

Research article

Assessing the Impact of Housing Quality and WASH Access on Household Morbidity in West Sumatra, Indonesia

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ABSTRACT

Improving household health is a fundamental pillar of sustainable development, yet the transition from infrastructure provision to improved health outcomes often encounters significant structural and behavioral barriers. This study investigates the impact of housing adequacy and access to Water, Sanitation, and Hygiene (WASH) facilities on household morbidity in West Sumatra, Indonesia. Utilizing household-level microdata from the 2024 SUSENAS (National Socioeconomic Survey with a sample of 43,201, this research employs binary logistic regression to estimate the likelihood of household health complaints. The empirical findings are that housing adequacy, access to safe drinking water, and improved sanitation are significant positive determinants of household health. Conversely, the study finds that the mere physical presence of hygiene facilities and higher household expenditure are negatively associated with health status, suggesting that economic capacity alone does not guarantee well-being without corresponding health-seeking behaviors and targeted investments. Furthermore, significant rural-urban disparities and the influence of sociocultural factors, such as Minangkabau settlement patterns, highlight the complexity of the infrastructure-health nexus. These findings underscore the need for integrated, multisectoral policies that combine physical infrastructure expansion with educational interventions to promote effective hygienic practices and bridge the health-infrastructure gap in decentralized governance frameworks.

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1. INTRODUCTION

Improving household health status is a fundamental pillar of human and sustainable development. Within the framework of the Sustainable Development Goals (SDGs), health is determined not only by the availability of clinical services but also by the complex interplay of social, economic, and environmental determinants. Adequate housing and access to water, sanitation, and hygiene (WASH) are critical social determinants of health; they play a pivotal role in achieving good health and well-being (SDG 3), sustainable cities and communities (SDG 11), and clean water and sanitation (SDG 6) (Brown et al., 2023; Okesanya et al., 2024; and Yan et al., 2025). From a development economics perspective, housing conditions and WASH access influence health outcomes through multiple causal pathways. These include exposure to hazardous environmental conditions, residential overcrowding, and restricted access to basic services, all of which concurrently increase household morbidity and disease vulnerability. In Indonesia, specifically in West Sumatra Province, disparities in housing quality and WASH access persist across regions and socioeconomic strata, potentially exacerbating health inequalities. Consequently, analyzing the linkages between adequate housing, WASH, and household morbidity is essential for formulating integrated and sustainable development policies (Hanri, 2025).

Adequate housing serves as a primary determinant of health, as structural durability, residential density, and access to WASH facilities are directly associated with disease risk and overall quality of life (Bentley et al., 2025). However, accelerated urbanization, demographic pressures, and infrastructural constraints have

widened disparities in WASH access. These gaps are empirically correlated with increased morbidity from preventable diseases, particularly in environments characterized by poor sanitation and inadequate solid waste management (Bhattacharjee et al., 2025; Okesanya et al., 2024; and World Health Organization, 2020). Empirical evidence suggests that inadequate housing quality and limited access to water, sanitation, and hygiene are associated with higher disease prevalence and increased healthcare expenditures, particularly in low- and middle-income countries (Spears, 2020; and Yandan et al., 2025). Conversely, improvements in housing infrastructure, such as enhanced building material quality and superior ventilation systems, have been linked to significant reductions in mortality and morbidity risks (Künn & Palacios, 2024).

Indonesia continues to face structural challenges in improving population health, which remain tethered to limited access to adequate housing and WASH facilities. Between 2015 and 2025, the national morbidity rate declined only marginally, from 30.35% to 28.3% (Indonesian Statistics, 2021) suggesting that basic infrastructure improvements have not yet fully translated into optimal health outcomes. While the 2025-2029 National Medium-Term Development Plan (RPJMN) emphasizes integrating health policies with housing and sanitation provision, implementation gaps remain. At the national level, the proportion of households living in adequate housing remains relatively low at 62.25% (Indonesian Statistics, 2024). In contrast, access to improved sanitation, safe drinking water, and proper hygiene facilities is considerably higher, reaching 83.6%, 92.64%, and 80.15%, respectively (Indonesian Statistics, 2024). This achievements continue to reflect substantial regional and socioeconomic disparities, further influenced by housing tenure status, which dictates both housing quality and household investment decisions.

