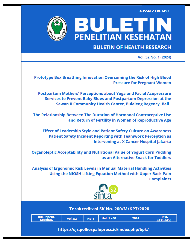

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Integrated Intervention for Stunting and Tuberculosis Screening in Mothers and Children: A Case Study at Kapan Health Center, East Nusa Tenggara

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ABSTRACT

Background: The burden of stunting remains a major issue in Indonesia. Data from the Indonesia Nutrition Status Survey (SSGI) in 2024 reported a much higher prevalence of approximately 37%. Infectious diseases remain a major public health concern in Timor Tengah Selatan (TTS) Regency, with tuberculosis (TB) being one of the most common comorbidities observed in stunted children. Early detection of stunting and TB is crucial in reducing their incidence rates.
Methods: The use of portable X-ray technology, which is practical, mobile, fast, and accurate, serves as an effective diagnostic tool for public health centers in remote areas. This initiative aims to strengthen the implementation of interventions for stunted children and TB screening in mothers and stunted children. The scope of activities includes health education, improving maternal knowledge about stunting, severe malnutrition, and undernutrition, as well as measuring antroprometric followed by TB screening. This activity involved 300 participants (150 children and 150 mothers) at Kapan public health center.
Results: Our result identified 145 children with low BMI, 15 children with severe malnutrition, 16 children with undernutrition, and 32 children with stunting. Portable X-ray imaging detected TB indications in two children (both with a history of severe malnutrition and stunting) and one elderly mother.
Conclusion: The adoption of portable X-ray technology enables public health centers to provide more comprehensive and high-quality healthcare services, thereby improving overall community health standards. These findings also recommend a government policy for the use of portable X-ray machines, which significantly accelerate the early detection of tuberculosis cases, particularly among vulnerable groups such as children.

INTRODUCTION

According to data from the Health System Dashboard (DaSK), the highest disease burden in Indonesia is currently due primarily to non-communicable diseases (NCDs). Nusa Tenggara Timur (NTT) faces several major health challenges due to a high overall disease burden. Factors such as geographical isolation, economic constraints, limited access to healthcare services, and inadequate infrastructure further exacerbate these challenges. One of the most significant health issues in NTT is the high prevalence of stunting, which is among the highest in Indonesia. Chronic malnutrition remains a serious problem, particularly among young children and pregnant women(Chiu et al., 2013; Gusman, Notoatmodjo, & Aprilia, 2021)

In NTT, although stunting rates have decreased over time, they remain above the national average. For instance, as of early 2024, the prevalence of stunting in NTT was 37% based on data from the Indonesian Nutritional Status Survey (SSGI) indicated a higher stunting rate (Kementrian Kesehatan RI, 2025). Data on stunting rates in Timor Tengah Selatan (TTS) Regency also indicates a concerning trend despite ongoing reduction efforts. According to the latest available data, the number of stunted children in TTS was 57.8% in 2024. This trend suggests that efforts to reduce stunting still face significant challenges, particularly given the national target of reducing stunting to 14% by 2024 (Kementrian Kesehatan RI, 2025).

Children suffering from both stunting and tuberculosis (TB) face severe health challenges. This dual burden adversely affects growth, development, and immune function. Active TB can lead to weight loss and malnutrition due to decreased appetite, increased metabolism, and poor nutrient absorption (Ria Saputri Rejeki & Gerry Katon Mahendra, 2023). Moreover, children with TB are more likely to experience growth delays because their bodies prioritize combating the infection over promoting growth. Stunted children typically have compromised immune systems, rendering them more susceptible to infections, including TB. Chronic malnutrition—a primary cause of stunting—can further worsen the prognosis for children with TB. Diagnosing TB in stunted children is particularly challenging because symptoms such as chronic cough, mild fever, and weight loss often overlap with indicators of malnutrition. Furthermore, TB treatment requires long-term therapy (6–12 months) and must be accompanied by nutritional interventions to address stunting (Chiu et al., 2013; Prihartono & Sulianti Saroso, 2017; Yanti, Betriana, & Kartika, 2020).

