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Original Article

How do Poverty, Education, and Health Budgets Impact Life Expectancy? The Mediating Role of Sanitation

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Abstract: Life expectancy is a crucial indicator of the well-being and quality of life of a population. Numerous factors influence life expectancy, including government policies in allocating budgets to key sectors. This study examined the relationship between poverty, education, health budgets, and life expectancy, considering the role of sanitation as a mediating factor. This study aims to elucidate how these three sectors interact in affecting life expectancy, and to what extent sanitation acts as a mediating factor in the relationship between budget allocation and life expectancy. This study analysed the effects of poverty, education, and health budgets on life expectancy in Aceh Province, as well as the role of sanitation as a mediating variable. Secondary data in the form of panel data with 345 observations from 23 districts/cities over 15 periods in Aceh Province from to 2008-2022 were utilised. Panel data regression analysis was employed to estimate the research model, while path analysis and Sobel test were used to assess the mediating role. The results revealed that poverty had a significant negative effect on sanitation, while education and health budgets had significant positive effects. Regarding life expectancy, poverty, education, and sanitation had significant positive effects, but the health budget did not show a significant impact. Furthermore, poverty, education, and health budgets had significant indirect effects on life expectancy through the mediation of sanitation. The indirect effect of poverty on life expectancy through sanitation was negative, while the indirect effect of education on life expectancy through sanitation was positive. This research provides valuable insights for policymakers to optimise budget allocations to increase life expectancy by considering the important role of sanitation as a mediating factor. These findings emphasise the importance of reducing poverty and increasing education to improve sanitation and ultimately enhance life expectancy.

Keywords: Poverty, Health budget, Education, Sanitation, Life expectancy

1. Introduction

Life expectancy is a crucial indicator for assessing quality of life and human development. Various factors, including health conditions, access to healthcare facilities, and economic circumstances, significantly influence life expectancy (Felangi & Yasa, 2021; Gergely, 2024). In Aceh Province, where life expectancy is comparatively low, a comprehensive understanding of the factors that affect this indicator is essential. This study aimed to analyse the impact

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of poverty, health budget allocation, and average years of schooling on life expectancy across 23 districts in Aceh Province from 2008 to 2022. Additionally, it examined the mediating role of sanitation in these relationships. Unlike previous research, this study's focus on the Aceh Province and the incorporation of sanitation as a mediator offers a novel perspective on life expectancy dynamics. Based on this framework, this study hypothesises that poverty negatively affects sanitation, while education and health budgets positively influence it. Furthermore, poverty is expected to have a negative impact on life expectancy, whereas education, health budgets, and sanitation are anticipated to positively affect life expectancy. This study also posits that sanitation mediates the effects of poverty, education, and health budgets on life expectancy. Through rigorous hypothesis testing, this study aims to provide a comprehensive understanding of the factors influencing life expectancy in Aceh Province, potentially informing more effective and targeted policy formulation.

Table 1. Life Expectancy in Aceh Province from 2018 to 2022

No	Region	Life Expectancy (Year)				
		2018	2019	2020	2021	2022
1.	Simeulue	65,00	65,22	65,26	65,28	65,48
2.	Aceh Singkil	67,16	67,36	67,39	67,43	67,65
3.	Aceh Selatan	64,02	64,27	64,35	64,40	64,64
4.	Aceh Tenggara	67,77	68,04	68,14	68,22	68,48
5.	Aceh Timur	68,44	68,67	68,72	68,74	68,94
6.	Aceh Tengah	68,62	68,82	68,85	68,86	69,05
7.	Aceh Barat	67,72	67,93	67,98	67,99	68,19
8.	Aceh Besar	69,59	69,77	69,78	69,79	69,99
9.	Pidie	66,68	66,89	66,94	66,95	67,15
10.	Bireuen	70,92	71,16	71,22	71,26	71,48
11.	Aceh Utara	68,61	68,79	68,80	68,81	69,01
12.	Aceh Barat Daya	64,65	64,91	65,00	65,06	65,30
13.	Gayo Lues	65,12	65,38	65,47	65,53	65,77
14.	Aceh Tamiang	69,28	69,52	69,58	69,63	69,87
15.	Nagan Raya	68,89	69,14	69,22	69,24	69,45
16.	Aceh Jaya	66,88	67,11	67,16	67,19	67,40
17.	Bener Meriah	68,99	69,19	69,22	69,26	69,48
18.	Pidie Jaya	69,81	70,06	70,14	70,18	70,41
19.	Banda Aceh	70,10	71,36	71,45	71,52	71,79
20.	Sabang	70,21	70,45	70,51	70,56	70,79
21.	Langsa	69,16	69,37	69,42	69,43	69,63
22.	Lhokseumawe	71,27	71,52	71,60	71,64	71,87
23.	Subulussalam	63,69	63,94	64,02	64,07	64,30
Total		69,64	69,64	69,87	69,93	69.96

