

Original Research

The Effect of Family Centered Empowerment Model based on Virtual Education to Improve on Strengthening the Family Role as DOTS Supervisor in Children with Pulmonary TB

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ABSTRACT

Background: Tuberculosis (TB) remains a major public health problem in Indonesia, particularly among children. Effective treatment adherence requires family involvement, where the role of Directly Observed Treatment Short-course (DOTS) supervisors is crucial. Innovative empowerment strategies are needed to strengthen family participation. This study aimed to examine the effect of the Family-Centered Empowerment Model (FCEM) based on virtual education to strengthen the role of families as DOTS supervisors for children with pulmonary TB.

Methods: A quasi-experimental design with control and intervention groups was conducted. A total of 74 respondents were recruited using a total sampling approach. The intervention group received FCEM-based virtual education, while the control group received routine care. Data were collected using the FCEM questionnaire and analyzed with the Wilcoxon Signed Rank Test and Mann-Whitney U test.

Results: The results showed that elderly respondents predominated in both groups, accounting for 62.2% in the control group and 67.6% in the intervention group. In the control group, most families remained in the low category (64.9%), whereas in the intervention group, the majority shifted to the high category (75.7%). The findings confirmed a significant difference between the two groups after the FCEM based on virtual education intervention (p -value 0,011).

Conclusion: It should not contain any references or displayed equations. The FCEM based on virtual education has more effectively strengthened the role of families as DOTS supervisors in children with pulmonary TB. This approach can be used as an innovative strategy to improve treatment success and accelerate progress toward TB elimination targets in Indonesia.

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INTRODUCTION

Tuberculosis (TB) remains a global health problem with high morbidity and mortality rates, particularly in developing countries, including Indonesia. Indonesia ranked second in the country facing the triple burden of tuberculosis (World Health Organization, 2024). Children became a vulnerable group at high risk of TB infection due to their immature immune systems and frequent close contact with adults with pulmonary TB (Dianti, 2023). Cases of pulmonary tuberculosis recurrence in pediatric patients are increasing due to non-compliance with TB treatment, and a 2.3% decrease in treatment success rates for children with pulmonary TB (Perhimpunan Dokter Paru Indonesia, 2021). Thus, the government supports TB elimination efforts by monitoring treatment until successful treatment outcomes.

Tuberculosis management in children requires long-term treatment with strong adherence to medication regimens to achieve optimal recovery (Section et al., n.d.). Despite the implementation of the national TB control program, many children with pulmonary TB still experience non-compliance with medication (Kemenkes RI, 2023). This condition is influenced by a lack of family knowledge, low motivation, limited access to information, and a lack of active family involvement in supporting their children (Komunitas et al., n.d.). As a result, treatment failure rates, TB transmission, and drug resistance remain high. Drug resistance impacts children's growth and development. Further impacts can even lead to death.

Limited information on tuberculosis preventive treatment identified a trigger for the ever-increasing number of pulmonary TB cases (Marwansyah & Sholikhah, 2016). Several studies showed that education-based interventions can improve medication adherence in TB patients. FCEM has proven effective in strengthening families' capacity to care for ill members (Bekti, 2017). This family empowerment model can reinforce the health system within the family, cultivating healthy lifestyle behaviors (Sari et al., 2024). Empowerment begins with clients gaining knowledge and skills to act based on informed choices (Butler et al., 2025). Furthermore, developments in digital technology and virtual platforms have made health education more accessible, interactive, and sustainable. However, the integration of FCEM with virtual educational media in the context of assisting children with pulmonary TB with medication is still rarely studied.

Previous research has focused primarily on face-to-face education or conventional counseling programs (Abidin, 2018). Only a few studies have combined the family-based empowerment model with a virtual education approach (Saftarina & Fitri, 2020). Accordingly, there is limited empirical evidence regarding the effectiveness of virtual education-based FCEM in strengthening the role of families as caregivers for children with pulmonary TB. This study offers a solution in the form of implementing a Virtual Education-based Family Centered Empowerment Model (Anderson et al., 2021). This model not only improves family knowledge but also strengthens their attitudes, motivation, and skills in assisting their children with pulmonary TB drug therapy (Mailani, 2023). A virtual platform was chosen to make educational access more flexible, easy, and sustainable (Latif & Tiala, 2022).

The high rate of non-adherence to medication in children with pulmonary TB impacts therapy failure (Saftarina & Fitri, 2020). Furthermore, the development of digital technology presents significant opportunities to enhance the effectiveness of family-based health interventions. By empowering families through virtual media, it is hoped that medication adherence in children with pulmonary TB will improve,

positively impacting public health. This research is expected to make a significant contribution to the development of family empowerment strategies through innovative, technology-based approaches. The results can strengthen childhood TB control programs at the health service level, increase family involvement, and prevent drug resistance due to non-adherence to therapy. The main advantages of this intervention are its efficiency, flexibility, and family-oriented nature, making it widely applicable in various community contexts.

