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Investigating the Role of Health Expenditure on Tuberculosis Incidence in Indonesia

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Abstract

Tuberculosis has remained a persistent Indonesia health problem. With multiple government and donor initiatives to eradicate TB and its detrimental effects on Indonesia's health outcomes, the incidence of TB in Indonesia is still worsening. This study aimed to investigate the impact of health expenditure on TB incidence in Indonesia, which is one of the countries with the highest TB incidences globally. The method used is (Autoregressive Distributed Lag) to employ short-run and long-run effects using time series data from Indonesia from 2000 to 2021. The Findings demonstrate a significant inverse relationship between health expenditures (both public and private) and the incidence of tuberculosis. Increased public spending on healthcare is associated with a lower incidence of TB, both in the short and long term. Similarly, private health spending significantly contributes to TB reduction, with effects observed both immediately and over the long run. Furthermore, other variables also affect TB incidence. Higher Gini coefficients and unemployment rates are associated with increased TB incidence, while higher rates of BCG immunization and greater public effectiveness are associated with lower TB incidence.

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INTRODUCTION

Tuberculosis (TB) remains one of the most persistent global health challenges, affecting millions of people annually. In 2020, TB caused approximately 1.5 million deaths, including 214,000 among individuals with HIV, making it the 13th leading cause of death worldwide and the second leading cause of death from infectious diseases after COVID-19 (WHO, 2021b). Each year, more than 10 million people are exposed to TB, and the number of cases has been rising since 2021 (WHO, 2022). According to WHO, the highest TB burden in 2020 and 2021 was recorded in India, Indonesia, and the Philippines (WHO, 2022).

Indonesia, in particular, faces a severe TB crisis, ranking second globally in TB incidence, accounting for 9.2% of global TB cases (WHO, 2022). In 2021, the country reported a 17% increase in TB cases, reaching 969,000 cases—equivalent to one new case every 33 seconds—resulting in an incidence rate of 354 per 100,000 people (Chakaya et al., 2021). Furthermore, WHO's 2022 Global TB Report estimated that TB-related deaths in Indonesia reached approximately 144,000 per year.

Beyond its devasting health impact, TB also poses a significant economic burden. According to WHO, the overall annual cost of TB in Indonesia is US $6.9 billion, including the loss of productivity because of illness and premature death (WHO, 2023). Additionally, households face a direct financial burden due to out-of-pocket healthcare expenses, further straining the country's healthcare system (Hafez et al., 2020).

Recognizing TB as a significant public health issue, the Indonesian government incorporated TB incidence reduction targets into its 2020–2024 National Medium-Term Development Plan (RPJMN). However, despite setting a target of 272 cases per 100,000 population in 2020, Indonesia reported 312 cases per 100,000 population that year, followed by another unmet target in 2021 (Chasmir et al., 2023). The government's subsequent target of 190 cases per 100,000 population by 2024 raises concerns about the effectiveness of current strategies (Chasmir et al., 2023).

Indonesia's health expenditure per capita has increased over time, with contributions from both the public and private sectors, as shown in Figure 1. A sharp increase in public health expenditure was observed in 2020–2021, largely driven by the COVID-19 pandemic. However, Indonesia has exhibited a slower growth trend in health spending compared to the average for lower-middle-income countries and remains significantly behind upper-middle-income countries over the past two decades (WHO, 2021a). For instance, in 2014, Indonesia's per capita health expenditure was lower than that of Malaysia, Thailand, and Vietnam. While this may indicate lower investment in healthcare, it could also be influenced by the relatively lower cost of healthcare services in Indonesia (Mahendradhata et al., 2017).

Furthermore, public health spending remains lower than private spending, with out-of-pocket (OOP) payments accounting for a substantial portion of healthcare costs. OOP refers to medical expenses paid directly by patients and not covered by insurance, which has been shown to significantly hinder healthcare access (Onah & Govender, 2014). As a result, access to healthcare, particularly for TB treatment, may be compromised. A similar pattern is observed in India, which has the highest global TB incidence and total health spending below the average for lower-middle-income countries (WHO, 2021a). A comparable situation exists in Myanmar, where total health expenditure is among the lowest in the region at USD 26.66, yet the country has one of the highest TB burdens. In 2015, Myanmar also recorded the highest out-of-pocket healthcare expenses in the ASEAN region (Myint, Pavlova, & Groot, 2019).

Health expenditure plays a critical role in improving public health by increasing access to medical services, supporting disease prevention efforts, and ensuring effective treatment (Ministry of Health, 2022). Several studies have demonstrated that higher health spending contributes to expanded healthcare access, including the availability of more medical facilities, essential medical equipment, and improved hospital standards (Anwar et al., 2023). The WHO also emphasizes that health expenditures reflect investments in health resources, access, and services, including nutrition.

Increased health expenditure is particularly relevant for TB control efforts, as it supports key activities such as early detection, accurate diagnosis, treatment adherence programs, and improved access to healthcare services, all of which directly impact TB incidence (Behlül & Özdal, 2022). Preventative health services, including screening tests, are essential in reducing disease incidence, and adequate funding for these services enhances both public health outcomes and financial stability (Behlül & Özdal, 2022). Conversely, insufficient funding for infection prevention programs has been shown to negatively affect disease control efforts, as evidenced by setbacks in TB and HIV prevention in Europe (O'Riordan, 2015).

