



Optimizing Pesantren Management for Tuberculosis Prevention through BREATHE Program

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Abstract

Tuberculosis (TB) remains a significant public health problem in Indonesia, particularly in Islamic boarding schools (*pesantren*), where overcrowding, prolonged close contact, and limited institutional health governance increase transmission risks. This study aims to optimize *pesantren* management in TB prevention through the development of the BREATHE program (Building Resilient Environments Against Tuberculosis Hazards in Education). A mixed-methods embedded design was applied, with quantitative data collected from a cross-sectional survey of 223 students in two *pesantren* in Banyumas Regency to measure knowledge, attitudes, and preventive behaviors, complemented by environmental observations. Qualitative data were obtained through in-depth interviews and focus group discussions with key stakeholders, analyzed thematically using Open Code software and triangulation. Results showed that most students had low knowledge (54.3%), balanced attitudes (positive: 50.7%; negative: 49.3%), and relatively good preventive behaviors (56.5%). Environmental assessments revealed overcrowding, poor ventilation, and high humidity. Qualitative findings highlighted the absence of TB-specific Standard Operating Procedures (SOPs), limited health management capacity, stigma, and financial constraints as major barriers. Based on these insights, the BREATHE program prototype was developed, integrating governance strengthening, human resource capacity building, environmental risk control, and health service integration. This model provides a replicable framework for TB prevention in high-risk residential educational settings and contributes to global discourse on institutional health governance in Islamic education.

INTRODUCTION

Tuberculosis remains a global health problem and continues to be a leading cause of death from infectious disease worldwide. The World Health Organization (2021) estimated that approximately 10 million people fell ill and 1.5 million of them died from tuberculosis in 2021 (World Health Organization, 2024). Indonesia is among the countries carrying the highest tuberculosis burden

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ranking third globally after India and China. An estimated 821,200 tuberculosis cases occurred in Indonesia in 2024, with treatment coverage still below the expected target (Rahmanda et al., 2026). This burden is reflected in the persistently high case numbers across provinces, including Central Java, which ranks third nationally in the number of reported cases (Kementerian Kesehatan, 2025).

Within Central Java, Banyumas Regency ranks first, with a case notification rate of 205.90 per 100,000 population and a treatment success rate of 79 % (BPS, 2021). Effective case finding requires particular attention to high-risk settings, which in tuberculosis control include detention facilities, hospitals, workplaces, areas of high poverty and residential dormitories (Krisniawati et al., 2025). Islamic boarding schools, both traditional and modern, fall within this category of congregate settings. BPS, (2021) records at least 193 Islamic boarding schools in Banyumas accommodating tens of thousands of students, which places these institutions at elevated risk of tuberculosis (Putri et al., 2017). The magnitude of this risk is evident in a study of two boarding schools in Bangkalan, where 30 % of adolescent residents tested positive for latent tuberculosis infection and a low level of knowledge carried the highest risk of any factor examined (Ananto et al., 2024).

The risk factors for tuberculosis in Islamic boarding schools include occupancy density that raises the likelihood of transmission within confined spaces, poor environmental and hygiene conditions, inadequate ventilation and lighting, and low levels of knowledge and unfavourable attitudes towards disease prevention among residents (Mariana & Hairuddin, 2018). These conditions call for boarding school management oriented towards tuberculosis control. At the same time, Islamic boarding schools hold considerable potential as sites of disease prevention through the strengthening of effective health management programmes (Collein et al., 2024). Standardised programmes have been shown to reduce transmission risk by ensuring that health management, early detection and treatment procedures are implemented correctly and consistently (Asfiya et al., 2021).

A number of previous studies demonstrate the importance of institutional management in controlling tuberculosis in densely populated residential settings. Systematic screening of priority groups and educational institutions has identified substantial numbers of previously undetected tuberculosis cases (Vo et al., 2020), while separating teaching and sleeping quarters and providing adequate ventilation reduces the risk of tuberculosis occurrence (Hou et al., 2020). Institutional management that embeds tuberculosis prevention within routine activities has been shown to prevent cluster epidemics in schools and dormitories (Dorjee et al., 2021; Yuan et al., 2023; Zhang et al., 2024).

