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EFFECTIVENESS OF MOPETA MODEL IN PREVENTING TUBERCULOSIS AMONG CHILDREN

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ABSTRACT
Tuberculosis (TB) remains a major infectious disease burden in Indonesia, and children aged 12–14 years are highly vulnerable because their immune systems are not yet mature and their exposure at home and at school is intense. To evaluate the effectiveness of the MOPETA (Tuberculosis Prevention Model) mentoring model, delivered through the School Health Unit (UKS), in improving knowledge, attitude, practice, motivation and support for TB prevention among children in Semarang City. A one-group pretest–posttest design was applied to 40 children aged 12–14 years selected using predetermined inclusion and exclusion criteria. Data were collected by structured interview and direct observation before and after the intervention, and were analysed using the Wilcoxon Signed Rank Test after normality testing with Shapiro–Wilk. Before the intervention, 23 children (57.5%) had adequate knowledge, while 24 (60%) showed negative attitude, 23 (57.5%) negative practice, 24 (60%) negative motivation and 24 (60%) negative support. After the intervention, all 40 children (100%) demonstrated good knowledge and positive attitude, practice, motivation and support, with Z values ranging from −4.862 to −5.531 (p=0.000). MOPETA mentoring through UKS significantly improved TB prevention behaviour among schoolchildren and offers a replicable, low-cost school-based model that contributes to closing the prevention gap in childhood tuberculosis.

Keywords: childhood tuberculosis; health education; MOPETA model; school health unit; tuberculosis prevention

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INTRODUCTION

Tuberculosis (TB) is an infectious disease that remains a major global health problem (World Health Organization, 2022a), including in Indonesia, which is one of the countries with the highest TB burden in the world. Indonesia recorded 42,187 cases of TB among children in 2021, a number that increased significantly compared with the previous year (Dinas Kesehatan Provinsi Jawa Tengah, 2021). The prevalence of tuberculosis in Central Java in 2022 again increased sharply, to 61,594 cases compared with 42,187 cases in 2021, and the highest number of cases occurred among children aged 12–14 years, totalling 26,979 cases (Direktorat Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, 2022). School-aged children, particularly those aged 12–14 years, are a group that is highly vulnerable to TB infection because their immune systems are not yet fully mature and because of their high potential for exposure, both at home and at school.

Globally, childhood TB remains a substantially under-recognised contributor to morbidity and mortality. Of an estimated 1.1 million children who develop TB disease each year, fewer than 36.5% are diagnosed and notified to national TB programmes, with under-notification being most severe among children under five years of age, whose case-reporting rate reaches only about 27.5% (Mashiach et al., 2026; World Health Organization, 2022b). TB-related mortality among children

under 15 years is estimated at approximately 226,000 deaths annually, with around 80% occurring in children under five, and verbal autopsy and medical record analyses indicate that as many as 96% of children who die from TB-related complications never received any anti-tuberculosis treatment (World Health Organization, 2022b). These outcomes are largely driven by chronic delays in diagnosis, inadequate linkage to care, and limited access to effective treatment and prophylactic regimens (Mashiach et al., 2026).

The high mortality observed in young children is closely related to the immunological immaturity of their immune systems, which often fail to contain the rapid progression from initial Mycobacterium tuberculosis infection to active, disseminated disease (Mashiach et al., 2026). In addition, paediatric pulmonary TB is characteristically paucibacillary, meaning that the bacteriological burden is often below the detection threshold of conventional sputum smear microscopy, and young children frequently cannot produce adequate sputum samples voluntarily (Basile et al., 2022; Belew et al., 2025; MacLean et al., 2019). Children with comorbid conditions such as HIV co-infection, severe malnutrition and other forms of immunosuppression are at substantially higher risk of progression to active TB disease, including extrapulmonary forms such as TB meningitis (Mashiach et al., 2026; Tornheim & Dooley, 2017).