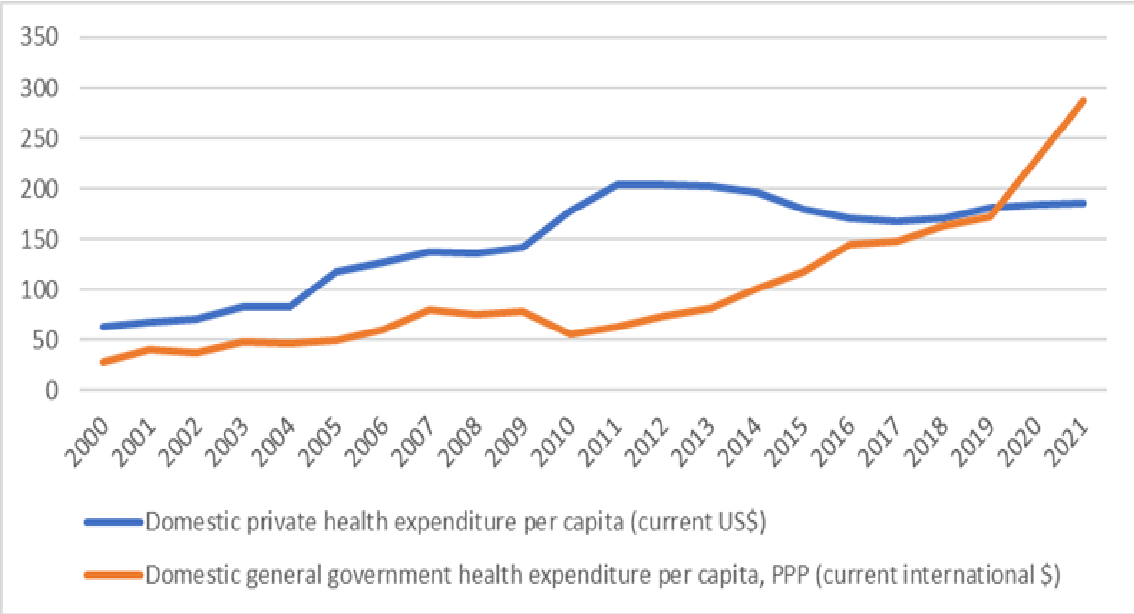

Figure 1. Trend of Health Expenditures Indonesia 2000-2021
Sources: World Development Indicator, 2024 (Processed

Assessing the true impact of health expenditures presents significant challenges. According to the Public Health Agency of Canada (2021), public health investments often require substantial upfront costs, while their benefits may only become apparent in the long term. In Indonesia, evaluating health spending is particularly complex due to challenges in planning and budgeting, which affect the measurement of spending performance (Ministry of Health, 2022). The benefits of these investments take time to materialize (Masters et al., 2017). This phenomenon is evident in studies analyzing the delayed impact of health investments, such as school-based health promotion programs, which yield the most significant benefits in late adulthood (OECD, 2010). This underscores the importance of considering long-term effects when assessing the effectiveness of health spending interventions (Thornton, 2011; Lichtenberg, 2024).

This analysis examines the role of health expenditures in Indonesia, focusing on both public and private spending. Public health expenditures include government internal transfers and grants, government subsidies to voluntary schemes, and social health insurance contributions. Private domestic sources consist of revenues from households, corporations, and non-profit organizations (WHO, 2021). This study employs incidence measurement, which tracks new cases as a more sensitive approach to understanding the dynamics driving TB incidence and the effectiveness of control measures, as opposed to prevalence, which reflects the total disease burden (Katushabe et al., 2024).

Although limited research directly explores the relationship between health expenditure and TB incidence, studies in other contexts provide valuable insights. Research on China, for instance, indicates that increased public health expenditure contributes to a decline in TB incidence (Liu et al., 2020). Similarly, ASEAN countries with higher per capita health expenditures generally exhibit declining TB incidence trends (Shanmuham et al., 2022). However, findings on the broader relationship between health expenditure and general health outcomes remain inconclusive (Brown, 2014; Manyika et al., 2019; Dhrifi, 2020; Li & Yuan, 2019). For example, a study in Nigeria using the ordinary least squares (OLS) method found that private health spending was associated with lower neonatal, child, and infant mortality rates, whereas government health expenditure per capita showed a positive correlation with these indicators (Olayiwola et al., 2020). Conversely, research by Rezapour et al. (2019) analyzing countries by income level found no significant impact of private health spending on health outcomes.

This study employs the Autoregressive Distributed Lag (ARDL) model, which is particularly suitable for analyzing the dynamic relationship between health expenditures and TB incidence in Indonesia. The model controls for key variables, including BCG immunization coverage, unemployment, the Gini ratio, and government effectiveness. The ARDL approach allows for the examination of relationships that may not be immediate, recognizing that healthcare investments often take time to translate into improved health outcomes. This method enables the differentiation of short-term and long-term effects, which is crucial for understanding the nature of these relationships.

This study tests six hypotheses, outlined as follows: H1: The increase in public health spending lowers the incidence of TB immediately; H2: The increase in public health spending lowers the incidence of TB in the long term; H3: The increase in private health spending lowers the incidence of TB immediately; H4: The increase in private health spending lowers the incidence of TB in the long term; H5: Higher coverage of BCG immunization decreses the incidence of TB immediately; H6: Higher coverage of BCG immunization decreses the incidence of TB in the long term; H7: Unemployment rates increase the incidence of TB immediately; H8: Unemployment rates increase the incidence of long term; H9: Gini ratios increase the incidence of TB immediately; H10: Gini ratios increase the incidence of TB in the long term; H11: Government effectiveness positively lowers the incidence of TB immediately; H12: Government effectiveness positively lowers the incidence of TB in the long term.

