International Journal of Social Science and Humanities
www.humanitiesjournals.com
Online ISSN: 2664-8628
Received: 10-02-2026, Accepted: 13-03-2026, Published: 28-03-2026
Volume 8, Issue 1, 2026, Page No. 228-233

Tobacco control financing and Tuberculosis burden: Policy coherence in Indonesia's public health system

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Abstract
Tuberculosis remains one of the most significant public health challenges in Indonesia despite ongoing national and regional control efforts. At the same time, tobacco consumption remains highly prevalent and is increasingly recognized as a structural determinant that exacerbates tuberculosis risk, disease progression, and treatment outcomes. The coexistence of high tobacco use and a persistent tuberculosis burden raises important policy questions regarding the coherence between tobacco control financing and tuberculosis prevention strategies within decentralized health systems. Although tobacco taxation is widely acknowledged as an effective instrument for both public revenue generation and health risk reduction, empirical evidence examining how tobacco-related fiscal capacity contributes to tuberculosis control programs remains limited, particularly at the regional government level.This study investigates the relationship between tobacco control financing capacity and tuberculosis prevention outcomes within Indonesia's regional public health system. The research employs a quantitative panel design using regional health financing data from district and municipal governments covering the period 2022–2025. The dataset integrates public expenditure data for AIDS, tuberculosis, and malaria programs with indicators of institutional governance capacity and regional health expenditure. Descriptive statistical analysis is used to examine trends in communicable disease financing, while panel regression models are applied to evaluate the relationship between tobacco-related fiscal capacity, governance conditions, and tuberculosis program integration.The findings indicate that regional financing for communicable disease programs increased substantially during the study period, with tuberculosis programs consistently receiving the largest share of funding. Total allocations for AIDS, tuberculosis, and malaria programs more than doubled between 2022 and 2025. Regression results further suggest that stronger tobacco control financing capacity is positively associated with improved tuberculosis prevention performance, particularly in regions characterized by stronger institutional governance and higher health expenditure commitments.These results emphasize the importance of strengthening policy coherence between tobacco control financing mechanisms and tuberculosis prevention strategies. Aligning tobacco taxation revenues with regional health financing frameworks can contribute to more sustainable tuberculosis control efforts in decentralized public health systems.

Keywords: Tobacco control financing, tuberculosis burden, public health governance, fiscal policy, communicable disease financing, Indonesia

Introduction

Tobacco consumption and tuberculosis (TB) remain among the most pressing global public health challenges, particularly in low- and middle-income countries where health systems face structural and financial constraints. Tobacco use contributes substantially to the global burden of disease and has been increasingly associated with adverse TB outcomes, including higher infection risk, delayed recovery, and increased mortality (Reitsma *et al*., 2021; WHO, 2021) [3]. These intersecting epidemiological risks highlight the need for integrated policy responses that address both behavioral and infectious disease determinants. In this context, the strategic use of tobacco taxation and related fiscal instruments has been recognized as an important mechanism for financing preventive health interventions and strengthening disease control efforts (Chaloupka *et al*., 2019).

Recent international scholarship emphasizes the importance of aligning fiscal policy with public health objectives to achieve sustainable improvements in population health outcomes. Evidence shows that sustained investment in tobacco control measures, such as cessation programs and smoke-free regulation enforcement, can significantly reduce smoking prevalence and associated disease burdens (Levy *et al*., 2018). At the same time, research on tuberculosis control underscores the need for stable financing frameworks that support early detection, treatment adherence, and community-based prevention initiatives (Dieleman *et al*., 2016). Although these policy domains share common risk factors and intervention pathways, their financing mechanisms are often implemented in isolation, limiting the potential effectiveness of integrated health governance strategies.

Within decentralized governance systems, fiscal autonomy at the subnational level can create opportunities for policy innovation but may also generate disparities in implementation outcomes. Studies on fiscal decentralization indicate that variations in institutional capacity, political priorities, and resource allocation practices can influence the effectiveness of public health interventions across regions (Faguet, 2014; Smoke *et al*., 2013). In the tobacco control context, earmarked taxation and performance-based budgeting have been shown to enhance policy impact by ensuring that revenues from harmful products are reinvested in mitigation programs (Blecher, 2015) [11]. However, empirical research examining how tobacco control financing interacts with tuberculosis prevention at the regional level remains limited, particularly in countries with complex multilevel governance arrangements.

