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ORIGINAL ARTICLE

RISK FACTORS AND CHARACTERISTICS OF ACTIVE AND LATENT TUBERCULOSIS IN CHILDREN ≤ 14: ACTIVE CASE FINDING

Faktor Risiko dan Karakteristik Tuberkulosis Aktif dan Laten Pada Anak ≤ 14 Tahun: Penemuan Kasus Aktif

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ABSTRACT

Background: In 2024, 135,000 tuberculosis (TB) cases were reported in Indonesian children, accounting for part of the 885,000 total TB cases nationwide. Pediatric TB remains a concern due to children's vulnerability from immature immunity, poor nutrition, and close contact with TB patients. Early detection through active case finding (ACF) is crucial for identifying active and latent TB in at-risk populations. **Purpose:** To determine the prevalence of active and latent TB and analyze associated risk factors among children screened through ACF. **Methods**: A cross-sectional study was conducted among 870 children in Sidoarjo Regency using ACF. Active TB was diagnosed through symptom interviews and sputum examination, while latent TB was determined by tuberculin skin test (TST). Nutritional status was assessed using body mass index (BMI). Bivariate analysis was performed to assess associations with active TB. Results: The prevalence of active TB was 4%, and that of latent TB was 4.7%. Among TB cases, 46% were active and 54% latent. Malnutrition was common in active (77%) and latent (46%) TB. Bivariate analysis showed no significant associations with gender, close contact, or passive smoking. Children aged <5 years had a higher risk than those aged 5–14 years (OR = 3.11; 95% CI: 0.99–9.79; p = 0.064). Nutritional status was significantly associated with active TB ($\chi^2 = 7.85$; p = 0.049). Underweight children had nearly four times higher risk of active TB compared to those with normal nutrition (OR = 3.94; 95% CI: 1.32–11.76; p = 0.018). **Conclusion**: ACF was effective in

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detecting active and latent TB among children. Malnutrition was a significant risk factor, suggesting that nutritional interventions should be integrated into pediatric TB control strategies**.** Patients had close contact with active TB patients.

ABSTRAK

Latar Belakang: *Tuberkulosis (TBC) merupakan masalah kesehatan masyarakat global, termasuk di Indonesia. Deteksi dini melalui pendekatan Active Case Finding (ACF) penting untuk menemukan kasus TBC aktif dan laten, terutama pada populasi berisiko.* ***Tujuan:*** *Mengetahui prevalensi TBC aktif dan laten serta menggambarkan karakteristik pada anak-anak dengan TBC aktif dan TBC laten melalui pendekatan skrining ACF.* ***Metode:*** *Penelitian ini merupakan studi cross sectional deskriptif yang dilakukan pada anak-anak di Kabupaten Sidoarjo menggunakan metode ACF. Skrining TBC aktif dilakukan melalui wawancara gejala, pemeriksaan dahak, sedangkan diagnosis TBC laten menggunakan tes kulit tuberkulin (TST). Data status gizi diperoleh dari pengukuran indeks massa tubuh (IMT).* ***Hasil:*** *Dari total 870 anak yang terjaring selama ACF, prevalensi TBC aktif 4% dan laten TBC adalah sebesar 4,70%. Di antara kasus TBC yang terdeteksi, 46% merupakan TBC aktif dan 54% TBC laten. Mayoritas individu dengan TBC aktif (77%) dan TBC laten (46%) memiliki status gizi kurang (IMT <18,5 kg/m²), menunjukkan adanya keterkaitan antara malnutrisi dengan status infeksi TBC. Sebagian besar (68%) TBC Laten memiliki kontak erat dengan pasien TBC Aktif.* ***Simpulan:*** *Pendekatan ACF efektif dalam mengidentifikasi kasus TBC aktif dan laten pada populasi berisiko termasuk anak-anak. Status gizi kurang ditemukan secara dominan baik pada kasus TBC laten maupun aktif, sehingga intervensi gizi dapat menjadi komponen penting dalam strategi penanggulangan TBC.*

INTRODUCTION

Tuberculosis (TB) remains a major global health challenge, particularly in children who are more vulnerable to severe disease progression. The Global Tuberculosis Report 2023, published by the World Health Organization (WHO), estimated 10.6 million new TB cases worldwide in 2022, with approximately 12% occurring in children under 15 years old (1). Childhood TB is a significant concern, as it often reflects ongoing transmission within the community. In 2022, an estimated 134,000 cases of TB occurred in Indonesian children, but only about 56% were detected and reported, indicating substantial underdiagnosis and underreporting (WHO, 2023; Ministry of Health, Republic of Indonesia, 2023). Recognizing this, the Indonesian government, through Presidential Decree Number 67 of 2021, set a target to eliminate TB by 2030, aiming to reduce the incidence to 65 per 100,000 population, with pediatric TB control being a critical component of this strategy (2).