Efforts to reduce stunting have been implemented across various sectors at the national, provincial, and local levels in TTS. The difficulty in achieving the national target of reducing stunting to 14% may be partly attributed to comorbidities such as TB, HIV, hepatitis B, and other related conditions. Pediatric TB can be transmitted from infected mothers or other family members, making early detection of TB cases in stunted children and mothers a critical component of TB control programs. TB screening for children and parents is a program that is rarely implemented in community health centers. As far as we have reviewed, there is limited research reporting tuberculosis detection in children with stunting.

A portable X-ray is a radiological device that can be transported to a patient's bedside or other necessary locations. Portable X-ray devices integrated with artificial intelligence (AI) represent a promising innovation in radiology (Widianti, 2024). Recent studies have explored the use of portable X-ray technology for TB diagnosis in Indonesia. Active case detection using mobile X-ray units combined with other diagnostic methods has shown promising results in identifying TB cases in high-prevalence areas (Paskaria et al., 2024). These systems aim to accelerate TB diagnosis, especially in areas with limited radiology expertise. These approaches demonstrate significant potential for enhancing TB detection rates and reducing diagnostic delays in Indonesia (Paskaria et al., 2024).

METHODS

This study employed a descriptive quantitative cross-sectional design and was conducted in December 2024. This study was conducted within the framework of the Gerakan Masyarakat Sehat (Germas), or Healthy Community Movement. During the preparation phase, the research team coordinated with the TTS Health Office, the Regional Secretary of TTS, and the head of the

Kapan Community Health Center. Coordination focused on technical aspects such as the implementation schedule and identifying the individuals involved in the Germas program. The target sample comprised 150 children under five years of age and 150 mothers. This study received ethical approval from the Ethics Committee of Poltekkes Kemenkes Kupang, with approval number No. LB.02.03/1/0250/2024 dated November 21, 2024. All participants provided written informed consent as proof of their willingness to participate.

The study activities commenced with participant registration, followed by the measurement of weight and height (or body length) for both children and their mothers. Subsequently, a health education session addressing stunting and tuberculosis (TB) was provided, followed by TB screening conducted via interviews. A specialized team from the Pratama Clinic of the Kupang Polytechnic of the Ministry of Health performed TB screening using a portable X-ray device (Fuji Film Portable X-ray Unit FDR-Xair®, Type XD 2000, Serial Number XDRH-6623). The research results were processed descriptively using Excel and presented in tables accompanied by narrative descriptions.

RESULTS

This study involved 300 respondents, comprising 150 children and 150 mothers. The children were toddlers (aged 1–5 years). The majority of the mothers were in the 31–40-year age range, with 11 elderly mothers (aged 61–80 years) also included. Most mothers were housewives (see Table 1). Portable X-ray imaging indicated that one mother and two children were positive for tuberculosis (TB).

Tabel 1. Characteristics of Subject Participants

Characteristics	n	%
Gender of Chidren		
Female	77	51,3
Male	73	48.7
Age of Chidren		
1 – 2 years	76	50.7
3- 4 years	74	49.3
Age of Mother		
21-30 years	32	21.3
31-40 years	65	43.3
41-50 years	26	17.3
51-60 years	16	10.7
61-70 years	8	5.3
71-80 years	3	2.0
Occupation of Mother		
Housewife	108	72.0
Teacher	3	2.0
Community Health Volunteer	5	3.3
Private Sector	6	4.0
Farmer	11	7.3
Village Official	5	4.3

TB risk factor screening was conducted through interviews with the mothers, and the results are presented in Table 2. Regarding nutritional status, 97% children had a low body mass index (BMI). According to weight-for-height (WHZ) classification, 70% children were well nourished, 10% were severely malnourished, 11% were moderately malnourished, and 9% were overweight. In terms of height-for-age (HAZ) status, 55% children were classified as normal, 32% as stunted, and 13% as tall. None of the children had a history of contact with TB patients or a previous TB diagnosis; however, 2% children had a history of contact with people living with HIV (PLHIV), and 40% children were exposed to passive smoking.

Among the mothers, 5% had a low BMI, and 11% were classified as obese. Four mothers (6%) reported a history of contact with TB patients, 1% had a previous TB diagnosis, and 6% were pregnant. Additionally, 39% mothers reported contact with smokers, and 1% reported contact with PLHIV.

