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# Government Health Spending and Life Expectancy: Evidence from Cities and Districts in Indonesia

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## Abstract

Life expectancy is widely recognized as a fundamental indicator of population health, and its improvement is often linked to government health spending, particularly in decentralized health systems. This study aimed to investigate the relationship between local government health expenditures and life expectancy in decentralized Indonesia. Data from 492 cities and districts, spanning from 2015 to 2019, were analyzed using a two-way fixed effects regression model to control for time-invariant district characteristics and common temporal shocks. The findings indicated that a 10% increase per capita in government health expenditure was associated with a 0.01% increase in life expectancy. This association was established after adjusting for key health system and contextual variables, including physician density, sanitation coverage, poverty rates, and proportion of fiscal transfers from the central government. The association remained strong and statistically significant across all model parameters. The results demonstrated that increased local health expenditure improves population health outcomes.

**Keywords:** fixed effects, health spending, life expectancy, panel data

## Introduction

Life expectancy (LE) is a crucial metric for assessing the health status of a population, as it indicates the average lifespan projected based on current mortality rates.<sup>1</sup> Indeed, it is one of the fundamental global health impact indicators. It is a key measure used for facilitating temporal and geographical comparisons of population health as well as evaluating the effectiveness of health systems to enhance the overall quality of life and societal wellbeing.<sup>1,2</sup>

A wide range of social determinants of health contribute to variations in LE across populations. Key factors include demographic and socioeconomic variables, such as education level, per capita income, poverty rate, labor productivity, and dependency ratio.<sup>3-6</sup> For instance, poverty and dependency ratios have been linked to shorter LE.<sup>4,5</sup> In the low- and middle-income countries, barriers such as access to clean water, sanitation, and effective control of communicable diseases further hinder improvements in LE.<sup>7</sup> In addition, behavioral factors, including smoking, poor diet, and heavy alcohol intake,<sup>6,8</sup> exacerbate the risk of noncommunicable diseases, such as diabetes and obesity, which contribute to premature mortality.<sup>7</sup> Economic factors, including gross domestic product (GDP) per capita and income disparity, are also consistently identified as key determinants of LE across various settings.<sup>6,7</sup> Unemployment rates and economic inequality are determinants that affect the degree to which healthcare spending improves LE.<sup>3</sup> It is noteworthy that the use of renewable energy has helped people live longer.<sup>9</sup>

While social and environmental factors are critical, the health system remains the primary domain for intervention, particularly through investment in strengthening delivery, infrastructure, and human resources for health (HRH). An ecological study at the provincial level in Indonesia found that health physician density and healthcare facilities were positively associated with LE.<sup>10</sup> However, among the health system building blocks, health financing is a fundamental enabler, as it provides the means to sustain essential services, respond to health needs, and improve overall access and quality.<sup>6,9,11</sup> A link between health spending and economic growth has also been established, with some studies suggesting that LE and health expenditures influence each other.<sup>12</sup> Increased health investment improves LE through multiple channels, including better disease prevention, improved access to curative services, enhanced maternal and child health programs, and stronger health infrastructure.<sup>6,9,13</sup>

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While investment in healthcare plays a significant role in improving LE, especially in public health,<sup>14</sup> the level of effectiveness varies considerably among nations. Considering the Organization for Economic Cooperation and Development (OECD) countries, a 1% increase in health expenditure is associated with a 0.02% increase in LE in the United States and a 0.12% increase in Germany, with healthcare spending being more effective in extending male LE than female LE.<sup>15</sup> Another study found that the elasticity was 0.006 in low and middle-income countries and 0.0009 in high-income countries.<sup>16</sup> Increased investment in healthcare is expected to directly and indirectly elevate LE by enhancing nutrition, controlling communicable and noncommunicable diseases, and increasing access to vital healthcare services (e.g., immunization and maternal care).