This infectious TB disease is spreading across various age groups. The age group that is most vulnerable to TB infection is children (3). Data from the Indonesian Health Profile in 2023, the age group with the most TB cases found was the 0-14 years age group, which amounted to 16.70%. This number was increased from the previous year, which amounted to 15.30% in 2022. Child TB cases are seen increasing from year to year. In 2021, cases of TB in children in Indonesia reached 42,187, then in 2022, they increased to 100,726. Between January and March 2023, a total of 118,438 TB cases were reported in Indonesia. This is a very significant increase in the number of pediatric TB cases in Indonesia. The Ministry of Health even reported that the incidence rate increased by 200 percent from 2021(3).

One of the provinces with high cases of childhood TB is East Java. According to the East Java Health Profile, the number of cases of childhood TB among children aged 0-14 years increased from 2021 to 2023. In 2021, the number

of child TB cases was 2,792; in 2022, there were 8,298 cases; and in 2023, there were 10,992 cases. According to the East Java Health Profile for 2021-2023, Sidoarjo Regency is ranked fifth in terms of the number of pediatric tuberculosis cases, which have increased annually. In 2021, there were 154 cases of pediatric tuberculosis; in 2022, this number increased to 560 cases, and in 2023, it further increased to 956 cases.

Children have a higher risk of being exposed to TB in areas with a high incidence of tuberculosis, this is because the child's immune system is not yet maximized. Therefore, early diagnosis is necessary to maximize treatment (4). Early detection in children is more challenging than in adults because the symptoms of pediatric tuberculosis are often atypical, and bacteriological examination results are often negative. On the other hand, TB infection in children also indicates active transmission in the household environment, making it an important indicator for family-based interventions (5).

Childhood TB has its own characteristics and is slightly different from TB in adults. Signs and symptoms of childhood TB, according to the WHO, are chronic cough, defined as unremitting and unimproved cough for >21 days with or without wheezing; fever with body temperature >38°C for 14 days, weight loss or failure to thrive; feeling sick or weak, lethargic, and/or reduced cheerfulness; and night sweats. As children have an increased risk of developing severe disease in the weeks to months following infection, they are a high priority when identified as contacts with infectious patients (6).

The increase in TB cases certainly increases the risk of children getting infected with TB. TB transmission in children is relatively high due to close contact with adults suffering from TB (7). Early identification of TB in children is very important to stop the spread of the disease and the adverse effects of the manifestations of TB disease. One of the disease prevention strategies is early detection screening, as an effort to prevent the condition from worsening (8).

To reduce delays in diagnosis and speed up intervention, Active Case Finding (ACF) strategies have been widely introduced in TB control programs. ACF is a proactive approach to TB case finding through systematic screening of high-risk populations, including children who are close contacts to adult TB patients. ACF enables early detection of active TB cases and latent infections (ILTB), which can then be followed up with the provision of TB Preventive Therapy (TPT) or Anti-Tuberculosis Drugs (OAT), depending on the results of further testing (9).

TPT is given to children who are infected with TB but not yet showing active symptoms, to prevent progression to active TB disease. Meanwhile, OAT is given to children who have shown symptoms and diagnostic results that meet the criteria for active TB. The widespread implementation of TPT has been shown to reduce the risk of conversion to active TB by up to 90% when properly prescribed and correctly targeted (WHO, 2020). However, variations in implementation persist in the field, including the selection of children who receive TPT or OAT, which depends on factors such as data availability, health worker training, and family compliance (10).

