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Tracing Tuberculosis: A comprehensive evaluation of surveillance system performance in Kendari District, Southeast Sulawesi

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Abstract

Tuberculosis (TB) remains a major public health challenge in Indonesia, highlighting the need for a robust and responsive surveillance system to guide effective control strategies. This study aimed to evaluate the performance of the TB surveillance system at Puskesmas Wua-Wua by assessing its input, process, output components, and surveillance attributes. A descriptive qualitative design was employed, using total sampling to recruit key and general informants involved in TB program implementation. Data were collected through semi-structured interviews, direct observation, and document review, and analyzed using Miles and Huberman's interactive model with methodological and source triangulation to enhance data credibility. The findings show that digital transformation through the SITB platform has substantially improved data processing, reporting efficiency, and timeliness, enabling real-time access to surveillance information and supporting evidence-based decision-making. Several surveillance attributes including simplicity, flexibility, completeness, and timeliness performed strongly, and structured validation mechanisms supported data quality. However, the most critical gaps were observed in the input components: limited human resource capacity, dual workloads, insufficient certified training, and inadequate funding for essential operational needs. These constraints hindered optimal data validity, analytical capacity, and long-term system sustainability. Although reporting and cross-sectoral collaboration largely complied with national regulations, the absence of epidemiological analysis at the health center level and logistical shortages indicated areas requiring strengthening. Despite notable digital progress, the TB surveillance system's effectiveness relies on strengthened workforce capacity, sustainable financing and improved interfacility coordination to ensure a system that is both technologically advanced and operationally resilient.

Keywords: Tuberculosis; Surveillance Evaluation; Input; Process; Output; Attribute

1 Introduction

Pulmonary tuberculosis is a chronic infectious disease caused by Mycobacterium tuberculosis, which primarily affects the lungs. Transmission occurs through droplets or droplet nuclei measuring <5 microns that are released when individuals with pulmonary TB cough, sneeze, or speak. This disease can affect all age groups. The main symptom of pulmonary TB is a productive cough lasting ≥2 weeks, accompanied by other symptoms such as blood-tinged sputum, hemoptysis, shortness of breath, fatigue, loss of appetite and weight, as well as fever persisting for more than one month (1,2).

Tuberculosis (TB) remains one of the major challenges in global public health despite various control efforts implemented by many countries. If left untreated or if treatment is incomplete, TB can lead to serious complications and may result in death. Pulmonary TB has a broad impact on affected individuals physically, psychologically, and socially. Without proper management, this disease may cause a range of complications, including the spread of infection, severe respiratory tract bleeding, malnutrition, multidrug resistance, and other health problems (3).

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According to the Global Tuberculosis Report, TB remains one of the leading causes of morbidity and mortality worldwide. It is the second highest cause of death from a single infectious agent after COVID-19, and its mortality rate is even twice as high as that of HIV/AIDS. Globally, WHO reported that in 2021 there were approximately 10.4 million TB cases with a prevalence of 0.26% and 1.5 million deaths. This number increased in 2022 to 10.7 million cases with a prevalence of 0.263% and 1.6 million deaths. However, in 2023, the estimated number of TB cases reached 10.8 million, with a slightly decreased prevalence of 0.262%, while TB-related deaths declined to 1.3 million. Thirty high-burden countries contributed 87% of all global cases, with two-thirds originating from eight countries: India (27%), Indonesia (10%), China (7.1%), Pakistan (5.7%), Nigeria (4.5%), Bangladesh (3.6%), and the Democratic Republic of the Congo (3.0%) (4)

According to the Global TB Report 2023, Indonesia currently ranks second in the world for the highest number of TB cases after India. In Indonesia, 443,235 TB cases were recorded in 2021 with a prevalence of 0.31%. This number increased to 724,309 cases in 2022 with a prevalence of 0.42%, and rose again in 2023 to 809,000 cases with a prevalence of 0.56% (2). Tuberculosis (TB) remains a serious public health problem in Indonesia. Data from the World Health Organization (WHO) show that Indonesia is among the countries with the highest TB burden globally. Despite various control efforts, many TB cases remain undetected, reported late, or not recorded at all (underreporting). This situation indicates that the TB surveillance system is not yet optimal in capturing the true epidemiological situation (4).