In West Sumatra Province, while housing quality and access to WASH services have exhibited an upward trend, these improvements have not translated into a commensurate increase in population health status. This is evidenced by the persistently high prevalence of self-reported health complaints, which indicates a gap between infrastructure provision and actual health outcomes. This gap highlights the important, yet underexplored, role of behavioral factors and household socioeconomic conditions. West Sumatra presents a compelling "development paradox": the province maintains a relatively high human development index (HDI) and poverty levels below the national average, yet its morbidity rates and access to adequate housing and WASH facilities lag behind national benchmarks. This divergence is further underscored by significant intra-provincial disparities between districts and municipalities. For instance, morbidity prevalence varies from 15.05% in Sawahlunto City to 21.5% in Tanah Datar Regency. Similarly, access to adequate housing ranges from a low of 42.97% in South Solok Regency to 84.38% in Solok City. The gap in improved sanitation is even more pronounced, with Pasaman Regency reaching only 49.35% coverage compared to 92.19% in Solok City.

The selection of West Sumatra as a focal point for this study is justified by its unique sociocultural and institutional landscape within Indonesia's decentralized governance framework. Minangkabau cultural norms, which often involve extended family living arrangements and specific settlement densities, may heighten shared exposure to environmental health risks. Such factors can render partial infrastructure improvements less effective than in other contexts. Furthermore, these vulnerabilities are exacerbated during the post-recovery phases of hydrometeorological disasters, which frequently impact the province's housing integrity and WASH access. Although existing literature establishes that housing and WASH are critical to health, most research has examined these variables in isolation or focused narrowly on specific vulnerable groups like young children and indicators of undernutrition (Bhattacharjee et al., 2025; Brown et al., 2021; Priyadarshini & Gundimeda, 2025; Sahiledengle & Agho, 2021; and Yan et al., 2025). Furthermore, studies in Indonesia have largely relied on aggregate, area-level analyses that fail to capture household-level variations in health risks or the nuanced role of local socioeconomic characteristics (Agusmal et al., 2025; Priyadarshini & Gundimeda, 2025). Addressing these gaps, this study analysis the impact of adequate housing and WASH access on household health in West Sumatra Province, while simultaneously exploring the policy dynamics and implementation constraints at the regional level.

This study is structured to provide a comprehensive analysis of the nexus between infrastructure and public health in West Sumatra. Following this introduction, the second section details the research methodology, describing the household-level microdata utilized and the econometric approach employed to capture variations in health risks. The third section presents the empirical results, including a comparative analysis of regional disparities and the influence of sociocultural factors such as Minangkabau settlement patterns on health outcomes. The fourth section discusses these findings within the context of Indonesia's

decentralized governance. Finally, the paper concludes with a summary of key findings and offers evidence-based policy recommendations aimed at bridging the gap between infrastructure provision and household health status.

2. RESEARCH METHODS

2.1. Data Collection

This study employs the quantitative research design utilizing a cross-sectional approach. Descriptive analyses are conducted to characterize the households in West Sumatra, specifically focusing on housing conditions and access to WASH facilities. Furthermore, multivariable analytical methods are employed to examine the associations between housing and WASH conditions and household health outcomes, while adjusting for relevant socio-demographic covariates. The primary data are derived from the March 2024 National Socioeconomic Survey (SUSENAS) conducted by Indonesian Statistics (BPS). Specifically, the study utilizes the core questionnaire, which provides comprehensive data on housing characteristics, education, employment, social protection, and health, alongside the consumption module to measure household expenditure. The unit of analysis is the household, with a total analytical sample of 43,201 households residing in West Sumatra Province. The operational definitions, measurement units, and data sources for these variables are summarized in Table 1.