Data Source: Central Bureau of Statistics of Aceh (2022)

Table 1 presents the Life Expectancy (LEX) data for 23 regions in Aceh from 2018 to 2022. A general upward trend in LEX was observed across most regions over these five years. Simeulue experienced an increase in LEX from 65.00 years in 2018 to 65.48 years in 2022. Banda Aceh, one of the regions with the highest LEX, demonstrated a rise from 70.10 years in 2018 to 71.79 years in 2022. Conversely, Subulussalam, which had the lowest LEX, also exhibited an increase from 63.69 years in 2018 to 64.30 years in 2022. The average LEX across the region showed a modest improvement, rising from 69.64 years in 2018 to 69.96 years in 2022. This trend suggests an overall enhancement in health and quality of life in Aceh during the observation period.

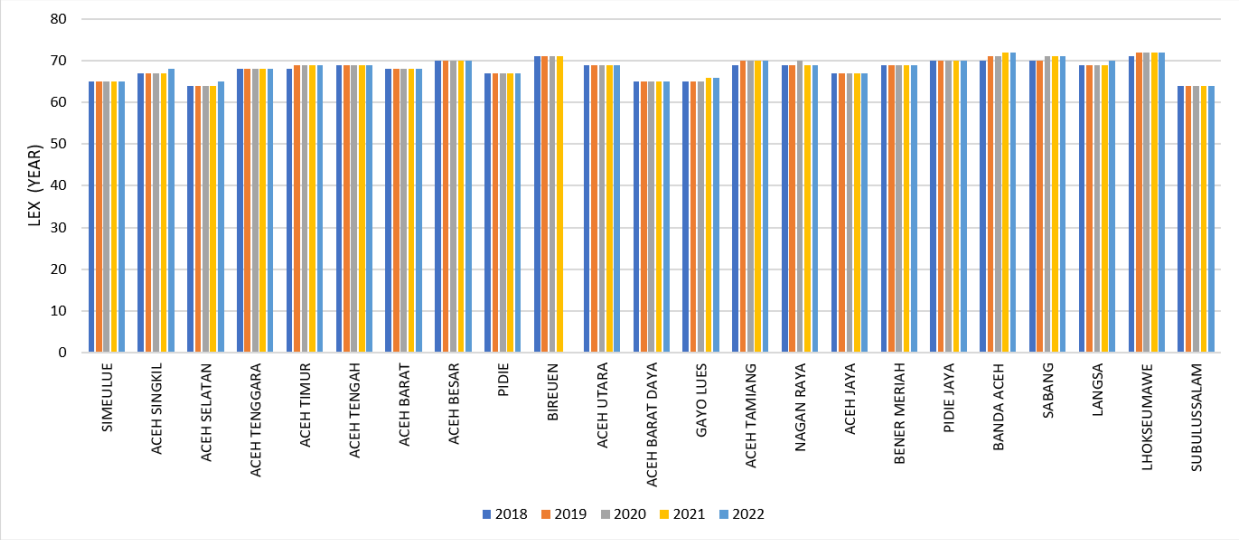

Figure 1. Development of Life Expectancy in Districts/Cities in Aceh Province (2018-2022)