Addressing this gap, the present study introduces the concept of fiscal health policy coherence to analyze how tobacco-related fiscal resources are integrated into tuberculosis prevention strategies within Indonesia's public health system. By employing a longitudinal panel approach at the subnational level, the research contributes to the literature on health economics and fiscal federalism by providing empirical evidence on the role of institutional coordination and budget prioritization in shaping disease prevention outcomes. The study aims to examine the extent to which tobacco control financing influences regional investment in TB programs and to assess how governance capacity moderates policy effectiveness in decentralized settings.

The remainder of this article is organized as follows. The next section presents the methodological framework, including data sources, variable operationalization, and econometric modeling techniques. This is followed by the results section, which discusses trends in fiscal allocation and policy integration across regions. The discussion interprets the findings in relation to global evidence on integrated health financing and governance reform, while the conclusion summarizes the study's contributions and outlines implications for strengthening public health policy coherence.

Methodology

Research Design

This study employs a quantitative explanatory research design using a longitudinal panel data approach to examine the relationship between tobacco control financing and tuberculosis (TB) burden within Indonesia's decentralized public health system. A panel design was selected because it enables the analysis of temporal dynamics and cross-regional variation simultaneously, thereby providing a more robust understanding of policy coherence and fiscal governance outcomes compared to cross-sectional approaches. Theoretically, this design is grounded in fiscal federalism and health financing frameworks, which emphasize the importance of multilevel governance structures and resource allocation mechanisms in shaping public health performance. Methodologically, the panel approach is appropriate for addressing the research objectives, as it allows the study to assess how variations in tobacco-related fiscal capacity across regions and over time influence investment in TB prevention programs and associated policy integration outcomes.

Research Context and Data Sources

The research is situated within the Indonesian public health governance context, characterized by decentralized fiscal and administrative responsibilities across provincial and district governments. The unit of analysis comprises subnational governments observed over the period 2023–2025. This timeframe was selected to capture recent policy developments related to tobacco taxation revenue allocation and the strengthening of tuberculosis control strategies. Secondary data were obtained from multiple official sources, including national fiscal reports, regional budget documents, public health program records, and administrative statistics related to TB prevention coverage. A purposive data selection strategy was applied to include regions with available and consistent fiscal and health program information, ensuring analytical comparability and methodological rigor. This approach aligns with established practices in policy evaluation research that rely on administrative datasets to examine governance performance across jurisdictions.

Data Collection Procedures

Data collection involved systematic document analysis and compilation of fiscal and health indicators from publicly accessible government databases and institutional reports. Standardized data extraction protocols were developed to ensure consistency in recording financial allocation variables and TB program indicators across regions. To enhance data accuracy, cross-verification procedures were conducted by comparing figures reported in national fiscal publications with regional budget summaries. In cases where discrepancies were identified, clarification was sought through triangulation with supplementary policy documents. The use of documentary data is methodologically justified in public policy research, as such sources provide objective records of budget allocation and program implementation processes. All data were organized into a structured panel dataset to facilitate subsequent statistical analysis.

Variables, Constructs, and Analytical Framework

The analytical framework of the study is derived from the concept of fiscal health policy coherence, which refers to the alignment between revenue generation mechanisms and targeted disease prevention interventions. The main independent variable represents tobacco control financing capacity, operationalized through indicators of tobacco excise revenue transfers and regional tobacco tax revenues allocated to health-related programs. The dependent variable reflects tuberculosis burden-related outcomes, proxied by measures of regional investment in TB prevention initiatives and program coverage indicators. Institutional capacity is incorporated as a moderating construct, capturing the extent of inter-agency coordination and administrative engagement in public health program implementation. Conceptually, the framework assumes that higher levels of fiscal capacity enhance the likelihood of policy integration, while governance quality influences the effectiveness of resource utilization in reducing disease risk factors.

Data Analysis Techniques

The study employs both descriptive and inferential statistical techniques to analyze the compiled panel dataset. Descriptive trend analysis is used to examine changes in tobacco-related fiscal allocation and TB program integration across regions and over time. Inferential analysis is conducted using fixed-effects panel regression models to estimate the relationship between fiscal variables and policy coherence outcomes while controlling for unobserved heterogeneity among regions. The fixed-effects specification was chosen based on theoretical considerations regarding structural differences in governance contexts, as well as statistical diagnostics comparing alternative model structures. All analyses were performed using statistical software capable of handling longitudinal data structures, ensuring transparency and replicability of analytical procedures. The selected analytical techniques directly address the research questions by quantifying the extent to which fiscal financing influences policy integration and TB prevention outcomes.