Table 1. Variable Definitions, Measurements, and Data Sources

Variables	Description	Measurement	Source
Household Health (HH)	Indicates whether any household member experienced health complaints during the last month	Binary (1 = no health complaints; 0 = at least one complaint)	SUSENAS 2024 Core, Block XI (code R1102)
Housing Adequacy (HOUS)	Adequacy of housing based on floor area, floor type, wall material, and roof condition	Binary (1 = adequate; 0 = inadequate)	SUSENAS 2024 Core, Block XVIII (code R1804, R1806A, R1807, R1808)
Safe Drinking Water (WATR)	Household access to safe drinking water sources	Binary (1 = piped water, protected well, refill water; 0 = otherwise)	SUSENAS 2024 Core, Block XVIII (code R1810A)
Sanitation Adequacy (SANT)	Availability of improved sanitation facilities	Binary (1 = swan-neck toilet; 0 = otherwise)	SUSENAS 2024 Core, Block XVIII (code R1809B)
Hygiene Facility (HYGN)	Availability of hand washing facilities in the household	Binary (1 = available; 0 = not available)	SUSENAS 2024 Core, Block XVIII (code R1815A)
Per Capita Expenditure (ln(Ex))	Total household spending divided by the number of family members	Natural logarithm (IDR)	SUSENAS 2024 Consumption Module
Employment Status (EMP)	Employment status of household head	Binary (1 = formal employment; 0 = informal)	SUSENAS 2024 Core, Block VII (code R707)
Education Level (EDUC)	Education attainment of household head	Binary (1 = college or higher; 0 = high school or lower)	SUSENAS 2024 Core, Block VI (code R614)
Gender (GEN)	Gender of household head	Binary (1 = male; 0 = female)	SUSENAS 2024 Core, Block IV (code R405)
Regional (REG)	Type of residence area	Binary (1 = rural; 0 = urban)	SUSENAS 2024 Core, Block I (code R105)

Household health is proxied by household-level morbidity, extracted from the 2024 SUSENAS Core questionnaire (Block IV, Question R1102). This metric records whether any household member experienced health complaints encompassing both infectious and chronic conditions, within the previous month. The variable is operationalized as a binary indicator, where a value of 1 represents a "healthy household" (no reported health complaints) and 0 indicates otherwise. This measure is a standard component of national health and poverty assessments, including Indonesia's Multidimensional Poverty Index, providing a consistent

metric of overall household wellbeing. Although the one-month recall period primarily captures short-term morbidity and does not differentiate between disease severity or individual-level variation, it is considered appropriate for this study; housing quality and WASH conditions are most strongly associated with acute health issues observable within short-term periods.

The primary independent variables consist of housing quality and WASH indicators. Housing adequacy is measured through physical dwelling characteristics as defined by Statistics Indonesia, including floor area, flooring type, wall materials, and roof condition. Access to safe drinking water is classified based on source: piped water, protected wells, and refillable water are categorized as safe. Sanitation adequacy is assessed by the type of toilet facility, with flush or "swan-neck" systems classified as adequate. Hygiene is proxied by the availability of handwashing facilities within the home. All housing and WASH variables are coded as binary indicators (1 = adequate/available; 0 = inadequate/unavailable). To mitigate potential confounding bias, the model includes several sociodemographic control variables, including household size, log-transformed monthly per capita household expenditure, the gender of the household head, and the education level of the household head (categorized as college or higher versus high school or lower). Additionally, the model accounts for the household head's employment status (formal versus informal) and the geographic place of residence (urban versus rural).

2.2. Model Specification

The analytical framework integrates descriptive statistics, bivariate chi-square tests, and multivariable binary logistic regression to evaluate the associations between housing adequacy, WASH access, and household health, while controlling for relevant sociodemographic factors. The empirical model is specified as follows:

$$\ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 HOUS + \beta_2 WATR + \beta_3 SANT + \beta_4 HYG N + \sum \beta_n x_{j=1,2,...,n} + \epsilon_i \quad (1)$$

Here, $\ln(P/(1-P))$ denotes the log-odds of the probability that a household experienced health complaints during the previous month; HOUS represents housing adequacy based on physical dwelling characteristics according to Statistics Indonesia standards (1 = adequate; 0 = otherwise); WATR indicates access to safe drinking water, coded as 1 if the household utilizes piped water, protected wells, or refillable water, and 0 for other sources; SANT denotes sanitation adequacy, coded as 1 if the household utilizes a private toilet with a flush or swan-neck system, and 0 otherwise; HYG N represents the presence of household hygiene facilities, coded as 1 if handwashing facilities are available within the household; and $\sum \beta_n x_{j=1,2,...,n}$ refers to a vector of socioeconomic and regional characteristics included as control variables.