However, the relationship between health spending and LE is not always straightforward. While a study suggests that investment in healthcare can enhance LE,<sup>17</sup> others argue that expenditures on social protection may have a more significant influence.<sup>8,9,12</sup> Public health expenditure appears to have a more pronounced effect on LE compared to private health spending. However, this effect diminishes when public health spending exceeds 8% of the GDP and also varies across countries.<sup>14</sup>

The above global studies have expanded the understanding of the factors influencing LE worldwide. However, comprehensive empirical studies focusing on the Indonesian context remain limited, especially at the subnational level, where the decentralization of the health sector has placed substantial responsibilities on city and district governments. This study provided empirical evidence by utilizing city and district panel data to investigate the impact of local government health spending on LE. These findings will contribute to the global discourse on health financing in decentralized settings, highlighting the effectiveness of fiscal interventions at the subnational level in improving public health outcomes.

Only a few empirical studies have investigated how health spending affects LE in Indonesia at the city or district levels. Most studies on Indonesia typically analyze data at the provincial level. In contrast, studies focusing on cities or districts are usually limited to one or a few provinces, rather than covering the entire country.<sup>10,18,19</sup> By addressing this gap, this study enhanced the understanding of how local health spending relates to population health and laid the groundwork for the future assessment of spending efficiency to inform the optimal allocation of limited health resources.

Given this background, this study aimed to (a) provide evidence on health spending and LE in Indonesia at the city and district level nationwide, taking into account contextual factors, and (b) generate empirical evidence that can inform policy recommendations for improving population health outcomes in Indonesia. This study enhances the understanding of how local health expenditure relates to population health and lays the groundwork for future assessments of spending efficiency to inform the optimal allocation of scarce health resources. This study furnished substantial empirical evidence about the correlation between local government health expenditure and life expectancy at the subnational level in Indonesia. The findings were expected to help policymakers allocate health resources more effectively to improve population health outcomes. This study also intended to add to the scholarly conversation about decentralized health financing by providing information that could be useful for other countries with comparable systems of government.

## Method

This study used a panel data regression model to examine the effect of government health spending on LE across cities and districts in Indonesia from 2015 to 2019. The two-way fixed effects (TWFE) specification was selected to monitor temporal and interdistrict variations. After excluding cities and districts with missing values for key variables for more than two consecutive years, the final dataset consisted of 2,460 observations, representing 492 cities and districts each year. The study period was chosen to reflect the time after the implementation of the National Health Insurance scheme, when the health financing reform took place, and to exclude the confounding effects of the coronavirus disease 2019 (COVID-19) pandemic, which started impacting Indonesia in early 2020.

This study used data obtained from multiple official databases. The LE and poverty headcount index were obtained from Statistics Indonesia. The LE data were produced by Statistics Indonesia using indirect demographic methods to get the data at the district level. The number of physicians was sourced from the Indonesian Ministry of Health, data on health expenditures from the regional government budget reports accessed from the Indonesian Ministry of Finance website, and household sanitation access from the INDO-DAPOER World Bank database. Fiscal data, including health spending, were sourced from audited government financial reports; however, the quality of reporting may vary across districts due to differences in administrative capacity. These characteristics were taken into consideration in model design and interpretation.

The initial variable selection was achieved by combining theoretical and empirical evidence from existing studies and subsequently applying a correlation test to the independent variables. Before model generation, the variance inflation factor (VIF) and condition index (CI) tests, along with the variance decomposition proportion, were used to assess multicollinearity between variables.<sup>20</sup> The VIF values were below 5, and the maximum CI was 7.38, which was significantly lower than the standard criterion of 30. This indicated that the independent variables exhibited minimal multicollinearity. Furthermore, three prevalent methods were applied to determine the appropriate panel regression model: pooled ordinary least squares (pooled OLS), random effects (RE), and fixed effects (FE).<sup>21</sup>

Both theoretical frameworks and empirical diagnostic assessments were employed to inform model selection. Initially, the authors employed the Breusch–Pagan Lagrange Multiplier test to determine whether the pooled OLS model outperformed the RE panel model. The results indicated strong panel effects (p-value <0.05), suggesting that the panel estimator was the optimal selection. Subsequently, the Hausman test was used to determine the appropriate model between the FE and RE models. While the null hypothesis posited that the RE estimator was consistent and efficient, the alternative hypothesis posited that the RE estimator was inconsistent because of the correlation between unobserved individual effects and regressors. The Hausman test results indicated that the FE model was more suitable in this context (p-value <0.05).