MATERIALS AND METHODS

This quasi-experimental study applied a pre-post-test control group design (Susanti, 2024). The objective of this study was to assess the impact of an education-based Family-Centered Empowerment Model (FCEM) on strengthening family involvement as DOTS supervisors for pediatric pulmonary tuberculosis. The study was conducted in June 2025 at the Aurduri Community Health Center (Puskesmas) in Jambi City, the study location. The instrument used was a structured questionnaire to measure the study variables. The dependent variable was the strengthening of the role of families as DOTS supervisors in children with pulmonary tuberculosis. Data were collected using the validated Family-Centered Empowerment Model (FCEM) questionnaire. The independent variable was the virtual educational activity for families of DOTS supervisors in children with pulmonary tuberculosis, measured using the educational sheet.

Respondents were selected using a total sampling technique. A total of 74 participants were recruited, with 37 allocated to the intervention group and 37 to the control group. Respondents were families (parents/guardians) of children aged 1-18 years diagnosed with pulmonary TB and undergoing treatment at a community health center (Puskesmas). The family members were appointed by the Puskesmas as TB DOTS supervisors and lived in the same household. The family had access to a smartphone and agreed to participate in virtual education by signing an informed consent form. Families unable to participate in the entire intervention series and children with TB who had severe comorbidities that interfered with their treatment program were excluded from the study.

The study began with a pre-test. A pre-test questionnaire, lasting 15–20 minutes, was administered to both groups before the intervention. The questionnaire instrument was tested for validity and reliability in an initial trial (a trial with 20 respondents outside the main sample). The intervention group was then given an intervention program, the Family Centered Empowerment Model (FCEM) program, based on virtual education. The virtual education program was structured into four modules: (1) Basic TB education for children and the role of the family; (2) Communication techniques and child motivation; (3) Treatment management and side effects (Module); and (4) Emotional support and progress monitoring. The materials were delivered through interactive educational videos, PDF modules, and Zoom. The control group received only conventional in-person education during visits to the community health center, in accordance with service standards. After virtual education, both groups were asked to complete a post-test questionnaire using the same instrument to measure changes in strengthening the family's role as a DOTS supervisor.

All respondent data is kept confidential and will be used solely for research purposes. To ensure confidentiality, participant identities were anonymized and the data securely stored under the responsibility of the principal investigator. The collected data

were analyzed using univariate methods to describe respondent characteristics and to assess the strengthening of the family's role as DOTS supervisors before and after the intervention. The Wilcoxon Signed-Rank Test was used to compare differences in strengthening the family's role as a DOTS supervisor before and after treatment, and the Mann-Whitney U test was used to compare differences in the family's role as a DOTS supervisor between the two groups. The confidence interval was 95%, and the significance level was 5%.

This study was approved by the Ethics Committee of Poltekkes Kemenkes Jambi Indonesia (KEPK) (Approval letter No: LB.02.06/2/382/2025) for providing support throughout this research. We also extend our appreciation to the healthcare staff and family members who participated in this study for their valuable time and cooperation. Before participation, all individuals were fully informed of the study objectives and procedures and provided written informed consent.

RESULTS

The results of this study were described in Table 1 n 2.

Table 1. Respondents' Characteristics

Characteristics	Control group		Intervention group	
	N	%	n	%
Age				
Early adults	14	37.8	12	32.4
Older adults	23	62.2	25	67.6
Gender				
Male	21	56.8	15	40.5
Female	16	43.2	22	59.5
Family roles time				
Less than 1 year	18	48.6	25	67.6
More than 1 year	19	51.4	12	32.4
Income level				
Below the minimum wage	25	67.6	16	43.2
Above the minimum wage	12	32.4	21	56.8
Job				
Civil servant	19	51.4	19	29.7
Private sector	10	27.0	10	27.0
Self employee	8	21.6	8	43.2
Education level				
Elementary (elementary)	5	13.5	5	43.2
Secondary (middle high school)	13	35.1	15	32.4
Higher (university)	19	51.4	19	24.3
Family type				
Nuclear	21	56.8	21	35.1
Extended	16	43.2	16	64.9

As shown in Table 1, respondent characteristics varied considerably between the control group (n = 37) and the intervention group (n = 37), particularly in relation to families serving as DOTS supervisors for children with pulmonary TB. The majority of

respondents in both groups were elderly, comprising 62.2% of the control group and 67.6% of the intervention group. The control group was predominantly female (56.8%), had incomes below the minimum wage (67.6%), worked as civil servants (51.4%), had higher education (51.4%), and living with nuclear families (56.8%). In contrast, the intervention group was predominantly male (59.5%), had new DOTS supervisors (67.6%), had incomes above the minimum wage (56.8%), worked as self-employed (43.2%), had primary education (43.2%), and lived with extended families (64.9%).