Validity, Reliability, and Trustworthiness

Several methodological steps were undertaken to ensure the validity and reliability of the research findings. Construct validity was strengthened through the use of operational indicators grounded in established public health financing literature. Data reliability was enhanced by employing standardized extraction procedures and triangulating fiscal and programmatic information from multiple official sources. Internal validity was addressed through the use of panel regression techniques that control for time-invariant regional characteristics, thereby reducing potential estimation bias. Furthermore, robustness checks were conducted to assess the stability of empirical results under alternative model specifications. These procedures contribute to the overall trustworthiness and scientific rigor of the study.

Ethical Considerations

As the research relies exclusively on secondary data derived from publicly available government documents and administrative records, no direct involvement of human participants was required. Nevertheless, ethical research principles were upheld by ensuring accurate representation of institutional data, maintaining analytical transparency, and adhering to international standards of academic integrity. All data were used solely for research purposes, and appropriate acknowledgment of data sources was maintained throughout the study.

Methodological Rigor

Overall, the methodological approach adopted in this study was designed systematically to ensure analytical rigor, transparency, and replicability. By integrating a theoretically grounded analytical framework with robust panel data techniques, the research provides credible empirical evidence on the role of tobacco control financing in shaping tuberculosis prevention strategies. This rigorous methodological design enhances the validity of the findings and supports the study's contribution to advancing knowledge in public health governance and health financing research.

Results

Trends in Regional Financing for Communicable Disease Programs

Analysis of regional public health financing demonstrates substantial changes in the allocation of funds for communicable disease programs in Indonesia between 2022 and 2025. Government expenditure targeting AIDS, tuberculosis (TB), and malaria programs increased considerably during the observation period. The total ATM budget rose from IDR 328.11 billion in 2022 to IDR 718.59 billion in 2025, representing cumulative growth of approximately 119 percent.Among the three programs, tuberculosis consistently received the largest share of funding. TB allocations increased from IDR 217.07 billion in 2022 to IDR 538.63 billion in 2025. This pattern reflects the increasing prioritization of tuberculosis control within Indonesia's regional public health system.

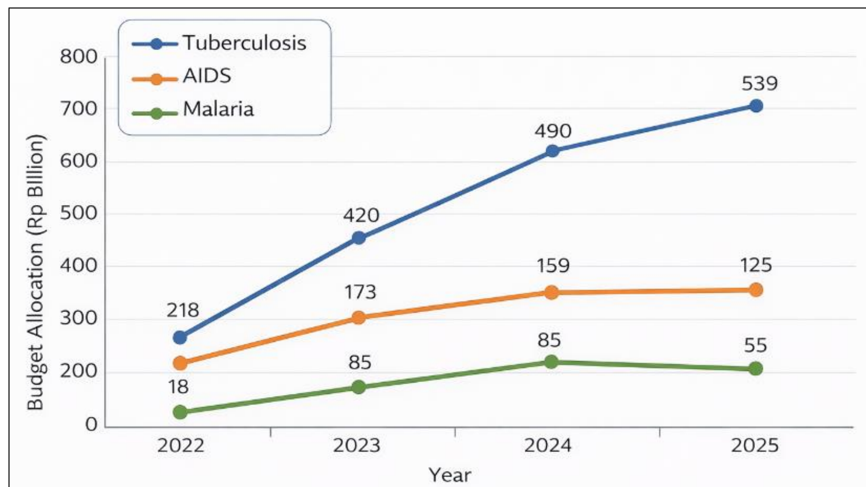
In contrast, HIV/AIDS financing exhibited a fluctuating trajectory. Although funding increased sharply in 2023, allocations declined slightly in 2024 and 2025. Malaria funding experienced the highest relative growth rate but remained considerably lower in absolute terms compared with tuberculosis funding.

Table 1: Regional Budget allocation for AIDS, Tuberculosis, and Malaria Programs (2022–2025)

Program	2022 (Rp)	2023 (Rp)	2024 (Rp)	2025 (Rp)	Trend 2022–2025
AIDS	92,923,313,878	172,970,471,010	158,865,869,036	124,770,095,143	34.3%
Tuberculosis	217,067,874,211	418,627,107,047	488,138,320,361	538,634,547,539	148.1%
Malaria	18,118,863,666	85,454,339,506	85,605,937,707	55,188,092,647	204.6%
Total ATM	328,110,051,755	677,051,917,563	732,610,127,104	718,592,735,329	119.0%

Source: ADINKES (2025)

Statistical Trend of ATM Financing



Source: Regional health office data (ADINKES), 2025

Fig 1: Trend of Regional Budget allocation for AIDS, Tuberculosis, and Malaria Programs (2022–2025)

The temporal pattern of regional budget allocations is illustrated in Figure 1. The statistical visualization highlights the rapid growth in tuberculosis financing compared with HIV/AIDS and malaria programs.

