

Access to improved sanitation and health expenditure in Indonesia: An empirical analysis

Adrian Chrisnahutama*

Faculty of Business and Economics, University of Surabaya, Indonesia

*) Corresponding Author (e-mail: achrisnahutama@staff.ubaya.ac.id)

Abstract

Health expenditure remains one of the main determinants of financial burdens for households in developing countries, including Indonesia. While previous studies have documented the health benefits of improved sanitation, there is still limited evidence regarding its economic consequences. Understanding this relationship is crucial for designing effective policies to both improve public health and alleviate financial burden. This study aims to examine the effect of access to improved sanitation on household health expenditure in Indonesia and to investigate whether this effect varies across regions with different levels of infrastructure development. Using the 2019 National Socioeconomic Survey (*Susenas*), this study finds that access to improved sanitation significantly reduces the likelihood of experiencing health problems, which in turn lowers health expenditure. The effect is substantially larger and statistically significant outside Java-Bali, where baseline sanitation coverage is lower and health risks are higher. Conversely, the effect is insignificant in the rest of Indonesia apart from Java-Bali, suggesting diminishing marginal returns in areas with relatively advanced infrastructure.

Keywords: Sanitation, Health Expenditure, Health Problem.

Abstrak

Pengeluaran kesehatan merupakan salah satu determinan utama dari beban finansial bagi rumah tangga di negara berkembang, termasuk Indonesia. Walaupun berbagai penelitian sebelumnya telah mendokumentasikan manfaat kesehatan dari sanitasi yang layak, bukti empiris mengenai konsekuensinya terhadap ekonomi masih terbatas. Memahami hubungan ini sangat penting untuk merancang kebijakan yang efektif guna meningkatkan kesehatan masyarakat sekaligus mengurangi beban finansial. Penelitian ini bertujuan untuk mengkaji pengaruh akses terhadap sanitasi layak terhadap pengeluaran kesehatan rumah tangga di Indonesia dan menginvestigasi apakah pengaruh tersebut bervariasi antarwilayah dengan tingkat pembangunan infrastruktur yang berbeda. Dengan menggunakan data Survei Sosial Ekonomi Nasional (*Susenas*) 2019, penelitian ini menemukan bahwa akses terhadap sanitasi layak secara signifikan mengurangi kemungkinan individu mengalami keluhan kesehatan, yang pada gilirannya menurunkan pengeluaran kesehatan. Lebih lanjut, hasil penelitian ini juga menunjukkan bahwa pengaruh tersebut secara substansial lebih besar dan signifikan secara statistik di luar Jawa-Bali, di mana cakupan sanitasi dasar lebih rendah dan risiko kesehatan lebih tinggi. Di sisi lain, pengaruh dari sanitasi layak tidak signifikan terhadap pengeluaran kesehatan di Jawa-Bali. Hal ini mengindikasikan adanya diminishing marginal returns di wilayah dengan infrastruktur yang relatif lebih maju.

Kata kunci: Sanitasi, Pengeluaran Kesehatan, Keluhan Kesehatan.

How to cite: Chrisnahutama, A. (2026). Access to improved sanitation and health expenditure in Indonesia: An empirical analysis. *Journal of Economics Research and Policy Studies*, 6(2), 629–641. <https://doi.org/10.53088/jerps.v6i2.3214>



1. Introduction

Health expenditure remains an important source of financial vulnerability among households, particularly in developing countries. Despite the expansion of public health insurance schemes and improvements in healthcare accessibility, many households still need to allocate a considerable share of their resources to healthcare utilization (Aregbeshola & Khan, 2018; Bosch et al., 2000; Clasen et al., 2014; Gertler & Gruber, 2002; Wagstaff, 2005). Previous studies have consistently shown that poor health conditions and chronic diseases are among the main determinants of healthcare spending, catastrophic health expenditure, and impoverishment (Arsenijevic et al., 2016; Azzani et al., 2019; Husna & Sukartini, 2021; Li et al., 2013; Yao et al., 2025). Therefore, identifying factors that can prevent illness and reduce healthcare spending remains an important policy concern to ensure the prosperity and welfare of society.