In response to this global burden, the World Health Organization has, since 2022, promoted a dual approach that combines active case-finding and treatment of TB disease with testing and treatment of latent TB infection through TB preventive treatment (TPT), alongside the adoption of child-friendly, non-sputum-based diagnostic tools and decentralised models of care (Mullen et al., 2026; Signorino et al., 2022; World Health Organization, 2022b; Zawedde-Muyanja et al., 2021). In Indonesia, which carries one of the highest global TB burdens, closing the case-detection and prevention gap among children remains a national priority, particularly given persistent under-notification and the limitations of conventional diagnostic approaches in detecting paucibacillary infection in children (Tobing et al., 2026).

As an effort to reduce transmission rates, the Ministry of Health, together with the Ministry of Education, Culture, Research and Technology, has developed the TB-Care School Guidelines (Pedoman Sekolah Peduli TBC) as part of the implementation of the 2030 TB Elimination Programme. This programme is implemented across sectors, involving School Health Unit (UKS) coordinators at the provincial and district or city levels. Its objective is to strengthen promotion and prevention activities related to TB transmission within educational settings. The TB-Care School programme functions to disseminate information about TB widely, particularly to the education community, regarding prevention, transmission, examination and quality treatment. In addition, this programme also aims to foster the role of educational institutions in shaping clean and healthy living behaviours and character as a step towards TB prevention (Direktorat Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan, 2022).

To support the effectiveness of these efforts, a school-based mentoring model is needed through the School Health Unit (Unit Kesehatan Sekolah/UKS). As a health facility within the educational environment, UKS plays an important role in the early detection and prevention of infectious diseases. This mentoring model focuses on education and on the development of positive attitudes and behaviours that support TB prevention. Innovation in UKS mentoring can be strengthened through the use of digital technology, such as health information-based applications that can improve programme efficiency, expand educational reach, and support screening, diagnosis and monitoring of TB cases more effectively. Such school-based approaches are consistent with emerging international models, including programmes that engage teachers, school health staff and community health workers in symptom screening and stigma reduction as an entry point for community-level TB control among adolescents (Abelti et al., 2025; Zawedde-Muyanja et al., 2021).

Despite the existence of national policies and guidelines, the implementation of structured, technology-supported mentoring models within UKS to address childhood TB prevention remains limited, particularly in the context of Semarang City. Furthermore, even where diagnostic and screening infrastructure has improved, uptake of preventive interventions among child contacts in Indonesia remains markedly low, with caregiver-related factors frequently cited as major barriers to TPT initiation (Ridwan et al., 2025; Tobing et al., 2026). This gap underscores the need for an evidence-based mentoring model that integrates education, attitude formation and behavioural practice. This study therefore aimed to determine the effectiveness of the MOPETA (Tuberculosis Prevention Model) mentoring model, implemented through UKS, in improving the knowledge, attitude, practice, motivation and support of children aged 12–14 years in the prevention of tuberculosis in Semarang City.

METHOD

This study employed a one-group pretest–posttest design. The study was conducted in Semarang City, Central Java, Indonesia, and involved 40 students aged 12–14 years as respondents, selected on the basis of predetermined inclusion and exclusion criteria. This design was used because there was a single group of respondents whose knowledge, attitude, practice, motivation and support regarding TB prevention were measured before and after the MOPETA intervention, with no separate control group. The variables measured in this study included knowledge, attitude, practice, motivation and support related to TB prevention, all of which were assessed using a structured questionnaire that had previously been validated. Data collection was carried out through interviews using the questionnaire and through direct observation of respondents' practices.

Prior to its use in this study, the questionnaire was tested for validity and reliability on a group of students with characteristics comparable to those of the respondents but who were not included in the study. Validity was assessed using the Pearson product-moment correlation and reliability using Cronbach's alpha, and all items met the accepted criteria for both tests. The instrument was therefore considered valid and reliable for measuring knowledge, attitude, practice, motivation and support regarding tuberculosis prevention. The intervention consisted of UKS mentoring delivered through the MOPETA (Model Pencegahan Tuberkulosa) model, which included health education sessions and direct practice activities related to TB prevention. The intervention was administered to all respondents, and data were collected before (pre-test) and after (post-test) the intervention.