Descriptive statistics were initially utilized to map housing and WASH access alongside the risk of health complaints across various districts and municipalities. The results of the logistic regression are interpreted using Odds Ratios (ORs) to indicate the likelihood of health complaints. To ensure statistical robustness, model fit was rigorously assessed using the Likelihood Ratio (LR) test and the Hosmer-Lemeshow test.

3. RESULTS AND DISCUSSION

3.1. Results

Table 2 presents the descriptive statistics for household health, housing conditions, and WASH indicators, alongside relevant sociodemographic control variables in West Sumatra. On average, 68.6% of households are classified as healthy, indicating that no household members reported health complaints during the one-month recall period. Regarding physical infrastructure, adequate housing conditions are observed in 78.6% of the sample, while access to safe drinking water and improved sanitation facilities reaches 82.2% and 88.5%, respectively. Access to hygiene facilities is notably high, with 92.5% of households reporting the availability of handwashing stations. The mean of logged household expenditure is 14.11, suggesting moderate economic variation across the provincial sample. In terms of sociodemographic characteristics, 16.4% of household heads are engaged in formal employment, and 7.2% have attained higher education. Furthermore, 55.8% of the surveyed households are situated in urban areas. Collectively, these descriptive statistics reveal relatively robust access to housing and WASH facilities, yet they also highlight underlying variations in health outcomes and socioeconomic status across West Sumatra.

Model performance was evaluated using the Likelihood Ratio (LR) test and the Hosmer-Lemeshow goodness-of-fit test. The LR test confirms the joint significance of the explanatory variables, while Wald tests were employed to assess the significance of individual coefficients. As shown in Table 3, the LR test yielded a statistic of 351.24 with a $p < 0.001$, confirming that the logistic regression model is statistically significant and that the included variables effectively explain variations in household health status.

Table 2. Result of Descriptive Statistics

Variables	Mean	Median	Minimum	Maximum	Std. Dev.
HH	0.6857	1.00	0.00	1.00	0.4642
HOUS	0.7863	1.00	0.00	1.00	0.4098
WATR	0.8217	1.00	0.00	1.00	0.3827
SANT	0.8846	1.00	0.00	1.00	0.3194
HYGN	0.9251	1.00	0.00	1.00	0.2631
ln(Ex)	14.109	14.04	12.70	17.16	0.4840
EMP	0.1641	0.00	0.00	1.00	0.3704
EDUC	0.0721	0.00	0.00	1.00	0.2587
GEN	0.0721	0.00	0.00	1.00	0.4999
REG	0.5582	1.00	0.00	1.00	0.4965

The Hosmer-Lemeshow test reported a chi-square value of 34.49 (p -value < 0.001), indicating a statistically significant difference between observed and predicted values. However, given the large sample size ($n = 43,201$), the Hosmer-Lemeshow test is known to be highly sensitive and may reject a model even when deviations are substantively minor. Therefore, model adequacy is primarily established based on the LR test results and the substantive interpretation of the regression coefficients.

Binary logistic regression was employed to examine the relationship between the independent variables, comprising housing conditions, access to safe drinking water, sanitation, and hygiene facilities, and the dependent variable of household health, while adjusting for sociodemographic controls including per capita expenditure, employment, education, gender, and region. The logistic model is appropriate for this analysis as the dependent variable is dichotomous, distinguishing between healthy households (coded as 1) and those reporting health complaints (coded as 0). This approach allows for the estimation of how each factor influences the probability of a household remaining free of morbidity.

Table 3. Results of Logistic Regression Estimation

Dep. Variables = $\ln \left(\frac{P}{1-P} \right)$					
Variables	Coefficient	z	$P > z $	Odds Ratio (OR)	dy/dx
HOUS	0.0750	2.85	0.004	1.0664	0.0137
WATR	0.1113	4.04	0.000	1.1178	0.0238
SANT	0.0699	2.02	0.043	1.0336	0.0070
HYGN	-0.0881	-2.11	0.035	0.9286	-0.0158
ln(Ex)	-0.2749	-11.83	0.000	0.7613	-0.0583
EMP	0.2556	8.33	0.000	1.2918	0.0547
EDUC	0.1237	2.81	0.005	1.1326	0.0266
GEN	0.2098	10.01	0.000	1.2335	0.0448
REG	-0.0773	-3.42	0.001	0.9201	-0.0177
Constant	4.4253	13.49	0.000	83.533	
Diagnostic test	Statistic	p-value			
Likelihood Ratio (LR)	351.24	0.000			
Hosmer-Lemeshow	34.49	0.000			

