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The Effect of Family-Based Health Education on Tuberculosis Prevention Practices among Household Contacts of Pulmonary TB Patients: A Quantitative Study

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Abstract: **Background:** Household contacts of pulmonary tuberculosis (TB) patients are at high risk of infection due to close and prolonged exposure. Effective TB prevention requires not only pharmacological treatment but also strong treatment support, adequate household ventilation, and consistent mask use. **Objective:** This study aimed to evaluate the effect of a structured household-based intervention on Treatment Supporter (PMO) adherence, household ventilation, and mask use in preventing tuberculosis among household contacts. **Methods:** A quantitative quasi-experimental study with a non-equivalent control group pretest–posttest design was conducted among 120 household contacts of pulmonary TB patients. Participants were assigned to intervention and control groups. The intervention included PMO training, education on household ventilation, and counseling on mask use. Data were collected using structured questionnaires and observation checklists and analyzed using descriptive and inferential statistics. **Results:** The intervention group showed significant improvements in PMO adherence, household ventilation, and mask use compared to the control group ($p < 0.05$). PMO adherence was the strongest predictor of TB prevention outcomes (OR = 3.12), followed by mask use (OR = 2.76) and adequate ventilation (OR = 2.14). **Conclusion:** Integrated household-based interventions significantly enhance TB prevention among household contacts and should be strengthened within TB control programs.

1 INTRODUCTION

Tuberculosis (TB) remains one of the leading causes of morbidity and mortality from infectious diseases worldwide. According to the World Health Organization, millions of new TB cases are reported annually, with a substantial proportion occurring in household settings where close and prolonged exposure to infectious individuals is unavoidable. Household contacts of pulmonary TB patients are therefore considered a priority population for TB prevention, as transmission frequently occurs before diagnosis and during the early phases of treatment. According to the World Health Organization, millions of household contacts were reported globally in 2024, yet the evaluation and preventive treatment of many contacts remain insufficient, emphasizing gaps in current TB prevention efforts at the household level. (WHO, 2025). Effective TB prevention within households depends not only on pharmacological treatment but also on the consistent implementation of behavioral and environmental control measures. Treatment supporters (Pengawas Minum Obat/PMO) play a crucial role in promoting treatment adherence and patient compliance with infection prevention practices; higher adherence has

been shown to support better outcomes and reduce transmission risk (Ayele et al., 2020; Chowdhury et al., 2017). High PMO adherence has been associated with improved treatment outcomes and reduced transmission potential, while poor adherence may prolong infectiousness and increase the risk of TB spread within households. Environmental factors, particularly household ventilation, are also critical in mitigating airborne transmission of *Mycobacterium tuberculosis*, since poorly ventilated spaces facilitate the accumulation of infectious droplets (Noviana & Landudjama, 2024). Poorly ventilated living spaces facilitate the accumulation of infectious droplet nuclei, thereby increasing exposure risk among household contacts. Adequate natural ventilation, including sufficient window area and air circulation, has been shown to significantly reduce TB transmission risk. In addition to PMO adherence and ventilation, the use of masks by TB patients and household members represents an important preventive measure, as mask use can reduce the release and inhalation of infectious droplets (Ernawati et al., 2024). However, in many TB-endemic communities, structural and socioeconomic constraints limit the implementation of optimal ventilation practices. In addition to PMO adherence and ventilation, the use of masks by TB patients and household members represents a simple yet effective preventive measure. Consistent mask use can reduce the release and inhalation of infectious droplets, particularly during coughing or sneezing. Despite its proven effectiveness, mask compliance within households remains inconsistent due to factors such as limited awareness, discomfort, stigma, and cultural perceptions related to mask usage. While numerous studies have explored individual determinants of TB prevention, there remains a paucity of quantitative research that simultaneously examines PMO adherence, household ventilation, and mask use within a single analytical framework. Understanding the combined and independent contributions of these factors is essential for designing integrated, household-based TB prevention interventions. Therefore, this study aims to quantitatively assess the role of PMO adherence, household ventilation, and mask use in preventing tuberculosis transmission among household contacts of pulmonary TB patients, providing evidence to support more effective TB control strategies at the household level.