To ensure the robustness of the FE estimates, the authors conducted diagnostic tests for heteroskedasticity and serial correlation using the modified Wald test for groupwise heteroskedasticity in the FE model and the Wooldridge test for serial correlation.<sup>22</sup> Both tests confirmed the presence of serial correlation (p-value <0.05) and heteroskedasticity (p-value <0.05). Accordingly, the final model applied TWFE with standard errors clustered at the district level (Model 6), which corrected for both heteroskedasticity and autocorrelation within the panels. The year (time dummies) was used to control for unobserved shocks or policy changes over time that impact all districts. The final model specifications were as follows:

$$\ln(LE)_{it} = \beta_0 + \beta_1 \ln(PHE_{it}) + \beta_2' \ln(X_{it}) + \alpha_i + \tau_t + \varepsilon_{it}, \quad (1)$$

$\ln(LE)_{it}$  is the LE in district  $i$  at time  $t$ , and  $\ln(PHE_{it})$  refers to the per capita health spending by the government.  $X_{it}$  pertains to control variables, including the ratio of physicians to population ( $\ln DOC$ ), access to sanitation ( $\ln SANIT$ ), poverty rate ( $\ln POVERT$ ), and proportion of fiscal transfer to total district government spending ( $\ln TRANSFER$ ). In this equation,  $\tau_t$  denotes the year-specific effects,  $\alpha_i$  signifies the district-specific effects, and  $\varepsilon_{it}$  represents the error term. This method enabled the evaluation of the impact of government health spending on LE within districts while accounting for both observable and unobservable variations between districts and over time. All data management and analysis in this study were conducted using STATA 18 (licensed under Universitas Indonesia).

## Results

Table 1 presents key descriptive statistics for the main variables used in the analysis, specifically LE and health spending by city and district governments. The average LE at the city and district level during the 2015–2019 period was 69.1 years, with a standard deviation (SD) of 3.45 years. Nevertheless, there remain cities and districts with a lower LE of 55.5 years.

**Table 1. Descriptive Statistics of Key Variables Across Cities and Districts in Indonesia, 2015–2019**

Variable	Observation	Mean	SD	Min	Max	Description
Life expectancy (years)	2,460	69.11	3.45	55.50	77.55	Main outcome variable
Per capita government health spending (USD100*)	2,460	7.39 (0.52)	5.66 (0.40)	1.15 (0.08)	57.97 (4.07)	District government spending
Doctors per 10,000 population <sup>23</sup>	2,460	4.60	6.58	0.04	67.20	Human resources for health
Proportion of improved sanitation (%)	2,460	74.66	14.40	3.84	99.11	Basic service
Poverty rate (%)	2,460	12.38	7.41	1.67	45.74	Economic context
TKDD share in Regional Budget realization (%)	2,460	79.49	12.86	11.15	146.25	Fiscal transfer dependency

**Notes:** TKDD = *Transfer ke Daerah dan Dana Desa* (transfer to regions and village funds), SD = standard deviation.

\*based on Bank of Indonesia average exchange rate in 2019 (1USD=IDR14,127), available from <https://www.bi.go.id/id/statistik/informasi-kurs/transaksi-bi/Default.aspx>

On average, city and district governments spend USD 52.00 per capita annually for health, with substantial variations ranging from USD 809 to USD 407.75. This variation reflected significant disparities in fiscal health capacity across cities and districts. The average number of doctors per 10,000 population<sup>23</sup> was 4.6 in terms of the availability of HRH. The average proportion of transfer to regions and village funds/*Transfer ke Daerah dan Dana Desa*, which reached 79.49% of provincial budget realization, indicated a high level of fiscal dependence on the central government. This proportion even reached a maximum of 146.25%, indicating that the value of transfers received in some regions exceeded the total provincial budget expenditure recorded from 2015 to 2019 (for instance, due to low budget execution). These results reflected an extreme dependence on central transfers, both due to limited local revenue capacity and disproportionate central allocation schemes.

The socioeconomic context variable indicated that an average of 12.38% of the population lived in poverty. This condition illustrated that social vulnerability remained high. Concurrently, 74.66% of the population had access to proper sanitation facilities, which also affected the achievement of overall health indicators. These findings suggested that environmental and social determinants remain critical barriers to achieving improvements in public health.