One of the most important public health interventions is the provision of improved sanitation. Access to improved sanitation reduces exposure to environmental contaminants and waterborne diseases, thereby improving health outcomes (Brenneman & Kerf, 2022; Ejemot-Nwadiaro et al., 2021; Fewtrell et al., 2005). From a human capital perspective, improved health enables individuals to participate more effectively in economic activities and enhance productivity (Becker, 1962; Grossman, 1972). Numerous studies have documented the health benefits of sanitation improvements. Esrey et al. (1991) reported that households with improved sanitation and safe drinking water experience lower risks of diarrhea deaths by 26 percent. Similarly, Wolf et al. (2018) concluded that those aforementioned infrastructures reduce children's diarrhea prevalence. In the context of developing countries, Cameron & Olivia (2011), Komarulzaman et al. (2017), and Patunru (2015) found that unimproved sanitation along with inadequate drinking water sources and poor hygiene are associated with a higher incidence of diarrheal diseases in Indonesia. Moreover, Noguchi et al. (2021) concluded that improved sanitation and hygiene improve health and reduce diarrhea incidence among children in Lao PDR. Other studies also have demonstrated that sanitation improvements reduce healthcare dependency, lower malnutrition rates, decrease child mortality, and increase primary school enrollment (Fenwick et al., 2018; Piper et al., 2017).

Although the relationship between sanitation and various health outcomes has been extensively studied, there is considerably limited evidence regarding the economic consequences of sanitation improvements. Reductions in health expenditure represent a direct and measurable economic benefit of sanitation investments. If improved sanitation can prevent disease incidence, households may require fewer healthcare services and incur lower medical expenses. Therefore, understanding the relationship between sanitation access and health expenditure provides a more comprehensive assessment of sanitation benefits beyond conventional health indicators.

This issue is particularly relevant in Indonesia. Despite substantial progress in sanitation development over the past decades, access to improved sanitation remains uneven across regions (Patunru, 2015). Data from Statistics Indonesia (2019) show

that provinces in Java and Bali have generally better infrastructure coverage and public goods provision than provinces in Sumatra, Kalimantan, Sulawesi, Maluku, and Papua. These disparities may influence the extent to which sanitation improvements generate economic benefits. In areas where sanitation coverage remains relatively limited, improvements in sanitation access may produce larger health gains and stronger reductions in healthcare spending. On the other hand, in regions where sanitation coverage is higher, the marginal benefits of further improvements may be smaller. Nevertheless, empirical evidence regarding such regional heterogeneity remains scarce.

This study aims to examine the effect of access to improved sanitation on household health expenditure in Indonesia and to investigate whether this effect varies across regions with different levels of infrastructure development. In order to achieve this objective, this study utilizes the 2019 National Socioeconomic Survey (*Survei Sosial Ekonomi Nasional*—Susenas), a nationally representative household dataset collected by Statistics Indonesia. The dataset covers approximately 1.2 million individuals across all provinces in Indonesia, providing comprehensive information on household characteristics, health status, health expenditure, sanitation facilities, and various socioeconomic indicators. The large sample size and national coverage make this dataset particularly suitable for examining the relationship between sanitation and health expenditure, as well as for conducting subgroup analysis across different regions.

This study contributes to the literature in three important ways. First, it examines the relationship between access to improved sanitation and household health expenditure, an outcome that has received relatively limited attention in the sanitation literature. Second, it provides evidence from Indonesia, a developing country with substantial disparities in sanitation infrastructure and development outcomes. Third, it investigates regional heterogeneity in the effect of sanitation access on health expenditure by comparing major island groups with different levels of infrastructure development. This study provides new evidence on the economic benefits of sanitation investments and offers insights for policymakers seeking to improve public health while reducing the financial burden of healthcare expenditures.

2. Research Method

This study uses a quantitative approach that aims to investigate the relationship between sanitation and health expenditure in Indonesia. Cross-sectional data is used in this study. Cross-section is a type of data that is collected by observing multiple objects at one period of time (Wooldridge, 2016). This study utilizes the 2019 National Socioeconomic Survey (Susenas), Indonesia's nationally representative household data that provide information about socioeconomic conditions, such as household expenditure, health status, housing characteristics, and many more (Johar et al., 2019; Statistics Indonesia, 2019). In 2019, Susenas provides information about 300,000 households or approximately 1.2 million individuals. The population in this study is all

household members who have expenditure on health for the last 12 months. We acquire 1.169.618. This number accounts for approximately 261.550.835 population.

The data on health expenditure includes all out-of-pocket expenditures such as drug purchases, medical check-ups, massages/cupping, and transport to health facilities. This study classifies respondents' health status based on the Statistics Indonesia definition: 1) someone who experienced health problems due to illness, chronic diseases, accidents, or anything else a month prior to the survey; and 2) otherwise.