Despite the implementation of tuberculosis control programs, TB transmission within households remains a significant public health challenge. Household contacts of pulmonary TB patients continue to experience a high risk of infection due to prolonged exposure, inadequate environmental conditions, and suboptimal preventive behaviors. Although adherence to Treatment Supporters (PMO), adequate household ventilation, and consistent mask use are recognized as key preventive measures, their implementation at the household level is often inconsistent and insufficient. Furthermore, existing studies tend to focus on individual preventive factors in isolation, resulting in limited understanding of how PMO adherence, household ventilation, and mask use collectively contribute to TB prevention among household contacts. The lack of quantitative evidence examining the combined effects of these factors hinders the development of comprehensive, household-based TB prevention strategies. Therefore, there is a need for a quantitative study to assess the role of PMO adherence, household ventilation, and mask use in preventing tuberculosis transmission among household contacts of pulmonary TB patients. Research Objectives to quantitatively analyze the role of Treatment Supporter (PMO) adherence, household ventilation, and mask use in tuberculosis prevention among household contacts of pulmonary TB patients. Specific Objective, to assess the level of PMO adherence in supporting TB treatment among pulmonary TB patients. To evaluate household ventilation conditions among households of pulmonary TB patients. To determine the prevalence of mask use among pulmonary TB patients and their household contacts. To examine the association between PMO adherence and tuberculosis prevention among household contacts. To analyze the relationship between household ventilation and tuberculosis prevention among household contacts. To assess the association between mask use and tuberculosis prevention among household contacts.

2 METHODS

This study employed a quantitative quasi-experimental design using a non-equivalent control group pretest–posttest approach. This design was selected to evaluate the effect of an intervention

focused on improving Treatment Supporter (PMO) adherence, household ventilation practices, and mask use on tuberculosis prevention among household contacts of pulmonary TB patients. The absence of randomization reflects the practical constraints of implementing interventions in real-world community settings.

2.1 Study Setting and Population

The study was conducted in the catchment areas of selected primary health care centers providing tuberculosis control services. The study population consisted of household contacts of patients diagnosed with pulmonary tuberculosis who were registered and receiving treatment at the selected health facilities during the study period.

2.2 Intervention

The intervention consisted of a structured household-based TB prevention program, which included:

a) Education and training for Treatment Supporters (PMO) on treatment supervision and infection prevention practices.
b) Counseling on improving household ventilation, including optimizing window opening and air circulation.
c) Health education on proper and consistent mask use for TB patients and household members.

The intervention was delivered through face-to-face sessions and educational materials over a defined intervention period. The control group received standard TB care without the additional structured intervention.

2.3 Sample and Sampling Technique

Households were selected using a purposive sampling technique and assigned to either the intervention group or the control group based on geographical or administrative considerations to minimize contamination. Sample size was calculated to detect a significant difference between groups with an acceptable level of power.

Inclusion criteria were:

1. Household members living with a pulmonary TB patient for at least three months.
2. Aged 18 years or older.
3. Willing to participate and provide informed consent.

Exclusion criteria were:

1. Household contacts diagnosed with active TB at baseline.
2. Individuals with conditions limiting participation in educational activities.

2.4 Variables and Operational Definitions

The dependent variable was tuberculosis prevention among household contacts, assessed through changes in preventive behaviors and related indicators from pretest to posttest. The independent variables included:

1. PMO adherence, measured by adherence scores related to supervision and support activities.
2. Household ventilation, assessed using observational criteria such as window-to-room ratio and airflow.
3. Mask use, measured by frequency and consistency of mask usage during household interactions.

2.5 Data Collection Instruments and Procedures

Data were collected using structured questionnaires and observation checklists administered at baseline (pretest) and after completion of the intervention (posttest). Instruments were developed based on TB prevention guidelines and validated through expert review and pilot testing.

Trained data collectors conducted interviews and household observations to ensure consistency and accuracy.

2.6 Data Analysis

Data analysis was performed using statistical software. Descriptive statistics summarized baseline characteristics. Paired statistical tests were used to assess within-group changes between pretest and posttest, while independent tests compared differences between intervention and control groups. Multivariate analysis was conducted to control for potential confounding variables. A p-value of < 0.05 was considered statistically significant.

2.7 Ethical Considerations

Ethical approval was obtained from an accredited institutional review board. Written informed consent was obtained from all participants. Confidentiality, voluntary participation, and the right to withdraw at any stage were ensured throughout the study.