In Southeast Sulawesi Province, the number of tuberculosis (TB) cases continues to show an increasing trend. Based on the Southeast Sulawesi Health Profile from the Provincial Health Office, 3,368 TB cases were recorded in 2021 with a prevalence of 0.18%. This number increased to 4,440 cases in 2022 with a prevalence of 0.29%, and rose again to 4,672 cases in 2023 with a prevalence of 0.33%. Kendari City remains the area with the highest number of TB cases in the province (5).

Data from the Kendari City Health Office show that in 2021 there were 627 cases with a prevalence of 0.19%. This number increased to 853 cases in 2022 with a prevalence of 0.23%, and further rose to 903 cases in 2023 with a prevalence of 0.25%. The prevalence of tuberculosis (TB) per 100,000 population during 2020–2023 across districts in Kendari City shows a significant upward trend, including Abeli District (7,172), Kambu District (3,460), Kendari District (3,195), and Wua-Wua District (2,408) (6). Specifically, Wua-Wua District has demonstrated a consistently increasing prevalence each year, from 123 cases per 100,000 population in 2020 to 311 cases in 2023. The cumulative prevalence over the past four years has reached 2,408, which is relatively high compared to several other districts. This condition indicates that the Wua-Wua Community Health Center (Puskesmas) serves an area with a substantial and persistent TB burden. The high prevalence highlights the real challenges faced by Wua-Wua Puskesmas in TB control (6).

Tuberculosis surveillance is a program requirement for continuous monitoring and analysis of data and information related to the occurrence of TB as well as the health problems and conditions that influence it. This surveillance aims to support effective and efficient control measures and serves as a reference for determining strategies, planning, implementation, monitoring, and evaluation of TB programs (7).

In essence, surveillance functions as a “disease detective” that traces case patterns, identifies transmission pathways, and ensures that no case escapes reporting. However, in practice, TB surveillance still faces various challenges, including limited health personnel, delays in reporting, poor data quality, and insufficient utilization of digital technologies. These issues lead to control policies and interventions that are often ineffective, as they are based on incomplete or non-representative data. the importance of topic, making general statements about the topic and presenting an overview on current research on the subject. Your introduction should clearly identify the subject area of interest.

The study titled “Tracing Tuberculosis: A Comprehensive Evaluation of Surveillance System Performance in Kendari District, Southeast Sulawesi” is essential for assessing the extent to which the TB surveillance system has effectively fulfilled its role. By analyzing the strengths and weaknesses of the existing system, this research can provide evidence-based recommendations to strengthen surveillance mechanisms at both the Puskesmas and district levels. The findings will be beneficial not only for health policymakers but also for frontline health workers in improving early detection, accuracy of reporting, and follow-up of TB cases.

Furthermore, this study supports the national goal of TB elimination by 2030 by ensuring that every “trace” of TB within the community can be uncovered. Strengthening surveillance through this research is therefore a strategic step to break the chain of TB transmission, enhance the quality of epidemiological data, and accelerate the achievement of public health targets in Indonesia.

2 Material and methods

2.1 Research Design

This descriptive qualitative study employed a case study design to evaluate the implementation of tuberculosis (TB) surveillance at the Puskesmas Wua-Wua in 2025. The site was selected due to a marked increase in TB cases over the past three years and its position as one of the five health centers with the highest TB prevalence among the eleven Puskesmas in Kendari City.

2.2 Study Participants and Sampling

A total sampling technique was used, whereby all members of the target population were included. Participants consisted of two groups: (1) key informants, namely the TB Program Officer and TB Surveillance Staff at the health center, and (2) general informants, represented by the TB Surveillance Officer at the Kendari City Health Office.

2.3 Variables

The TB surveillance system was evaluated using an input–process–output framework and key surveillance attributes. Input variables assessed essential resources supporting surveillance activities, including human resources, funding, guidelines or standard operating procedures, materials and reporting forms, and digital applications used for data management. Process variables examined mechanisms of data collection, data processing procedures, epidemiological analysis and interpretation, and dissemination practices. Output variables focused on the immediate results of surveillance activities. Surveillance attributes assessed the completeness, accuracy, and timeliness of surveillance information.