The results of the logistic regression analysis in Table 3, indicate that most independent variables exert a statistically significant influence on household health. Housing adequacy has a positive and significant effect ($\beta_1 = 0.075$; $p = 0.004$), with an OR of 1.07, this indicates that households with adequate housing conditions are approximately 1.07 times more likely to maintain good health compared to households in inadequate settlements. Similarly, access to improved water sources shows a highly significant and positive

association ($\beta_2 = 0.111$; $p < 0.001$; OR = 1.12), this implies that clean water significantly improves household health 1.12 times more compared to households that do not have access to clean water. Sanitation also contributes positively and significantly to household health ($\beta_3 = 0.070$; $p = 0.043$; OR = 1.03), implying that households with access to improved sanitation are 1.03 times more likely to be healthy compared to households without access to improved sanitation. Interestingly, hygiene facilities exhibit a negative and significant effect ($\beta_4 = -0.088$; $p = 0.035$; OR = 0.93), which implies that in this particular model, the presence of such facilities has a 0.93 times lower probability of being in the “healthy” category. Furthermore, per capita expenditure (log-transformed) shows a negative and highly significant effect ($\beta_5 = -0.275$; $p < 0.001$; OR = 0.76), this implies that per capita expenditure with a large number of family members has a 0.76 times lower probability of getting adequate health care.

Among the control variables, formal employment status is positively and significantly associated with better health ($\beta_6 = 0.256$; $p < 0.001$; OR = 1.29), implying that households with formal employment status were 1.29 times more likely to maintain better health than households with informal employment. Higher education also yields a positive and significant effect ($\beta_7 = 0.124$; $p = 0.005$; OR = 1.13), implying that households with higher education were 1.13 times more likely to maintain better health than households with lower education. Similarly, gender (male-headed households) exhibits a positive and significant influence ($\beta_8 = 0.210$; $p < 0.001$; OR = 1.23), implying that male-headed households were 1.23 greater likely to maintain better health compared to female-headed households. Meanwhile, residing in a specific region (rural/urban distinction) has a negative and significant effect ($\beta_9 = -0.077$; $p = 0.001$; OR = 0.92), this implies that households living in rural areas are 0.92 times less likely to maintain health than households living in urban areas. Overall, these findings underscore that environmental, socioeconomic, and demographic factors are critical determinants of household health status in West Sumatra.

3.2. Discussion

The descriptive statistics indicate that a majority of households in West Sumatra possess relatively robust access to adequate housing and WASH facilities. A significant proportion of the population reports access to safe drinking water, improved sanitation, and functional handwashing stations. Nevertheless, only 68.6% of households are classified as healthy, defined as being free from health complaints in the preceding month, which suggests that substantial variations in health status persist despite generally favorable environmental conditions. This finding implies that access to basic physical infrastructure alone is insufficient to guarantee optimal health outcomes; rather, socioeconomic and behavioral factors serve as critical, complementary determinants. Regarding model robustness, the LR test confirms that the logistic regression model is statistically significant, demonstrating that the explanatory variables jointly account for variations in household health status. Although the Hosmer-Lemeshow goodness-of-fit test rejects the null hypothesis of a perfect fit, this result should be interpreted with caution given the large sample size ($n=43,201$). In large datasets, the Hosmer-Lemeshow test is highly sensitive and often detects statistically significant but substantively minor deviations. Consequently, model adequacy is more reliably established through the LR test results and the substantive interpretation of the estimated coefficients.

The regression analysis confirms that both physical and socioeconomic factors are significantly associated with household health in West Sumatra. Adequate housing conditions are positively correlated with better health outcomes, reinforcing the role of the domestic environment as a vital protective factor. This finding aligns with previous literature demonstrating that substandard housing environments escalate the risks of morbidity and malnutrition, whereas superior housing quality mitigates vulnerability to infectious diseases and chronic health issues (Brown et al., 2023; and Tustingi et al., 2020). Similarly, access to safe drinking water and improved sanitation exhibits a positive association with household health. These results corroborate existing evidence that clean water and standardized sanitation systems remain critical in preventing waterborne and environmentally related diseases. Furthermore, the findings support the broader scholarly consensus that healthy housing and WASH infrastructure are essential health determinants, even in regions where coverage is relatively high (Biswas et al., 2024; Cameron et al., 2021; Krieger & Higgins, 2002; Njuguna, 2019; and Wolf et al., 2023). Conversely, the negative association found between hygiene and household health appears counterintuitive. This result may stem from measurement limitations, as the hygiene indicator utilized in this study captures the mere presence of handwashing facilities rather than actual hygienic practices or behaviors. Additionally, a reporting bias or reverse causality