Tabel 2. Results of TB Risk Factor and Symptom Screening

Variables	Children (n)	%	Mothers (n)	%
BMI				
Underweight (17.0–18.4)	145	96.7	8	5.3
Normal (18.5–25.0)	3	2.0	126	84.0
Obesity (25.0–27.0)	2	1.3	16	10.7
Nutritional Status				
Weight-for-Height				
Good	105	70.0		
Severe Malnutrition	15	10.0		
Moderate Malnutrition	16	10.7		
Overweight	14	9.3		
Height-for-Age				
Normal	82	54.7		
Stunting	48	32.0		
Tall	20	13.3		
History of Contact with TB Patients				
No	150	100.0	141	94.0
Bacteriologically confirmed	0	0.0	9	6.0
Previous TB Diagnosis				
No	150	100.0	149	99.3
Yes	0	0.0	1	0.7
Smoking				
No	90	60.0	91	61.0
Yes/Passive	60	40.0	59	39.0
History of Contact with PLHIV				
No	148	98.0	149	99.3
Yes	2	2.0	1	0.7
History of Diabetes Mellitus (DM)				
No	150	100.0	149	99.3
Yes	0	0.0	1	0.7
Pregnancy (Mothers only)				
No	N/A	N/A	146	97.3
Yes	N/A	N/A	4	2.7

The results of TB symptom screening are summarized in Table 3. The majority of the children were asymptomatic, with only two exhibiting unexplained weight loss. Among the mothers, four reported a persistent cough, and one reported symptoms of fever and night sweats in the absence of physical activity.

Tabel 3. Results of TB Symptom Screening

Variables	Children (n)	%	Mothers (n)	%
Cough				
No	150	100.0	146	97.3
Yes	0	0.0	4	2.7
Unexplained Weight Loss				
No	148	98.7	150	100.0
Yes	2	1.3	0	0.0
Fever of Unknown Origin				
No	150	100.0	149	99.3
Yes	0	0.0	1	0.7

Variables	Children (n)	%	Mothers (n)	%
Night Sweats Without Activity				
No	150	100.0	149	99.3
Yes	0	0.0	1	0.7
TB Symptom Screening Result				
No	150	100.0	150	100.0
Yes	0	0.0	0	0.0
Screening for Other Respiratory Diseases				
No	150	100.0	150	100.0
Yes	0	0.0	0	0.0

Chest X-ray images are presented in Figure 1. Figure 1A illustrates normal lung conditions, whereas Figures 1B, 1C, and 1D show abnormalities indicative of TB. A radiology specialist interpreted these images. The observed abnormalities in TB-positive cases included:

Infiltrates – radiopaque (whiter) areas on the lung field that indicate inflammation and tissue consolidation due to TB infection; Cavitation – the presence of hollow spaces in lung tissue resulting from necrosis caused by TB bacteria; Pleural Adhesions – thickening or retraction of the pleura that may obliterate the costophrenic angle; Hilar Lymphadenopathy – enlargement of lymph nodes in the lung hilum; and Apical Involvement – TB infections frequently affecting the upper lung regions (John, Abdulkarim, Usman, Rahman, & Creswell, 2023; Odume et al., 2023)