The scholarly rationale for this study rests on three considerations. First, the epidemiological literature consistently identifies congregate residential settings as amplifiers of tuberculosis transmission, yet the evidence base is dominated by studies of prisons, hospitals and secular boarding schools; the Islamic boarding school, an institution that in Indonesia alone houses several million adolescents, remains comparatively under-examined as a unit of analysis. Second, the existing body of work on tuberculosis in Islamic boarding schools is overwhelmingly descriptive and individual-centred, reporting the knowledge, attitudes and practices of students without interrogating the institutional systems that shape those outcomes. This leaves an explanatory gap: knowing that students possess limited knowledge does not, in itself, explain why an institution has no mechanism for converting that knowledge

into a detection and referral pathway. Third, although the Ministry of Health and the Ministry of Religious Affairs jointly issued technical guidance on tuberculosis prevention and control in Islamic boarding schools in 2022 (Kementerian Kesehatan, 2025), preliminary observation indicated that many institutions still lack a robust and standardised system, producing a discernible gap between national policy and institutional practice (Lönnroth et al., 2021).

Theoretically, this study is situated at the intersection of two bodies of thought. The Social Ecological Model Mcleroy et al., (1988) holds that health behaviour is produced by the interaction of individual, interpersonal, institutional and policy levels; while this model is widely invoked in tuberculosis research, the institutional level is frequently treated as a background variable rather than as a locus of intervention. The Conceptual Framework of Access to Health Care Levesque et al., (2013) complements this by treating access as the outcome of an interaction between the supply-side characteristics of a health system and the demand-side abilities of individuals. Reading the two frameworks together suggests a proposition that this study sets out to examine, namely that in a residential educational institution the organisation itself functions as an intermediate supply-side actor, and that the absence of institutional governance can neutralise both national policy and individual health literacy. The implementation of tuberculosis control in Islamic boarding schools must therefore also account for social and cultural factors, including social norms, the authority of the *kiai* and community involvement, since these strongly shape implementation success (Nurjannah et al., 2022).

The intended contribution of this study is therefore twofold. Empirically, it provides an integrated account of tuberculosis risk in Islamic boarding schools that links measured student-level knowledge, attitudes and practices to institutional governance conditions within a single analytical frame, rather than treating them as separate literatures. Theoretically, it extends the Levesque framework by specifying the residential educational institution as an intermediate layer of access, and translates that extension into an operational form, namely a named programme model and a standard operating procedure prototype that can be adopted, evaluated and refined by other institutions. Looking forward, as Indonesia pursues its tuberculosis elimination target, the capacity of congregate educational institutions to detect and manage cases internally will become increasingly consequential, and a transferable institutional model is a prerequisite for that capacity.

Accordingly, this study aimed to optimise the management of Islamic boarding schools in handling tuberculosis through the development of a standardised programme named BREATHE (Building Resilient Environments Against Tuberculosis Hazards in Education), guided by three questions: what are the levels of knowledge, attitudes and prevention practices among students, and what are the environmental conditions in which they live; what institutional, sociocultural and financial factors constrain tuberculosis management in these settings; and what programme model can integrate these findings into an implementable institutional system.

METHODS

This study used a mixed-methods approach with an embedded design, in which the qualitative data served as the core data and the quantitative data as supporting data (Creswell & Plano Clark, 2018; Engkizar et al., 2023, 2024, 2026; Muhlasin et al., 2026; Seminikhyna & Lutsenko, 2024). This design was chosen to obtain comprehensive results and robust conclusions through cross-

validation. The study was conducted in two phases at two Islamic boarding schools in Banyumas Regency, Central Java, Indonesia, namely Pondok Pesantren Miftahul Falah in Tambak District, which has traditional characteristics, and Pondok Pesantren Zam-Zam in Cilongok District, which has modern characteristics, between March 2025 and March 2026. The stages of the design are summarised in figure 1.