may be present: households experiencing frequent health issues may be more inclined to report or invest in hygiene facilities as a reactive measure. Previous studies by Winter et al. (2021) and reports from the World Health Organization (World Health Organization, 2020) emphasize that the presence of facilities does not inherently guarantee consistent handwashing behavior, particularly in lower-income settings. This highlights the necessity of addressing behavioral factors, such as health awareness and social norms, alongside physical infrastructure.

The analysis of control variables reveals that socioeconomic status significantly influences household health in West Sumatra. Educational attainment and formal employment of the household head are both positively associated with better health outcomes. These findings suggest that higher education and stable employment enhance a household's capacity to access critical health information, utilize professional healthcare services, and adopt health-promoting behaviors. Furthermore, demographic characteristics such as the gender of the household head play a significant role, likely reflecting underlying differences in intra-household decision-making processes and health-related responsibilities (Abubakar, 2017; De, 2018; Ghosh et al., 2022; Irianti & Prasetyoputra, 2021). Conversely, per capita expenditure exhibits a negative association with household health status. This counterintuitive finding may indicate that higher household spending in this context reflects increased reactive costs associated with treating existing illnesses rather than a proactive investment in preventive well-being. Additionally, higher expenditure does not automatically equate to greater investment in health-enhancing goods or services, as resources may be allocated toward non-essential consumption. This supports the study by Brown et al. (2023) the argument that income growth alone is insufficient to improve population health without targeted health-specific investments.

Finally, the place of residence shows a significant negative relationship with health, underscoring persistent rural-urban disparities. Households in rural areas of West Sumatra face elevated health risks, which can be attributed to limited infrastructure, reduced access to clinical healthcare, and higher exposure to various forms of housing deprivation. This finding is consistent with an earlier study by Osei & Owoo (2024); and Ulman & Awiek (2020), identifying rural housing poverty as a major contributor to poor household health outcomes. These findings confirm that while housing quality and WASH infrastructure are vital determinants of family health in West Sumatra, their effectiveness is closely intertwined with household socioeconomic characteristics. The results suggest that public health strategies cannot rely solely on broad economic growth. Instead, improving health outcomes requires integrated policy interventions that combine the physical provision of high-quality housing and WASH facilities with educational programs designed to promote effective and sustained hygienic practices.

4. CONCLUSIONS

This study demonstrates that household health in West Sumatra is fundamentally shaped by the complex interplay of environmental infrastructure and socioeconomic determinants. The empirical findings confirm that adequate housing conditions and robust access to safe drinking water and improved sanitation serve as critical foundations for family well-being, effectively supporting superior health outcomes across the province. These results underscore the continued relevance of basic living conditions as primary social determinants of health in the context of regional development in Indonesia. Furthermore, the research highlights that socioeconomic characteristics, most notably the education level and employment status of the household head, are pivotal in enhancing a household's capacity to navigate health risks, make informed wellness choices, and utilize clinical healthcare services. However, the persistence of health disparities across residential areas indicates that geographic location remains a significant barrier to equity, with rural households continuing to face unique vulnerabilities compared to their urban counterparts.

A critical finding of this study is that neither increased household expenditure nor the mere physical availability of hygiene facilities automatically translates into improved health status. This nuance suggests that economic capacity and infrastructure provision are necessary but insufficient on their own. Instead, the effective use of resources, coupled with health-seeking behaviors and heightened awareness, remains the essential "last mile" in achieving better morbidity outcomes. From a policy perspective, these findings necessitate a transition toward a more integrated and multisectoral approach to public health. Future interventions should not only focus on the technical expansion of housing quality and WASH infrastructure but also prioritize the strengthening of education and formal employment opportunities. Moreover, promoting healthy behaviors through community-based programs is vital to ensure that infrastructural

gains are maximized. Coordinated, cross-sectoral actions are essential to address the "development paradox" observed in West Sumatra and to achieve sustainable, equitable improvements in population health.