Although ACF implementation and TPT/OAT treatment have been part of the national TB elimination strategy, studies specifically examining the characteristics of children receiving these interventions in Indonesia are limited. Most reports are aggregated and do not provide detailed information on risk factors such as nutritional status, gender, or history of close contact. This information is crucial for supporting the strengthening of evidence-based policies and improving the effectiveness of ACF programs for children. Despite the availability of national data and global evidence on the effectiveness of Active Case Finding (ACF) and TB Preventive Therapy (TPT), there remains a lack of detailed research at the local level in Indonesia, particularly regarding pediatric populations. Previous studies have largely focused on aggregated data without stratification by important determinants such as age group, sex, nutritional status, and history of close contact. Moreover, evidence that specifically analyzes the characteristics of children who receive TPT compared to those who are treated with Anti-Tuberculosis Drugs (OAT) is still scarce. This creates a knowledge gap in understanding which groups of children are most vulnerable and how early detection strategies can be optimized in practice. Addressing this gap is crucial to strengthening evidence-based decision-making and ensuring that ACF programs targeting children are more precise, effective, and equitable. Therefore, this study aims to analyze the characteristics of children aged ≤14 years who received TPT and OAT and calculate prevalence rates of latent and active TB found during ACF activities.

METHODS

This study employed a cross-sectional design with a quantitative approach, utilizing data obtained from ACF activities through screenings conducted

in Sidoarjo District at 5 Puskesmas (Tanggulangin, Gedangan, Sukodono, Porong, and Sidoarjo) over 3 months. The ACF activities included symptom interviews, sputum examinations for suspected cases, and tuberculin skin tests (TST) for children at risk, to detect both active and latent TB cases as early as possible. The study subjects were all children aged ≤14 years involved in TB screening through ACF activities, at points determined by the puskesmas, such as Posyandu centers, Schools, and other community activities. The sample obtained from screening activities in the five health centers was 870 children.

Latent tuberculosis (LTBI) is a positive immune response to Mycobacterium tuberculosis infection, as indicated by a reactive tuberculin skin test (TST) or interferon-gamma release assay (IGRA), without any clinical signs or symptoms of active TB disease, without radiological abnormalities, and without acid-fast bacilli (AFB) in sputum examination. Individuals with LTBI do not transmit the disease.

Active TB Disease is a condition in which Mycobacterium tuberculosis infection develops into a disease with clinical symptoms (e.g., cough ≥2 weeks, fever, weight loss, night sweats), supported by radiological evidence. It may be accompanied by positive laboratory test results (AFB, culture, or rapid molecular test/Xpert MTB/RIF). Active TB cases have the potential to transmit the disease to others.

Data collected in this TB screening activity used screening forms for children aged <14 years provided by the TB Team of the Indonesian Ministry of Health, and data collection was carried out through interviews with mothers/caregivers. The flow of screening carried out to determine whether the child has active TB or latent TB is shown in Figure 1. Children who meet the presumptive requirements will continue with the diagnosis according to the standard. In contrast, those who meet the criteria for latent TB will be followed up by conducting a Mantoux examination.

Data were analyzed using SPSS 17 statistical software for descriptive statistics, including frequency, percentage, and prevalence. Univariate analysis was conducted to describe the characteristics of the subjects, including sex, age, nutritional status, close contact, and passive smoking status. The results of the characteristics of the children who have been screened will be used to calculate the prevalence rates of active TB and latent TB. This study has been approved by the Health Research Ethics Clearance Commission of the Faculty of Dental Medicine, with approval number 1059/HRECC.FODM/X/2024.

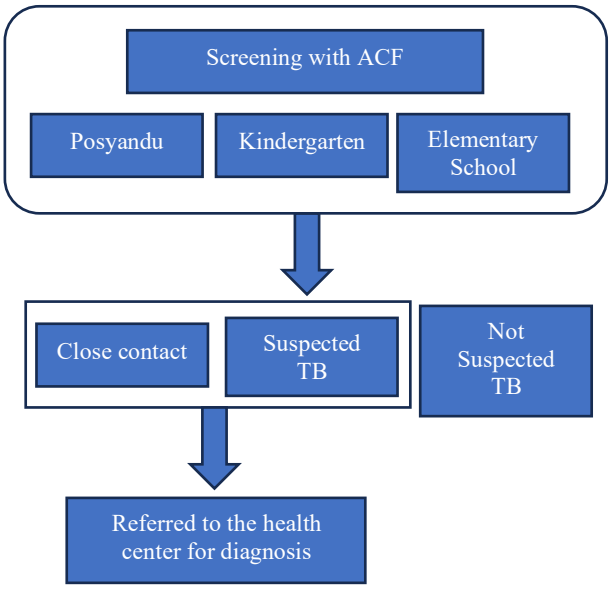

Figure 1. Screening flow through ACF activities in Sidoarjo District

RESULTS

During the ACF activity, the prevalence rates were 4.70% for latent TB and 4% for active TB. The characteristics of the children screened during the ACF are shown in the following table. The results of the screening conducted on 870 children are shown in Table 1.