Table 2. Regression Results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	RE	FE	FE-Robust-Cluster	RE	FE	FE-Robust-Cluster
lnPHE	0.006*** (<0.001)	0.007*** (<0.001)	0.007*** (0.001)	0.001* (<0.001)	0.001*** (<0.001)	0.001*** (<0.001)
lnDOC	0.005*** (<0.001)	0.005*** (<0.001)	0.005*** (0.001)	0.002*** (<0.001)	0.001*** (<0.001)	0.001** (<0.001)
lnSANIT	0.013*** (0.001)	0.012*** (0.001)	0.012*** (0.002)	0.006*** (0.001)	0.006*** (0.001)	0.006*** (0.001)
lnPOVERT	-0.017*** (0.001)	-0.014*** (0.001)	-0.014*** (0.002)	0.002** (0.001)	0.007*** (0.001)	0.007*** (0.001)
lnTRANSFER	0.003*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.000 (0.001)	0.001* (0.001)	0.001 (0.001)
Constant	4.186*** (0.003)	4.190*** (0.002)	4.190*** (0.003)	4.236*** (0.003)	4.245*** (0.002)	4.245*** (0.003)
Observations	2,460	2,460	2,460	2,460	2,460	2,460
R-squared		0.646	0.646		0.813	0.813
Number of cities and districts	492	492	492	492	492	492
Wald chi <sup>2</sup>	3416.786			7223.156		
F-stat		717.177	270.815		946.956	312.218
Time effect	No	No	No	Yes	TWFE	TWFE

**Notes:** RE = random effect, FE = fixed effect; lnPHE = government's per capita health spending, lnDOC = doctors to population ratio, lnSANIT = access to sanitation; lnPOVERT = poverty rate, lnTRANSFER = proportion of transfer to regions and village funds to total district government spending, TWFE = two-way fixed effect.

Standard errors are in parentheses.

\*\*\*p-value <0.01, \*\*p-value <0.05, \*p-value <0.1

Table 2 presents the regression results in various models. The TWFE model with clustered robust standard errors (Model 6) confirms that LE was positively associated with increased local government health spending, with an elasticity of 0.001. Specifically, a 10% increase in per capita health spending was associated with a 0.01% increase in LE. This relationship remained statistically significant even after controlling for both time-invariant district characteristics and time-varying national trends. The high R-squared value (0.813) indicated that the model explained a substantial proportion of LE variation within cities and districts across the study period. In this study, higher doctor density and greater household access to sanitation were positively associated with higher LE. In preliminary models (models 1 to 3), poverty rates were initially linked to higher LE, but this association shifted in direction after adjusting for time.

## Discussion

This study contributed to the growing body of literature by highlighting the persistent disparities in LE across cities and districts in Indonesia, ranging from 55.50 years to 77.55 years. The findings indicated that some regions were lagging

in achieving basic health indicators, which could be attributed to differences in access, quality of services, and other social determinants. The doctor-to-patient ratio met the national requirements (the Indonesian Ministry of Health Regulation No. 75 of 2014)<sup>24</sup> but not the World Health Organization standard (1 doctor per 1,000 or 10 doctors per 10,000).<sup>23</sup> The socioeconomic context further indicated that social vulnerability remained significantly high, as reflected by the poverty rate. The presence of cities and districts with persistently low access to basic sanitation services during the study period (2015–2019) indicated that inequality in access to fundamental life-supporting services remained a critical issue. Overall, these findings indicated that the essential infrastructure for supporting healthy living was not equitably distributed across cities and districts in Indonesia.

The analysis also showed that health spending had a positive effect on LE. These results were consistent with prior empirical evidence at both national and subnational levels, including studies conducted in various regions such as South Africa,<sup>25</sup> South Asia,<sup>26</sup> OECD countries,<sup>6</sup> the Aral Sea Basin,<sup>27</sup> Brazil,<sup>28</sup> Pakistan (using time series analysis),<sup>29</sup> and Kepulauan Riau Province, Indonesia.<sup>30</sup> For instance, in the South African context, LE at the subnational level was more influenced by regional poverty levels in some areas.<sup>31</sup>

The empirical results from this study provided robust evidence that local government health spending had a positive impact on population health outcomes. This positive and statistically significant association remained consistent across all model specifications, including the final model (TWFE with clustered robust standard errors or model 6), which controlled for both time-invariant city and district characteristics and common time shocks. The lower coefficient of health spending after accounting for time effects suggested that nationwide trends, such as technological progress or macroeconomic changes, may have confounded earlier estimates.