RESEARCH METHODS

This study adopts the Grossman framework, a widely recognized model where health demand is conceptualized as an investment in health capital. This framework is appropriate as it links health investment to improved health outcomes.

H=F(X) .... (1)

In this equation, H represents health outcomes, while X denotes the inputs influencing the health production function F. Although the Grossman framework is typically applied at the micro-level for analyzing individual health, some studies have extended its application to the macro-level by transforming variables into aggregate forms.

H = F(y,s)... (2)

In this context, h denotes individual health status, y represents independent variables, and ,s denotes other variables that represent socioeconomic and institutional factors.

H = F (y1, y2, ..., yn, s1, s2, ..., sm)............. (3)

where (y1,y2,...,yn=y;s1,s2,...,sm= s1), with n dan m representing the number of variables. In this study, tuberculosis (TB) incidence serves as the health output (h). The independent variables include public health expenditure (y1) and private health expenditure (y2). Control variables are represented by BCG immunization coverage (s1), unemployment rate (s2), the gini ratio (s3) and government effectiveness (s4). Control variables in this study were selected based on their theoretical relevance to tuberculosis dynamics and public health outcomes (Katushabe et al., 2024) (Wang, 2019) (Pelissari et al., 2018).

$$tb_t = \beta 0 + puhe_{t-1} + pvhe_{t-1} + \delta j + Zt + \varepsilon t \quad \text{..(4)}$$

Here, tb_t t represent the TB incidence at time t, where j=1,…n indicates the number of control variables. TB incidence is defined as the estimated number of new and relapsed cases per year, expressed per 100,000 population, encompassing all forms of TB, including cases among individuals living with HIV.

The variable puhe represents public health expenditure, while pvhe denotes private health expenditure, both measured at time t. These are the main variables in the model. Z_t represent control variables, δt denotes the coefficients for control variables, while εt and β_0 are error term and intercept.

Equation (4) transforms variables into natural logarithms to capture elasticity, reduce data skewness, and mitigate heteroskedasticity. This transformation also facilitates the analysis of non-linear and non-monotonic relationships between independent and dependent variables.

$$lntb_t = \beta 0 + lnpuhe_t - i + lnpvhe - i + \delta j + Zt + \varepsilon t \quad \text{..................................(5)}$$

This study also applies the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests on each variable to avoid spurious regressions. Then, Bound Testing is developed first to ensure that the variables have long-run equilibrium. Once the co-integration relationship is established, the next step is the selection lag model using the Schwarz Bayesian Information Criterion (SBIC) and AIC. This study uses ARDL (Autoregressive Distributive Lag) to measure the dynamic effect of each variable and see the existence of a long-run relationship between the variables (Pesaran, M. H., Shin, Y., & Smith, 1999). The ARDL model estimation is as follows:

$$\Delta lntb_t = \alpha_0 + lntb_{t-1} + \alpha_1 ln\, puhe_{t-1} + \alpha_2\, lpvhe_{t-1} + \delta_j Z_{\ t-1} + \sum_{i=1}^{m} \alpha_{4i} \Delta lnmi_{t-1} + \sum_{i=1}^{m} \alpha_{5i} \Delta lnpuhe_{t-1} + \sum_{i=1}^{m} \alpha_{6i}\, \Delta pvhe_{t-1} + \sum_{i=1}^{m} \delta_j Z_{\ t-1} + \varepsilon t \quad \text{.......(6)}$$

where Δ = First-difference operator; α0 = the intercept, i = lag length, εt = error term. Finally, Diagnostic tests are conducted to ensure the validity of ARDL estimation results. The ECM model is estimated as follows:

$$\Delta lntb_t = \gamma_0 + lntb_{t-1} + \gamma_1 ln\, puhe_{t-1} + \gamma_2\, lnpvhe_{t-1} + \delta_j Z_{\ t-1} + \sum_{i=1}^{m} \gamma_{4i} lntb_{t-1} + \sum_{i=1}^{m} \gamma_{5i} \Delta lnpuhe_{t-1}\ \sum_{i=1}^{m} \gamma_{6i} \Delta lnpvhe_{t-1} + \sum_{i=1}^{m} \delta_j Z_{\ t-1} + \gamma_4 ECT_{T-1} + \mu_I \quad \text{......(7)}$$

In that equation, ECT_{T-1} (Error Correction Term) stands for the error correction term that extracted residuals from the regression of the long-run equation. The coefficient γ4 reflects the proportion of TB incidence imbalance corrected in the next period, representing the speed of adjustment, and is expected to have a negative sign.