Data normality was assessed using the Shapiro–Wilk test, given that the sample size was fewer than 50. As the data were found not to be normally distributed, differences between pre-test and post-test results for each variable (knowledge, attitude, practice, motivation and support) were analysed using the Wilcoxon Signed Rank Test, with a significance level of $p<0.05$. This study was conducted in accordance with the applicable ethical principles for research involving human subjects. Ethical clearance was obtained from the Health Research Ethics Committee (Komisi Etik Penelitian Kesehatan), Faculty of Medicine, Universitas Negeri Semarang, under Ethical Exemption Certificate No. 880/KEPK/FK/KLE/2025, issued on 12 April 2025. Informed consent was obtained from all respondents and their parents or guardians prior to data collection. Participation was voluntary, and the confidentiality of all personal data was maintained throughout the study.

RESULT

Based on the results presented in table 1, of the 40 respondents prior to the intervention, the majority had an adequate level of knowledge regarding tuberculosis prevention in children, namely 23 children (57.5%). A total of 24 children (60%) showed a negative attitude, 23 children (57.5%) had negative prevention practices, 24 children (60%) had negative motivation, and 24 children (60%) showed negative support towards tuberculosis prevention efforts in children.

Table 1
Knowledge, attitude, practice, motivation and support towards the prevention of pulmonary TB transmission in children before the intervention (n=40)

Variable	Category	f	%
Knowledge	Good	16	40.0
	Adequate	23	57.5
	Poor	1	2.5
Attitude	Positive	16	40.0
	Negative	24	60.0
	Total	40	100.0
Practice	Positive	17	42.5
	Negative	23	57.5
	Total	40	100.0
Motivation	Positive	16	40.0
	Negative	24	60.0
	Total	40	100.0
Support	Positive	16	40.0
	Negative	24	60.0
	Total	40	100.0

Note. Data were obtained from the pre-test measurement of 40 children aged 12–14 years.

Table 2
Knowledge, attitude, practice, motivation and support towards the prevention of pulmonary TB transmission in children after the intervention (n=40)

Variable	Category	Frequency (n)	Percentage (%)
Knowledge	Good	40	100.0
	Adequate	0	0.0
	Poor	0	0.0
	Total	40	100.0
Attitude	Positive	40	100.0
	Negative	0	0.0
	Total	40	100.0
Practice	Positive	40	100.0
	Negative	0	0.0
	Total	40	100.0
Motivation	Positive	40	100.0
	Negative	0	0.0
	Total	40	100.0
Support	Positive	40	100.0
	Negative	0	0.0
	Total	40	100.0

Note. Data were obtained from the post-test measurement of the same 40 respondents.

Table 3
Distribution of normality test results for the pre-test and post-test knowledge, attitude, practice, motivation and support variables

Variable	f	Sig. (Shapiro–Wilk)
Pre-test knowledge	40	0.000
Post-test knowledge	40	0.000
Pre-test attitude	40	0.000
Post-test attitude	40	0.000
Pre-test practice	40	0.000
Post-test practice	40	0.000
Pre-test motivation	40	0.000
Post-test motivation	40	0.000
Pre-test support	40	0.000
Post-test support	40	0.000

Note. The Shapiro–Wilk test was applied because the sample size was fewer than 50.

Based on the results presented in Table 2, after the intervention all 40 respondents (100%) demonstrated good knowledge, a positive attitude, positive prevention practices, positive motivation

and positive support towards tuberculosis prevention efforts in children. Based on the normality test results presented in Table 3, the significance values for the pre-test and post-test data on knowledge, attitude, practice, motivation and support were all 0.000 ($p<0.05$), indicating that the data were not normally distributed. A non-parametric test was therefore selected for the analysis of pre-test and post-test differences.

Table 4
Distribution of Wilcoxon Signed Rank Test results for the pre-test and post-test knowledge, attitude, practice, motivation and support variables

Variable (pre–post)	Z	Asymp. Sig. (2-tailed)
Knowledge	−5.531	0.000
Attitude	−4.862	0.000
Practice	−5.303	0.000
Motivation	−5.324	0.000
Support	−5.107	0.000

Note. Significance was set at $p<0.05$.

Based on the results of the Wilcoxon Signed Rank Test presented in Table 4, the Z values obtained were −5.531 for knowledge, −4.862 for attitude, −5.303 for practice, −5.324 for motivation and −5.107 for support, with a p-value (Asymp. Sig. 2-tailed) of 0.000 ($p<0.05$) for all variables. These results indicate that the research hypothesis is accepted, meaning that there is a significant difference in the levels of knowledge, attitude, practice, motivation and support before and after the intervention regarding TB prevention in children.