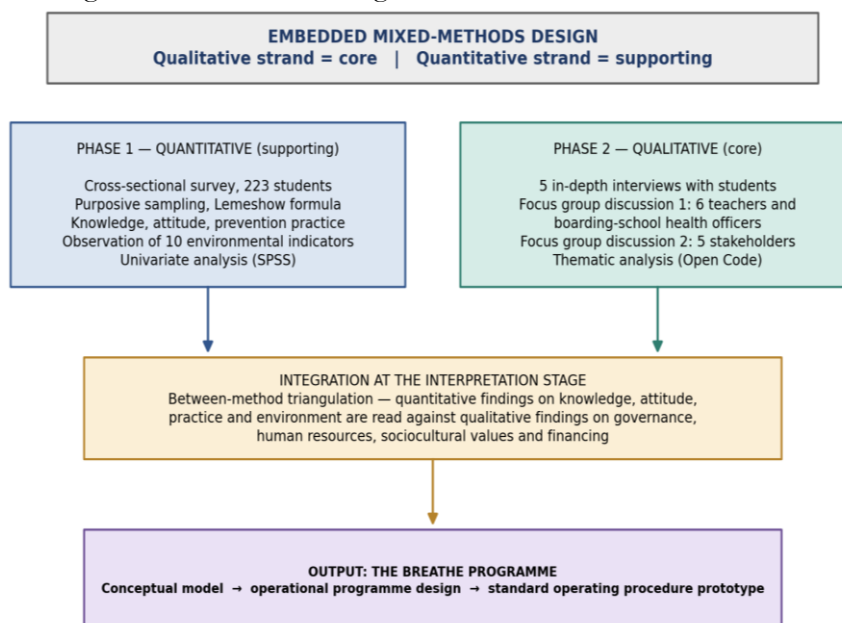


Fig 1. Stages of the embedded mixed-methods design applied in this study

The first phase was quantitative, comprising a cross-sectional survey measuring students' knowledge, attitudes and tuberculosis prevention practices, together with observation of environmental conditions. The sample size was determined using the Lemeshow formula with a 95 % confidence level and a finite population correction, yielding 223 respondents, consisting of 95 students from Pondok Pesantren Miftahul Falah and 128 students from Pondok Pesantren Zam-Zam. Purposive sampling was applied with the following inclusion criteria: active students who had resided in the institution for at least the preceding three months, aged between 10 and 19 years, willing to participate, not currently undergoing tuberculosis treatment, and undergoing a rapid molecular test at the time of data collection (Efendi et al., 2026; Hermawansyah, 2025; Saidi et al., 2025; Sugiyono, 2019). The instrument was a standard questionnaire previously used in studies conducted in comparable Islamic boarding school settings. Environmental conditions were assessed through structured observation of ten indicators: ventilation, lighting, occupancy density, room cleanliness, handwashing facilities, mask use, tuberculosis education media, sputum management, referral access and the availability of an isolation room. The quantitative data were analysed univariately using statistical software.

The second phase was qualitative and served to develop the BREATHE programme through in-depth exploration of the availability of the residential environment, the pastoral support provided by the institution, sociocultural values and the availability of financing. Data were collected through in-depth interviews with five students as key informants and two focus group discussions. The first focus group discussion involved six teachers and boarding school health officers, while the second involved five stakeholders, namely two tuberculosis programme officers from the Banyumas District Health Office, one representative of the Ministry of Religious Affairs, one

tuberculosis programme officer from a community health centre, and one representative of the Indonesian Association of Public Health Promoters and Educators. Participants were selected purposively on the basis of their involvement, knowledge and strategic role in boarding school management or in the health system.

The qualitative data were analysed using thematic analysis (Braun & Clarke, 2006; Engkizar et al., 2025; Kassymova et al., 2025), identifying, analysing and reporting patterns or themes within the data with the assistance of Open Code qualitative analysis software. Data credibility was strengthened through between-method methodological triangulation, combining the quantitative and qualitative approaches to enhance the validity of the findings. The two data types were integrated at the interpretation stage in order to generate a conceptual model, a programme design and a standard operating procedure prototype for BREATHE. The study received ethical approval from the Health Research Ethics Committee of the Faculty of Health Sciences, Universitas Jenderal Soedirman, under number 1854/EC/KEPK/V/2025, and written informed consent was obtained from all participants.

RESULT AND DISCUSSION

Respondent characteristics and levels of knowledge, attitudes and practices

The first phase of the study involved 223 students as respondents. The mean age of respondents was 14 years, with a range of 11 to 18 years, and female students predominated, numbering 119 (53.4 %), as presented in table 1.