Table 2. Respondents' Characteristics

Variabel	Control group		Intervention group	
	n	%	n	%
Family role as DOTS Supervisor				
Low	24	64.9	9	24.3
High	13	35.1	28	75.7
Wilcoxon Rank Test	p-value (0.020)		p-value (0.001)	
Mann-Whitney	p-value = 0.011			

Based on Table 2, the results demonstrated a significant difference in strengthening the role of families as DOTS Supervisors between the control and intervention groups. In the control group, the majority of families were categorized as low (64.9%), while in the intervention group, the majority had shifted to the high category (75.7%). Although both groups showed improvement, the Wilcoxon Signed Rank Test indicated a markedly greater increase in the intervention group ($p = 0.001$) compared with the control group ($p = 0.020$). Furthermore, the Mann–Whitney post-test ($p = 0.011$) confirmed a significant difference between the two groups after the intervention, with the intervention group showing greater improvement following the virtual education program.

DISCUSSION

The results of this study indicate variations in the characteristics of respondents in the control and intervention groups, including age, gender, experience as a DOTS supervisor, socioeconomic status, and occupational and educational backgrounds. The majority of respondents were in the older adult category. This is consistent with research (Kemenkes RI, 2023), which reported that older DOTS supervisors have a higher level of responsibility in assisting patients, despite limitations in physical stamina.

These findings underscore the need to support older DOTS supervisors by offering accessible, practice-focused training resources. In terms of gender, the control group was predominantly female, while the intervention group was predominantly male. A consistent finding of this study was investigated in a study (Latif & Tiala, 2022), which showed that women tend to have higher levels of empathy and patience in their role as DOTS supervisors, while men excel in discipline. This suggests that intervention approaches can be tailored to gender preferences, for example, by strengthening emotional communication in men and enhancing managerial skills in women.

A length of experience as a DOTS supervisor is a highly important factor in the success of pulmonary tuberculosis treatment. While the intervention group consisted of a majority of new DOTS supervisors, this was different from the control group, which had an equal balance of old and new DOTS supervisors. (Butler et al., 2025) found that

good experience as a DOTS supervisor was more effective when approaching managing non-compliance of patients taking pulmonary TB medication. In fact, most new DOTS supervisors will demonstrate great enthusiasm and receptivity to the training opportunity.

These results underscore the importance of tailoring strengthening interventions to foundational skills for new DOTS supervisors and providing knowledge updates and mentoring strategies for experienced DOTS supervisors. From a socioeconomic perspective, the control group predominantly earned income below the minimum wage, while the intervention group mostly earned income above it. Other similar studies also found that poor economic conditions contributed to the lack of implementation of DOTS supervisors, in addition to the main obstacles related to time, transportation costs, and access to health information (Mariani et al., 2022). A DOTS supervisor with better economic conditions tends to be more flexible and able to support patients consistently; a DOTS supervisor with limited financial resources may face barriers to maintaining ongoing mentoring.

In terms of occupation and education, the control group was predominantly civil servants with tertiary education, while the intervention group was predominantly self-employed with primary education. These results are similar to those of (Rostaminasab et al., 2023), which emphasized that education level influences the ability of DOTS Supervisors or Directly Observed Treatment Supervisors to understand health materials, absorb information, and teach it back to patients. Therefore, interventions for DOTS supervisors with basic education should be simpler, using visual, audio, or hands-on methods to make the message easier to understand and apply.

This study adds novelty by demonstrating that differences in DOTS supervisor characteristics directly impact intervention effectiveness, rather than merely serving as descriptive data. Most previous studies only assessed intervention outcomes without deeply linking them to respondent backgrounds (Seniwati et al., 2023). This study demonstrates that factors such as age, gender, experience, socioeconomic status, occupation, and education must be considered in designing mentoring programs. With a more personalized approach based on respondent characteristics, interventions are expected to be more targeted, improve patient compliance, and have a long-term impact on the success of disease control programs.

The study results showed that the family's role as a DOTS supervisor improved after the virtual education-based Family Empowerment Centered Model (FECM) intervention. Most families remained in the lower category (64.9%), it moved to the higher category (35.1%) among those who didn't receive the virtual education program. This result identified that family empowerment is needed for children with pulmonary TB to be effective as DOTS supervisors. Before the program, most families were not active, only sometimes reminding patients to take their medicine. This may be because the control group only received standard education about pulmonary TB and the importance of following medication rules. Supporting research found that education with a one-way approach tends to lead to long-term changes in family behavior (Khakhong et al., 2023).