2.4 Instruments and Data Collection

Data were collected through individual semi-structured interviews with TB program personnel and surveillance officers, supported by a mobile device for recording responses. Direct observation using a structured checklist was conducted to verify the availability of resources and to assess actual data collection and reporting practices. Document review was carried out using a laptop to examine reporting forms and surveillance records.

2.5 Data Analysis

Data were analyzed using Miles and Huberman's interactive model, which includes data reduction, data display, and conclusion drawing/verification. To ensure data credibility, source triangulation was applied by comparing information from different informant groups, and methodological triangulation was conducted through interviews, field observations, and document review. Findings were subsequently validated through member checking with the respective informants

3 Results and discussion

Effective TB surveillance is a critical component of TB control programs, providing essential epidemiological data for planning, implementing, and evaluating interventions. Surveillance system evaluation is necessary to identify strengths and weaknesses, ensure data quality, and guide system improvements. This study assessed the TB surveillance system at BLUD UPTD Puskesmas Wua-Wua, Kendari City, using an evaluation framework encompassing input, process, output, and surveillance attributes. The discussion presents the evaluation findings in the context of current scientific evidence and best practices in TB surveillance, with the aim of offering evidence-based recommendations to strengthen the system.

3.1 Input

3.1.1 Human Resources

The findings of this study highlight the complexity of human resource challenges within the TB surveillance system. The TB program officer at puskesmas Wua-Wua manages not only the TB program but also additional responsibilities such as rabies, leprosy, yaws, and administrative tasks related to operational funding (BOK). This dual workload increases the risk of fatigue, reduces focus, and may compromise the quality of surveillance data recording and reporting. Although the DOTS TB Team structure has been formally established, staff capacity remains insufficient. Most training provided is limited to non-certified refresher sessions, while formal training such as Training of Trainers (ToT) is

accessible only to a small number of staff. Gaps in training are particularly evident among laboratory and pharmacy personnel, whose roles are critical in diagnosis and drug logistics management.

Adequate human resources both in number and competency are essential for successful policy implementation, as staff directly carry out program activities. In TB control programs, dual task burdens among DOTS team members have been shown to reduce performance, often stemming from insufficient staffing levels that require personnel to take on additional duties (8).

3.1.2 Facilities and Infrastructure

The assessment of facilities and infrastructure presents a mixed picture. While TB drug availability is reported to be stable, discrepancies remain between annual logistics planning and actual distribution. The transition toward digital systems has progressed well, supported by accessible Communication, Information, and Education (IEC) materials and digital document repositories. The SITB (Tuberculosis Information System) application functions as the backbone of surveillance, integrating case management, laboratory data, logistics, and adverse event monitoring. However, reliance on personal resources—such as staff-owned motorcycles and mobile phones for field activities—suggests limited institutional support for operational infrastructure.

SITB is a national information system for managing TB control data with adjustable coverage across administrative levels and all health facilities in Indonesia. It can operate online or offline and integrates with other health information systems. SITB supports national TB control targets, including TB elimination by 2030 and a TB-free Indonesia by 2050. It is used for case reporting of both drug-sensitive and drug-resistant TB, as well as logistics and laboratory data management. Such system integration is essential for efficient TB surveillance (9).

3.1.3 Funding

Funding constraints present a structural challenge that affects the smooth implementation of TB surveillance activities. At the primary health center level, the BOK (Health Operational Assistance) budget only covers transportation for contact investigation and treatment monitoring, leaving other essential operational needs including regular staff training unfunded. At the district level, financial support comes from multiple sources such as the Global Fund, regional budgets (APBD), and the national DAK non-physical fund. Despite these funding streams, available resources remain limited and are often prioritized for high-risk cases, such as patients lost to follow-up, while essential logistical supplies such as surgical masks have reportedly been unavailable for the past two years.