Table 1. Characteristics of quantitative respondents (n = 223)

Variable	n (%)	Mean	Minimum–maximum
Age (years)	—	14	11–18
Sex: male	104 (46,6)		
Sex: female	119 (53,4)		
Total	223 (100,0)		

The univariate analysis showed that most students had poor knowledge of tuberculosis, held attitudes that were almost evenly divided between positive and negative, and reported prevention practices that tended to be good. The distribution of these categories is presented in figure 2.

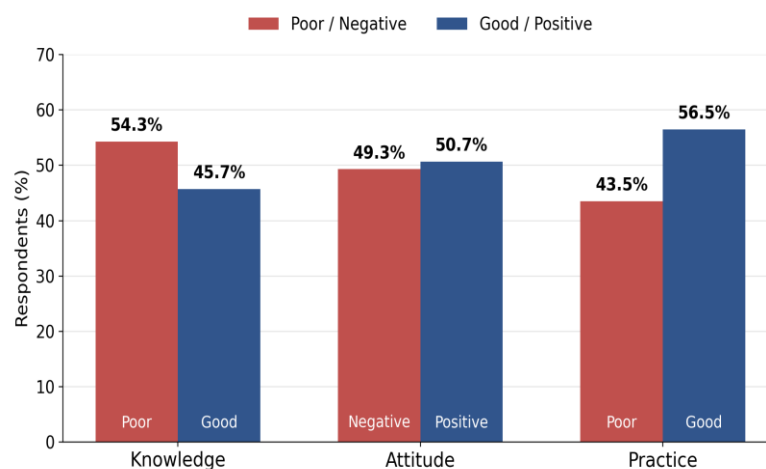


Fig 2. Distribution of knowledge, attitude and tuberculosis prevention practice categories among students (n = 223)

The finding that more than half of the students (54.3 %) had poor knowledge is consistent with studies identifying low health literacy as a principal determinant of delayed tuberculosis detection and treatment (Storla et al., 2008). Item-level analysis, presented in figure 3, shows that most students understood basic concepts such as the cause of the disease (91.9 %) and its mode of transmission (87.0 %), as well as hygiene practices including handwashing (97.8 %) and cough etiquette (92.8 %). Notable misconceptions nevertheless persisted: only 68.2 % correctly rejected the belief that tuberculosis is a hereditary disease, and only 78.0 % recognised that a person can be reinfected after recovery.

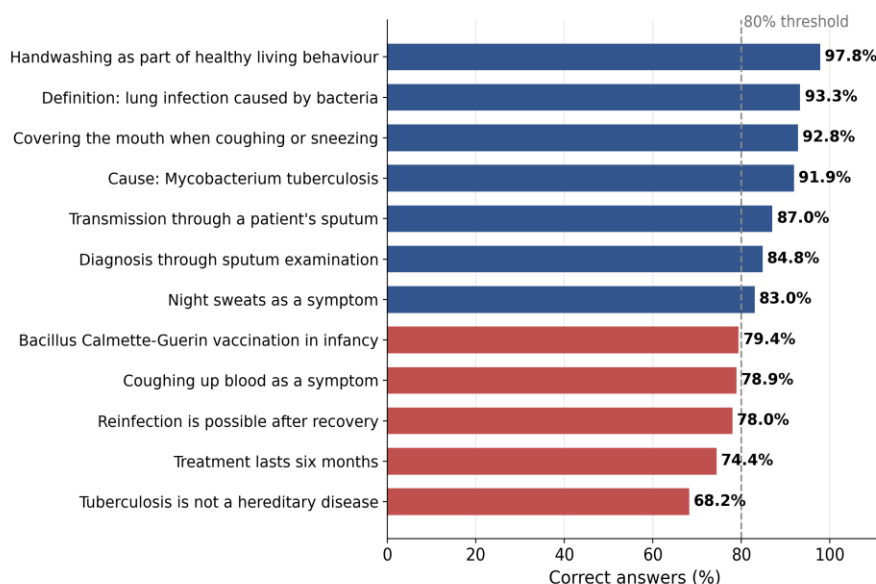


Fig 3. Percentage of correct answers among students across twelve tuberculosis knowledge items