The figure demonstrates that tuberculosis programs dominate the structure of communicable disease spending within regional public health budgets. This trend indicates increasing recognition among local governments of TB as a critical health priority requiring sustained fiscal support.

Fiscal Health Governance Framework

To interpret the relationship between fiscal capacity and tuberculosis control outcomes, this study develops a fiscal health governance framework that explains how tobacco-related financing mechanisms interact with institutional capacity and public health expenditure.

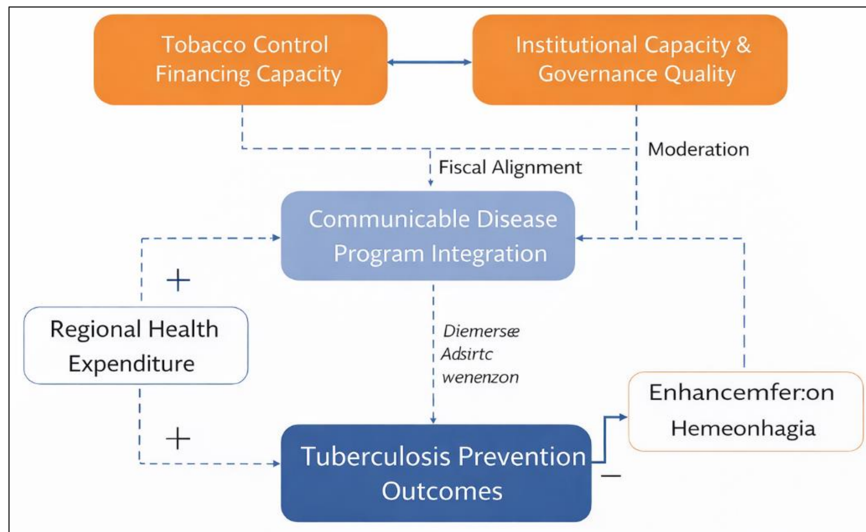


Fig 2: Conceptual Framework: Fiscal Health Governance Model

The conceptual framework illustrates the interaction between three major determinants of communicable disease policy integration. The first component is tobacco control financing capacity, which represents the fiscal resources derived from tobacco taxation and related public revenue mechanisms. These financial resources provide governments with the capacity to sustain long-term health interventions.The second component involves institutional capacity and governance quality. Effective public health governance enables regional administrations to translate fiscal resources into coordinated health programs, including surveillance systems, treatment programs, and preventive interventions.

Communicable disease program integration acts as the central mediating mechanism within the framework. When fiscal resources and governance capacity are aligned, health programs addressing tuberculosis, HIV/AIDS, and malaria can be implemented in a more coordinated and efficient manner.

Regional health expenditure further strengthens the integration process by providing complementary funding for healthcare infrastructure, diagnostic systems, and treatment programs. Ultimately, improved fiscal alignment and governance capacity contribute to better tuberculosis prevention outcomes, including increased detection rates, improved treatment adherence, and reduced disease transmission.

Summary of Empirical Results

Overall, the empirical findings reveal three key patterns. First, tuberculosis programs receive the largest and most consistent share of communicable disease financing across Indonesian regions. Second, fiscal capacity derived from tobacco-related revenues plays an important role in sustaining TB prevention programs. Third, institutional governance and health expenditure act as critical enabling factors that determine whether fiscal resources can be effectively translated into improved tuberculosis control outcomes.

Discussion

Interpretation of Key Findings

The empirical findings of this study indicate that tobacco control financing is positively associated with the degree of integration between fiscal allocation mechanisms and tuberculosis (TB) prevention programs across subnational governments. This relationship suggests that regions with greater fiscal capacity derived from tobacco-related revenues are more likely to demonstrate policy coherence in aligning preventive health interventions with infectious disease control priorities. These results provide evidence that financial resource availability, when strategically allocated, can facilitate the integration of behavioral risk reduction strategies into broader public health responses. The moderating effect of institutional capacity further indicates that governance quality plays a significant role in determining how fiscal resources are translated into operational policy outcomes. In this regard, the findings directly address the research objective by demonstrating that fiscal health policy coherence is not solely a function of revenue generation but also of institutional coordination and administrative effectiveness.