Table 1
Characteristics of Screened Children at The Study Site

Variable	n	%
Sex		
Boy	467	53.68
Girl	403	46.32
Age		
< 5 years	546	63.2
5-14 years	324	36.8
Nutritional Status		
Underweight	132	15.18
Normal	674	77.47
Overweight	37	4.25
Obesity	27	3.10
Close contact with active TB	332	38.16
Yes	419	48.16
No	119	13.68
Unknown		
Passive Smoker	359	41.26
Yes	511	58.74
No		

Table 1 shows that most respondents participating in the ACF activities were children under 5 years old, and the majority (77%) had a good nutritional status during the screening. Most respondents (38%) also had close contact with TB patients. Some of the risk factors experienced by the children screened were quite diverse and led to TB symptoms commonly found in children. Most of the children had symptoms of unexplained weight loss/BB not increasing within 2 months, as well as coughing for more than 2 weeks, as shown in Table 2.

Table 2
Description of Risk Factors Among The Screened Children

Symptom	n	%
- Cough ≥ 2 weeks	44	4.70
- Weight loss without a clear cause / Weight has not increased in the previous 2 months	104	11.20
- Fever without obvious cause ≥ 2 weeks	4	0.40
- Lethargy or malaise, the child is less active	6	0.60
- Coughing up blood	2	0.20

The results of the ACF implementation in Sidoarjo District, conducted at 5 Puskesmas, are presented in Figure 2. Each of the Health Centers has implemented ACF and identified cases of active TB and latent TB, as shown in Figure 2. Of the 870 children screened through ACF, 76 children were found to be eligible for further TB testing, both through diagnosis scoring and TST testing. Of the 870 children screened through ACF, 41 children had latent TB infection and were eligible for TB preventive therapy, and 35 children had active TB infection. They should continue to receive TB treatment for 6 months. The descriptions of each group are presented in Table 3.

Based on the table above, it can be seen that in the Active TB and Latent TB groups, most of them are toddlers. In the latent TB group, it can be seen that most (53.68%) have a good/more nutritional status. While in the active tuberculosis group, 77.10% had poor nutritional status. In close contact with TB patients, it can be seen that 68% of children with latent TB have contact with those who have active TB.

Bivariate analysis showed that most variables were not significantly associated with the incidence of active TB in children (Table 3). Based on gender, boys had a lower tendency to develop active TB than girls (OR = 0.73; 95% CI: 0.29–1.80; p = 0.646). Children aged <5 years had a higher risk than children aged 5–14 years (OR = 3.11; 95% CI: 0.99–9.79; p = 0.064), although this result did not reach statistical significance. Similarly, a history of close contact with active TB patients (OR = 0.40; 95% CI: 0.15–1.05; p = 0.092) and exposure as a passive smoker (OR = 0.71; 95% CI: 0.29–1.77; p = 0.498) did not show a significant relationship.

Conversely, nutritional status was found to be significantly associated with the incidence of active TB. The Chi-square test showed a difference in distribution between nutritional status categories and TB incidence (χ^2 = 7.85; p = 0.049). Underweight children had an almost four times higher risk of developing active TB compared to children with normal nutrition (OR = 3.94; 95% CI: 1.32–11.76; p = 0.018). Meanwhile, the severely underweight category also showed a tendency toward increased risk (OR = 3.38; 95% CI: 0.94–12.14), but the results were not statistically significant (p = 0.107).

DISCUSSION

TB in children is a major challenge in global TB control programs, especially in developing countries with a high burden of disease. This study shows that children under five years of age are more susceptible to TB, both in latent and active TB. According to the CDC, the groups at risk of developing TB disease were children younger than 5 years old (CDC). Children under 5 years of age are at the highest risk of developing the disease after being infected with a microbacterial infection, as indicated by a positive tuberculin skin test (TST). They are also at the highest risk of contracting miliary tuberculosis and tuberculous meningitis (11).

