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Original Article

AN INTEGRATED NURSING EDUCATION MODEL FOR TUBERCULOSIS PREVENTION AND ENVIRONMENTAL SANITATION IMPROVEMENT THROUGH COMMUNITY-BASED TOTAL SANITATION (STBM)

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ABSTRACT

Background: Tuberculosis (TB) remains a major public health problem in Indonesia, where household environmental conditions, sanitation quality, and limited community awareness strongly influence transmission. Strengthening TB prevention requires integrated approaches that combine biomedical, behavioral, and environmental health strategies. The Community-Based Total Sanitation (STBM) program, alongside Contact Investigation (CI) and Tuberculosis Preventive Therapy (TPT), presents an opportunity for comprehensive community-level intervention.
Objectives: This study aimed to evaluate the effectiveness of an integrated nursing education model combining clinical TB education, CI, TPT counselling, and STBM-based sanitation triggering in improving knowledge, hygiene practices, and environmental sanitation among TB-affected households in Jombang Regency.
Methods: A quasi-experimental one-group pre–post design was conducted with 48 participants recruited purposively from households of active TB patients and at-risk community members. The intervention included structured TB education, symptom-based CI screening, TPT counselling, and participatory STBM triggering. Knowledge was assessed using a validated questionnaire, while hygiene behaviors and household sanitation conditions were evaluated through structured observations. Data were analysed using paired t-tests, McNemar tests, and effect size calculations.
Results: Knowledge scores increased significantly from a mean of 54.76 to 74.67 ($p < 0.001$) with a very large effect size (Cohen's $d = 2.07$). Hygiene practices, particularly handwashing with soap at critical times, showed significant improvement ($p < 0.001$). Environmental sanitation indicators, including improved latrine ownership and enhanced household ventilation, also demonstrated positive changes after the intervention.
Conclusion: The integrated nursing education model effectively improved knowledge, hygiene behavior, and environmental sanitation among participants, demonstrating strong potential as a community-based TB prevention strategy. Although limited by the absence of a control group and a short follow-up period, the model is suitable for adoption in primary healthcare programs to strengthen holistic TB control efforts.

Keywords: Tuberculosis, Nursing Education Model, Community-Based Total Sanitation (STBM), Environmental Sanitation, Behavior Change.

INTRODUCTION

Tuberculosis (TB) remains one of the most significant public health challenges globally and in Indonesia, which continues to rank among the eight countries with the highest TB burden worldwide (World Health Organization, 2023). Transmission of TB is strongly influenced not only by clinical and microbiological factors but also by environmental and behavioral determinants such as inadequate ventilation, household overcrowding, poor sanitation, and suboptimal hygiene practices (Taylor et al., 2016; Freeman et al., 2017). Although national TB control strategies have improved treatment success rates, challenges regarding early case detection and interruption of household transmission persist, indicating the need for more comprehensive community-level interventions (Kementerian Kesehatan Republik Indonesia, 2024). Recent global evidence highlights that effective TB prevention requires integrating biomedical, psychosocial, and environmental health approaches to reduce exposure risk and strengthen community resilience (MacPherson et al., 2024; Seid et al., 2022).

Contact Investigation (CI) and Tuberculosis Preventive Therapy (TPT) are critical secondary prevention strategies recommended by the World Health Organization to reduce the progression of latent TB infection, particularly among household contacts and individuals with comorbidities such as HIV (World Health Organization, 2024; Abelti et al., 2025). However, implementation barriers persist due to limited community understanding and low risk perception. At the same time, Indonesia's Community-Based Total Sanitation (STBM) program emphasizes behavioral change across five pillars of sanitation, which, although primarily associated with fecal–oral disease prevention, also contribute to improved environmental hygiene and reduced vulnerability to airborne diseases through enhanced household cleanliness and air quality (Kementerian Kesehatan Republik Indonesia, 2020; WHO & UNICEF, 2023).

Despite the availability of these complementary approaches, few studies in Indonesia have integrated clinical TB education, CI, TPT counseling, and STBM-based environmental sanitation into a single comprehensive model. Most existing interventions address these components separately, limiting their potential impact on household-level transmission pathways. Therefore, this study addresses a critical gap by developing and implementing an integrated nursing education model designed to strengthen TB-related knowledge, promote preventive behaviors, and improve environmental sanitation among households of TB patients in Jombang Regency.

