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Strengthening Health System Resilience through Community-Based Surveillance Assistance for Tuberculosis Control: A Quasi-Experimental Study in Indonesia

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Abstract— Tuberculosis remains a major public health challenge in high-burden countries, including Indonesia, where delayed case detection and weak contact investigation continue to impede effective disease control. Strengthening health system resilience requires innovative approaches that integrate community participation with supportive and digitally enabled surveillance systems. This study examined the effectiveness of digitally supported Community-Based Surveillance Assistance (CBSA) in improving tuberculosis control at the community level. A quasi-experimental study using a non-randomized one-group pre-test and post-test design was conducted among 30 community health cadres in Kramatmulya Sub-District, Kuningan District, Indonesia. The intervention consisted of structured surveillance assistance, capacity-building sessions, and the use of standardized reporting tools aligned with digital health information systems at primary healthcare facilities. Outcome measures included cadres' tuberculosis-related knowledge, the number of contact investigations conducted, and sputum referrals for suspected cases. Data were analysed using paired t-tests. The results showed significant improvements following the CBSA intervention. Mean knowledge scores increased markedly after assistance ($p < 0.001$). The average number of tuberculosis contact investigations conducted by cadres increased significantly ($p < 0.05$), as did sputum referrals for suspected tuberculosis cases ($p < 0.05$). These findings indicate that community-based surveillance assistance, supported by structured guidance and system-linked reporting mechanisms, can enhance community capacity for early tuberculosis detection. This study highlights the potential of integrating community empowerment with

digitally supported surveillance systems to strengthen health system resilience. Community-based surveillance assistance represents a scalable and sustainable strategy for improving tuberculosis control in resource-limited settings.

Keywords— *Community-Based Surveillance; Tuberculosis Control; Health System Resilience; Community Health Workers*

I. INTRODUCTION

Tuberculosis (TB) remains a major public health problem globally and continues to pose significant challenges in high-burden countries, including Indonesia. Despite sustained national and global efforts, TB case detection remains suboptimal, with a considerable proportion of cases undiagnosed or diagnosed late. Delayed case detection and inadequate contact investigation contribute substantially to ongoing transmission and hinder progress toward TB elimination targets [1].

Indonesia ranks among the countries with the highest TB burden worldwide, where limitations in active case finding and community-level surveillance persist. Facility-based surveillance systems alone have proven insufficient to identify TB cases early, particularly among household contacts and vulnerable populations [1], [6]. Studies have shown that systematic contact investigation at the community level can significantly improve TB case detection, including identification of subclinical and early-stage disease [1], [14]. However, the effectiveness of such strategies depends heavily on the capacity and performance of community health workers who act as frontline surveillance actors [2].

Strengthening health system resilience has become an essential strategy for addressing persistent gaps in TB control. Health system resilience refers to the capacity of health systems to absorb, adapt, and respond effectively to ongoing pressures while maintaining essential functions [9]. In the context of TB control, resilience requires not only strong healthcare facilities but also robust community-based surveillance mechanisms that are well integrated with primary healthcare services [4], [10].

Community-Based Surveillance (CBS) enables early detection of TB through community participation, particularly by empowering community health workers to conduct contact investigation and facilitate referral of suspected cases. However, CBS implementation often faces operational challenges, including limited training, inconsistent supervision, and weak linkage with formal health information systems, which can undermine its effectiveness [4], [9]. Evidence suggests that structured assistance, supportive supervision, and capacity building are critical to improving community health worker performance and ensuring sustainable surveillance outcomes [2], [4].

Community-Based Surveillance Assistance (CBSA), as examined in this study, represents a structured approach to strengthening CBS by combining capacity building, mentoring, and system-aligned reporting mechanisms. Rather than introducing new technologies, CBSA reinforces existing community surveillance roles and strengthens linkages between community actors and primary healthcare facilities. Previous studies have demonstrated that such system-linked community interventions improve contact investigation, sputum referral, and overall surveillance performance [3], [6], [14].