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REFERENCES

- Abubakar, I. R. (2017). Access to Sanitation Facilities among Nigerian Households: Determinants and Sustainability Implications. *Sustainability (Switzerland)*, 9(4), 1–17. <https://doi.org/10.3390/su9040547>
- Agusmal, Y., Lisa, M., Hikmi, N., Irawati, S., Rizki, A., & Hijratul, D. (2025). Association of inadequate WaSH, housing, and infectious diseases with undernutrition hotspots among children under five: findings from a national survey in Indonesia. *Clinical Epidemiology and Global Health*, 36(August), 102211. <https://doi.org/10.1016/j.cegh.2025.102211>
- Bentley, R., Mason, K., Jacobs, D., Blakely, T., Howden-chapman, P., Li, A., Adamkiewicz, G., & Reeves, A. (2025). Series Housing as a Determinant of Health 1 Housing as a Social Determinant of Health: A Contemporary Framework. *The Lancet Public Health*, 10(10), e855–e864. [https://doi.org/10.1016/S2468-2667\(25\)00142-2](https://doi.org/10.1016/S2468-2667(25)00142-2)
- Bhattacharjee, S., Ismail, M., & Ferdous, N. (2025). Exploring the Spatial Nexus of Wash and Child Health in Khulna using Geospatial Techniques. *City and Environment Interactions*, 28(October), 100256. <https://doi.org/10.1016/j.cacint.2025.100256>
- Biswas, S., Adhikary, M., Alam, A., Islam, N., & Roy, R. (2024). Disparities in Access to Water, Sanitation, and Hygiene (WASH) Services and the Status of SDG-6 Implementation across Districts and States in India. *Heliyon*, 10(18), e37646. <https://doi.org/10.1016/j.heliyon.2024.e37646>
- Brown, C., Calvi, R., & Penglase, J. (2021). Sharing the Pie: An Analysis of Undernutrition and Individual Consumption in Bangladesh. *Journal of Public Economics*, 200, 104460. <https://doi.org/10.1016/j.jpubeco.2021.104460>
- Brown, C., Ravallion, M., & van de Walle, D. (2023). Child health and the housing environment. *World Development*, 168, 106265. <https://doi.org/10.1016/j.worlddev.2023.106265>
- Cameron, L., Chase, C., Haque, S., Joseph, G., Pinto, R., & Wang, Q. (2021). Childhood Stunting and Cognitive Effects of Water and Sanitation in Indonesia. *Economics and Human Biology*, 40(May 2019), 100944. <https://doi.org/10.1016/j.ehb.2020.100944>
- De, I. (2018). Determinants of Rural Sanitation in India and Implications for Public Policy. *Journal of Water Sanitation and Hygiene for Development*, 8(4), 650–659. <https://doi.org/10.2166/washdev.2018.038>
- Ghosh, P., Hossain, M., & Alam, A. (2022). Water, Sanitation, and Hygiene (WASH) Poverty in India: A District-level Geospatial Assessment. *Regional Science Policy and Practice*, 14(2), 396–416. <https://doi.org/10.1111/rsp3.12468>
- Hanri, M., Dewi, C. E., & Puspita, S. D. (2025). Urgent Choices: Evaluating the Impact of Housing and Wash Programs in Indonesia. *Journal of Developing Economies*, 10(1), 132–150. <https://doi.org/10.20473/jde.v10i1.60247>
- Irianti, S., & Prasetyoputra, P. (2021). Rural–urban Disparities in Access to Improved Sanitation in Indonesia: A Decomposition Approach. *Sage Open*, 11(3). <https://doi.org/10.1177/21582440211029920>
- Krieger, J., & Higgins, D. L. (2002). Housing and Health: Time Again for Public Health Action. *American Journal of Public Health*, 92(5), 758–768. <https://doi.org/10.2105/AJPH.92.5.758>
- Künn, S., & Palacios, J. (2024). Health Implications of Housing Retrofits: Evidence from a Population-Wide Weatherization Program. *Journal of Health Economics*, 98, 102936. <https://doi.org/10.1016/j.jhealeco.2024.102936>
- Njuguna, J. (2019). Progress in Sanitation among Poor Households in Kenya: Evidence from Demographic and Health Surveys. *BMC Public Health*, 19(1), 1–8. <https://doi.org/10.1186/s12889-019-6459-0>
- Okesanya, O. J., Eshun, G., Ukoaka, B. M., Manirambona, E., Olabode, O. N., Adesola, R. O., Okon, I. I., Jamil,