Table 1. Operational Definition Variable

Objective	Variable	Description
Dependent Variables	Incidence of Tuberculosis	Incidence of TBC (1000 population at risk)
Independent Variables	Public Health Expenditure	Domestic general government health expenditure per capita, PPP (current international $)
	Privat Health Expenditure	Domestic private health expenditure per capita (current US$)
Controls Variables	Immunization of BCG	Immunization, BCG (% of one-year-old children)
	Unemployment Rate	Unemployment, total (% of total labor force) (modeled ILO estimate)
	Gini Ratio	Index Gini
	Government Effectiveness	Government Effectiveness (WB WGI Estimate)

Sources: World Development Indicator, 2024 (Processed)

RESULTS AND DISCUSSION

Table 2 presents the descriptive statistics. The highest recorded TB incidence occurred in 2000, with 370 cases, while the lowest was in 2020, indicating a declining trend. The negative skewness suggests that lower TB incidence values were more frequent, while the kurtosis indicates that extreme TB incidence values were not prevalent. Public health expenditure ranged from 27.99 to 286.96, while private health expenditure varied between 63.61 and 204.38, reflecting significant fluctuations in healthcare spending over different periods. Skewness and kurtosis measurements indicate that public health expenditures exhibit high values, pulling the mean to the right. This trend may be attributed to the substantial increase in public health spending in 2020–2021 during the COVID-19 pandemic. In contrast, private health expenditures show negative skewness, suggesting a predominance of lower values that shift the mean to the left. Additionally, the kurtosis indicates fewer extreme values over the years.

Table 2. Descriptive Statistics

Variable	St.dev	Mean	Min	Max	Skewness	Kurtosis
TBC Incidence	20.34321	341.3182	301	370	-.1920384	1.974387
Public Health Expenditure	66.74544	99.19548	27.99401	286.9634	1.353681	4.187806
Privat Health Expenditure	47.97503	147.6956	63.60616	204.3823	-.5683961	1.929516
Immunization BCG	5.059174	86.5	78	98	.1919614	2.458965
Unemployment rate	1.475633	5.539682	3.59	8.06	.3104341	1.67967
Gini Ratio	3.323874	36.66364	29.5	40.8	-.655985	2.563753
Government Effectiveness	.2637183	-.2112672	-.5964545	.3473631	.7080571	2.667999

Sources: World Development Indicator, 2024 (Processed)

BCG immunization, included as a control variable, has remained relatively stable over the past two decades. A skewness value of 0.19 and a kurtosis of 2.45 suggest that its distribution is nearly symmetrical and close to normal. The unemployment rate reached its lowest point at 3.59% in 2019, while the highest level was recorded at 8.06% in 2007. The skewness of 0.31 suggests that unemployment rates were slightly elevated during certain years. However, the kurtosis indicates that Indonesia has not experienced extreme fluctuations in unemployment over this period.

The Gini ratio exhibits moderate variability, ranging from 29.5 to 40.8. A skewness of -6.65 suggests that inequality is slightly concentrated in higher values, while the kurtosis, which is relatively close to normal, indicates that inequality levels have not fluctuated significantly. Lastly, government effectiveness has shown negative values, with a minimum of -0.59, reflecting lower perceptions of government performance, particularly in 2003. The skewness (0.70) and kurtosis (2.66) suggest that government effectiveness scores have generally remained low without extreme variations.

Table 3. Unit Root Test Result

Variable	ADF			PP		
	statistic (Z_t)	**P-value**	**Order of Cointegration**	**Test-Statistic (Z_t)**	**P-value**	**Order of Cointegration**
TBC Incidence	-8.470	0.0000***	I(1)	-8.847	0.0000***	I(1)
Public Health Expenditure	-5.232	0.0000***	I(1)	-5.164	0.0000***	I(1)
Privat Health Expenditure	-3.393	0.0112**	I(1)	-3.434	0.0099***	I(1)
Immunization BCG	-3.908	0.0020***	I(1)	-3.851	0.0024***	I(1)
Unemployment rate	-4.341	0.0004***	I(1)	-4.381	0.0003***	I(1)
Gini Ratio	-3.516	0.0076***	I(1)	-3.519	0.0075***	I(1)
Government Effectiveness	-6.389	0.0000***	I(1)	-6.232	0.0000***	I(1)

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Sources: World Development Indicator, 2024 (Processed)

Several tests are conducted; the unit root test in this study uses the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods, as shown in Table 3. With a 95% confidence level, all variables exhibit stationarity at I(1).

The Wald test (F-statistic) assesses whether there is a long-term relationship (cointegration) between the variables in the model. The null hypothesis states that there is no cointegration among the variables, while the alternative hypothesis indicates the presence of cointegration.

Table 4. Cointegration Test

Test Statistic	**Value**	**K**
F-Statistic	7.731	6
Significance	I(0) Bounds	I(1) Bounds
10%	2.12	3.23
5%	2.45	3.61
2,5%	2.75	3.99
1%	3.15	4.43

Source: Data Processed, 2024

The cointegration test can be calculated by comparing the F-statistic with the critical F-values (Pesaran H, Shin Y, 2001). Based on Table 5, the calculated F-value is 7.731. This value exceeds the upper bound I(1) at a 1% significance level. Therefore, the null hypothesis is rejected, indicating the existence of a long-term relationship between the independent and dependent variables.

Table 5. Lag selected

ll (null)	ll(model)	Df	AIC	BIC	Selected Length
30.28382	68.00909	13	-110.0182	-96.43939	(1 1 1 1 1 1 0)

Source: Data Processed, 2024

Table 6. Diagnostic Test

Test	Null Hypothesis	Statistics	Conclusion
Durbin-Watson	Has not autocorrelation	2.2204	Null hypothesis accepted
Bgodfrey LM Test	Has not autocorrelation	0.0915	Null hypothesis accepted
Jarque-Bera: Normality Test	Error is normally distributed	0.7633	Null hypothesis accepted
Breusch Pagan Test	Homokedasticity	0.0759	Null hypothesis accepted
White-test	Homokedasticity	0.0397	Null hypothesis accepted
Ramsey RESET test	correct model specification	0.1043	Null hypothesis accepted
CUSUM Test	no structural change (stable)	0.2508	Null hypothesis accepted

Source: Data Processed, 2024

In Table 4, the optimal lag length was automatically selected using the Akaike Information Criterion (AIC), ensuring that each variable was assigned the most appropriate number of lags. The maximum lag was set to 1 to prevent overfitting and mitigate potential multicollinearity while maintaining a parsimonious model.