Sanitation refers to the management of excreta from the facilities used by individuals/households through emptying and transporting the excreta for treatment and reuse. World Health Organization and United Nations Children's Fund (2019) defines improved sanitation as facilities that are designed to hygienically separate excreta from human contact and are used by own household members. Therefore, improved sanitation can be classified as follows: 1) flush toilets or pit latrines with slabs; and 2) facilities that are used by own household members.

Improved sanitation does not directly affect health expenditure, but rather through health problem incidence. In order to identify the causal effect, this study employs Two-Stage Least Squares (2SLS).

$$Y_i = \beta_0 + \beta_1 X_i + u_i \dots\dots\dots (1)$$

$$X_i = \beta_0 + \beta_1 z_{1i} + \beta_2 z_{2i} + \beta_3 z_{3i} + \beta_4 z_{4i} + \beta_5 z_{5i} + \beta_6 z_{6i} + u_i \dots\dots\dots (2)$$

Table 1 shows summary statistics of variables used in this study. Health expenditure per capita (in logarithms) has a mean of 9,341. The mean value of this variable is slightly different between Java-Bali and other regions. In Java-Bali, the mean of health expenditure per capita (in logarithms) is 9.508, while in other regions it is 9.268. This shows that respondents who resided in Java-Bali had higher health expenditures than other regions.

The health status variable has a proportion of 0.319. This can be interpreted as 31.9 percent of respondents reported that they experienced a health problem one month prior to the survey. The proportion of this variable in Java-Bali is higher than in other regions. It is shown that Java-Bali has a proportion of 0.366 or 36 percent, while other regions have a proportion of 0.298 or 30 percent.

The improved sanitation ownership variable has a proportion of 0.755, meaning that 75.5 percent of respondents had flush/pour toilets or pit latrines with slabs, and the facilities were limited to household members. Java-Bali has a proportion of improved sanitation of 0.817 or 81.7 percent, compared to other regions (0.728 or 72.8 percent). These conditions show that the provision of proper sanitation in Java-Bali is better than in other regions.

Individual socioeconomic status consists of three variables: age of the respondent, sex of the respondent, and the classification of the region where the respondents reside. The mean value of the age variable is 30.52 years. Respondents residing in Java-Bali have a higher mean value of this variable (33.4 years) than other regions

(29.3 years). The sex variable shows that male and female respondents are relatively balanced. The type of region has a proportion of 0.411, meaning that more respondents reside in rural areas than urban areas. This variable has substantial differences between Java-Bali and other regions. 60.3 percent of respondents in Java-Bali live in urban areas, while only 32.7 percent of respondents in other regions live in urban areas.

An individual's level of education is measured by the years of schooling. In general, the mean years of schooling is 6.64 years. This shows that the average level of education of respondents in this study is equivalent to junior high school level. Respondents residing in Java-Bali tend to have a higher level of education than other regions. The mean years of schooling in Java-Bali is 6.84 years, while in other regions it is 6.55 years.

Individual welfare condition consists of two variables, expenditure per capita (in logarithms) and floor types. The expenditure per capita (in logarithms) variable has a mean value of, while the floor types variable has a proportion of 0.0416 or 4.2 percent. The percentage of open defecation variable has a mean value of 0.101. This variable has a lower value in Java-Bali than in other regions. This shows that environmental hygiene in Java-Bali is better.

Table 1. Summary Statistics

Variables	Full Sample		Java-Bali ⁺		Others ⁺⁺	
	Mean/ Proportion	SD	Mean/ Proportion	SD	Mean/ Proportion	SD
Dependent Variable						
Health Expenditure per Capita (in Logarithm)	9.341	1.533	9.508	1.558	9.268	1.516
Instrumented Variable						
<i>Health Status</i>						
Experienced health problem = 1	0.319		0.366		0.298	
<i>Sanitation Ownership Status</i>						
Improved Sanitation Ownership (Yes = 1)	0.755		0.817		0.728	
<i>Individual Socioeconomic Status</i>						
Age	30.52	20.36	33.40	20.95	29.26	19.97
Sex (Male = 1)	0.501		0.497		0.503	
Type of Region (Urban = 1)	0.411		0.603		0.327	
<i>Individual Education</i>						
Years of Schooling	6.638	4.874	6.842	4.773	6.549	4.915
<i>Individual Welfare Conditions</i>						
Expenditure per Capita (in Logarithm)	13.67	0.630	13.71	0.661	13.66	0.615
Floor types (Soil or worse = 1)	0.0416		0.0527		0.0367	
<i>Environment Condition</i>						
Percentage of Open Defecation	0.101	0.192	0.0664	0.141	0.116	0.208
Observations	1,169,618		356,186		813,432	

3. Results and Discussion

3.1. Results

Providing access to improved sanitation for all people is a main priority of Indonesia's development objective. This correlates with Sustainable Development Goal (SDG) 6.2 by United Nations, which is "By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation". In order to track Indonesia's progress on improved sanitation provision, we employ some descriptive analysis.