2. Literature Review

2.1. Life Expectancy

Life Expectancy (LEX) serves as a crucial indicator of longevity and the healthy living dimension, as longevity is considered valuable and is closely associated with factors such as nutrition and health (Badan Pusat Statistik Provinsi Aceh, 2022). LEX represents an estimate of the average lifespan of an individual, calculated using an indirect approach and subsequently converted into a life expectancy index. This index employs a maximum value of 85 years and a minimum value of 20 years by UNDP standards (United Nations Development Programme, 2016). Furthermore, LEX functions as a key metric for assessing government performance in enhancing public welfare and health status (Ardianti et al., 2012).

2.2. Poverty

Poverty is conceptualised as a state of insufficient financial and material resources necessary for survival. Todaro and Smith (2015) delineated poverty into two categories: absolute and relative poverty. Absolute poverty is characterised by income levels and needs that are confined to the basic or minimum requirements for a decent standard of living (Suriani, 2017). By contrast, relative poverty is viewed through the lens of social inequality, where individuals may have met their basic needs but remain significantly below the living standards of their surrounding communities (Machmud, 2016). Multiple factors contribute to poverty, including diminished productivity, limited employment opportunities, low educational attainment of household heads, dependence on natural resources and existing conditions, expenses associated with traditional rituals, and restricted access to capital (Kaplale, 2012). Additionally, uneven development, particularly in rural areas, exacerbates poverty (Pramesti & Utomo, 2023). Strategies for poverty alleviation include high-quality education, investments in human capital, and equitable development. Notably, high-quality education has been identified as a potential means of disrupting the poverty cycle (Sugiharjo et al., 2022).

2.3. Health Budget

The health budget is defined as the financial resources necessary to organise health efforts for individuals, families, and communities. In Indonesia, local governments are mandated to allocate a minimum of 10% of their regional budgets (APBD), excluding salaries, to the health sector–a practice known as mandatory spending (Kementerian Keuangan Republik Indonesia, 2022). An adequate health budget can enhance access to quality health services, improve service quality through professional healthcare training and modern equipment procurement, and support disease prevention and health promotion initiatives (Kementerian Kesihatan Republik Indonesia, 2023). Furthermore, health budgets contribute to environmental improvements, job creation, and increased economic productivity, all of which have the potential to extend life expectancy (Maretta, 2019). Indonesia has achieved success in reducing birth and death rates, thus impacting the growth of the working-age population. However, this strategy is considered less effective in the short term because of its relatively low birth rate (Jannah & Indah Fitriana, 2023).

2.4. Education

Education is widely recognised as a fundamental developmental objective that contributes to the formation of individuals with quality and character (Abrar & Sufirmansyah, 2022). Governments actively engage in enhancing educational quality through various initiatives, including improving teachers' qualifications and providing scholarships (Pasaribu et al., 2022). High Average Years of Schooling (AYS) indicates elevated educational levels, which correlate with reduced poverty rates. According to Badan Pusat Statistik Provinsi Aceh (2022), Indonesia's national AYS increased from 8.54 years in 2021 to 8.69 years in 2022, although it remains below the average of developed nations. Akasumbawa et al. (2021) argued that education propels economic growth and welfare, rendering it a crucial target for public investment. (Meik, Suhartatik (2018) posit that a high AYS can enhance people's knowledge of healthy living behaviours and proper sanitation, thereby improving their overall quality of life (Rasnino et al., 2022).