Following the establishment of the ARDL model, diagnostic tests were conducted, including assessments for autocorrelation, normality, heteroskedasticity, and model specification using the Ramsey RESET and Cusum tests. These tests were essential to ensure the validity and reliability of the model's interpretation. The results confirm that the estimated model is appropriate. As presented in Table 7, no serial autocorrelation or heteroskedasticity was detected. The Jarque-Bera normality test further indicates that the residuals follow a normal distribution, while the Ramsey RESET test confirms that the model is correctly specified. Additionally, the study conducted a stability test using the Cusum test. The results, at a 5 percent significance level, provide no evidence of instability in the estimation, implying that the coefficients remain stable over time

Table 7. The Short-Run Effect Result

Variable	Coefficient	Std. Err.	t	P>|t|
Incidence of Tuberculosis	-3.43816**	.08963611	-3.84	0.005
Public Expenditure	-0,13471**	0,052323	-2,57	0,033
Public Expenditure (lag 1)	-0,15747***	0,038571	-4,08	0,004
Private Expenditure	-0,21891**	0,071301	-3,07	0,015
Private Expenditure (lag 1)	-0,93	-0,93	-0,93	-0,93

Variable	Coefficient	Std. Err.	t	P>|t|
Immunisation BCG	-0,22638	0,123098	-1,84	0,103
Immunization BCG (lag 1)	-0,1626	0,125353	-1,3	0,231
Unemployment	0,021963	0,01277	1,72	0,124
Unemployment (lag 1)	0,034746**	0,009624	3,61	0,007
Ratio Gini	0,685423	0,386891	1,77	0,114
Ratio Gini (lag 1)	0,237964	0,191706	1,24	0,25
Government Effectiveness	0,037749	0,608895	0,62	0,553
_cons	26,78115**	5,600172	4,78	0,001

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Data processed, 2024

The short-term results are presented in Table 7, while the long-term estimations are presented in Table 8. Public health expenditures positively reduce TB incidence in the short and long term. These findings align with previous studies analyzing China, which found that increased public health expenditure per capita was associated with decreased TB incidence (Liu et al., 2020). Similarly, studies in ASEAN countries show that countries with higher health expenditures, Brunei, Singapore, Malaysia, and Thailand, have a lower incidence of TB compared to other ASEAN countries with lower health expenditures (Shanmuham et al., 2022).

The effectiveness of public health expenditure in reducing TB incidence is largely attributed to its emphasis on prevention, particularly through early detection and treatment interventions. In 2020, the allocation for preventive and diagnostic programs amounted to approximately 3,264,393 million and increased to 4,150,838 million in 2021, representing more than 50% of total TB-related spending (Ministry et al., 2023). The National Strategy for Tuberculosis underscores that increased government investment through public financing aims to enhance diagnostic equipment, treatment availability in healthcare facilities, and more intensive outreach efforts (Ministry et al., 2023). This aligns with Imantria and Kurnia (2024), who advocate for prioritizing promotive and preventive programs over curative approaches.

However, the short-term effects of public health expenditure on TB incidence reduction remain relatively small compared to the cumulative long-term impact, despite being statistically significant. Similar findings have been reported in studies analyzing the effect of public health interventions on mortality prevention. These studies suggest that public health spending does not yield immediate results but has a cumulative impact over time (Brown, 2014). Conversely, short-term estimates from the United States indicate that country-level health expenditures contribute to reductions in mortality related to cardiovascular diseases, diabetes, and cancer (Martin et al., 2020).

The impact of increased public health spending on reducing TB incidence becomes more pronounced over the long term. Studies conducted in Canada indicate that public health expenditure is most effective in lowering preventable mortality over extended periods. These findings are further reinforced by comparisons with static panel estimations, which demonstrate a larger long-term impact than static estimates (Ammi et al., 2024; Martin et al., 2020). Other studies support the idea, arguing that health investment has a widespread effect in the long run (Suhrcke et al., 2006). dditionally, mathematical models suggest that reductions in public health spending have led to lower TB case detection and an increased long-term risk of TB resurgence. The decline in public health spending is expected to weaken case detection efforts and treatment effectiveness, ultimately increasing

TB-related mortality, with projections indicating that these effects may persist for over a decade (Reeves et al., 2015; Gianella et al., 2016).

Table 8. The long-run Effect Result

Variable	Coefficient	Std. Err.	t	P>|t|
Public Expenditure	-.0629408***	.0049266	-12.78	0.000
Private Expenditure	-.0498366***	.0110633	-4.50	0.001
Immunisation BCG	-.0555017**	.0249866	-2.22	0.048
Unemployment	.0123769***	.0011709	10.57	0.000
Ratio Gini	.1076011*	.0491131	2.19	0.051
Government Effectiveness	-.0024691	.011248	-0.22	0.830
_cons	25.5674	4.064955	6.29	0.000

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 ; The ARDL model lags selected by the SBIC criterion

Source: Data processed, 2024

Private health expenditures also exhibit a significant negative relationship with TB incidence. In the short run, the impact of private expenditure on TB incidence follows a nuanced pattern. While private expenditure appears effective in immediately lowering incidence by improving healthcare access, its effect diminishes with a one-period lag. This may be attributed to the predominance of out-of-pocket (OOP) payments in Indonesia's private health expenditure (Ministry of Health, 2022), which creates financial barriers to consistent and timely healthcare access (Myint et al., 2019; Rad et al., 2013). These findings align with studies suggesting that private health expenditures are ineffective in the short term (Katushabe et al., 2024).