Read against the wider literature, this pattern is analytically more informative than the aggregate score alone. The items answered correctly are those addressed by routine school and community health messaging, whereas the two weakest items concern aetiology and the durability of immunity, which are precisely the concepts that govern help-seeking behaviour. A student who believes tuberculosis to be hereditary has no reason to interpret a persistent cough as a transmissible condition warranting reporting, and a student who believes recovery confers permanent immunity has no reason to re-present after treatment completion. The knowledge deficit identified here is therefore not diffuse but concentrated at the point where knowledge would otherwise translate into action, which explains why generic health education has limited effect in these settings and why structured, sustained and concept-specific education is required (Hoa et al., 2009; Kwak et al., 2019).

The near-even division of attitudes between positive (50.7 %) and negative (49.3 %) indicates ambivalence about the importance of tuberculosis prevention (Sommerland et al., 2017). Prevention practices that tended to be good (56.5 %), by contrast, suggest that preventive behaviours have begun to be adopted even though they are not yet fully underpinned by adequate knowledge; a study of students in another Islamic boarding school in the same regency likewise found knowledge to be the strongest predictor of tuberculosis prevention behaviour (Rahmanda et al., 2026). This apparent inconsistency, in which practice outperforms both knowledge and attitude, is theoretically significant. Under the Theory of Planned Behaviour (Ajzen, 1991), behaviour that is not sustained by favourable attitudes is typically driven by subjective norms and perceived behavioural control rather than by personal conviction. In the Islamic boarding school, the communal routine and the authority of the caregiving structure

supply exactly those normative pressures. The practical implication is that current preventive behaviour is externally regulated and therefore fragile: it is likely to persist only while supervision persists, and to decay in its absence. This reading is consistent with the Social Ecological Model [Mcleroy et al., \(1988\)](#) and the Health Promotion Model [\(Pender et al., 2011\)](#), which locate behaviour in the interaction between individual, social and physical conditions, and it indicates that interventions in this setting should aim to convert externally enforced compliance into internalised practice, for instance by ensuring the correct and consistent use of masks [\(MacIntyre & Chughtai, 2015\)](#).

Environmental conditions in the Islamic boarding schools

Observation of the ten indicators showed that student dormitories possessed natural ventilation in the form of windows, but that this was not used optimally because the windows were not opened routinely. Occupancy density was high, with a single room accommodating approximately 25 to 40 students, which does not meet healthy housing standards, and some students still slept on the floor without bedding. Handwashing facilities were not evenly distributed, the use of masks by symptomatic students depended on supervision by the caregiving staff, and no tuberculosis standard operating procedure, dedicated education media, sputum management procedure or isolation room was available. The institutions had established referral access to the community health centre, but presumptive cases were generally managed by sending the student home.

These observations confirm that the physical environment is an important determinant of tuberculosis transmission, in line with evidence on the role of natural ventilation in preventing airborne contagion [\(Escombe et al., 2007\)](#), while crowding, poor ventilation and low nutritional status increase susceptibility to infection [\(Lönnroth et al., 2010; Organization, 2022\)](#). The observations also allow a more specific interpretation. The limiting factor identified here was not the absence of physical infrastructure but the absence of a rule governing its use: windows existed but were not opened, and referral access existed but was not activated. Environmental risk in this setting is thus best understood as a governance problem expressed in physical form, which is why the intervention model developed below places environmental control inside the standard operating procedure rather than treating it as a matter of building renovation.

Qualitative findings and the synthesis of the BREATHE approach

The qualitative exploration revealed that the tuberculosis problem in Islamic boarding schools is located not only at the individual level but also at the level of the system. The management of sick students still relied on verbal policy applied situationally, no formal allocation of roles existed for students or caregiving staff as prevention agents, and no dedicated budget line had been established for tuberculosis management. The sociocultural values of the institution had supportive dimensions, including solidarity, obedience to the policies of the *kiai* and an active caregiving structure, but they also generated barriers in the form of stigma towards sick students and a tendency to send students home without structured follow-up. The perception that tuberculosis is a source of shame produced fear of social exclusion and academic consequences, consistent with systematic reviews of tuberculosis stigma [Courtwright & Turner, \(2010\); Sommerland et al., \(2017\)](#) and with findings on tuberculosis stigma in Islamic boarding school settings [\(Rahman et al., 2019\)](#).