This study also underscored the importance of accounting for both spatial and temporal heterogeneity in panel data analysis to avoid overstating the influence of health spending. Thus, this study provided a solid foundation for further studies into the efficiency of government health spending. Although the estimated elasticity coefficient appeared modest, its cumulative implications at scale remained policy relevant. The elastic analysis showed that a 10% increase in health spending per person was associated with a 0.01% increase in LE. Despite the modest elasticity, the policy implications were substantial when scaled to the population level. The elasticity is higher than the estimate for low-income countries (0.006) obtained using cross-country simple regression.<sup>16</sup> The stable relationship across model specifications suggested that increasing government health expenditure remains an effective pathway to improving population health outcomes.

Higher physician density was associated with higher LE, a finding consistent with those of other studies.<sup>32,33</sup> Similarly, improved sanitation coverage was linked to higher LE, highlighting the critical role of healthcare infrastructure and basic public health services.<sup>34,35</sup> Using FE model specification, poverty remained a negative determinant, showing persistent socioeconomic disparities in health outcomes across districts.<sup>5,35–37</sup> The change in the correlation between poverty rate and LE after accounting for time effects might reflect the overall decline in poverty levels across Indonesian districts during the study period. The inclusion of year effects was likely to account for this temporal trend, which reflected nationwide improvements in socioeconomic conditions. Omitting the poverty rate from the TWFE model did not materially alter the elasticity of health spending with respect to this variable. Over time, a steady increase in health spending might yield greater improvements in the overall health of cities and districts' populations, especially when complemented by interventions that address other social determinants of health.

Although this study employed robust statistical techniques, it was subject to limitations in data quality. First, LE data at the city and district levels in Indonesia were based on modeled estimates conducted by Statistics Indonesia, rather than from direct vital registration. This could result in measurement bias, particularly at the subnational level, such as cities and districts. Second, financial reporting inconsistencies between cities and districts could affect the precision of expenditure data. Although the application of FE and clustered robust standard errors mitigated some concerns by controlling for time-invariant heterogeneity and intra-district correlation, the study design was still observational. Future research can address endogeneity problems by employing dynamic panel models, instrumental variable approaches, or quasi-experimental designs to strengthen causal inference and better understand the mechanisms linking district-level health spending to population health outcomes. Collectively, these findings suggested that increased government spending on healthcare at the city and district levels was associated with longer life expectancy in Indonesia. Consistent results across different model specifications supported the modest estimated elasticity, demonstrating the reliability of this positive relationship.

## Conclusion

This study confirms that the health spending of city and district governments significantly influences LE in Indonesia's decentralized setting. It highlights the importance of integrating health system components, such as physician density, sanitation coverage, poverty, and the proportion of transfer to regions and village funds. The findings of this study advance the field by providing empirical evidence that strengthens the rationale for improving subnational health financing. It establishes a foundation for future studies to employ dynamic models that capture long-term effects of health spending on population health and health spending efficiency. Given the modest yet significant effect of health spending on LE, policymakers should monitor the efficiency of local government health spending. This is crucial for monitoring resource allocation decisions, ensuring effectiveness, and reducing regional disparities in health outcomes by considering various factors within the health system and social determinants of health.

## Abbreviations

LE: Life expectancy; GDP: Gross domestic product; HRH: Human resources for health; OECD: Organization for Economic Cooperation and Development; TWFE: Two-way fixed effects; VIF: Variance inflation factor; CI: Condition index; Pooled OLS: Pooled ordinary least squares; RE: Random effect; FE: Fixed effect; SD: standard deviation.

## Ethics Approval and Consent to Participate

This study was granted ethical clearance from the Research Ethics Commission of the Faculty of Public Health Universitas Indonesia (Approval No. 8/UN2.F10.D11/PPM.00.02/2023).

## Competing Interest

Authors declare that there are no competing financial or personal interests that might have affected the performance of the work described in this manuscript.

## Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Authors' Contribution

KS and BH were involved in the design of the study; KS conducted the data analysis, wrote, and revised the manuscript. BH, ACS, and MN reviewed the manuscript.

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