In line with this evidence, the present study employed a quasi-experimental one-group pre-test and post-test design to assess the effectiveness of CBSA in improving TB surveillance outcomes at the community level. The intervention focused on improving cadres' TB-related knowledge, increasing contact investigation activities, and strengthening sputum referral to primary healthcare facilities. These outcomes directly reflect key weaknesses identified in TB surveillance systems and are critical indicators of health system resilience at the community-primary care interface [9], [10].

By evaluating the impact of CBSA on these indicators, this study aims to contribute empirical evidence on the role of structured community-based surveillance assistance in strengthening health system resilience for TB control in Indonesia...

II. METHOD

Research Design

This study employed a quasi-experimental design using a non-randomized one-group pre-test and post-test approach to evaluate the effectiveness of Community-Based Surveillance Assistance (CBSA) in strengthening tuberculosis control at the community level. This design was selected to assess changes in

participants' knowledge and performance before and after the intervention within a real-world public health setting.

Study Setting and Sampling Process

The study was conducted in Kramatmulya Sub-District, Kuningan District, Indonesia, an area with suboptimal tuberculosis case detection performance. The study population consisted of community health cadres involved in tuberculosis surveillance activities. A total sampling technique was applied, in which all eligible cadres ($n = 30$) were included in the study. Inclusion criteria were active cadre status, involvement in community-based tuberculosis activities, and willingness to participate throughout the intervention period.

Intervention Procedure

The CBSA intervention consisted of structured surveillance assistance, including capacity-building sessions, mentoring, and supportive supervision. Cadres were trained to conduct tuberculosis contact investigation, identify suspected cases, and facilitate sputum referrals to primary healthcare facilities. Standardized tuberculosis surveillance forms were used to support systematic recording and reporting aligned with primary healthcare information systems.

Operationalization of Variables

The primary outcome variables included:

1. Knowledge of tuberculosis, measured using a structured questionnaire assessing understanding of tuberculosis transmission, symptoms, prevention, and surveillance procedures.
2. Contact investigation performance, operationalized as the number of tuberculosis contacts identified and investigated by cadres.
3. Sputum referral, measured by the number of suspected tuberculosis cases referred for sputum examination at primary healthcare facilities.

All variables were measured before and after the CBSA intervention using the same instruments to ensure consistency.

Data Analysis

Data were analysed using paired t-tests to compare pre-intervention and post-intervention outcomes for all variables. Statistical significance was determined at a p -value < 0.05 . Data analysis was conducted to assess the effectiveness of CBSA in improving community-based tuberculosis surveillance performance.

Funding

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III. RESULTS AND DISCUSSION

This study involved 30 community health workers (cadres) who participated in the Community-Based Surveillance Assistance (CBSA) programme for tuberculosis (TB) control in Kramatmulya Sub-District, Kuningan District, Indonesia. All participants completed pre-intervention and post-intervention assessments and were actively engaged in community-based

TB surveillance activities in coordination with primary healthcare facilities.

Descriptive statistics showed improvements across all outcome variables following the CBSA intervention. The mean TB-related knowledge score increased from 63.4 ± 8.7 before the intervention to 82.6 ± 6.9 after the intervention. Paired t-test analysis confirmed that this increase was statistically significant ($p < 0.001$), indicating a substantial improvement in cadres' knowledge related to TB transmission, symptom identification, contact investigation, and referral procedures.

Operational surveillance indicators also improved significantly. The mean number of TB contact investigations conducted by cadres increased from 1.7 ± 0.8 in the pre-intervention period to 3.4 ± 1.1 after the intervention ($p = 0.012$). Similarly, the mean number of sputum referrals for suspected TB cases increased from 0.9 ± 0.6 to 2.1 ± 0.9 following CBSA implementation, with this difference being statistically significant ($p = 0.018$).