- S., Singh, A., Eliseo, D., Prisno, L., Ali, H. M., & Chowdhury, A. B. M. A. (2024). Water, Sanitation, and Hygiene (WASH) Practices in Africa: Exploring the Effects on Public Health and Sustainable Development Plans. *Tropical Medicine and hEalth*, 52(1), 68. <https://doi.org/10.1186/s41182-024-00614-3>
- Osei, R. D., & Owoo, N. S. (2024). Multi-dimensional Poverty and Health Outcomes in Ghana. *Social Sciences and Humanities Open*, 10(October 2023), 101108. <https://doi.org/10.1016/j.ssaho.2024.101108>
- Priyadarshini, M., & Gundimeda, H. (2025). Analyzing the Health Impact of Substandard Housing Environment and Access to Water, Sanitation and Hygiene in India. *BMC Public Health*, 25(1), 4181. <https://doi.org/10.1186/s12889-025-25028-6>
- Sahiledengle, B., & Agho, K. (2021). Determinants of Childhood Diarrhea in Households with Improved Water, Sanitation, and Hygiene (WASH) in Ethiopia: Evidence from a Repeated Cross-sectional Study. *Environmental Health Insights*, 15, 11786302211025180. <https://doi.org/10.1177/11786302211025180>
- Spears, D. (2020). Exposure to Open Defecation can Account for the Indian Enigma of Child Height. *Journal of Development Economics*, 146(July 2018), 102277. <https://doi.org/10.1016/j.jdeveco.2018.08.003>
- Tustingi, L. S., Gething, P. W., Gibson, H. S., Greenwood, B., Knudsen, J., Lindsay, S. W., & Bhattid, S. (2020). Housing and Child Health in Sub-Saharan Africa: A Cross-sectional Analysis. *PLoS Medicine*, 17(3), 1–18. <https://doi.org/10.1371/JOURNAL.PMED.1003055>
- Ulman, P., & Awiek, M. (2020). Housing Poverty in Polish Households and its Diversity. *Folia Oeconomica Stetinensia*, 20(1), 437–455. <https://doi.org/10.2478/fofi-2020-0026>
- Winter, J. C., Darmstadt, G. L., & Davis, J. (2021). The Role of Piped Water Supplies in Advancing heAlth, Economic Development, and Gender Equality in Rural Communities. *Social Science and Medicine*, 270(January), 113599. <https://doi.org/10.1016/j.socscimed.2020.113599>
- Wolf, J., Johnston, R. B., Ambelu, A., Arnold, B. F., Bain, R., Brauer, M., Brown, J., Caruso, B. A., Clasen, T., Colford, J. M., Mills, J. E., Evans, B., Freeman, M. C., Gordon, B., Kang, G., Lanata, C. F., Medlicott, K. O., Prüss-Ustün, A., Troeger, C., Boisson, S., & Cumming, O. (2023). Burden of Disease Attributable to Unsafe Drinking Water, Sanitation, and Hygiene in Domestic Settings: A Global Analysis for Selected Adverse Health Outcomes. *The Lancet*, 401(10393), 2060–2071. [https://doi.org/10.1016/S0140-6736\(23\)00458-0](https://doi.org/10.1016/S0140-6736(23)00458-0)
- World Health Organization. (2020). *WHO Global Strategy on Health, Environment and Climate Change: The Transformation Needed to Improve Lives and Well-being*. World Health Organization. <https://www.who.int/publications/i/item/9789240000377>
- Yan, H., Gallant, A. J., Delahunty-pike, A., Langley, J. E., Zsager, A., Abaga, E., Ziegler, C., Karabanow, J., Hwang, S. W., & Pinto, A. D. (2025). Social Science & Medicine Addressing Housing Insecurity as A Social Determinant of Health: A Systematic Review of Interventions in Healthcare Settings. *Social Science & Medicine*, 384(August), 118557. <https://doi.org/10.1016/j.socscimed.2025.118557>

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