Table 3
Description of Risk Factors Among The Screened Children

Variable	Latent TB		Active TB		OR	95% CI	P-value
	n	%	n	%			
Sex							
Boy	22	53.70	16	45.70	0.73	0.29 – 1.80	0.646
Girl	19	46.30	19	54.30			
Age							
< 5 years old	27	65.90	30	85.70	3.11	0.99-9.79	0.064
5−14 years old	14	34.10	5	14.30			
Nutritional status							
Severely underweight	7	17.10	9	25.70	3.38	0.94 – 12.14	0.107
Underweight	12	29.30	18	51.40	3.94	1.32 – 11.76	0.018
Normal	21	51.20	8	19.50			
Overweight	1	2.40	0	0			
Close contact with active TB							
Yes	28	68.30	16	45.70	0.40	0.15 – 1.05	0.092
No	12	29.30	17	48.60			
Unknown	1	2.40	2	5.70			
Passive smoker							
Yes	21	51.20	15	42.90	0.71	0.29 – 1.77	0.498
No	20	48.80	20	57.10			

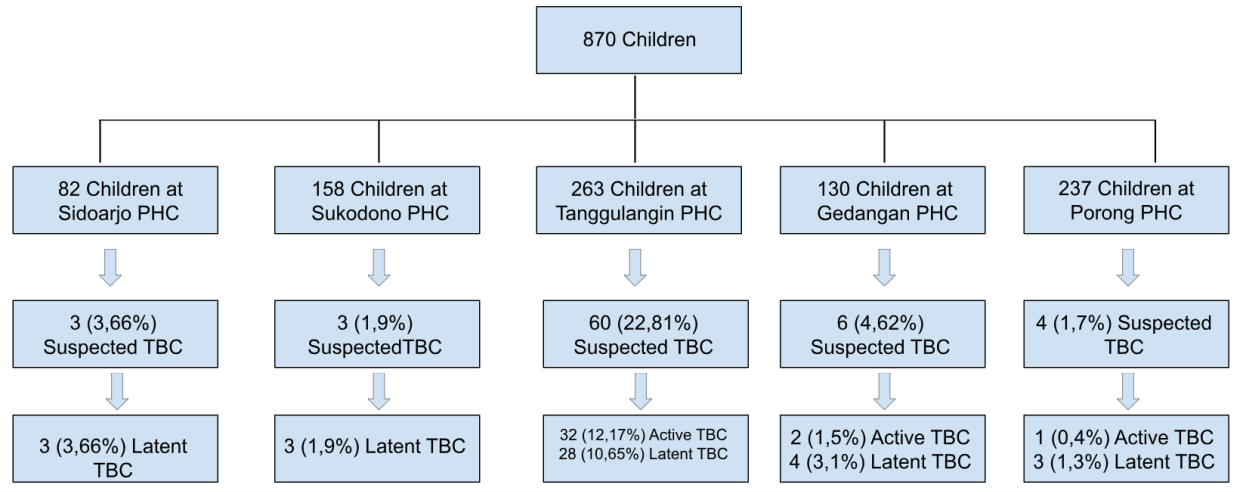

Figure 2. Scheme for implementing ACF screening for childhood tuberculosis in 5 health centers in Sidoarjo district in 2024

Young age is an important risk factor because the immune system of children in this phase is not fully developed, so it is unable to block Mycobacterium tuberculosis infection effectively. This finding is consistent with the results of the study by Nolt and Starke, which stated that children, especially toddlers, have a high risk of progressing from latent infection to active TB disease in a relatively short time after exposure. In addition to biological factors, the behavior of young children who are still very dependent on adults and the home environment also makes them more often exposed to risks, especially if there are family members who suffer from active TB (12).

This research aligns with the findings of Majumdar et al (14), who state that nutritional status affects the transmission/infection of TB

germs. A person with poor nutrition has a 2.92 times higher risk of contracting TB, while those in the malnutrition group have a 4.22 times higher risk of contracting TB (13). In latent TB, it can be seen that the nutritional status is still pretty good because the TB germs are not yet active, while children with active TB are more commonly found in malnutrition.

Nutritional factors also play a crucial role in the progression of TB disease. In this study, children with poor and insufficient nutritional status were found to be more common in the active TB group than in the latent group. It supports the hypothesis that malnutrition weakens the immune response, especially in the cell-mediated immunity pathway, which is crucial in controlling TB infection. According to research conducted by Assefa et al (15), malnutrition disrupts the function of macrophages and T lymphocytes, two important components in suppressing the growth of tuberculosis bacteria. Children with poor nutritional status are also more prone to complications when infected with TB, such as growth failure and weight loss that is difficult to recover, despite therapy. Therefore, nutritional interventions should be an integral part of pediatric TB screening and management (15).