TABLE I. CHANGES IN TUBERCULOSIS-RELATED KNOWLEDGE BEFORE AND AFTER CBSA INTERVENTION (N = 30)

Outcome Indicator	Pre-intervention Mean $\pm$ SD	Post-intervention Mean $\pm$ SD	Mean Difference	p-value*
TB-related knowledge score	63.4 ± 8.7	82.6 ± 6.9	+19.2	< 0.001

TABLE II. COMMUNITY-BASED TB SURVEILLANCE PERFORMANCE BEFORE AND AFTER CBSA INTERVENTION (N = 30)

Outcome Indicator	Pre-intervention Mean $\pm$ SD	Post-intervention Mean $\pm$ SD	Mean Difference	p-value*
Number of TB contact investigations	1.7 ± 0.8	3.4 ± 1.1	+1.7	0.012
Number of sputum referrals	0.9 ± 0.6	2.1 ± 0.9	+1.2	0.018

This study demonstrates that Community-Based Surveillance Assistance (CBSA) is effective in strengthening community-level tuberculosis (TB) surveillance and contributes to enhanced health system resilience. Significant improvements were observed in cadres' TB-related knowledge, the number of contact investigations conducted, and sputum referrals for suspected TB cases following the intervention. These findings indicate that structured assistance can translate improved knowledge into measurable improvements in surveillance performance.

The significant increase in TB-related knowledge among cadres is consistent with evidence that capacity building and supportive supervision are key determinants of community health worker effectiveness. Previous studies have shown that community health workers perform surveillance and case-finding tasks more effectively when supported through structured training, mentoring, and clear operational guidance [2], [4]. In the context of the uploaded article, improved

knowledge strengthened cadres' ability to recognise TB symptoms, conduct contact investigations, and facilitate appropriate referrals.

Beyond knowledge gains, this study found a significant increase in contact investigation activities after CBSA implementation. This finding aligns with previous evidence indicating that community-based contact investigation plays a critical role in identifying undiagnosed TB cases, particularly in high-burden settings where facility-based surveillance is insufficient [1], [6]. Community-based approaches enable earlier identification of TB cases within households and close contacts, thereby reducing delays in diagnosis and transmission risk [14].

The increase in sputum referrals observed in this study further indicates improved linkage between community surveillance activities and primary healthcare diagnostic services. Strengthening this community-facility interface is a key component of effective TB control and has been highlighted in multiple studies as essential for improving case detection and treatment initiation [3], [10]. In the uploaded article, sputum referral served as an indicator of functional integration between community-based surveillance and formal TB services, reflecting improved system coordination.

From a health system resilience perspective, CBSA enhances the adaptive capacity of the TB surveillance system by reinforcing surveillance functions at the community level. Health system resilience emphasises the ability to maintain core functions under routine pressures and respond effectively to ongoing challenges [9]. By strengthening community surveillance capacity and improving reporting and referral mechanisms, CBSA supports system adaptability and continuity of TB control efforts in resource-limited settings.

Importantly, CBSA emphasises structured human support rather than reliance on standalone technological solutions. This approach is consistent with evidence suggesting that digital and system-linked tools are most effective when combined with strong human and organisational support structures [7], [8]. By aligning community surveillance activities with existing health system processes, CBSA offers a pragmatic and sustainable approach to strengthening TB surveillance.

Despite these strengths, this study has limitations. The use of a non-randomised one-group pre-test and post-test design limits causal inference, and the relatively small sample size may restrict generalisability. Additionally, the study did not assess long-term sustainability or cost-effectiveness of CBSA. Nevertheless, the consistency of improvements across multiple surveillance indicators supports the potential of CBSA as a scalable strategy for strengthening community-based TB surveillance and enhancing health system resilience.