Nationally, TB control in Indonesia is financed through various sources, including the central government budget (APBN), regional budgets (APBD), Global Fund grants, and contributions from non-governmental partners such as USAID and YKI (10). Between 2018 and 2022, funding from the Global Fund increased annually, whereas APBN, APBD, and partner contributions fluctuated from year to year. The findings of this study align with research by (11), which reported persistent funding shortages at Puskesmas Bergas, underscoring the critical role of adequate financial support in ensuring the effective implementation of TB control programs. Insufficient government funding may hinder program performance and impede the achievement of national and global TB elimination targets (10).

3.1.4 Stakeholder Engagement and Networking

Cross-sectoral collaboration emerged as a positive aspect of the surveillance system. The involvement of Bhabinkamtibmas (community police officers) in addressing challenges related to patient visits and the role of FEPPM (a Global Fund partner) in hospital oversight demonstrate active partnership building. Laboratory networking also functions effectively, with Wua-Wua Health Center referring sputum samples to Puuwatu Health Center, which operates a TB Molecular Scanner (TCM). At the oversight level, the District Health Office coordinates a network involving 15 primary health centers, 16 hospitals, the regional public health laboratory (Labkesda), and the municipal pharmaceutical installation (IFK). This multi-stakeholder engagement aligns with the integrated approach required for effective TB control.

A strong collaboration network across primary care facilities, hospitals, and private providers not only accelerates the identification of TB suspects and cases but also enhances compliance with mandatory TB reporting systems. Engagement of all health service providers especially from the private sector is essential to reduce under-reporting (Ministry of Health, 2024). Such stakeholder involvement and robust networking are key indicators of system strength, consistent with Ministry of Health Regulation No. 67/2016, which emphasizes the need for multisectoral and well-coordinated partnerships in TB control (12).

3.2 Process

3.2.1 Data Collection and Data Processing

Data collection was carried out through two approaches: active surveillance which included in-facility screening and contact investigation in the community and passive surveillance, obtained from hospital reports through the SITB system. Data processing has been fully integrated into the SITB application, which records the entire TB case management workflow, from suspect identification and laboratory examination to treatment regimen assignment and monthly treatment evaluation. This integration eliminates the need for duplicate manual recording, thereby reducing administrative burden and minimizing the potential for error. The Tuberculosis Information System (SITB) is the primary national surveillance platform for TB in Indonesia, designed to accelerate data collection processes and strengthen coordination across health facilities in support of the National TB Control Program (13).

A study by Putra et al., (2025) reported that the quality of SITB is high, as it is easily accessible through a web-based platform and equipped with clear user guidelines. In terms of net benefit, SITB offers substantial advantages, particularly by improving time efficiency in TB case recording and reporting. Direct benefits include immediate improvements following SITB implementation, such as increased efficiency in recording and reporting processes thereby reducing manual workloads and enhanced data accuracy through standardized inputs that align with national TB recording guidelines. At the clinical management level, these benefits are evident in the ease of monitoring TB cases and accessing real-time data to support decision-making. For patients, direct benefits include improved quality of medical records and assurance of treatment continuity. Indirect benefits represent long-term impacts that support broader program goals, such as strengthening the reputation of health facilities in public health programs, improving staff capacity in using health information technologies, and contributing to the achievement of the 2030 TB elimination targets through enhanced case detection. These long-term benefits also include the strengthening of the overall health system through improved data integration and the establishment of collaborative networks among health facilities involved in TB surveillance.

3.2.2 Data Analysis and Interpretation

The Regulation of the Minister of Health of the Republic of Indonesia No. 45 of 2014 on the Implementation of Health Surveillance states that data analysis in surveillance may be conducted using descriptive or analytical epidemiological approaches. Descriptive analysis is used to illustrate the distribution patterns of a disease and its influencing factors based on person, place, and time. Meanwhile, analytical analysis aims to identify relationships between variables that may contribute to increased disease incidence or other health problems (15).

This study found that although roles in data analysis were clearly defined, they were unevenly distributed. The primary health center functions mainly as a data entry unit, focusing on inputting operational data into SITB without conducting further descriptive or analytical analysis. In contrast, the responsibility for data analysis and interpretation lies entirely with the District Health Office. The District Health Office performs trend analysis, generates data visualizations such as graphs using Microsoft Excel, and maps cases with Quantum GIS to identify areas with a high TB burden.