DISCUSSION

The MOPETA model, implemented as part of UKS mentoring, serves as a vehicle for health education in schools and has been shown to be capable of changing children's knowledge and behaviour in TB prevention. Its comprehensive approach, which incorporates the dimensions of motivation and support, further strengthens the effectiveness of the programme. The significant findings from the Wilcoxon test support the conclusion that this model not only enhances theoretical understanding but also translates into practical behaviour in the field. Nevertheless, programme sustainability and the strengthening of school environmental factors remain essential for achieving long-term outcomes.

These results are consistent with earlier school- and community-based health education studies, which have repeatedly demonstrated that structured educational interventions improve knowledge and shape preventive attitudes and behaviours towards tuberculosis (Marwah et al., 2024; Sianturi et al., 2025; Xie et al., 2025). Previous Indonesian research has likewise reported that education-based instruments delivered in the primary school setting significantly strengthen the social support surrounding the child and parental commitment to TB prevention (Indriatie et al., 2026), while international evidence has confirmed that health education is a central component of effective paediatric TB prevention strategies (Reuter et al., 2020). The present study extends this body of work by showing that a single mentoring model delivered through the existing School Health Unit can improve five dimensions of TB prevention simultaneously rather than knowledge alone.

Knowledge, attitude, practice, motivation and support before the intervention

Based on the results presented in Table 1, before the intervention the majority of the 40 respondents had an adequate level of knowledge, namely 23 children (57.5%). This condition indicates that the respondents already possessed a basic understanding related to tuberculosis prevention in children; however, this knowledge was not yet comprehensive and did not cover all important aspects. The adequate level of knowledge may be attributed to limited access to health information, the lack of continuous educational activities, and the minimal use of information media within the school environment. Knowledge itself is acquired through experience and sensory stimulation captured by an individual's senses (Sianturi et al., 2025). This suboptimal level of knowledge can affect

respondents' attitudes and prevention practices, indicating the need for improvement through targeted and sustainable interventions.

In addition, the pre-intervention results also showed a negative attitude among 24 children (60%) and negative prevention practices among 23 children (57.5%). This indicates that although some respondents had adequate knowledge, this was not yet fully reflected in positive attitudes and prevention practices. Knowledge that is not accompanied by deep understanding and awareness of the importance of prevention has not been able to drive changes in attitude and behaviour. This condition may be influenced by low individual motivation, a lack of support from the surrounding environment, and the suboptimal implementation of health education in schools.

Furthermore, the pre-intervention results showed negative motivation among 24 children (60%) and negative support among 24 children (60%). This indicates that most respondents did not yet have a strong internal drive or adequate external support to undertake tuberculosis prevention measures. Low motivation may be caused by a lack of understanding regarding the benefits of prevention, as well as by the perception that the risk of contracting the disease is low. Meanwhile, the lack of support from the school environment, family and peers also contributes to the low active participation of respondents in TB prevention efforts. It can therefore be concluded that, prior to the intervention, most respondents had not yet demonstrated optimal capacity in the aspects that play an important role in tuberculosis prevention efforts in children.

Knowledge, attitude, practice, motivation and support after the intervention

Based on the results presented in Table 2, there were significant changes in knowledge, attitude, practice, motivation and support for tuberculosis prevention in children after the intervention was provided. All 40 respondents (100%) showed an improvement in knowledge to a good level after the intervention. This is consistent with the Health Belief Model, which explains that changes in a person's health behaviour are influenced by their perceptions of susceptibility, severity, perceived benefits and perceived barriers. In this context, the improvement in knowledge after the intervention contributed to changes in respondents' attitude, practice, motivation and support in TB prevention efforts within the school environment.