METHODS

Study Design

This study employed a quasi-experimental one-group pre–post design to evaluate the effectiveness of an integrated nursing education model combining tuberculosis (TB) clinical education, Contact Investigation (CI), Tuberculosis Preventive Therapy (TPT) counseling, and Community-Based Total Sanitation (STBM) triggering. The design was selected because it allowed for direct measurement of changes in participants' knowledge, hygiene practices, and

environmental sanitation conditions before and after the intervention in a real-world community setting. Although the absence of a comparison or control group limits causal inference, this design is commonly applied in community-based health promotion research where randomization is not feasible and ethical considerations prioritize inclusive participation. The pre–post assessment approach enabled identification of the intervention's immediate effects, supporting evaluation of its potential applicability within broader public health and primary care contexts.

Settings

This study was conducted in the working areas of several primary healthcare centers (Puskesmas) in Jombang Regency, East Java, an area with a moderate tuberculosis burden and a community context characterized by diverse household sanitation conditions. The intervention took place across village-level communities where active TB cases had been identified, enabling engagement with both TB-affected households and community members at risk of exposure. The setting was chosen due to its epidemiological relevance, existing challenges in case detection, and the need for strengthened preventive measures integrating both clinical and environmental health approaches. Activities were conducted over three months and utilized community halls, Puskesmas meeting rooms, and participants' households as locations for educational sessions, sanitation assessments, and participatory triggering events.

Research Subject

Research subjects consisted of households of active TB patients, their household contacts, community health volunteers (kader kesehatan), and local community leaders who play a role in public health mobilization. Participants were recruited using purposive sampling based on inclusion criteria that required them to either live with or frequently interact with an active TB patient, have no prior structured education on tuberculosis preventive therapy (TPT) or STBM, and be willing to participate fully in all intervention components. A total of 48 participants were enrolled, representing a combination of TB-affected family members and community actors capable of influencing sanitation and hygiene behavior. This population was selected to ensure that the intervention directly targeted individuals at the highest risk of TB transmission, as well as those who could support broader community change.

Instruments

Data were collected using a set of validated instruments tailored to assess knowledge, hygiene practice, and environmental sanitation. Knowledge was measured using a 20-item questionnaire covering TB transmission, prevention, contact investigation, TPT, and sanitation principles, with construct validity indicated by item–total correlations greater than 0.30 and reliability demonstrated through a Cronbach's alpha coefficient of 0.87. Hygiene behavior was assessed using a structured handwashing observation checklist focusing on five critical times. Environmental sanitation was evaluated with a household sanitation checklist aligned with the five pillars of the STBM program, capturing variables such as latrine conditions, waste management, water handling, and household ventilation. Additional instruments included a symptom-based screening form for contact investigation and a monitoring sheet for early TPT adherence.

Data Collection

Data were collected at two time points using pre-test and post-test procedures. Baseline data were gathered before the intervention through administration of the knowledge questionnaire, direct observation of household sanitation, and assessment of hygiene practices. Following the three-month intervention, the same instruments were reapplied to measure changes in knowledge, behavior, and sanitation conditions. Contact investigation data were collected during home visits using the symptom screening form, while TPT adherence was monitored periodically using structured logs. Field researchers and trained nurses conducted all data collection activities to ensure consistency, accuracy, and adherence to protocol standards.

Data Analysis

Quantitative data were analyzed using descriptive and inferential statistics. Changes in knowledge scores between pre-test and post-test assessments were examined using paired sample t-tests, allowing determination of statistical significance in mean score differences. Behavioral changes in handwashing practices were analyzed using the McNemar test, which is appropriate for assessing shifts in paired categorical variables. Effect size was calculated using Cohen's d to evaluate the practical magnitude of the intervention's impact. Sanitation data were summarized descriptively to illustrate changes across STBM indicators. All analyses were conducted with a significance level of $\alpha = 0.05$.

Ethical Considerations

This study received ethical approval from the Ethics Committee of STIKes Husada Jombang. Ethical considerations were applied throughout all stages of the research. Participants were provided with clear information regarding the study's purpose, procedures, potential risks, and benefits before giving written informed consent. Confidentiality was maintained by anonymizing participant data and securely storing all records. Participation was entirely voluntary, and individuals were informed of their right to withdraw at any time without negative consequences. Home visits for contact investigation and sanitation assessment were conducted respectfully, ensuring privacy and adherence to health protocols.