Data interpretation involves presenting information in a clear, engaging, and easily understandable manner. This stage helps readers grasp the meaning conveyed by the data. The interpretation conducted by the Kendari City Health Office aligns with the provisions of the Ministerial Regulation No. 45/2014, which mandates the presentation of results in the form of infographics, including tables, charts, and maps (15).

The findings of this study are consistent with research by (14), which reported that at the primary health center level, data were not analyzed based on individual or temporal variables. Meanwhile, at the District Health Office of Kupang, data analysis was performed in a limited capacity and adjusted to reporting needs, typically on a quarterly, semi-annual, and annual basis. The analysis process was supported by the SITB application, which provides analytical outputs according to national TB program indicators, facilitating data assessment by district TB managers. The analysis results were then presented in tables, diagrams, and charts. To assess program performance and progress, appropriate indicators such as impact indicators, key indicators, and operational indicators—are essential tools for evaluation.

3.2.3 Dissemination and Feedback Mechanisms

Dissemination is the process of delivering data or messages to individuals or groups with the aim of ensuring that the information is received, understood, and ultimately utilized. Dissemination activities may be conducted through various methods, including meetings, outreach sessions, bulletins, circular letters, routine reports, and scientific publications (15).

In this study, information dissemination was conducted through structured forums, such as biweekly meetings that discuss national priority programs (MBG, CKG, TB) and involve cross-sectoral stakeholders up to the national government level. This mechanism ensures that strategic information regarding TB program achievements and challenges reaches key decision-makers. Feedback, delivered in the form of data validation is conducted monthly at the health center and semiannually at the city level. Data Validation serves to verify consistency between SITB data and manual records and to correct errors such as double entry. Supervisory visits and monitoring and evaluation (M&E) activities also form part of the feedback mechanism, although their frequency has reportedly declined due to budget constraints and is now prioritized for underperforming health centers.

Information dissemination plays a crucial role in ensuring that policymakers have an adequate understanding of program performance, enabling them to make informed and targeted decisions. Furthermore, dissemination supports the assessment of intervention effectiveness and helps identify strengths and weaknesses. In the context of surveillance, information dissemination also involves providing feedback to data sources to improve the quality of collected data (16).

3.3 Output

The results of surveillance activities are presented as epidemiological information in the form of reports. This information includes various TB program indicators impact indicators, key indicators, and operational indicators which serve as benchmarks for assessing progress and the effectiveness of tuberculosis control efforts (17).

The primary output of the surveillance system is an informative and timely epidemiological report. At Puskesmas Wua-Wua, the reporting process has undergone significant digital transformation. TB surveillance reports are fully integrated into the SITB system, eliminating the need for the health center to prepare and submit manual reports to the District Health Office. According to the District Health Office, six key performance indicators form the core outputs of TB surveillance reporting: (1) achievement of the Minimum Service Standards (SPM) for TB, (2) treatment coverage, (3) case detection, (4) enrollment rate, (5) treatment success rate, and (6) TB Preventive Therapy (TPT) coverage. Reports generated by the District Health Office are not only descriptive but also analytical, documenting challenges and evaluating the effectiveness of interventions. This reflects an evolution of the surveillance output system from basic statistical reporting to a management tool that supports continuous program improvement. Although some challenges remain in recording and reporting processes, the use of SITB provides substantial advantages for monitoring and evaluating TB control activities.

The Tuberculosis Information System (SITB), managed by the Directorate General of Disease Prevention and Control, is regarded as a relatively strong reporting system because it can generate estimates of TB burden, thereby enabling the calculation of under-reporting. However, according to the Director of Communicable Disease Prevention (P2M) in the June 2022 routine SITB report, reporting completeness remains low under 30% compared to the 48% target. The majority of TB case reports come from primary health centers (approximately 95%), and nearly all of them have adopted SITB. Exceptions remain in Papua and Maluku Provinces, where network limitations hinder full system utilization (17).