Table 2. Indonesia's Progress on Improved Sanitation Provision in 2000 – 2020

Type of Region	Year				
	2000	2005	2010	2015	2020
Rural	23.2	35.0	48.3	63.2	79.7
Urban	58.5	66.1	74.2	82.7	91.6
All	38.0	49.3	61.2	73.6	86.5

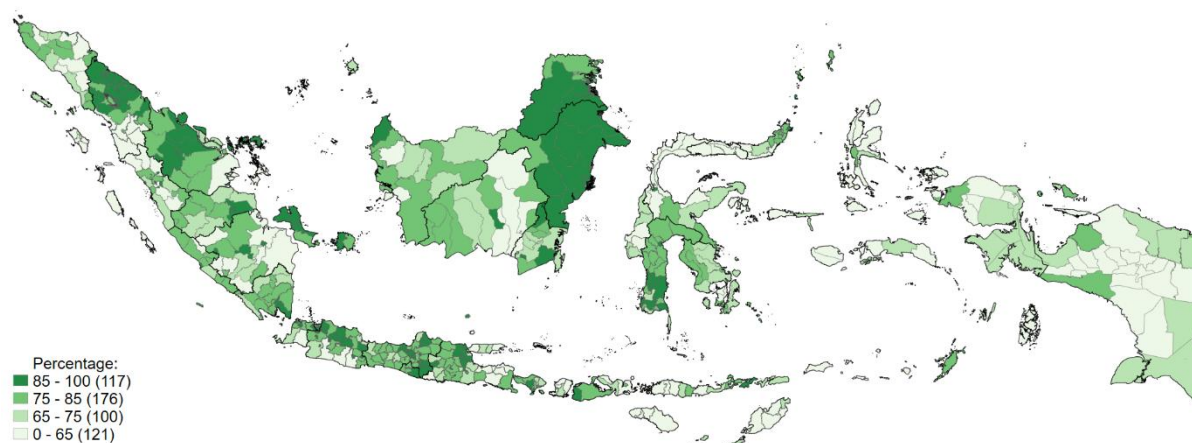
Note: Improved sanitation is flush/pour toilets or pit latrines with slabs and used by own household members

Source: World Bank (2020)

Table 2 provides information on Indonesia's improved sanitation provision progress in 2000, 2005, 2010, 2015, and 2020. Indonesia has made substantial progress in improving access over 20 years. In 2020, 86.5 percent of Indonesia's population had improved access, compared with 61.2 percent in 2010 and 38.0 percent in 2000. On the other hand, this provision seems unequal when we compare it in urban and rural regions. The gap in improved sanitation provision between these two categories remains high for 20 years. In 2020, for example, 91.6 percent of the urban population had access, compared with only 79.7 percent of the rural population. This condition shows that in 2020, more than 20 percent of the rural population in Indonesia used shared or public toilets, pit latrines, or defecated in fields, bushes, yard.

It is necessary to see whether access to improved sanitation has a spatial pattern, since Indonesia is a large archipelago and a diverse country. In order to track its provision, we employ descriptive spatial analysis. Figure 1 shows the spatial distribution of access to improved sanitation by districts. This map is built based on 2019 Susenas data. It is shown that there were big differences in improved sanitation provision in western Indonesia (Java, Bali, Sumatra, and some of Kalimantan) and eastern Indonesia (Sulawesi, Nusa Tenggara, Maluku, and Papua). This shows that Indonesia is also facing a big challenge in providing this access equally for every district.

Figure 1 shows that more than 85 percent of 117 districts had access to improved sanitation. These districts are mostly situated in Java, Bali, Sumatra, and eastern Kalimantan (shown by darker colours). On the other hand, there were still 121 districts with less than 65 percent, meaning that 35 percent of the population of those districts used unimproved access such as pit latrines, shared toilets, or defecated in open environments (shown by lighter colours).



Note: Improved sanitation is flush/pour toilets or pit latrines with slabs and used by own household members. Weight variable is used.

Figure 1. Improved Sanitation by Districts in Indonesia, 2019

Source: Author's estimation using 2019 Susenas data.