IV. CONCLUSIONS

This study shows that Community-Based Surveillance Assistance (CBSA) strengthens health system resilience for tuberculosis control at the community level. The intervention significantly improved cadres' tuberculosis knowledge,

increased contact investigation, and enhanced sputum referral for suspected cases. These results indicate that structured assistance and capacity building can improve community surveillance performance and strengthen linkage with primary healthcare services. The study contributes evidence that reinforcing existing community-based surveillance mechanisms supports tuberculosis control in resource-limited settings. However, the one-group design, small sample size, and single setting limit generalisability. Future studies should apply controlled designs, involve larger populations, and examine long-term sustainability and digital integration to optimise community-based tuberculosis surveillance.

REFERENCES

- [1] B. N. Nababan et al., "The yield of active tuberculosis disease and latent tuberculosis infection in tuberculosis household contacts investigated using chest X-ray in Yogyakarta Province, Indonesia," *Tropical Medicine and Infectious Disease*, vol. 9, no. 2, p. 34, 2024, doi: 10.3390/tropicalmed9020034.
- [2] N. S. Nida et al., "A systematic review of the types, workload, and supervision mechanism of community health workers: lessons learned for Indonesia," *BMC Primary Care*, vol. 25, no. 1, p. 82, 2024, doi: 10.1186/s12875-024-02319-2.
- [3] A. J. Gupta et al., "mHealth to improve implementation of tuberculosis contact investigation: a case study from Uganda," *Implementation Science Communications*, vol. 4, no. 1, p. 71, 2023, doi: 10.1186/s43058-023-00448-w.
- [4] H. Sanou et al., "How community-based health workers fulfil their roles in epidemic disease surveillance: a case study from Burkina Faso," *BMC Health Services Research*, vol. 24, no. 1, p. 1372, 2024, doi: 10.1186/s12913-024-11853-9.
- [5] World Health Organization, *Global Tuberculosis Report 2024*, Geneva: WHO, 2024.
- [6] Z. Sifumba et al., "Subclinical tuberculosis linkage to care following community-based screening in rural South Africa," *BMC Global Public Health*, vol. 2, p. 30, 2024, doi: 10.1186/s44263-024-00059-0.
- [7] K. Blanchet, P. Nam, B. Ramalingam, and F. Pozo-Martin, "Governance and capacity to manage resilience of health systems: towards a new conceptual framework," *International Journal of Health Policy and Management*, vol. 6, no. 8, pp. 431–435, 2017.
- [8] J. Lehmann and D. Sanders, "Community health workers: What do we know about them?" Geneva: WHO, 2007.
- [9] S. Chilala et al., "Individual, community and health system factors influencing time to tuberculosis notification," *BMC Health Services Research*, vol. 24, no. 1, p. 1241, 2024, doi: 10.1186/s12913-024-11697-3.
- [10] L. Chavez-Rimache, C. Ugarte-Gil, and M. J. Brunette, "The community as an active part in tuberculosis prevention and care: a scoping review," *PLOS Global Public Health*, vol. 3, no. 12, e0001482, 2023.
- [11] Kementerian Kesehatan Republik Indonesia, *Pedoman Nasional Penanggulangan Tuberkulosis*, Jakarta: Kemenkes RI, 2020.
- [12] R. K. Yadav et al., "Community engagement in tuberculosis prevention and care: a systematic review," *Journal of Global Health*, vol. 13, p. 04026, 2023.
- [13] A. Glaziou et al., "Global epidemiology of tuberculosis," *Seminars in Respiratory and Critical Care Medicine*, vol. 39, no. 3, pp. 271–285, 2018.
- [14] J. C. Uplekar et al., "Community-based active case finding for tuberculosis: navigating a complex minefield," *BMC Global Public Health*, vol. 2, p. 9, 2024, doi: 10.1186/s44263-024-00042-9.
- [15] T. Sheikh et al., "Health system resilience: concepts, challenges and future directions," *BMJ Global Health*, vol. 8, e011317, 2023.