RESULTS

The results of this study demonstrate substantial improvements in participants' knowledge, hygiene practices, and household environmental sanitation following the implementation of the integrated nursing education model. Analysis of knowledge scores revealed a marked increase from a pre-test mean of 54.76 ± 7.38 to a post-test mean of 74.67 ± 6.50, indicating a significant improvement in participants' understanding of tuberculosis transmission, contact investigation, preventive therapy, and sanitation principles. The paired sample t-test confirmed that this increase was statistically significant ($t = 14.33$, $p < 0.001$), while the calculated effect size (Cohen's $d = 2.07$) indicated a very large practical impact. This finding suggests that the intervention was highly effective in enhancing participants' health literacy and comprehension of preventive strategies.

In addition to cognitive improvements, significant behavioral changes were observed in hygiene practices, particularly in handwashing with soap during critical times. Before the intervention, a substantial proportion of participants did not consistently perform appropriate handwashing behaviors; however, post-intervention assessment showed that 21 individuals

who had not practiced proper handwashing began doing so. The McNemar test confirmed that this shift was statistically significant ($\chi^2 = 19.05$, $p < 0.001$), and no participants demonstrated a decline in behavior, indicating a complete absence of negative regression. These results highlight the effectiveness of the participatory STBM triggering approach in promoting sustained hygiene behavior adoption.

Environmental sanitation indicators also showed notable improvement. Households reported better ventilation, improved waste management practices, and increased adherence to sanitation standards aligned with the STBM pillars. Most prominently, there was an 18% increase in improved latrine ownership among participating households, reflecting concrete environmental modifications stimulated by the intervention. Enhanced ventilation was observed in 21% of households, demonstrating participants' responsiveness to clinical education regarding the importance of airflow in reducing the concentration of infectious droplets. These environmental changes support the premise that combining clinical and environmental interventions strengthens community-level resilience against TB transmission.

Taken together, the results confirm that the integrated nursing education model produced significant improvements across knowledge, behavior, and environmental conditions. The strong effect sizes and statistically robust findings indicate that the intervention successfully addressed both individual and household determinants of TB risk. The collective outcomes suggest high potential for scalability and integration into primary healthcare and TB control programs within similar community settings.

DISCUSSION

The results of this study demonstrate that the integrated nursing education model, which combines tuberculosis clinical education, Contact Investigation (CI), Tuberculosis Preventive Therapy (TPT) counseling, and Community-Based Total Sanitation (STBM) triggering, was highly effective in improving participants' knowledge, behavior, and household environmental sanitation. The significant increase in knowledge scores with a very large effect size indicates that the intervention succeeded in strengthening health literacy, which is consistent with global findings that community-based education improves TB awareness and enhances understanding of prevention strategies (World Health Organization, 2023, 2024). The participatory approach used in this study likely facilitated deeper internalization of information, as participants were able to relate educational content to actual conditions in their households, a mechanism emphasized in behavior-change models (Freeman et al., 2017).

Behavior change outcomes, particularly in handwashing with soap at critical times, further support the effectiveness of integrating STBM principles into TB education. The significant shift captured through the McNemar test aligns with evidence that participatory triggering approaches—rather than didactic instruction alone—are more successful in motivating immediate improvements in hygiene practices (WHO & UNICEF, 2023). The absence of negative regression in handwashing behavior post-intervention suggests that combining knowledge enhancement, skill demonstration, and environmental reinforcement creates stronger and more sustainable hygiene adoption. Similar results have been reported in sanitation promotion studies in sub-Saharan Africa and Southeast Asia, which found that integrated hygiene–sanitation interventions yield substantial behavioral improvements (MacPherson et al., 2024; Seid et al., 2022).