Interpreted alongside the quantitative results, the qualitative findings explain a pattern that the survey alone could not. The absence of a written procedure means that no institutional actor holds a defined obligation to detect, record or refer, so detection depends on the initiative of individual students

whose knowledge is, as shown above, deficient precisely at the point of interpretation. Stigma then compounds this by attaching a cost to disclosure. The practice of sending symptomatic student home is the rational outcome of these two conditions: in the absence of a procedure and in the presence of stigma, removal is the only available response, even though it displaces rather than interrupts transmission and severs the treatment relationship. This mechanism is what distinguishes the present analysis from earlier descriptive studies in similar settings, and it directly addresses the second research question.

The quantitative and qualitative findings were subsequently integrated into four core categories that provided the basis for naming the approach, as presented in table 2.

Table 2. Integration of quantitative and qualitative findings into the BREATHE approach

Component	Summary of findings and implications
Building Governance Capacity	Neither study site had a tuberculosis-specific standard operating procedure; management was verbal and situational. Implication: a formal, written tuberculosis standard operating procedure integrated into boarding school management is required.
Resilient Human Resources	Student knowledge remained poor and no formal roles had been allocated to prevention agents. Implication: a cadre or team of tuberculosis-aware students is needed, together with the active involvement of the caregiving staff.
Environmental Risk Control	Occupancy density was high, ventilation was not used optimally, and no sputum management procedure or isolation room existed. Implication: environmental risk control must be expressed as behavioral and environmental rules within the standard operating procedure.
Anti-Stigma and Psychosocial Protection	Negative attitudes persisted and tuberculosis was perceived as a source of shame, generating psychosocial resistance. Implication: an anti-stigma education strategy and psychosocial protection grounded in the values of the institution are required.

The contrast between tuberculosis management before and under the BREATHE programme across the five operational stages is summarised in figure 4.

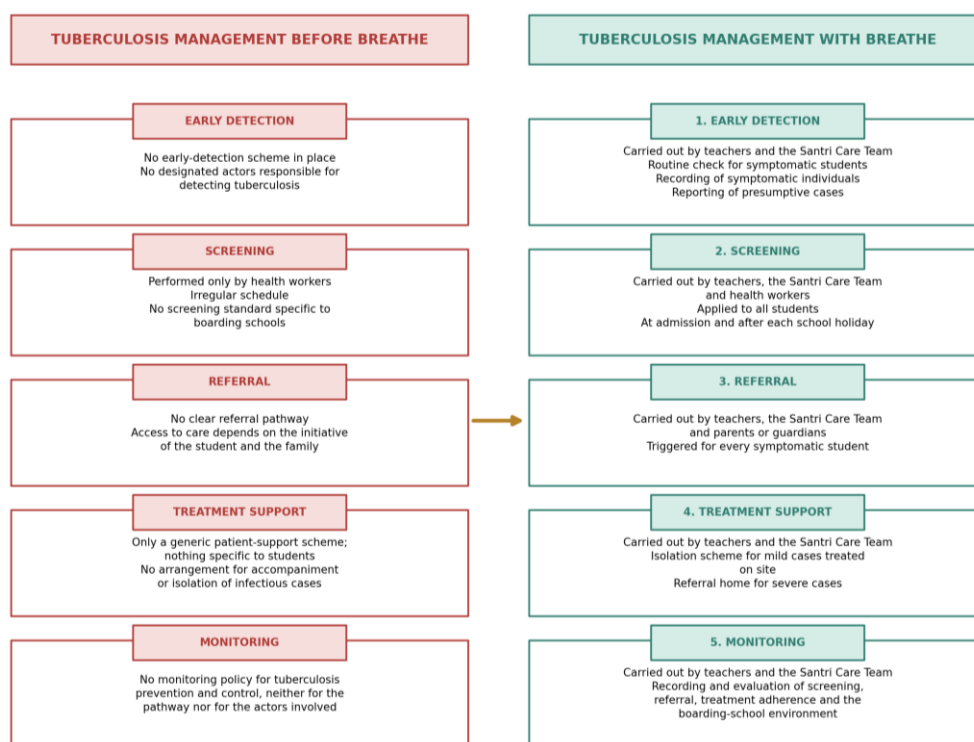


Fig 4. Tuberculosis management in Islamic boarding schools before and under the BREATHE programme