2.5. Sanitation

A healthy environment encompasses residential areas, workplaces, recreational spaces, and public facilities, which should be free from disturbances, such as improperly processed waste (liquid, solid, and gaseous), disease vectors, hazardous chemicals, excessive noise, radiation, and contaminated water, air, and food (Blum, 1981). The goal of maintaining a healthy environment is to enhance the quality of living conditions through the development of regional health systems that promote health-oriented cross-sector development (Wulandari & Siti Nurhayati, 2024), Environmental health quality standards and health requirements have been established for various environmental media, including water, air, soil, food, facilities, and buildings, as well as vectors and disease-carrying animals. Sectors such as industry, the environment, agriculture, public works, and housing play crucial roles in addressing downstream health impacts (Sari et al., 2022). On the basis of the background, problem formulation, theoretical foundation, and previous research discussed above, the relationships between the variables in this study can be illustrated through the conceptual framework presented in the following Figure:

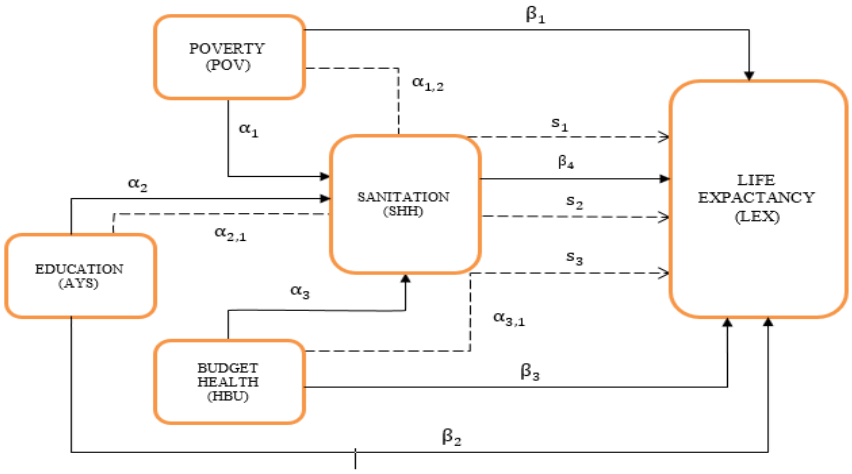

Figure 2. Research Framework

Figure 2 illustrates the complex relationships between socioeconomic factors and health outcomes. Poverty negatively impacts sanitation, whereas education and health budget allocations positively influence sanitation levels. Furthermore, poverty demonstrated a negative association with life expectancy, whereas education, health budget, and sanitation had positive effects on life expectancy. Notably, sanitation serves as a mediating factor between poverty, education, and health budget in their influence on life expectancy.

3. Materials and Methods

This study employed panel data from 23 districts/cities in Aceh Province spanning 2008-2022, encompassing 345 observations. This study utilises external data sourced from the Aceh Central Bureau of Statistics (BPS), Aceh Provincial Health Office Profile, and Directorate General of Fiscal Balance of the Indonesian Ministry of Finance. The dependent variable was life expectancy (LEX), while the independent variables included poverty (POV), health budget (HBU), and average years of schooling (AYS). Sanitary households (SHH) served as a mediating variable. The research methodology incorporates both descriptive and inferential statistical approaches. Descriptive analysis is employed to elucidate trends in life expectancy, whereas inferential analysis utilises panel data regression and path analysis,

specifically the Sobel test (Sobel, 1982). Data analysis model: This study uses 2 (two) panel data equation models, namely Model 1 for the sanitation function and Model 2 for the life expectancy function, namely:

Model 1: $SHH_{i,t} = \alpha_0 + \alpha_1 POV_{i,t} + \alpha_2 AYS_{i,t} + \alpha_3 HBU_{i,t} + \varepsilon_{i,t}$ (1)
Model 2: $LEX_{i,t} = \beta_0 + \beta_1 POV_{i,t} + \beta_2 AYS_{i,t} + \beta_3 HBU_{i,t} + \beta_4 SHH_{i,t} + \varphi_{i,t}$ (2)

Where SHH is sanitation eligible households, POV is poverty, HBU is health sector budget, AYS is average years of schooling, LEX is life expectancy, α_0, α_1, α_2, α_3 is constants, β_0, β_1, β_2, β_3, β_4 is regression coefficients, $\varepsilon_{i,t}$, $\varphi_{i,t}$is residuals, i : 1,2,3,,,,,23 (number of cross sections, 23 districts), t is 1,2,3,,,,,15 (number of time series, year 2008-2022). Model 1 is used to analyse the effect of independent variables on sanitation, while Model 2 is used to analyse the effect of independent variables and sanitation on life expectancy. The Sobel test was used to test the significance of the mediating role of sanitation.