There were seven districts in Indonesia where less than 5 percent of the population had improved sanitation. This can be interpreted as more than 95 per 100 people used unimproved access to defecate. These districts were Paniai (1.1 percent), Deiayai (1.9 percent), Puncak (2.3 percent), Mamberamo Tengah (3.1 percent), Intan Jaya (3.4 percent), Nduga (3.8 percent), and Yahukimo (4.4 percent). All of these districts were situated in Papua Province.

Based on Table 2 and Figure 1, it is concluded that there were disparities in improved sanitation provision in Indonesia. This condition raises the question of whether sanitation has different effects on different regions. In order to answer the question, we disaggregate the analysis into two regions, Java-Bali and the rest of Indonesia. Java-Bali consists of respondents who resided in Java and Bali, while the Rest of Indonesia consists of respondents who resided outside Java and Bali.

Table 3 presents the results of the first stage of Two-Stage Least Squares (2SLS) estimations. In the full sample, improved sanitation has a negative significant effect on health status (Coef. = -0.0074; 99%). Disaggregation results show that Java-Bali (Coef. = -0.0054; 95%) has a smaller coefficient than other regions (Coef. = -0.014; 99%), meaning that improved sanitation has a higher effect in poorer regions in terms of infrastructure.

The type of region variable has a positive significant effect on health status in the full sample and others subsample. This indicates that urban residents are more likely to suffer health problems than rural residents. On the other hand, the estimation results in the Java-Bali subsample show a negative coefficient. This indicates that respondents who live in rural areas in Java-Bali are more likely to experience health problems.

The percentage of open defecation variable shows a negative coefficient in the full sample and other subsamples, meaning that respondent who resides in better hygiene communities are less likely to experience health problems. However, in Java-Bali, the

coefficient has a positive value, meaning that this variable has an opposite effect. First stage regressions result will be used as determinants of health expenditure per capita.

Table 3. First Stage Regressions
(Instrumented Variable: Health Status (Health problem = 1))

Variables	Full Sample	Disaggregation	
		Java-Bali ⁺	Others ⁺⁺
Constant	-0.152*** (0.0149)	-0.116*** (0.0215)	-0.235*** (0.0171)
Sanitation Ownership Status			
Improved Sanitation Ownership (Yes = 1)	-0.00743*** (0.00174)	-0.00539** (0.00272)	-0.0137*** (0.00182)
Individual Socioeconomic Status			
Age	0.00282*** (3.42e-05)	0.00241*** (5.02e-05)	0.00315*** (3.93e-05)
Sex (Male = 1)	-0.0251*** (0.00128)	-0.0237*** (0.00195)	-0.0258*** (0.00141)
Type of Region (Urban = 1)	0.00532*** (0.00136)	-0.0182*** (0.00211)	0.0143*** (0.00160)
Individual Education			
Years of Schooling	-0.0196*** (0.000144)	-0.0213*** (0.000223)	-0.0172*** (0.000159)
Individual Welfare Conditions			
Expenditure per Capita (in Logarithm)	0.0398*** (0.00112)	0.0409*** (0.00161)	0.0427*** (0.00128)
Floor types (Soil or worse = 1)	0.0211*** (0.00319)	0.0147*** (0.00437)	0.00277 (0.00379)
Environment Condition			
Percentage of Open Defecation	-0.0159*** (0.00386)	0.0212*** (0.00739)	-0.0304*** (0.00368)
Observations	1,169,618	356,186	813,432

Note: *** indicates statistically significant at 0.01; ** indicates statistically significant at 0.05; * indicates statistically significant at 0.1. Robust standard errors in parentheses. A weight variable is used.

Source: Author's estimation using 2019 *Susenas* data.

Table 4. Second Stage Regression Results
(Dependent Variable: Health Expenditure per Capita (in Logarithm))

Variables	Full Sample	Disaggregation	
		Java-Bali ⁺	Others ⁺⁺
Constant	9.317*** (0.00784)	9.549*** (0.0120)	9.007*** (0.00873)
Health Status (Experienced health problem = 1)	0.441*** (0.0227)	-0.0418 (0.0324)	1.165*** (0.0275)
Goodness of Fit			
Observation	1,169,618	356,186	813,432
Kleibergen-Paap rk LM statistic for Underidentification Test	20,926.90	10,699.04	14,325.42
Cragg-Donald Wald F statistic for Weak Identification Test	6,504.05	2,220.36	3,934.42
R-squared	0.005	-0.002	-0.065

Note: *** indicates statistically significant at 0.01; ** indicates statistically significant at 0.05; * indicates statistically significant at 0.1. Robust standard errors in parentheses. \Weight variable is used.