The conceptual model and programme design

On the basis of this synthesis, a conceptual BREATHE model was developed in four layers: contextual risk factors as input, the core BREATHE interventions as process, institutional resilience as output, and tuberculosis control outcomes. The contextual risk factors comprise occupancy density, sub-optimal ventilation and lighting, high student mobility, limited health literacy, stigma and the absence of a standard operating procedure. The core interventions consist of six components: Building Governance Capacity, strengthening governance through the preparation of a standard operating procedure and the leadership role of the *kiai*; Resilient Human Resources, establishing a tuberculosis-aware student team as agents of early detection and treatment support, following evidence on the effectiveness of empowering student cadres reported by Puspitasari, (2017), Environmental Risk Control, regulating ventilation, lighting, occupancy density and cleanliness; Anti-Stigma and Psychosocial Protection, reducing stigma through integration with religious values and the strengthening of *ukhawah*; tracking, screening and treatment flow, covering early detection, routine screening, recording, referral and monitoring of treatment adherence; and Health System Integration, establishing collaboration with the community health centre and the district health office. Together these components are expected to produce institutional resilience and, in turn, to reduce diagnostic delay and the risk of tuberculosis transmission. The model is presented in figure 5.



Fig 5. Conceptual model of the BREATHE programme

The operational design of the programme was arranged sequentially, from early detection and screening through referral, support for adherence to anti-tuberculosis medication, and monitoring. The pathway was developed with reference to the Technical Guidelines for Tuberculosis Prevention and Control issued by the Kementerian Kesehatan, (2025) and then adapted to the

characteristics of the Islamic boarding school. Whereas the national guidance focuses primarily on facility-based services, the BREATHE pathway extends it by adding an active institutional role, including internal screening, early reporting by students and caregiving staff through the Santri Care Team, and supervision of medication within the institution. The institution thereby shifts from a passive posture, in which it waits for students to report once their condition has become severe, to a proactive posture in recognising tuberculosis risk, as emphasised in work on latent infection screening in boarding schools [Ananto et al., \(2024\)](#) and in reviews of diagnostic delay in tuberculosis ([Storla et al., 2008](#)). The pathway is presented in figure 6.