4. Results and Discussion

4.1. Descriptive Statistics

This study used panel data from 23 districts/cities in Aceh Province for the period 2008-2022, with a total of 345 observations. The variables studied include life expectancy (LEX), poverty (POV), health budget (HBU), average years of schooling (AYS), and sanitary households (SHH). The results of the descriptive analysis show:

Table 2. Descriptive Statistics Analysis

	LEX	POV	HBU	AYS	SHH
Mean	67.80954	17.98386	136450.5	9.105913	60.69243
Median	68.31000	18.24000	110498.3	8.830000	60.77000
Maximum	72.43000	30.26000	667824.5	13.03000	100.0000
Minimum	60.96000	6.900000	9430.854	6.770000	19.09000
Standard Deviation	2.520087	4.575163	104761.1	1.201236	22.20252
Skewness	-0.585101	-0.019588	1.528423	0.973412	-0.034515
Kurtosis	2.781428	2.878053	5.962230	4.029754	1.946624
Jarque-Bera normality	20.37149	0.235834	260.4622	69.72621	16.01903
Probability	0.000038	0.888770	0.000000	0.000000	0.000332
summary	23394.29	6204.430	47075414	3141.54	20938.89
Sum Sq. Dev	2184.689	7200.648	3.78E+12	496.3813	169575.5
Observations	345	345	345	345	345

Note: LEX is life expectancy in years, POV is the percentage of poor population in percent, HBU is the health sector budget in billion rupiah, AYS is the average years of schooling in years, and SHH is the percentage of sanitary households in percent**.**

Table 2 shows Life Expectancy (LEX), percentage of poor population (POV), health budget (HBU), average years of schooling (AYS), and percentage of sanitary households (SHH). The average LEX is 67.81 years with variations from 60.96 to 72.43 years. The average percentage of poor people is 17.98%, with a range of 6.90% to 30.26%. The average health budget is 136,450.5 billion rupiah, showing large variations with a range of 9,430.85 to 667,824.5 billion rupiah. The average year of schooling is 9.11 years, with a range of 6.77 to 13.03 years. The average percentage of sanitary households is 60.69%, with variation from 19.09% to 100%. Most variables showed asymmetrical data distribution, with LEX, HBU, AYS and SHH not normally distributed. Only POV approached a normal distribution. The large standard deviations for HBU and SHH indicate significant variation between observations.4.2. Results and Discussion

4.2. Panel Data Analysis

The results of the analysis include the selection of the best panel data regression model, classical assumption test, panel data regression analysis, hypothesis testing, and path analysis / sobel test (mediation), as well as discussion and implications of the results, it is necessary to determine the best panel data regression model between CEM, FEM, and REM before further data analysis is carried out, Determination of the best estimation model is carried out using three statistical tests, namely the Chow test, Hausman test, and Lagrange Multiplier test**.**

Table 3. Result of Panel Model Selection

Model	Statistics			Conclusion
	Chow	Hausman	Lagrange Multiplier	
Model 1	23,85420*** (0,0000)	8,289183 (0,0404)	-	FEM
Model 2	24,11230*** (0,0001)	9,500774 (0,0497)	-	FEM

Note: *** , ** is significant at the level 1 and 5 percent.