Conversely, the intervention group experienced a stronger improvement. Amount of 75.7% of families who had a high category Strengthening of DOTS supervisor, after the virtual education-based FECM intervention. Both groups further confirm that the virtual education-based FECM family empowerment model is more effective than routine education. This aligns with supporting research that found that without family

support, patients are at high risk of prematurely discontinuing treatment, which can lead to relapse, therapy failure, and even drug resistance (Nuriyanto & Rahayuwati, 2019). This situation indicated that a strengthened family role as DOTS supervisors during the treatment of children with pulmonary

Families not only serve as reminders but also as companions, motivators, and liaisons between patients and healthcare professionals (Rostaminasab et al., 2023). This change is crucial because the success of TB therapy depends heavily on patient adherence to long-term medication. Empowerment theory encompasses three main aspects: personal control, competence, and active participation (Mariani et al., 2022). Within this study, the application of FCEM facilitated family empowerment through three key mechanisms: (1) fostering a sense of control in managing the child's care (e.g., creating medication reminders), (2) enhancing competence via targeted education (e.g., recognizing medication side effects), and (3) promoting active engagement in daily medication supervision. Together, these mechanisms strengthened the family's capacity to consistently perform the family role of treatment supervisor (DOTS supervisors).

These findings emphasize that structured family empowerment is not only essential for improving treatment success in pediatric TB but also represents a sustainable approach to strengthening family engagement in long-term disease management. The results of this study are also supported by research by (R et al., 2020) which stated that family support is significantly related to adherence to taking TB medication in children. Similarly, research by (World Health Organization, 2024) emphasized the importance of family involvement in the Directly Observed Treatment Shortcourse (DOTS) strategy, because pediatric patients are highly dependent on the support of parents or caregivers. Thus, this study strengthens empirical evidence that a family-based approach is a key component in the success of pediatric TB treatment.

Based on the perspective of social support theory (Anderson et al., 2021). This study reinforces the central role of families in ensuring the successful treatment of chronic diseases. Families provide social support in the form of emotional encouragement during long-term therapy, informational reminders to take medication, and instrumental help such as preparing medication or accompanying patients to health facilities (Maemunah et al., 2021). Thus, strengthening the family's role through interventions is not only theoretically sound but also empirically proven effective (Dianti, 2023).

These findings also align with previous studies (Belarminus et al., 2023), (Sari et al., 2024) and (Section et al., n.d.), which demonstrated that family education plays a significant role in improving treatment adherence among TB patients. Previous studies reported that patients whose families are actively involved have a higher chance of treatment success than those who rely solely on personal motivation (Rosiyatul & Asri, 2024). However, this study adds value by providing a more systematic approach to strengthening the family's role. While previous studies provided brief educational sessions (Maemunah et al., 2021). This study investigated that a more structured and measurable intervention resulted in more significant results.

In addition to making an important contribution, this study also offers novelty. The FCEM virtual education program does more than provide brief information; it systematically reinforces the family's role in TB care (Komunitas et al., n.d.). Furthermore, this study compared control and intervention groups, allowing for a more objective assessment of the intervention's true effects. Another novelty lies in its

emphasis on the importance of families as a key factor in the success of TB therapy, often overlooked in health programs. The implications of these findings are far-reaching. Practically, the results of this study can serve as a basis for TB workers in primary healthcare facilities to strengthen family involvement in the patient support program.

Families are positioned not merely as passive observers but as empowered to become active partners with healthcare workers. From a programmatic perspective, this study emphasizes the importance of integrating family-based role-strengthening modules into the national TB control strategy (Lisum et al., 2023). If family-based interventions are widely implemented, it is expected that patient adherence will increase, treatment failure rates will decrease, and TB elimination targets will be achieved more quickly. Theoretically, the results of this study strengthen the theory of social support and provide empirical evidence that family interventions are more effective than approaches that focus solely on the patient.

Research also indicates that merely informative education is insufficient to change behavior; it must be accompanied by empowerment strategies that engage families emotionally, cognitively, and practically. FECM emphasizes the principle of partnership between health workers and families (Mariani et al., 2022). With this partnership, families are no longer positioned as passive objects but as active partners in ensuring children's therapy adherence. Therefore, it can be concluded that family empowerment-based interventions have proven effective in strengthening the family's role as a DOTS supervisor. As an innovative approach, this strategy has the potential to improve TB treatment outcomes and accelerate progress toward national TB elimination in Indonesia.

CONCLUSION

Strengthening the role of families as DOTS supervisors for children with pulmonary TB in the Air Duri Community Health Center, Jambi City, influenced by age, gender, education, income, and family type. The virtual education-based Family Centered Empowerment Model (FCEM) has a significant impact on strengthening the role of families as DOTS supervisors for children with pulmonary TB in the Air Duri Community Health Center, Jambi City. These findings underscore the urgent need to integrate technology into family empowerment interventions at the primary healthcare level, particularly in the management of chronic infectious diseases, including tuberculosis.

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