In addition to the improvement in knowledge, the results also showed positive changes in attitude, practice, motivation and support after the intervention. Respondents who initially had negative attitudes and prevention practices began to show more open attitudes and more active behaviour in implementing TB prevention measures. This indicates that the intervention not only improved the cognitive aspect but also influenced the affective and psychomotor domains of the respondents. The improvement in motivation and support after the intervention reflects a change in internal drive and reinforcement from the surrounding environment. Support from schools, peers and teachers plays an important role in shaping sustainable prevention behaviour. With UKS mentoring and the use of digital technology, the educational process becomes more engaging, accessible and interactive, thereby encouraging students' active participation in TB prevention activities. Overall, these results indicate that school-based health education interventions can be an effective strategy for improving knowledge, changing attitudes, improving practices, and strengthening motivation and support in tuberculosis prevention efforts among school-aged children.

Effect of health education on knowledge, attitude and preventive behaviour regarding TB transmission in children

The results of the Wilcoxon test presented in Table 4 show significant Z values for all variables, namely knowledge ($Z=-5.531$), attitude ($Z=-4.862$), practice ($Z=-5.303$), motivation ($Z=-5.324$) and support ($Z=-5.107$), with a p-value (Asymp. Sig. 2-tailed) of 0.000, well below the significance threshold of 0.05. These findings indicate a meaningful difference between conditions before and after the intervention, signifying that the intervention provided was effective in improving various

important aspects related to TB prevention in children. These results are corroborated by the study of Sianturi et al. (2025), which found an increase in respondents' knowledge from the poor category at 23.33% before the educational intervention to the good category at 93.33% afterwards. In addition, respondents' attitudes also improved from the poor category at 33.33% to the good category at 90.00% after education was provided. A similar study by Yenni and Meliyantari (2024) also found a significant relationship between the level of knowledge and attitudes towards measures to prevent the transmission of pulmonary TB, indicating that improved understanding directly contributes to more positive health behaviour changes. The significant changes observed in this study are consistent with the Knowledge–Attitude–Practice theory, which explains that an increase in a person's knowledge will shape positive attitudes and ultimately encourage practice and motivation in undertaking disease prevention measures. This theory is further supported by the study of Xie et al. (2025), which showed that systematic health education and promotion interventions are able to improve awareness and preventive behaviour towards TB across various age groups, including children as a vulnerable population.

Furthermore, Reuter et al. (2020) emphasised that effective prevention strategies, such as the provision of preventive therapy, vaccination and health education, play a central role in reducing TB incidence, particularly among children. The effectiveness of such interventions is reflected in the improvement of various important aspects related to TB prevention behaviour, as also found in this study. This finding is in line with the results of Marwah et al. (2024), which showed that structured and continuous education can shape positive attitudes and improve preventive health practices towards TB. It is therefore necessary to emphasise the importance of a comprehensive approach through health promotion using a UKS mentoring model that encompasses knowledge, attitude, practice, motivation and social support to control TB transmission among vulnerable groups such as children. Thus, the results of this study confirm that education- and motivation-based interventions not only improve knowledge, attitude and practice for TB prevention but also strengthen motivation and social support, both of which play important roles in the sustained success of tuberculosis prevention efforts in children.

Relevance of the MOPETA model within the broader context of childhood TB detection and prevention

The findings of this study are consistent with the global epidemiological context of childhood TB, which remains a substantial and underappreciated contributor to morbidity and mortality, particularly in resource-limited settings (Mashiach et al., 2026). Globally, of an estimated 1.1 million children who develop TB disease each year, fewer than 36.5% are diagnosed and notified to national TB programmes, leaving a large proportion of paediatric cases undetected (World Health Organization, 2022b). In Indonesia, closing the case-detection gap among children remains one of the most pressing challenges, compounded by the limitations of conventional microscopy in detecting the paucibacillary infections typical of paediatric TB (Basile et al., 2022; MacLean et al., 2019; Tobing et al., 2026). Strengthening school-based detection and prevention models such as MOPETA is therefore directly aligned with national efforts to reduce under-notification among school-aged children.