In terms of social epidemiology, a history of close contact with TB patients is one of the strongest risk factors for latent TB in children. This study strengthens the evidence that household exposure is the dominant route of transmission for childhood TB, as described by Sagili et al (16), who reported that children living with adults with bacteriologically confirmed TB were likely to have LTBI. Children who are closely contacted but asymptomatic often go unidentified due to limited diagnostic tools and family ignorance (17). This emphasizes the importance of active contact tracing and routine screening, especially in the household setting, as key strategies to reduce latent infection rates and prevent progression to active TB.

This study is also in line with research conducted by Birroudhoh (17), who found that most close contacts of TB patients showed positive results for LTBI. If this LTBI is not handled properly, the latent TB can develop into Active TB, so it is necessary to educate and ensure compliance with TB Prevention therapy for them. Another study from Karbito also stated that the prevalence of latent TB infection in close contacts of active TB is quite high (19).

Aside from describing the characteristics of children with active and latent TB, another important finding of this study is the urgency to find latent TB cases as early as possible. Children who have been infected with Mycobacterium tuberculosis but have not shown clinical symptoms (latent TB) are at risk of reactivation into active TB, especially if they do not receive appropriate preventive therapy. Intervention at the latent stage is a golden opportunity to break the chain of transmission and prevent more severe lung damage in the future. According to the WHO, children who received TB preventive therapy (TPT) based on early screening results showed a 63% reduction in the risk of developing active TB. This prevention is very strategic because the treatment of active TB takes longer, costs more, and has an impact on the quality of life of children (1).

The ACF or active case finding approach is valuable in this context, especially in pediatric TB control programs. Unlike the passive approach of waiting for patients to come to health facilities, ACF is proactive, reaching out to high-risk populations such as children in close contact with TB patients, children with poor nutrition, or those living in crowded environments. With ACF, detection of latent and active TB can be done early, before the child develops severe symptoms or becomes a source of infection. A study by Ghanaie et al (18) showed that implementing household-based ACF increased latent TB case finding in children by up to three times compared to passive approaches. In addition, ACF provides opportunities for direct education to families, monitoring of the home environment, and integration with other programs such as immunization and nutrition.

ACF also proved to be more cost-effective in the long term. Although it requires an initial investment in health worker training, screening logistics (TST or Interferon Gamma Release Assay (IGRA)), and contact tracing, it spares the health system from the burden of expensive active TB treatment. The cost of preventing one case of active TB through ACF and TPT is lower than the cost of treating late-diagnosed active TB. In high TB burden countries, the implementation of ACF, combined with strengthened surveillance systems and digital health data, has been shown to improve the coverage and efficiency of interventions (21).

The study findings, thus, emphasize the importance of a structured and targeted ACF approach in high-risk groups of children. Early screening for latent TB, prescription of TPT, and regular monitoring of nutritional status can minimize the transition to active TB (22). This benefits the individual child and has a major impact on TB control at the population level, as children

are indicators of active transmission in a community. The implementation of ACF should be viewed as a long-term public health investment, which requires a cross-sectoral commitment, family engagement, and support from national and local policies to eliminate childhood TB (23).

CONCLUSION

Active screening plays a crucial role in detecting both latent and active TB early, which is essential to prevent transmission among children. The findings highlight the strong link between malnutrition and the incidence of active TB, suggesting that nutritional status is an important factor in reducing vulnerability among children.

To address these challenges, ACF must be strengthened, particularly in high-burden areas such as the Sidoarjo district. ACF is an initial screening approach that allows cases to be detected earlier, with the hope that the disease has not yet progressed to a severe stage. Achieving the 2030 TB elimination target will require collaboration among healthcare providers, government agencies, and communities, with improved access to OAT and TPT for children, as well as stronger preventive therapy programs. This study is limited by its cross-sectional design, which prevents causal inference, and the restricted number of variables included. Future studies should employ longitudinal approaches and conduct more comprehensive variable analyses. Strengthening nutritional interventions alongside ACF could be an effective strategy to reduce the childhood TB burden.

CONFLICT OF INTEREST

This screening activity is the first step in a series of community service initiatives undertaken by the author and their team. These activities aim to implement the results of proven innovations in protein- and vitamin D-rich foods, such as biscuits and pasta, to complement TPT and OAT for children under 14 years old.

AUTHOR CONTRIBUTIONS

FS & ACA: Main conceptual idea, Writing Review, Editing; AME: Methodology; HTS & YL: Screening, WS & MSP: Data Collection; AG& MAHR: Data Analysis; LFN: Literature review and Draft Manuscript.

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