Source: Author's estimation using 2019 *Susenas* data.

Table 4 presents the results of the second stage of Two-Stage Least Squares (2SLS) estimations. The results showed that there were no underidentification and weak instrument problems in all subsamples. Therefore, the endogenous variable was used to estimate health expenditure per capita as a robust variable. The health status variable has a positive significant effect on health expenditure per capita (in logarithms) in the full sample. This can be interpreted as someone who experiences a health problem has 0.44 percentage points higher health expenditure than someone who does not experience it. Estimation results in the other subsample show a coefficient of 1.165. This indicates that someone who experiences a health problem in Sumatra, Kalimantan, Sulawesi, Maluku, Nusa Tenggara, or Papua has 1.17 percentage points higher health expenditure. In contrast to the full sample and other results, health status does not have a significant effect on health expenditures in Java-Bali.

4.2. Discussion

This study shows that access to improved sanitation is associated with a lower likelihood of experiencing health problems. This result is consistent with previous literature emphasizing the critical role of sanitation in improving health outcomes. Cameron & Olivia (2011) and Patunru (2015) documented that poor sanitation conditions are linked to higher incidence of diarrheal diseases in Indonesia. Furthermore, Noguchi et al. (2021) also found that improved sanitation along with proper hygiene reduces diarrhea incidence in Lao PDR. Supporting evidence is also provided by Fenwick et al. (2018) and Piper et al. (2017), who highlight that sanitation improvements help reduce disease burdens, particularly among vulnerable populations.

The findings of this study further reveal that individuals who experience health problems tend to have higher health expenditures. This aligns with existing studies suggesting that poor health status leads to increased utilization of healthcare services and higher medical costs. Li et al. (2013) show that households with members suffering from chronic illnesses are more likely to face catastrophic health expenditures. Similarly, Arsenijevic et al. (2016) report elevated healthcare spending among individuals with chronic conditions, while Azzani et al. (2019) identify illness as a key driver of catastrophic health spending. In Indonesia, Husna & Sukartini (2021) also demonstrate that poor health conditions increase the likelihood of financial hardship due to medical expenses. Overall, these results suggest that improved sanitation may indirectly reduce household healthcare expenditures by preventing health deterioration.

Furthermore, the results of this study also reveal significant heterogeneity. The effect of improved sanitation is stronger and statistically significant outside Java-Bali, while it is insignificant within Java-Bali, indicating variation in impacts across levels of regional development. This may reflect diminishing marginal returns in Java-Bali, where sanitation infrastructure is already relatively advanced, limiting additional health gains from further improvements. In contrast, regions outside Java-Bali, with lower baseline access to sanitation and higher exposure to sanitation-related diseases, experience larger marginal benefits. Structural disparities in infrastructure and public

service provision likely reinforce these differences. Households outside Java–Bali generally face more limited access to adequate sanitation and related services, making sanitation improvements more impactful in reducing health risks. Consequently, the associated reductions in healthcare expenditures are also more pronounced in these regions.

The findings of this study suggest that sanitation investments should be viewed as public goods provisions in order to reduce household financial burdens. Previous studies have primarily emphasized the health benefits of sanitation, such as lower morbidity and mortality rates (Komarulzaman et al., 2017; Noguchi et al., 2021; Wolf et al., 2018). This study extends the existing literature by indicating that sanitation improvements may also generate economic benefits through lower healthcare spending (Aregbeshola & Khan, 2018; Yao et al., 2025). Moreover, the stronger effects observed outside Java-Bali imply that sanitation programs may yield greater returns when targeted toward regions with lower infrastructure coverage and poorer sanitation conditions.

Nevertheless, several limitations should be acknowledged. First, the study utilizes cross-sectional data, which limits the ability to establish causal relationships. Second, health expenditure may be influenced by unobserved household characteristics that are not fully captured in the model. Therefore, the findings should be interpreted as evidence of association rather than strict causality. Future studies may employ panel data or quasi-experimental approaches to obtain more robust estimates of the effect of sanitation on healthcare spending.

4. Conclusion

Sanitation is an important issue in Indonesia as well as many other developing countries. This study finds that access to improved sanitation reduces health expenditure, thus prevent someone experience financial burdens. This suggests that tackling rising household expenditure can be mitigated by improving access to public goods, such as sanitation. High inequality of access to sanitation across Indonesia suggests that the government needs to prioritize the provision of infrastructure outside of Java and Bali. This study also finds that the effect of sanitation facilities would be higher in poor settings.