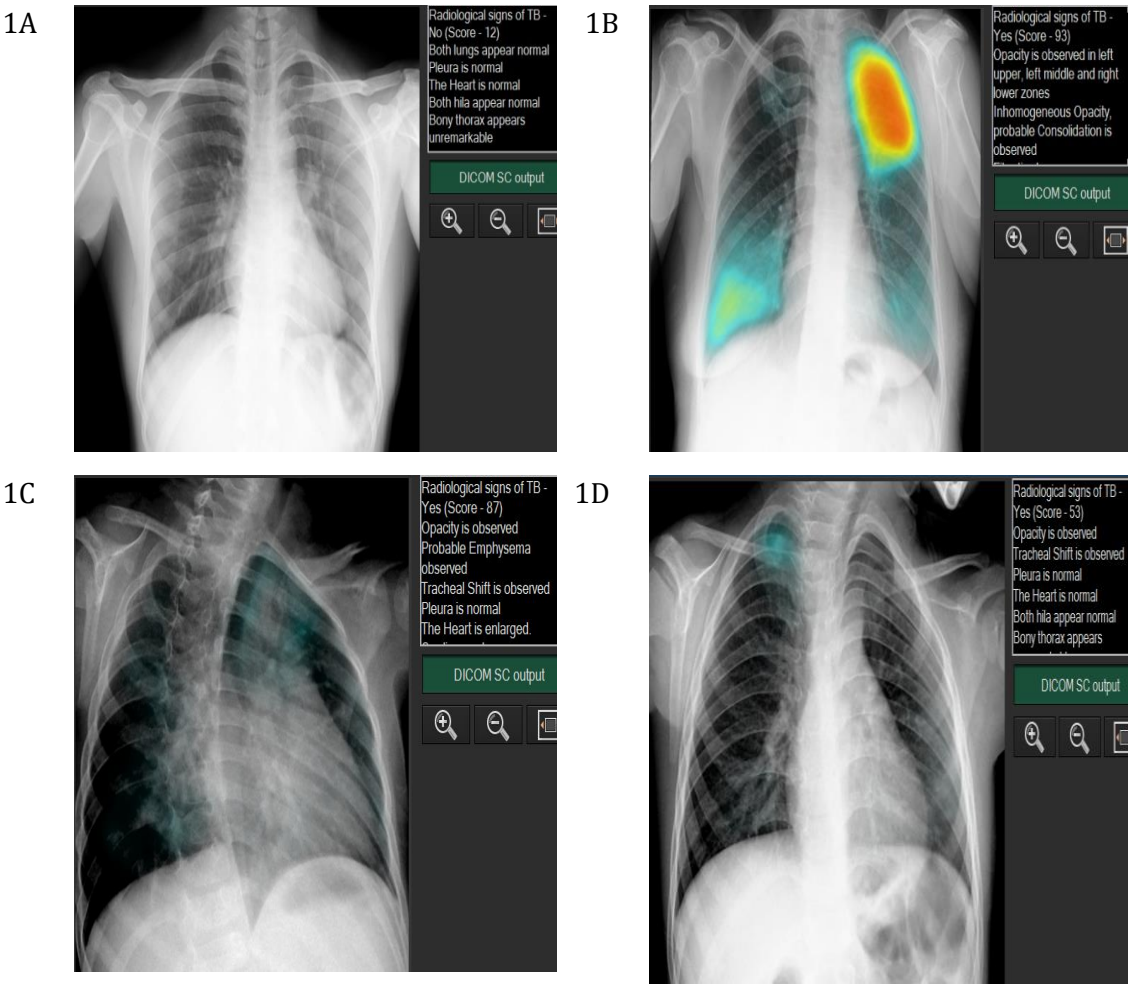

Figure 1. Results of portable X-ray imaging: 4A – negative X-ray image; 4B, 4C, 4D – positive X-ray images

Based on the screening results, respondents 1B and 1D were children with low BMI, severe malnutrition, and stunting, while respondent 1C was a 60-year-old mother with a history of diabetes mellitus and a normal BMI (see Table 4).

Tabel 4. Summary of Screening Results for Three Positive Respondents

Respondent Code	Status, Age	Screening Results
1B	Child, 4 years	Low BMI, severe malnutrition, stunting
1C	Mother, 60 years	History of diabetes mellitus; normal BMI
1D	Child, 4 years	Low BMI, severe malnutrition, stunting

DISCUSSION

Overall, Chest X-ray examinations identified two TB-suspected children, both of whom were stunted and severely malnourished. Notably, these two children did not exhibit symptoms such as cough, unexplained weight loss, fever, or night sweats. In addition, one elderly mother was suspected of having TB; she was asymptomatic, with risk factor screening indicating only a history of diabetes mellitus. The use of portable X-ray imaging in this study successfully detected lung abnormalities indicative of TB even in the absence of clinical symptoms.