3.4 Surveillance System Attributes

3.4.1 Simplicity

The simplicity of a surveillance system refers to the ease of its structure, reporting flow, and operational procedures. An effective surveillance system should be designed to be as straightforward as possible while still achieving its intended objectives (18). The TB surveillance system in this study setting demonstrates a high level of simplicity, largely due to the adoption of a single integrated platform, SITB. This application streamlines the entire surveillance workflow from initial case recording and treatment monitoring to report generation. Health workers are no longer burdened by multiple systems or complex manual forms. The requirement for real-time data entry, particularly for TCM diagnostic referrals, promotes discipline and accelerates data flow. Furthermore, the ability of the District Health Office to access data directly from SITB without relying on manual reports from primary health centers further simplifies the reporting hierarchy.

Regarding system attributes, the TB surveillance system is assessed as simple, with a sufficient number and type of data elements required for establishing TB diagnosis. Nonetheless, additional information such as social indicators and confirmation status (bacteriological or clinical) could further strengthen the system. In several other countries, studies have reported lower ratings for system simplicity due to time-consuming data collection processes and complex

reporting forms. However, other studies conducted in Yemen, Pakistan, and South Africa have found the TB surveillance system to be simple (19).

3.4.2 Flexibility

Flexibility assesses whether the TB surveillance system can adapt to changing information needs or operational conditions with minimal additional time, effort, or financial resources (19). Findings from this study indicate that the system is reasonably flexible. The SITB application undergoes periodic updates (every five years), incorporating new features and broader integration, such as linkage with SIHA (the HIV AIDS Information System). Flexibility is reflected not only in technological aspects but also in the system's responsiveness to policy changes (e.g., revisions to Ministerial Regulations and technical guidelines) and advancements in clinical management, such as the transition from injectable to fully oral regimens for drug-resistant TB and the introduction of shorter treatment regimens.

This ability to adapt to evolving policies, technologies, and scientific developments is essential for ensuring that the surveillance system remains relevant and effective in supporting the TB control program (20). The TB surveillance system in Jember District was likewise classified as flexible, as system changes did not require substantial increases in cost, personnel, time, or infrastructure. Consistent with the CDC definition, flexibility refers to a surveillance system's capacity to adjust to modifications in information needs without significant increases in resources (18).

3.4.3 Data Validity

Data validity is maintained through scheduled validation mechanisms. However, challenges to data validity persist, primarily in the form of double entry when patients move between health facilities before their cases are officially closed, as well as delayed data entry due to the multiple responsibilities carried by surveillance staff. The validation process conducted by comparing SITB data with manual records successfully identifies and corrects most of these errors. Nonetheless, the system's continued heavy reliance on data validation for data correction indicates that a strong culture of routine data quality assurance and consistent real-time data entry has not yet been fully institutionalized. High data validity is essential for ensuring accurate programmatic decision-making.

3.4.4 Completeness

Data completeness is generally reported to be good at the primary health center level, where real-time data entry is a prerequisite for service continuity. No missing data were reported, although minor errors such as incorrect age or national identification numbers (NIK) occasionally occur. At the hospital level, however, data completeness is often hindered by delayed input due to heavy outpatient service workloads. Patient mobility, which contributes to double entry, also affects the accuracy of complete data records. Validation activities again function as a safety net to identify and fill in missing or inconsistent information. Ensuring completeness across all facilities within the network particularly hospitals with high patient volumes remains an ongoing challenge requiring sustained attention.

Ensuring adequate data completeness is critical, as it directly affects the quality of generated information. More complete datasets provide a more accurate representation of the true situation, although perfect completeness is difficult to achieve. Some experts consider a completeness level of around 80% acceptable, except for specific data elements that must reach 100%. Data completeness encompasses report content (reporting items), all program activities, and all reporting units within the operational area. Assessing data completeness allows evaluation of how well the available data reflect actual conditions (21). In the context of EWARS, program performance is measured through the timeliness and completeness of reporting by all health facilities. High timeliness improves early warning signals for outbreaks, while high completeness enhances the system's capacity to detect broader outbreak patterns (21).

