prevention culture at the household level. This strategy has the potential to support TB elimination in primary care services, while also providing sustainable health and economic benefits.

4 Conclusion

The readiness of Tuberculosis Preventive Therapy services for children with Latent Tuberculosis Infection in public health centers across Surabaya is categorized as moderately ready, with an average readiness index of 75.18%. The IEC component showed the highest level of readiness, followed by TPT administration and LTBI examination, whereas contact investigation was the lowest-performing component. A disparity in readiness levels was observed across public health centers, with Pakis reporting the highest readiness and Jemur Sari the lowest. Proportionally, most public health centers were classified as ready in the components of LTBI examination, TPT administration, and IEC; however, only a few were considered ready in the contact investigation component. The practical implication of these findings highlights the urgent need to strengthen the investigation system through enhanced health worker training, adequate provision of infrastructure and logistics, and continuous supervision, particularly targeting public health centers with lower readiness levels.

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