However, in the long run, private health expenditure has demonstrated effectiveness in reducing TB incidence. Empirical studies corroborate these findings, with research in Uganda showing that private expenditure was more effective in preventing TB over extended periods, while still playing a role in treatment in the short term (Katushabe et al., 2024). Similar results have been observed in a static analysis of eight selected African countries, where private health expenditures significantly correlated with reduced TB incidence (Bein & Coker-Farrell, 2020). Additionally, a study across 25 countries found that private health expenditure contributed to improved health outcomes (Raeesi et al., 2018).

The findings also indicate that the estimated impact of private expenditure is lower than that of public expenditure in both the short and long run, as reflected in statistical comparisons and coefficient magnitudes. Similar studies have reported that public health expenditure exerts a more pronounced effect than private expenditure (Novignon et al., 2012; Akinci et al., 2014; Rad et al., 2013). This disparity may be attributed to the relatively lower contribution of the private sector to public health efforts (Raeesi et al., 2018). Nevertheless, the negative correlation between healthcare investment and TB incidence underscores the role of both short- and long-term healthcare investments in mitigating TB burden.

This study also accounts for factors beyond healthcare expenditure that influence TB incidence. Bacillus Calmette-Guérin (BCG) immunization exhibits an inverse relationship with TB incidence, consistent with previous research (Okafor et al., 2023). This inverse relationship is observed in both the short and long run, albeit with varying statistical significance. Since BCG immunization is designed for sustained protection, its long-term benefits become more apparent over time. These findings align with previous studies indicating that BCG vaccination can reduce TB incidence by approximately 49% over a ten-year period compared to the absence of prevention interventions (Marcus et al., 1997). Additionally, studies analyzing TB coverage in demographically similar regions over a 13-year period reinforce the effectiveness of BCG immunization in preventing TB (Sweeney et al., 2019).

Conversely, the unemployment rate exhibits a significant positive relationship with TB incidence, both in the short run (with a lag) and in the long run, indicating that rising unemployment exacerbates TB incidence. This suggests a delayed effect between variables. Several studies support these findings, highlighting the strong correlation between socioeconomic factors—such as employment status—and TB incidence. Lower income and inadequate nutrition can weaken immunity, increasing susceptibility to TB (Pelissari et al., 2018). Additionally, research has shown that regions with higher unemployment rates are positively associated with TB incidence, as measured by standardized morbidity ratios (SMR) (Tipayamongkholgul et al., 2013).

Similarly, the Gini coefficient, a measure of income inequality, exhibits a positive relationship with TB incidence. A high Gini ratio reflects significant inequality, which may contribute to the spread of TB. Since TB transmission occurs through direct contact between infected and vulnerable individuals, residential segregation can influence transmission patterns by shaping population density and interaction levels. Economically disadvantaged areas, characterized by low-cost housing, limited job access, and high population density, foster increased social interaction, thereby elevating the risk of TB transmission (Chetty et al., 2014; Zhao & Cao, 2020). Supporting this, studies indicate that a 10% increase in the Gini coefficient is correlated with a 4% increase in TB incidence. However, the short- and long-run effects of the Gini coefficient appear inconsistent. Some studies examining the Gini coefficient as a social determinant of pulmonary tuberculosis (PTB) found varying correlations across different groups and regions. The authors suggest that income inequality may be more closely linked to the quality of healthcare services rather than serving as a direct social determinant of TB (Zille et al., 2019). This supports the notion that healthcare services might have a more immediate impact on TB incidence than broader socioeconomic determinants in the long term

CONCLUSION

Health expenditure acts as an important prerequisite for healthcare performance. The studies investigated the dynamic effect of health expenditure on health outcomes using the incidence of TB as a proxy in Indonesia. The study contributes to the body of literature by studying the impact of health expenditure and socioeconomic and institutional factors on health outcomes in Indonesia. The result confirmed that public health expenditure and private expenditure can reduce the incidence of TB, especially in the long run. The result also revealed the negative signs of immunization and government effectiveness. Other variables, such as the Gini ratio and unemployment rate, positively increased TB incidence.

Although multiple factors influence TB incidence, health investments play a crucial role. Government and private sector support is essential for promoting health through effective spending and well-designed policies. Strengthening the socio-economy aspect, such as lowering the Gini ratio and the unemployment rate, is positively correlated with increases in the incidence of TB. Otherwise, coverage of BCG is also needed to protect individuals and institutions proxied by government effectiveness, which could lower the incidence.

REFERENCES

Akinci F, Hamidi S, Suvankulov F, A. A. (2014). Examining the Impact of Health Care Expenditures on Health Outcomes in the Middle East and North Africa (MENA) Region. *Journal of Healthcare Finance*, *14(1)*(July).