Environmental sanitation improvements observed in this study, such as increased latrine ownership and enhanced household ventilation, are important because they demonstrate the ability of holistic interventions to produce structural changes in household environments. Although TB is primarily airborne, literature shows that improved environmental conditions—including ventilation, waste management, and household hygiene—contribute to overall health resilience and reduce risk factors associated with TB transmission (Taylor et al., 2016). The 18% increase in improved latrine ownership and the 21% improvement in ventilation support global sanitation evidence that environmental modifications help reduce infectious disease exposure and enhance community protection (Freeman et al., 2017). The findings also affirm that integrating environmental interventions with TB-specific education produces synergistic effects that may not be achieved through biomedical measures alone.

The intervention also showed a positive influence on TPT acceptance and understanding. This is highly relevant, given that TPT uptake worldwide remains hindered by low awareness and misconceptions about latent TB (Bhargava, 2024; Alvarez et al., 2022). The improvement in participants' readiness to engage in TPT reflects the importance of targeted, culturally contextualized counseling, which previous studies have identified as a key facilitator of TPT adherence (Sun et al., 2018; Swindells et al., 2019). These outcomes are particularly important in areas like Jombang Regency, where HIV comorbidity remains present, and individuals with compromised immunity face a significantly increased risk of progression to active TB (Seid et al., 2022).

Despite these strengths, this study has limitations. The quasi-experimental one-group design does not allow causal attribution with the same rigor as randomized controlled trials, as external variables may also have influenced the observed changes (Bisallah et al., 2018). Additionally, the short follow-up period restricts conclusions about the sustainability of behavioral and environmental improvements. Previous sanitation behavior studies indicate that long-term reinforcement is often necessary to maintain hygiene behavior adoption (Freeman et al., 2017). The modest sample size and purposive sampling may also limit generalizability, although the findings remain valuable for community settings with similar epidemiological and socio-environmental characteristics.

Overall, this study provides strong evidence that combining biomedical, behavioral, and environmental components into a single community-based nursing education model is an effective strategy for strengthening TB prevention. The integration of CI, TPT counseling, and STBM triggering aligns with global recommendations for holistic TB control (World Health Organization, 2023, 2024) and demonstrates potential for scalability within primary healthcare systems. The substantial improvements observed suggest that this approach is highly relevant for TB-endemic regions and may serve as a model for future community-level disease prevention initiatives.

CONCLUSION

The findings of this study demonstrate that the integrated nursing education model—combining tuberculosis clinical education, Contact Investigation, Tuberculosis Preventive Therapy counseling, and Community-Based Total Sanitation triggering—was effective in improving participants' knowledge, hygiene behaviors, and household environmental sanitation. The significant increase in knowledge scores, supported by a very large effect size,

indicates that the intervention strengthened participants' health literacy and understanding of TB prevention. Behavioral improvements, particularly in handwashing with soap at critical times, further highlight the effectiveness of linking clinical education with participatory sanitation approaches. Additionally, the observed enhancements in ventilation and improved latrine ownership illustrate that environmental modifications can be achieved through community-driven interventions, supporting the broader effort to reduce household TB transmission risks.

SUGGESTION

Although the study's one-group design limits causal inference and the short follow-up period restricts conclusions about long-term sustainability, the overall results suggest that integrating biomedical, behavioral, and environmental components into a single community-based model offers a promising strategy for strengthening TB prevention in similar high-burden settings. Future research involving controlled designs and longer follow-up is needed to confirm the durability and scalability of this model.

LIMITATIONS

This study has several limitations that should be considered when interpreting the findings. First, the quasi-experimental design using a one-group pre–post approach without a control group limits the ability to establish causal relationships between the intervention and the observed outcomes. External factors such as community health campaigns or informal information sharing may also have influenced participants' knowledge and behavior during the study period.

Second, the sample size was relatively small, and participants were recruited through purposive sampling, which may limit the generalizability of the results to other populations or settings with different socio-demographic characteristics.

Third, the follow-up period of three months may not be sufficient to assess the long-term sustainability of behavioral and environmental changes. Previous research suggests that maintaining hygiene practices and sanitation improvements often requires continuous reinforcement and community engagement over longer periods.

Finally, several behavioral outcomes, particularly hygiene practices, were partly assessed through observation and self-reported practices, which may introduce reporting bias or the Hawthorne effect, where participants modify their behavior because they are aware that they are being observed.

Future studies employing randomized controlled designs, larger and more diverse samples, and longer follow-up periods are recommended to further validate the effectiveness and sustainability of the integrated nursing education model.

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