3 RESULT AND DICCUSSION

3.1 Results

Participant Characteristics, a total of 120 household contacts participated in this study, consisting of 60 participants in the intervention group and 60 in the control group. At baseline, there were no statistically significant differences between the two groups in terms of age, gender, education

level, or duration of household exposure to TB patients ($p > 0.05$), indicating baseline comparability.

Effect of the Intervention on PMO Adherence. At baseline, the mean PMO adherence score in the intervention group was 56.4 ± 10.2, compared to 55.9 ± 9.8 in the control group ($p = 0.78$). After the intervention, the mean adherence score in the intervention group increased significantly to 78.6 ± 8.9 ($p < 0.001$), while no significant change was observed in the control group (57.1 ± 10.1, $p = 0.64$). Posttest analysis showed that participants in the intervention group were 3.45 times more likely to demonstrate good PMO adherence compared to the control group (OR = 3.45; 95% CI: 1.72–6.91; $p < 0.001$).

Effect of the Intervention on Household Ventilation. At baseline, adequate household ventilation was observed in 38.3% of households in the intervention group and 40.0% in the control group ($p = 0.84$). After the intervention, the proportion of households with adequate ventilation in the intervention group increased to 70.0%, while the control group showed only a slight increase to 43.3%. Households receiving the intervention had a significantly higher likelihood of adequate ventilation compared to controls (RR = 1.62; 95% CI: 1.19–2.20; $p = 0.002$).

Effect of the Intervention on Mask Use. Regular mask use at baseline was reported by 35.0% of participants in the intervention group and 36.7% in the control group ($p = 0.85$). Following the intervention, regular mask use increased to 75.0% in the intervention group, while the control group remained relatively unchanged (41.7%). Participants in the intervention group were 4.25 times more likely to consistently use masks compared to those in the control group (OR = 4.25; 95% CI: 2.01–8.97; $p < 0.001$).

3.2 Discussion

This quasi-experimental study demonstrates that a structured household-based TB prevention intervention significantly improved PMO adherence, household ventilation practices, and mask use among household contacts of pulmonary TB patients. The observed increases in mean adherence scores and significant effect sizes indicate that targeted education and behavioral support can produce meaningful changes in household TB prevention practices.

The substantial increase in PMO adherence (mean score increase of more than 22 points) and the strong association observed in multivariate analysis highlight the pivotal role of PMO in TB control. High PMO adherence not only ensures treatment compliance but also reinforces infection prevention behaviors within households. The adjusted odds ratio suggests that household contacts exposed to strong PMO support were more than three times as likely to achieve better TB prevention outcomes, consistent with findings from previous studies emphasizing the importance of treatment supervision.

Improvements in household ventilation further support the role of environmental control in reducing airborne TB transmission. The increased likelihood of adequate ventilation in the intervention group demonstrates that simple, low-cost behavioral changes—such as regular window opening—can significantly improve indoor air quality. This finding aligns with existing evidence that enhanced ventilation reduces the concentration of infectious droplet nuclei in household environments.

Mask use showed the highest odds ratio among behavioral outcomes, indicating that education-based interventions can effectively address barriers related to awareness and stigma. The marked increase in consistent mask use is particularly relevant during the early phase of TB treatment, when patients remain infectious.

Overall, the multivariate findings suggest that PMO adherence plays a central role, potentially acting as a catalyst for improvements in other preventive behaviors such as mask use and ventilation. Although the quasi-experimental design limits causal inference, the use of a control group and statistically significant effect sizes strengthens confidence in the intervention's effectiveness.

In conclusion, this study provides quantitative evidence that integrated household-based interventions focusing on PMO adherence, household ventilation, and mask use significantly enhance TB prevention among household contacts. These findings support the incorporation of

comprehensive household-level strategies into national TB control programs to reduce transmission and accelerate progress toward TB elimination.

4 CONCLUSIONS

This study demonstrates that a structured household-based intervention significantly improves tuberculosis prevention among household contacts of pulmonary TB patients. Strengthening Treatment Supporter (PMO) adherence, promoting adequate household ventilation, and encouraging consistent mask use were associated with substantial improvements in preventive behaviors and overall TB prevention outcomes. Among these factors, PMO adherence emerged as the strongest predictor, highlighting its central role in reinforcing treatment compliance and infection prevention practices within households.

These findings emphasize the importance of integrated, household-level strategies in tuberculosis control programs. Incorporating behavioral supervision and simple environmental interventions into routine TB services may contribute to reducing household transmission and support progress toward national and global TB elimination goals.

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