3.4.5 Timeliness

Timeliness refers to the speed at which each stage of the surveillance system is carried out. It also encompasses the amount of time required to detect trends, identify outbreaks, or assess the impact of control measures (18). In this study, the timeliness attribute of reporting was achieved exceptionally well, largely due to the use of the SITB system. Real-time data entry by health facilities allows immediate access by the District Health Office, eliminating delays commonly encountered in manual reporting systems. A formal reporting cycle is scheduled every two weeks through command center meetings, which require continuously updated data. This efficiency demonstrates how digitalization can transform the speed and accuracy of surveillance information dissemination, enabling faster and more timely program responses. Consistent with these findings, (18) reported that the Health Office and primary health centers in Jember District achieved timely data collection, compilation, analysis, interpretation, and reporting.

Timeliness in reporting, case management, and information dissemination is a critical aspect of any surveillance system. Timely data reporting allows optimal use of information for internal decision-making. Furthermore, rapid and accurate data utilization supports the production of high-quality information, enhancing the effectiveness and efficiency of identifying and addressing priority health problems in the population. Therefore, timeliness in reporting, case response, and information dissemination is essential. Timely reporting increases opportunities for data-driven decision-making and strengthens TB control efforts (22,23).

3.5 Compliance and Non Compliance with National Regulations

The evaluation of the TB surveillance system at Puskesmas Wua-Wua demonstrates partial alignment with national regulatory standards, particularly the Minister of Health Regulation No. 45/2014 on Health Surveillance(15) and Regulation No. 67/2016 on Tuberculosis Control (12). Several components were implemented in accordance with the regulations, notably the use of SITB as the national recording and reporting system, routine data validation processes, and regular dissemination of information through biweekly coordination meetings. Key programmatic elements such as the establishment of the DOTS TB team, active and passive case finding, provision of TB Preventive Therapy, and adherence to national reporting requirements also conform to TB control guidelines.

However, important gaps remain. The absence of epidemiological data analysis at the health center level is inconsistent with the requirement for tiered surveillance as mandated in Regulation No. 45/2014, which emphasizes basic data analysis at the point of care. Similarly, limited reach to high-risk populations indicates partial non-compliance with the case finding requirements of Regulation No. 67/2016. Human resource constraints particularly dual workloads and inadequate certified training also diverge from national standards for staff competency and effectiveness. In terms of financing and logistics, insufficient funding and the absence of essential protective equipment, such as surgical masks, reflect gaps in meeting standards for adequate program resources. Although SITB utilization aligns with national reporting policies, the lack of analytical capacity at the health center undermines optimal data use for rapid response. Finally, while cross-sectoral collaboration involving police and NGO partners is consistent with regulatory expectations, coordination mechanisms would benefit from further strengthening to fully meet multisectoral collaboration principles.

Overall, the system shows substantial regulatory compliance in recording, reporting, and partnership mechanisms, but requires improvements in analytical capacity, financing, logistical support, and outreach to high-risk groups to fully meet national standards for effective TB surveillance and control.

4 Conclusion

The TB surveillance system at Puskesmas Wua-Wua has demonstrated substantial progress, particularly in its adoption of digital technology through the SITB platform. The processes of data management and report generation have become more efficient, integrated, and action-oriented. Several system attributes such as simplicity, flexibility, and timeliness also performed exceptionally well. However, this evaluation clearly highlights that the primary challenges lie within the input stage, particularly in human resources and financial support. These gaps have the potential to affect field-level implementation, data validity, and the long-term sustainability of the system. The future success of the surveillance system will depend not only on technological advancement but also on strong policy interventions aimed at strengthening the foundational components of human resources and financing. Therefore, improvement efforts should simultaneously maintain the digital strengths already achieved while aggressively addressing input-level constraints to ensure a TB surveillance system that is not only technologically advanced but also sustainable and effective.

Overall, the TB surveillance system at Puskesmas Wua-Wua meets several regulatory requirements, especially in terms of structure and reporting mechanisms. Nevertheless, significant gaps remain in operational implementation, particularly in human resources, data analysis, and financing.

Strong commitment from all stakeholders is essential to fully align program practices with national standards. Strengthening the system therefore requires targeted actions, including increased local government budget allocation, enhanced human resource capacity through rationalized workloads and certified training, further optimization of SITB with analytical dashboards for primary health centers, and stronger cross-sectoral networking to ensure complete and timely data contributions from all facilities.

Compliance with ethical standards

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Disclosure of Conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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