This study adds to the literature on health economics by explicitly linking an environmental determinant to a key economic outcome. It expands the theoretical framework of the demand for health by demonstrating that public goods act as a fundamental input into health production, hence reducing the financial burden of illness on households (Grossman, 1972). Moreover, the finding that the effect is context-dependent challenges the assumption of a uniform impact of health interventions and suggests that future theoretical models should account for baseline infrastructure development and regional characteristics. This reinforces the argument for a place-based approach in public health economics. It is important to provide better access to sanitation for all communities in Indonesia to improve public health.

These findings recommend several practical suggestions as follows. First, the government should prioritize investing in sanitation infrastructure provisions, particularly in regions outside Java-Bali. This ensures achieving returns in terms of public health improvement and household financial protection. Second, this study provides a strong fiscal argument for viewing sanitation not merely as a health intervention but as a strategic investment to suppress the incidence of out-of-pocket healthcare expenditures, which can push households deeper into poverty. Third, policymakers need to address the underlying structural disparities in infrastructure and public services across regions to ensure that the benefits of sanitation investments are realized and sustained.

Acknowledgements

Acknowledgements can be delivered to the parties who have helped with the research and completion of the writing of the manuscript. These parties can act as mentors, funders, providers of data, and so forth.

References

- Aregbeshola, B. S., & Khan, S. M. (2018). Determinants of catastrophic health expenditure in Nigeria. *The European Journal of Health Economics*, 19(4), 521–532. <https://doi.org/10.1007/s10198-017-0899-1>
- Arsenijevic, J., Pavlova, M., Rechel, B., & Groot, W. (2016). Catastrophic Health Care Expenditure among Older People with Chronic Diseases in 15 European Countries. *PLOS ONE*, 11(7), e0157765. <https://doi.org/10.1371/journal.pone.0157765>
- Azzani, M., Roslani, A. C., & Su, T. T. (2019). Determinants of Household Catastrophic Health Expenditure: A Systematic Review. *Malaysian Journal of Medical Sciences*, 26(1), 15–43. <https://doi.org/10.21315/mjms2019.26.1.3>
- Becker, G. S. (1962). Investment in Human Capital: A Theoretical Analysis. In *Investment in Human Beings* (pp. 9–49). National Bureau of Economic Research, Inc. <https://www.nber.org/books-and-chapters/investment-human-beings/investment-human-capital-theoretical-analysis>
- Bosch, C., Hommann, K., Rubio, G., Sadoff, C. W., & Travers, L. (2000). Water, Sanitation and Poverty. In *A Sourcebook for Poverty Reduction Strategies*. The World Bank.
- Brenneman, A., & Kerf, M. (2022). *Infrastructure and poverty linkages: A literature review*. International Labour Organization. https://www.ilo.org/emppolicy/pubs/WCMS_ASIST_8281/lang--en/index.htm
- Cameron, L., & Olivia, S. (2011). Sanitation and health: The past, the future and working out what works. In C. Manning & S. Sumarto (Eds.), *Employment, Living Standards and Poverty in Contemporary Indonesia* (p. 245). Institute of Southeast Asian Studies.
- Clasen, T., Pruss-Ustun, A., Mathers, C. D., Cumming, O., Cairncross, S., & Colford, J. M. (2014). Estimating the impact of unsafe water, sanitation and hygiene on the global burden of disease: evolving and alternative methods. *Tropical Medicine & International Health*, 19(8), 884–893. <https://doi.org/10.1111/tmi.12330>