Portable X-ray systems have emerged as valuable tools for TB screening in remote areas. Studies have demonstrated their effectiveness in active case-finding campaigns across various countries, including Nigeria, Malaysia, and Vietnam (Chiu et al., 2013; Odume et al., 2023; Vo et al., 2021). These ultra-portable devices, often integrated with artificial intelligence (AI) for image interpretation, have shown promising results in TB detection. For example, a study in Northeast Nigeria reported that AI-interpreted chest radiography (CXR) identified 89.4% of TB cases with higher specificity compared to symptom-based screening (John et al., 2023). Although portable X-ray images may be of lower quality than those produced by traditional systems, AI-based software analysis has demonstrated no significant difference in detecting TB abnormalities (Vo et al., 2021). The implementation of portable X-ray screening has improved TB case detection and enhanced access to TB services in remote populations (Odume et al., 2023; Vo et al., 2021).

TB and stunting are interconnected health issues affecting children in developing countries. Research has established a significant association between stunting and an increased risk of TB, with stunted children having a 3.54 to 9 times higher likelihood of TB infection than their well-nourished peers (Prihartono & Sulianti Saroso, 2017). The prevalence of TB infection among children with household TB contact is estimated at 38.10%, with stunted children facing a 2.36 times higher risk of infection (Bs. Titi Haerana et al., 2021). Stunting compromises immune responses, increasing susceptibility to TB and negatively impacting treatment outcomes (Deddy Herman & Delmi Sulastri, 2024). A strong correlation between TB and malnutrition in children has been observed, with malnutrition present in 63.1% of TB cases (Aibana et al., 2016). Other risk factors for childhood TB include lack of Bacillus Calmette-Guérin (BCG) immunization, prolonged exposure to TB patients, and age under 24 months (Bs. Titi Haerana et al., 2021; Prihartono & Sulianti Saroso, 2017)

Kapan Community Health Center serves a large geographic area with settlements extending into mountainous regions, which makes it challenging for health workers to reach households and for residents to access healthcare services. The high prevalence of stunting in this region may be partly attributed to underlying TB infections. Early TB case detection among both children and mothers is crucial for timely intervention by the *puskesmas*. The introduction of portable X-ray technology is considered essential for addressing the TB burden at *Puskesmas* Kapan. Portable X-ray systems enable on-site radiological examinations, eliminating the need for hospital referrals. Health workers can transport the device to rural villages for mass screening, and portable X-ray screening offers rapid results that reduce patient wait times. Although the initial investment is high, long-term benefits include cost savings from reduced hospital referrals. Modern portable X-ray technology produces high-quality images that can be accurately interpreted by medical professionals.

The limitations of this study include the small number of respondents, which is insufficient to represent data for the entire South Central Timor (TTS) district. Drawing conclusions based on

a limited sample size poses challenges for a descriptive study. Another limitation is the exclusion of registered TB patients at Kapan Health Center who live in the same household as children under five.

The acquisition of portable X-ray devices does, however, present several challenges. The high cost of these devices remains a significant barrier, and trained radiographers are required to operate and interpret the images. Routine maintenance is essential to ensure optimal performance, and strict adherence to radiation exposure safety measures is necessary in clinical settings. Despite these challenges, the benefits of implementing portable X-ray screening in community health centers far outweigh the drawbacks. By integrating this technology, community health centers can provide more comprehensive and high-quality healthcare services, ultimately improving public health outcomes.

CONCLUSION

In this study, we found a high prevalence of malnutrition among children, with 97% classified as underweight based on BMI, 10% suffering from severe malnutrition, 10.7% experiencing mild malnutrition, and 32% diagnosed with stunting. Tuberculosis (TB) cases were detected in two children with severe malnutrition and stunting, as well as in one elderly mother. The utilization of portable X-ray technology has proven to be highly beneficial for early TB detection in community health centers. Government support in the form of funding and training for healthcare professionals is essential to enhance access to portable X-ray technology in *Puskesmas*. Additionally, *puskesmas* must ensure that there are adequate human resources and infrastructure to operate these devices effectively.

There is a need to strengthen primary healthcare policies by integrating routine screening for stunting–tuberculosis comorbidity, particularly among at-risk children under five. In addition, a follow-up strategy involving longitudinal monitoring of TB-positive cases should be implemented to ensure treatment success and prevent long-term impacts on child growth and development.

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Conflicts Of Interest: We declare that all data presented in this study have not been previously published and that there is no conflict of interest among the authors.

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