Table 3 presents the optimal panel data regression model selection results for both models. The Chow Test and Hausman Test outcomes for Models 1 and 2 indicate that the fixed effects model (FEM) is the most suitable approach. For Model 1, the Chow Test yielded a statistic of 23.85420 ($p = 0.0000$), while the Hausman Test produced a statistic of 8.289183 ($p = 0.0404$). Similarly, for Model 2, the Chow Test resulted in a statistic of 24.11230 ($p = 0.0001$), and the Hausman Test generated a statistic of 9.500774 ($p = 0.0497$). These findings suggest that FEM is the optimal choice for both models. The Chow Test results reveal a cross-sectional F probability value of 0.0000 ($p < 0.05$), leading to the rejection of the null hypothesis and confirming that the Fixed Effect Model (FEM) is the most appropriate for estimating the regression equation. The Hausman Test results show a cross-section random probability value of 0.0404 ($p < 0.05$), which also resulted in the rejection of the null hypothesis and further supports the selection of the Fixed Effect Model (FEM) as the optimal approach for estimating the regression equation. Given the consistent results from both the Chow Test and Hausman Test in favour of the fixed effects model (FEM), it is unnecessary to conduct the Lagrange Multiplier Test. Consequently, this research employs a fixed effects model (FEM) for further analysis.

4.2.1. The Effect of Poverty, Health and Education Budgets on Sanitation

The panel data regression analysis presented in Model 1, which examines the impact of poverty, health budget, and education on sanitation, is summarized in Table 4. The results indicate that the regression model employed to assess the influence of the independent variables (poverty, health budget, and education) on the dependent variable (sanitation) is statistically significant. The high R-squared (0.831971) and Adjusted R-squared (0.818802) values suggest that approximately 83.19% to 81.88% of the variation in sanitation can be explained by the independent variables included in the model. Consequently, approximately 16.81% of the variation in sanitation may be attributed to factors not accounted for in the current model. The partial test results reveal that poverty and health budget exert a significant influence on sanitation outcomes.

Table 4. Result of Panel Regression Analysis for Model 1

Variable(s)	Coefficient	t-Statistic	Prob.
C	37,63330**	2,832282	0,0049***
POV	-2,024594***	-7,746536	0,0000***
HBU	3,61E-05***	4,907882	0,0000***
AYS	5,990411***	5,03247	0,0000***
R-squared	0,831971	F-statistic	63,17913
Adj, R-squared	0,818802	Prob, (F-statistic)	0,000000***

Note: *** ,**and * is a significant at the level of 1,5 and 10 percent

Table 4 presents the results of the panel data regression analysis. Model 1 demonstrates a significant relationship between the independent and dependent variables. The percentage of poor population (POV) exhibits a significant negative effect, suggesting that an increase in poverty is associated with a decrease in the dependent variable. Conversely, health budget (HBU) and average years of schooling (AYS) show significant positive effects, indicating that increased investments in health and education contribute to an increase in the dependent variable. The model demonstrated strong explanatory power, with 83.2% of the variation in the dependent variable explained by the independent variables. The high overall significance of the model (F-statistic with a p-value of 0.000) confirmed that this combination of independent variables effectively explained the variation in the dependent variable. These findings underscore the

importance of poverty alleviation policies, increased health spending, and improved educational quality in influencing the dependent variable, providing crucial implications for policymakers in designing comprehensive strategies to enhance people's welfare. The positive value of the health budget coefficient, significant t-statistic (4.907), and low probability (0.000) indicate a significant influence on sanitation. The large F-statistic (63.179) and very small probability (0.000) suggest that the model as a whole is statistically significant, implying that the independent variables (poverty, health budget, and education) have a significant effect on sanitation. In conclusion, the employed regression model can be considered robust in explaining variations in sanitation, with the included independent variables (poverty, health budget, and education) demonstrating significant individual and collective sanitation effects.

4.2.2. The Effect of Poverty, Health Budget, Education and Sanitation on Life Expectancy

The empirical findings from the panel data regression analysis, specifically Model 2, which examines the impact of poverty, health budget allocation, education, and sanitation on life expectancy, are presented in Table 5:

Table 5. Result of Panel Regression Analysis for Model 2

Variable(s)	Coefficient	*t-Statictic*	Probability
C	50,90442***	29,07712	0,0000***
POV	0,296882***	8,008467	0,0000***
HBU	-9,16E-07	-0,923359	0,3565
AYS	0,966558***	6,005787	0,0000***
SHH	0,047610***	6,534612	0,0000***
R-squared	0,779836	*F-statistic*	43,32233
Adj, R-squared	0,761836	*Prob, (F-statistic)*	0,000000***