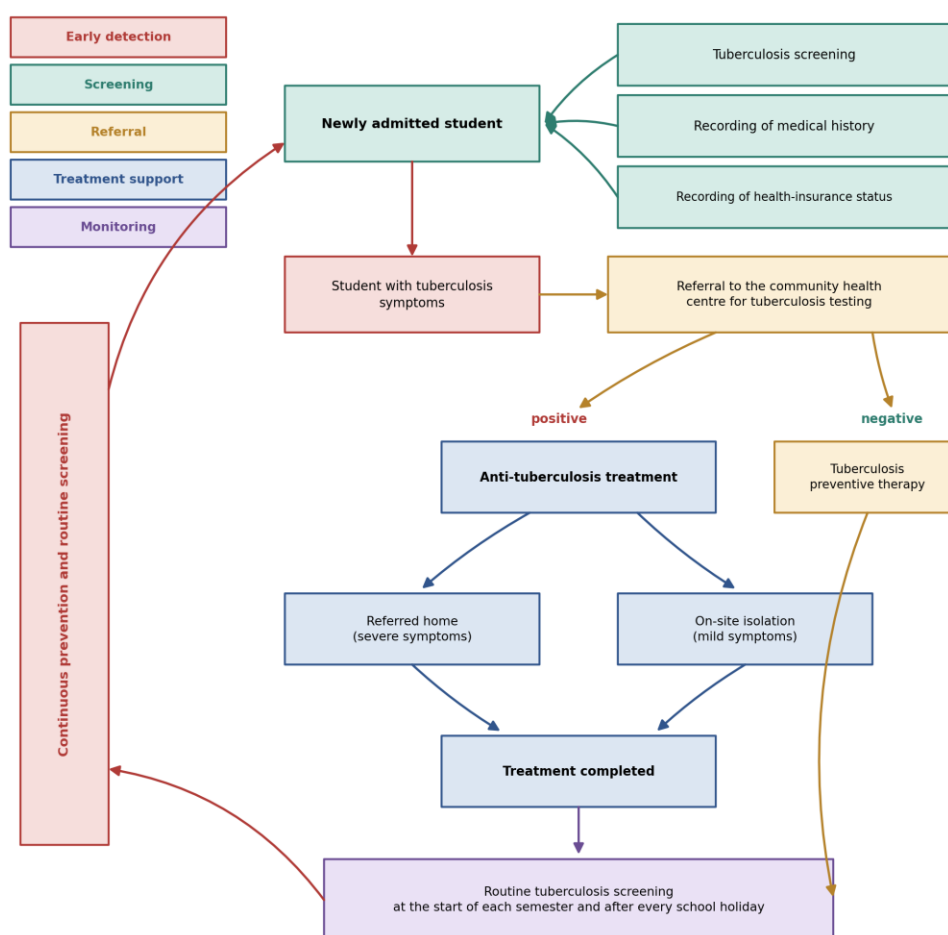


Figure 6. Operational flow of the BREATHE programme

The design of the model and programme is supported theoretically by the Conceptual Framework of Access to Health Care ([Levesque et al., 2013](#)), which treats service accessibility as the product of an interaction between the characteristics of the health system and the abilities of individuals to reach and use services. Read through this framework, the six BREATHE components map onto the dimensions of access in an institutionally specific way: governance capacity and health system integration operate on the approachability and availability of services; the Santri Care Team operates on the ability to perceive and to seek care; anti-stigma work operates on acceptability; and environmental control operates on the conditions that generate need in the first place. This mapping constitutes the theoretical contribution anticipated in the introduction, namely the specification of the residential educational institution as an intermediate supply-side actor within the access framework, and it answers the third research question by showing how the empirical findings can be assembled into an implementable system rather than a list of recommendations.

The final stage of development produced a standard operating procedure prototype as technical guidance for implementation, covering early detection, screening, referral, treatment and monitoring, so that implementation can proceed in a structured, consistent and standardised manner. Although the application of standard operating procedures in educational institutions faces challenges relating to the knowledge, attitudes and compliance of those responsible for enforcing them (Ahmad et al., 2024), implementation can nonetheless proceed through socialisation, training for caregiving staff and periodic evaluation, as demonstrated by capacity-building work with the caregivers of Islamic boarding schools in the same regency (Krisniawati et al., 2025). A comprehensive approach of this kind allows the resulting programme to be simultaneously evidence-based, contextual and applicable to the real needs of Islamic boarding schools.

CONCLUSION

This study concludes that the management of Islamic boarding schools in handling tuberculosis can be optimised through the development of the BREATHE programme, constructed systematically from the integration of quantitative and qualitative data. At the problem identification stage, most students had poor knowledge (54.3 %), held attitudes almost evenly divided between positive (50.7 %) and negative (49.3 %), and reported prevention practices that tended to be good (56.5 %), while environmental conditions were characterised by high occupancy density and ventilation that was available but not used routinely. The qualitative exploration revealed that the problem is multidimensional, involving limited governance marked by the absence of a tuberculosis standard operating procedure, weak human resource capacity, physical environmental risk, disease-related stigma and constrained financing. On the basis of these findings, a conceptual BREATHE model was developed that integrates governance strengthening, human resource capacity building, environmental risk control, psychosocial protection, a detection-to-treatment pathway and health system integration, subsequently operationalised through a programme design and a standard operating procedure prototype aligned with national guidance and adapted to the institutional context. The programme is recommended for adoption by Islamic boarding schools as a tuberculosis prevention policy and standard operating procedure, reinforced through sustained collaboration with district health offices and community health centres, and adopted by policymakers as a model for healthy boarding school development. The BREATHE model has the potential to be replicated in other residential educational settings with a high risk of disease transmission, and further research is recommended to test the effectiveness of its implementation.

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DECLARATIONS

Author contribution

Bella Wiranti: data curation, writing-original draft preparation and editing, conceptualization, **Arih Diyaning Intiasari:** methodology, **Dwi Sarwani Sri Rejeki:** validation, visualization, supervision, software.

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