The improvement in knowledge observed after the MOPETA intervention is particularly important given that childhood TB screening increasingly relies on the recognition of non-specific symptoms, such as a cough lasting more than two weeks, prolonged fever, or unexplained failure to gain weight, rather than on classic symptoms such as haemoptysis (World Health Organization, 2022b). Equipping children, families and school communities with the knowledge to recognise these symptoms supports earlier referral and active case-finding, which has been shown to identify disease at substantially earlier stages than passive referral pathways (Brough et al., 2023). The positive shift in motivation and support following the intervention also reflects findings from the broader literature on TB preventive treatment adherence, which emphasises that the success of

preventive interventions depends not only on the availability of effective and increasingly child-friendly regimens (Mulder et al., 2025) but also on the psychosocial support systems surrounding the child (Mkrtchyan et al., 2025). A multicentre observational study conducted in the 3HP era found that nearly 28% of paediatric household contacts failed to complete preventive treatment, with predictors of non-adherence including adverse drug reactions, multiple comorbidities, adolescent age and the absence of a primary caregiver (Zewdu et al., 2026). These findings highlight that behavioural and motivational interventions, such as those embedded in the MOPETA model, are essential complements to pharmacological advances in TB prevention.

Furthermore, the involvement of the School Health Unit as the platform for this intervention is consistent with the global shift towards decentralised, family- and community-centred models of TB care, which the World Health Organization has promoted since 2022 as a means of improving equity and access, particularly for socioeconomically disadvantaged populations (World Health Organization, 2022b; Zawedde-Muyanja et al., 2021). Evidence from Ethiopia demonstrated that community-based contact tracing and treatment support conducted by health extension workers achieved preventive treatment completion rates as high as 99.4%, compared with 88.0% in more centralised facility-based models (Abelti et al., 2025). Similarly, school-based initiatives have demonstrated that engaging teachers and school health staff in symptom screening and stigma reduction can serve as an effective entry point for community-level TB control, particularly among adolescents whose primary site of social interaction shifts from the household to the school environment (Kadam et al., 2025; Rahmalina & Darmawan, 2026).

In the Indonesian context, low uptake of preventive treatment remains a significant barrier despite improvements in diagnostic infrastructure. A study of household contacts found that only 3.3% of paediatric contacts of bacteriologically confirmed TB patients received preventive treatment, far below the Ministry of Health's target coverage of 50–90% (Ridwan et al., 2025). Caregiver-related factors, particularly older caregiver age and scepticism towards prolonged prophylactic medication in asymptomatic children, were identified as major barriers (Ridwan et al., 2025). Structured educational interventions, such as the Tuberculosis Prevention Smart Book implemented among the parents of elementary school children, have shown that improved health literacy can significantly enhance parental commitment to TB-related preventive behaviours ($p<0.05$), reinforcing the relevance of education-based mentoring models such as MOPETA in the Indonesian setting (Indriatie et al., 2026). Service-level innovations in screening and preventive therapy reported from other Indonesian cities point in the same direction (Catrianiningsih et al., 2025).

Taken together, these findings suggest that the significant improvements observed in knowledge, attitude, practice, motivation and support following the MOPETA intervention are not isolated results but are consistent with a broader body of evidence indicating that integrated, education-based and community-anchored approaches are central to closing the detection and prevention gap for childhood tuberculosis (Faisal et al., 2026; Mafirakureva et al., 2024). This study is not without limitations. The one-group pretest–posttest design and the absence of a control group mean that the observed improvements cannot be attributed to the MOPETA intervention with the same confidence as in a randomised controlled trial, and the relatively small sample of 40 children drawn from a single city limits the generalisability of the findings. Measurement immediately after the intervention also does not establish whether the improvements are sustained over time. Future research using a control group, a larger multi-site sample and longer follow-up is therefore recommended to confirm the durability and transferability of the model.

CONCLUSION

The UKS mentoring model based on MOPETA was effective in improving knowledge, attitude, practice, motivation and support for tuberculosis prevention among children aged 12–14 years in Semarang City, as evidenced by the significant differences between pre-test and post-test

measurements for all five variables, with all respondents reaching the good and positive categories after the intervention. The contribution of this study to science lies in demonstrating that a structured, school-based mentoring model delivered through the existing School Health Unit can simultaneously address the cognitive, affective, psychomotor, motivational and social support dimensions of tuberculosis prevention in a single low-cost intervention, thereby extending school-based health education research beyond knowledge transfer alone and providing an evidence-based, replicable model that supports national efforts towards tuberculosis elimination among school-aged children.

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