Anwar, A., Hyder, S., Mohamed Nor, N., & Younis, M. (2023). Government health expenditures and health outcome nexus: a study on OECD countries. *Frontiers in Public Health*, *11*(18). https://doi.org/10.3389/fpubh.2023.1123759

Bein, M., & Coker-Farrell, E. Y. (2020). The association between medical spending and health status: A study of selected african countries. *Malawi Medical Journal*, *32*(1), 37–44. https://doi.org/10.4314/mmj.v32i1.8

Brown, T. T. (2014). How effective are public health departments at preventing mortality? *Economics and Human Biology*, *13*(1), 34–45. https://doi.org/10.1016/j.ehb.2013.10.001

Behlül, S., & Özdal, M. A. (2022). Correlation of Trends in the Incidence of Selected Infectious Diseases with Healthcare Expenditures: An Ecological Study. *Cyprus Journal of Medical Sciences*, *7*(3), 365–372. https://doi.org/10.4274/cjms.2021.2021-69

Chakaya, J., Khan, M., Ntoumi, F., Aklillu, E., Fatima, R., Mwaba, P., Kapata, N., Mfinanga, S., Hasnain, S. E., Katoto, P. D. M. C., Bulabula, A. N. H., Sam-Agudu, N. A., Nachega, J. B., Tiberi, S., McHugh, T. D., Abubakar, I., & Zumla, A. (2021). Global Tuberculosis Report 2020 – Reflections on the Global TB burden, treatment and prevention efforts. *International Journal of Infectious Diseases*, *113*, S7–S12. https://doi.org/10.1016/j.ijid.2021.02.107

Chika N. Okafor; Ayesan Rewane; Ifeanyi I. Momodu. (2023) Bacillus Calmette Guerin.

Daniel M. Finkelstein, Jessica F. Harding, Diane Paulsell, Brittany English, Gina R. Hijjawi, and J.N. (2022) 'Economic Well-Being And Health: The Role Of Income Support Programs In Promoting Health And Advancing Health Equity', Government Programs & Policies, 41.

Dhrifi, A. (2020) 'Public Health Expenditure and Child Mortality: Does Institutional Quality Matter?', Journal of knowledge economy, 11, pp. 692–706. Available at: https://link.springer.com/article/10.1007/s13132-018-0567-4.

Gianella, C. et al. (2016) 'TB in vulnerable populations: The case of an indigenous community in the peruvian Amazon', Health and Human Rights, 18(1), pp. 55–68.

Hafez, R., Harimurti, P., & Martin-Hughes, R. (2020). Tuberculosis in Indonesia. *Tuberculosis in Indonesia*. https://doi.org/10.1596/35370

Ilori Isaac, O. S. S., & Adeleye, B. M. (2017). An Empirical Analysis of Public Health Expenditure on Life Expectancy: Evidence from Nigeria. *British Journal of Economics, Management & Trade*, *17*(4), 1–17. https://doi.org/10.9734/bjemt/2017/31783

Imantria, B. and Kurnia, A.S. (2024) 'Economics Development Analysis Journal Does Local Government Expenditure Lead to Human Development in Indonesia?', Economics Development Analysis Journal, 13(2), pp. 235–247. Available at: http://journal.unnes.ac.id/sju/index.php/edaj.

John T. Scholz, M.L. (1998) 'Trust and Taxpaying: Testing the Heuristic Approach to Collective Action', American Journal of Political Science, 42, pp. 398–417.

Katushabe, J., Nnyanzi, J.B. and Muwanga, G.S. (2024) 'Exploring the role of spending on malaria incidence in Uganda using the auto-regressive distributed lag approach', Malaria Journal, 23(1), pp. 1–14. Available at: https://doi.org/10.1186/s12936-024-04929-8.

Li, J., & Yuan, B. (2019) 'Understanding the effectiveness of government health expenditure in improving health equity: Preliminary evidence from global health expenditure and child mortality rate. International Journal of Health Planning and Management', International Journal of Health Planning and Management, 34(4), pp. 1968–1979. Available at: https://ideas.repec.org/a/bla/ijhplm/v34y2019i4pe1968-e1979.html.

Lichtenberg, F. R. (2004). Sources of U.S. Longevity increase, 1960–2001. *The Quarterly Review of Economics and Finance*, *44*(3), 369-389. https://doi.org/10.1016/j.qref.2004.05.005

Liu, J. et al. (2020) 'How investment in public health has impacted the prevalence of tuberculosis in China: A study of provincial variations between 2005 and 2015', International Journal of Health Planning and Management, 35(6), pp. 1546–1558. Available at: https://doi.org/10.1002/hpm.3034.

Mahendradhata, Y. et al. (2017) The Republic of Indonesia Health System Review.

Makuta, I., & Hare, B. O. (2015). Quality of governance , public spending on health and health status in Sub Saharan Africa : a panel data regression analysis. *BMC Public Health*, 1–11. https://doi.org/10.1186/s12889-015-2287-z

Manyika, W. et al. (2019) 'Health Financing: Relationship between Public Health expenditure and maternal mortality in Zimbabwe between the years 1980 to 2010', Medical Journal of Zambia, 46(1), pp. 61–70. Available at: https://doi.org/10.55320/mjz.46.1.229.

Ministry, T. H. E., Health, O. F., & Of, R. (2023). *Revised National Strategy Of Tuberculosis Care And Prevention In Indonesia 2020-2024 And Interim Plan For 2025-2026*.

Ministry of Health. (2022). *Pembiayaan kesehatan*.