- Ejemot-Nwadiaro, R. I., Ehiri, J. E., Arikpo, D., Meremikwu, M. M., & Critchley, J. A. (2021). Hand-washing promotion for preventing diarrhoea. *Cochrane Database of Systematic Reviews*, 2021(1). <https://doi.org/10.1002/14651858.CD004265.pub4>
- Esrey, S. A., Potash, J. B., Roberts, L., & Shiff, C. (1991). Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bulletin of the World Health Organization*, 69(5), 609–621. <https://pmc.ncbi.nlm.nih.gov/articles/PMC2393264/>
- Fenwick, C., Andres, L., de Jesus Filho, J., Borja-Vega, C., & Gomez-Suarez, R. (2018). Overview and Meta-Analysis of Global Water, Sanitation, and Hygiene (WASH) Impact Evaluations. In *Policy Research Working Paper* (p. 8444). World Bank. <https://doi.org/10.1596/1813-9450-8444>
- Fewtrell, L., Kaufmann, R. B., Kay, D., Enanoria, W., Haller, L., & Colford, J. M. (2005). Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *The Lancet Infectious Diseases*, 5(1), 42–52. [https://doi.org/10.1016/S1473-3099\(04\)01253-8](https://doi.org/10.1016/S1473-3099(04)01253-8)
- Gertler, P., & Gruber, J. (2002). Insuring Consumption Against Illness. *American Economic Review*, 92(1), 51–70. <https://doi.org/10.1257/000282802760015603>
- Grossman, M. (1972). On the Concept of Health Capital and the Demand for Health. *Journal of Political Economy*, 80(2), 223–255. <http://www.jstor.org/stable/1830580>
- Husna, A., & Sukartini, N. M. (2021). Determinants of Catastrophic Health Expenditure (CHE): An Indonesian Family Life Survey (IFLS) 2007 & 2014. *Journal of Economics, Business, & Accountancy Ventura*, 24(1), 156–170. <https://doi.org/10.14414/jebav.v24i1.2644>
- Johar, M., Soewondo, P., Pujisubekti, R., Satrio, H. K., Adji, A., & Wibisono, I. D. (2019). “Tahukah kamu?": Analisis Set Data Survei Sosial Ekonomi Nasional (Susenas). *Jurnal Ekonomi Dan Pembangunan Indonesia*, 19(2), 4. <https://doi.org/10.21002/jepi.2019.12>
- Komarulzaman, A., Smits, J., & de Jong, E. (2017). Clean water, sanitation and diarrhoea in Indonesia: Effects of household and community factors. *Global Public Health*, 12(9), 1141–1155. <https://doi.org/10.1080/17441692.2015.1127985>
- Li, X., Shen, J. J., Lu, J., Wang, Y., Sun, M., Li, C., Chang, F., & Hao, M. (2013). Household catastrophic medical expenses in eastern China: determinants and policy implications. *BMC Health Services Research*, 13(1), 506. <https://doi.org/10.1186/1472-6963-13-506>
- Noguchi, Y., Nonaka, D., Kounnavong, S., & Kobayashi, J. (2021). Effects of Hand-Washing Facilities with Water and Soap on Diarrhea Incidence among Children under Five Years in Lao People’s Democratic Republic: A Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, 18(2), 687. <https://doi.org/10.3390/ijerph18020687>
- Patunru, A. A. (2015). Access to Safe Drinking Water and Sanitation in Indonesia. *Asia & the Pacific Policy Studies*, 2(2), 234–244. <https://doi.org/10.1002/app5.81>
- Piper, J. D., Chandna, J., Allen, E., Linkman, K., Cumming, O., Prendergast, A. J., & Gladstone, M. J. (2017). Water, sanitation and hygiene (WASH) interventions: effects on child development in low- and middle-income countries. *Cochrane*

Database of Systematic Reviews, 2017(3), CD012613.
<https://doi.org/10.1002/14651858.CD012613>

Statistics Indonesia. (2019). *National Socioeconomic Survey (Susenas) 2019*. Statistic Indonesia.

Wagstaff, A. (2005). *The Economic Consequences Of Health Shocks*. World Bank.
<https://doi.org/10.1596/1813-9450-3644>

Wolf, J., Hunter, P. R., Freeman, M. C., Cumming, O., Clasen, T., Bartram, J., Higgins, J. P. T., Johnston, R., Medlicott, K., Boisson, S., & Prüss-Ustün, A. (2018). Impact of drinking water, sanitation and handwashing with soap on childhood diarrhoeal disease: updated meta-analysis and meta-regression. *Tropical Medicine & International Health*, 23(5), 508–525. <https://doi.org/10.1111/tmi.13051>

Wooldridge, J. M. (2016). *Introductory econometrics a modern approach* (5th ed.). Cengage Learning.

World Bank. (2020). *World Development Indicator*. World Bank Group.
<https://databank.worldbank.org/>

World Health Organization and United Nations Children's Fund. (2019). *Progress on household drinking water, sanitation and hygiene 2000–2017: Special focus on inequalities*. World Health Organization.
<https://www.who.int/publications/i/item/9789241516235>

Yao, X., Wang, D., Zhang, T., & Wang, Q. (2025). Chronic diseases and catastrophic health expenditures in elderly Chinese households: a cohort study. *BMC Geriatrics*, 25(1), 272. <https://doi.org/10.1186/s12877-025-05692-4>