Note: *** ,**and * is a significant at the level of 1, 5 and 10 percent

Table 5 presents the panel data regression analysis results for Model 2, which reveal several noteworthy findings. The percentage of poor people (POV), average years of schooling (AYS), and percentage of sanitary households (SHH) demonstrated significant positive influences on the dependent variable, indicating that increases in these variables contributed to an increase in the dependent variable. Interestingly, health budget (HBU) did not exhibit a significant effect in this model, in contrast to the findings in Model 1. This discrepancy may suggest that other factors influence the effectiveness of the health budget, or that there are potential indirect relationships that warrant further investigation. The model demonstrated robust explanatory power, with 77.98% of the variation in the dependent variable explained by the independent variables. The high overall significance of the model (F-statistic with a p-value of 0.000) confirms that the combination of these variables effectively elucidates the variation in the dependent variable. This finding underscores the importance of a holistic approach to development policy, considering factors such as poverty alleviation, improved education, and enhanced sanitation to positively influence the dependent variable. The Coefficient of Determination (R-squared) and Adjusted R-squared values of 0.779 and 0.761, respectively, indicate that the independent variables (poverty, health budget, education, and sanitation) explain approximately 77.98%–76.18% of the variation in life expectancy. The Partial Test (t-test) results reveal that the health budget (HBU) does not have a statistically significant effect on life expectancy. Conversely, poverty exhibits a significant positive effect at the 5% significance level, whereas education demonstrates a significant positive effect at the 5% or 1% significance level. The Simultaneous Test (F-test) yielded a high F-statistic value, indicating that the independent variables collectively exerted a simultaneous effect on life expectancy. The regression model is statistically significant and can be used to predict life expectancy. Based on this analysis, education appears to have the most substantial effect on life expectancy, followed by poverty, whereas the health budget does not demonstrate a significant impact.

4.2.3. Path Analysis and Sobel Test

In path analysis, the effect of independent variables on the dependent variable is described in the direct effect and indirect effect. In addition, this study uses the Sobel test to see the significance of the sanitation mediation variable can be seen from models 1 and 2:

Model 1 : SHH = 43.3065423397 - 1.718058*POV + 4.823183*AYS + 0.000032*HBU

Model 2 : LEX = 50.8956162688 + 0.277819*POV + 1.000908*AYS + 0.00000014*HBU + 0.045877*SHH

The results of the direct effect and indirect effect on path analysis can be seen below:

Table 6. Result of Direct, Indirect and Sobel Test Effects

Variable	Direct	Indirect	Sobel Test	
			Nilai Statistic	Prob.
POV → SHH	-1,718058***			
HBU → SHH	0,000032***			
AYS → SHH	4,823183***			
POV → LEX	0,277819***	-0,078819347	-5,3074***	0,00000011***
HBU → LEX	0,00000014	0,000001469	4,3202***	0,00001559***
AYS → LEX	1,000908***	0,221273166	4,0072***	0,00006142***
SHH → LEX	0,045877***			