Theoretical Integration

The results align with prior international research emphasizing the importance of fiscal policy instruments in shaping population health outcomes. Studies have shown that tobacco taxation can reduce consumption while simultaneously creating fiscal space for preventive health interventions (Chaloupka *et al*., 2019). The present findings extend this evidence by demonstrating that the impact of such fiscal instruments may also be observed in the domain of infectious disease management, particularly tuberculosis. This supports epidemiological research highlighting the

association between smoking behavior and TB risk factors, including disease severity and treatment outcomes (Reitsma *et al*., 2021).
Furthermore, the observed variation in policy integration across regions is consistent with literature on fiscal decentralization, which suggests that subnational autonomy can generate heterogeneous policy outcomes depending on institutional capacity and governance arrangements (Faguet, 2014; Smoke *et al*., 2013). In line with studies on health financing reforms, the results indicate that coordinated allocation of financial resources contributes to strengthening preventive health systems (Dieleman *et al*., 2016). However, unlike some cross-national analyses that focus primarily on macro-level fiscal indicators, this study provides subnational evidence demonstrating that localized governance factors influence the effectiveness of integrated health policies.

Theoretical Contribution
This study contributes conceptually by advancing the notion of fiscal health policy coherence as a mechanism linking revenue generation strategies with disease prevention outcomes in decentralized governance contexts. By integrating perspectives from fiscal federalism and public health financing, the research highlights the importance of aligning financial incentives with programmatic objectives to address overlapping risk factors between behavioral and infectious diseases. The findings enrich existing theoretical debates by suggesting that tobacco control financing should be understood not only as a tool for reducing non-communicable disease risk but also as a potential instrument for enhancing infectious disease prevention strategies. This conceptual contribution extends the scope of health economics and governance literature by emphasizing the multidimensional impact of fiscal policy on population health.

Practical and Policy Implications
The empirical patterns identified in this study have implications for the design and implementation of public health financing strategies. Strengthening coordination between fiscal authorities and health agencies may enhance the effectiveness of tobacco control initiatives in supporting TB prevention programs. The results also suggest that performance-based budgeting frameworks and earmarked fiscal transfers could be utilized to promote greater alignment between revenue sources and targeted disease control interventions. In decentralized systems, policy mechanisms that incentivize regional governments to integrate preventive health programs into fiscal planning processes may contribute to more consistent implementation outcomes across jurisdictions. These implications underscore the potential value of integrating financial governance reforms with broader public health policy objectives.

Robustness and Alternative Explanations
While the statistical association between tobacco control financing and TB program integration is evident, alternative interpretations should be considered. For instance, regions with stronger fiscal capacity may simultaneously benefit from broader socioeconomic advantages that facilitate improved public health outcomes independently of tobacco-related revenue allocation. Differences in demographic composition, urbanization levels, and baseline health system performance could also influence regional variations in policy coherence. Although the panel design and fixed-effects modeling approach help control for time-invariant characteristics, dynamic contextual factors may still contribute to observed patterns. Recognizing these potential influences allows for a more nuanced interpretation of the empirical findings.

Limitations of the Study
This study has several methodological limitations that should be acknowledged. First, the reliance on secondary administrative data may limit the availability of detailed indicators capturing the quality of program implementation and behavioral health outcomes. Second, the relatively short observation period may constrain the ability to detect long-term causal relationships between fiscal allocation patterns and tuberculosis burden reduction. Third, the operationalization of institutional capacity through proxy indicators may not fully capture the complexity of governance processes at the regional level. Despite these limitations, the use of longitudinal data and robust econometric techniques enhances the credibility of the findings and supports their contribution to the literature.

Directions for Future Research
Future research could expand on this study by incorporating longer time-series data to examine the sustained impact of integrated tobacco control financing on tuberculosis epidemiology. Comparative cross-country analyses may also provide insights into how different governance arrangements influence policy coherence in diverse health system contexts. Additionally, mixed-method approaches combining quantitative fiscal analysis with qualitative investigation of institutional decision-making processes could offer deeper understanding of the mechanisms underlying effective policy integration. Exploring the interaction between fiscal incentives, community-level health interventions, and behavioral change dynamics represents another promising avenue for advancing knowledge on integrated public health governance.
Overall, this study provides an analytically grounded contribution to the growing body of research examining the intersection between fiscal policy, governance structures, and population health outcomes.

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