Novignon, J., Olakojo, S.A. and Nonvignon, J. (2012) 'The effects of public and private health care expenditure on health status in sub-Saharan Africa: New evidence from panel data analysis', Health Economics Review, 2(1), pp. 1–8. Available at: https://doi.org/10.1186/2191-1991-2-22.

O'Riordan M, F. F. (2015). The impact of economic recession on infection prevention and control. *J Hosp Infect*, *89(4)*(340–5).

OECD. (2010). The impact of interventions. In: Obesity and the Economics of Prevention: Fit Not Fat. https://doi.org/10.1787/9789264084865-14-en

Olayiwola, S.O., Adedokun, A.S. and Olusanya, S.O. (2020) 'Government Health Expenditure and Health Outcomes in Nigeria', Journal of Economics and Policy Analysis *, 5(2), pp. 89–102.

Pelissari, D.M. et al. (2018) 'Identifying socioeconomic, epidemiological and operational scenarios for tuberculosis control in Brazil: An ecological study', BMJ Open, 8(6), pp. 1–10. Available at: https://doi.org/10.1136/bmjopen-2017-018545.

Pesaran, M. H., Shin, Y., & Smith, R.P. (1999) 'Pooled Mean Group Estimation of Dynamic Heterogeneous Panels', Journal of the American Statistical Association, 94(446), pp. 621– 634.

Pesaran H, Shin Y, S.R. (2001) 'Bounds testing approaches to the analysis of level relationships', Journal of Applied Econometrics, 16, pp. 289–326.

Rad, E. H., Vahedi, S., Teimourizad, A., Esmaeilzadeh, F., & Hadian, M. (2013). *Comparison of the Effects of Public and Private Health Expenditures on the Health Status : A Panel Data Analysis in Eastern Mediterranean Countries*. *1*(2), 163–167. https://doi.org/10.15171/ijhpm.2013.29

Raeesi, P. et al. (2018) 'Effects of private and public health expenditure on health outcomes among countries with different health care systems: 2000 and 2014', Medical Journal of the Islamic Republic of Iran, 32(1), pp. 205–209. Available at: https://doi.org/10.14196/MJIRI.32.35.

Reeves, A. et al. (2013) 'Does health spending stimulate economic growth?', Globalization and Health, 9(43), pp. 1–12.

Reeves, A. et al. (2015) 'Tuberculosis control and economic recession: Longitudinal study of data from 21 European countries, 1991–2012', Bulletin of the World Health Organization, 93(6), pp. 369–379. Available at: https://doi.org/10.2471/BLT.14.142356.

Rezapour, A. et al. (2019) 'The effects of health expenditure on health outcomes based on the classification of public health expenditure: A panel data approach', Shiraz E Medical Journal, 20(12). Available at: https://doi.org/10.5812/semj.88526.

Shanmuham, V., Shetty, J.K. and Naik, V.R. (2022) 'Incidence of tuberculosis in the association of South-East Asia Nation (ASEAN) countries and its relation with health expenditure: a secondary data analysis.', Manipal Journal of Nursing and Health Sciences, 8(1). Available at: https://doi.org/10.55889/2582-7979.1040.

Sweeney, E. et al. (2019) 'Impact of BCG vaccination on incidence of tuberculosis disease in southern Ireland', BMC Infectious Diseases, 19(1), pp. 1–5. Available at: https://doi.org/10.1186/s12879-019-4026-z.

Taylor, J.W., Curtis, N. and Denholm, J. (2020) 'BCG vaccination: An update on current Australian practices', Australian Journal of General Practice, 49(10), pp. 651–655. Available at: https://doi.org/10.31128/AJGP-06-20-5490.

Thornton, J. A. (2011). Does more medical care improve population health? New evidence for an old controversy. *Applied Economics*, *43*(24), 3325–3336. https://doi.org/10.1080/00036841003636243

Tipayamongkholgul, M., Podang, J. and Siri, S. (2013) 'Spatial analysis of social determinants for tuberculosis in Thailand.', Journal of the Medical Association of Thailand =

Chotmaihet thangphaet, 96 Suppl 5, pp. 116–121.

Wang, S.K. and J. (2019) 'Does Quality of Government Matter in Public Health?: Comparing the Role of Quality and Quantity of Government at the National Level', Sustainability [Preprint].

WHO (2021a) Global Health Expenditure Database. Available at: https://apps.who.int/nha/database/DocumentationCentre/Index/en.

WHO (2021b) 'Research and Innovation Universal Health Coverage, Social Determinants and Multisectoral Action Tb Financing Global Tuberculosis Report 2021', pp. 2020–2021. Available at: www.who.int/tb.

WHO (2022) Tuberculosis deaths and disease increase during the COVID-19 pandemic. Available at: https://www.who.int/news/item/27-10-2022-tuberculosis-deaths-and-disease-increase-during-the-covid-19-pandemic#:~:text=An estimated 10.6 million people, Organization's 2022 Global TB report.

WHO (no date) Indicator Metadata Registry List. Available at: https://www.who.int/data/gho/indicator-metadata-registry.

WHO. (2023). New World Bank Financing Aims to Strengthen Indonesia's Tuberculosis Response Program.https://www.worldbank.org/en/news/press-release/2023/01/16/new-world-bank-financing-aims-to-strengthen-indonesia-tuberculosis-response-program

Zille, A.I. et al. (2019) 'Social determinants of pulmonary tuberculosis in Brazil: An ecological study', BMC Pulmonary Medicine, 19(1), pp. 1–9. Available at: https://doi.org/10.1186/s12890-019-0855-1.