Note: *** ,**and * is a significant at the level of 1,5 and 10 percent

Table 6 reveals the complex relationships among variables through analyses of the direct, indirect, and Sobel test effects. The percentage of poor people (POV) exhibits a dual effect: negative sanitation (SHH) and positive life expectancy (LEX). This suggests that while poverty reduces access to proper sanitation, other factors may positively contribute to life expectancy. The health budget (HBU) positively influences sanitation but does not significantly affect LEX directly. However, HBU indirectly and positively impacts LEX through improved sanitation. Average years of schooling (AYS) consistently demonstrated positive effects on both sanitation and life expectancy, both directly and indirectly, confirming the importance of education in improving overall quality of life. Sanitation (SHH) has emerged as a crucial mediator that significantly positively affects life expectancy and serves as an indirect pathway for other variables that influence LEX. Sobel tests confirmed the significance of all indirect effects, emphasising the importance of sanitation as a mediating variable in this model. These findings suggest that efforts to increase life expectancy require a multidimensional approach that focuses on poverty alleviation, increased health budget allocation, improved access to education, and enhanced sanitation. The effect of the independent variables on the dependent variables is poverty (POV), which negatively affects sanitation (SHH) and positively affects life expectancy (LEX). The health Budget (HBU) positively affects sanitation (SHH) and life expectancy (LEX). Education (AYS) directly positively affected sanitation (SHH) and life expectancy (LEX). The mediation of the sanitation variable (SHH) was significant for the effects of poverty (POV), health budget (HBU), and education (AYS) on life expectancy (LEX). Path analysis revealed that the indirect effect of health budget (HBU) on life expectancy (LEX) through sanitation (SHH) was more significant than the direct effect. Sanitation plays a crucial role in increasing life expectancy, as supported by previous research. Education also positively affected life expectancy, which is in line with prior studies. Although expected to have a positive impact, health budget showed no significant effect on life expectancy in this study. Inefficiencies, suboptimal health programs, and high levels of corruption could account for this lack of significance. In conclusion, the results demonstrate that sanitation and education significantly contribute to increasing life expectancy, whereas the health budget shows no significant impact. This underscores the importance of improving access to sanitation and education to enhance overall well-being and longevity.

The findings of this study align with those of previous research conducted by Sari et al. (2022), who demonstrated that improving clean and healthy living behaviours through access to proper sanitation is positively correlated with increased life expectancy. A positive and significant relationship has been established between knowledge of clean and healthy living behaviours and life expectancy. The increasing elderly population is attributed to various factors, including economic progress and improvement in community well-being (Bangun, 2019), enhanced quality of life, and advancements in the health sciences. This increase in the elderly population likely results from improved health services and higher life expectancy, serving as an indicator of increased population longevity (Prabu Aji et al., 2022). Education has been identified as a significant factor influencing life expectancy, which is a key indicator of the Human Development Index (HDI). This assertion is supported by research conducted by Hepi & Zakiah (2018) who found that education has a significant positive effect on HDI (Rasnino et al., 2022). Contrary to some theories and research suggesting that proper investment in the health sector positively impacts human development, this study found that the health budget has an insignificant effect on life expectancy in the Aceh Province. This finding aligns with previous research that identified a minimal effect of health budgets on life expectancy, potentially due to other influential factors not included in this study's variables (Sari, 2022). Adhitya et al. (2022), observed a negative relationship between the health budget variable and life expectancy, indicating that increased budget allocation by local governments to the health sector does not contribute to improved life expectancy. This finding is consistent with research by Maretta (2019), which suggests that increased health sector budget allocation by local governments does not enhance life expectancy (LEX). This phenomenon may be attributed to inefficiencies in budget allocation, which prevent the achievement of development targets. Furthermore, Widodo et al. (2012), proposed that high corruption rates could lead to inefficient and misdirected budget allocations, resulting in a lack of a direct impact on public health quality development (Maretta, 2019).

5. Conclusions

The panel data regression and path analyses revealed that poverty, health budget, and education collectively significantly influence sanitation in Aceh Province. Specifically, poverty negatively affects both sanitation and life expectancy, whereas the health budget does not demonstrate a significant effect. Education and sanitation positively influenced life expectancy, whereas poverty had a negative effect. Notably, sanitation mediates the relationship between poverty, the health budget, education, and life expectancy in Aceh Province. These findings underscore the necessity for collaborative efforts between the government and stakeholders to address poverty, enhance education, optimise health budgets, and improve sanitation to increase life expectancy. Key recommendations include allocating adequate budgets for quality health services, increasing investment in the education sector to improve public awareness and promote health-promoting behaviours, and implementing regular monitoring and evaluation programs to increase life expectancy to ensure their effectiveness and facilitate necessary adjustments. By focusing on these areas, policymakers can work towards improving the overall quality of life and longevity of the population in Aceh Province.

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