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Analysis of Access to Electricity, Clean Water, and Sanitation on Malnutrition in Developing Countries

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ABSTRACT: Social infrastructure, which includes access to electricity, clean water, and sanitation, plays a critical role in addressing child malnutrition in developing countries. This study aims to determine the improvement of social infrastructure in the health sector, namely electricity, clean water, and sanitation on malnutrition as indicated by the stunting variable which is also one of the indicators of malnutrition. This research uses panel data regression with a sample of 10 developing countries (Indonesia, India, Pakistan, Burkina Faso, Bolivia, Botswana, Gabon, Guinea, Myanmar, and Bulgaria) in the 2020-2022 period. This research found a negative relationship between access to electricity, clean water, and sanitation and malnutrition, which means that increasing access to electricity, clean water, and sanitation can reduce malnutrition indirectly. Investment in social infrastructure, particularly in the health sector, is essential for economic growth and improved living conditions.

KEYWORDS: Electricity, Clean Water, Sanitation, Malnutrition, Stunting

I. INTRODUCTION

Access to electricity and water is fundamental to development and community welfare. Electricity is the foundation for many aspects of modern life, including economic activities, health, and education, while water is essential for basic daily human needs (Sitepu, 2023). Access to electricity is essential for economic and social development, as it enables the provision of clean water, efficient lighting, heating, cooking, sanitation, and health services (Apolo et al., 2017). The availability of electricity and clean water is critical given the uncertainty of the global situation for the sustainability of life and recovery especially from disasters, highlighting the need for alternative supply models to ensure sustainable access during emergencies (Ozcelik, 2017).

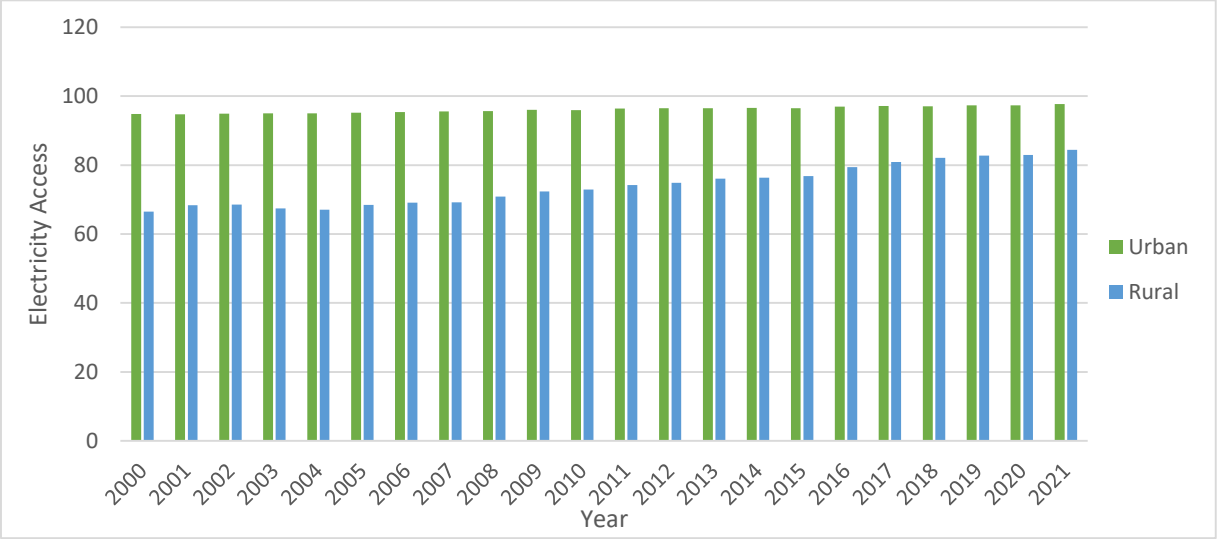

Figure 1 Global Electricity Access (% of Population)

Source: Worldbank

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Significant progress has been made in recent decades, with the proportion of the world's population with access to electricity increasing from 73% in 1998 to 90% by 2020. However, a major barrier that remains and stands in the way of achieving universal access to electricity is the lack of funding for off-grid sustainable energy solutions that can bring electricity to remote areas. It is estimated that between US$35 billion and US$40 billion is required annually between 2021 and 2030 to achieve universal electricity access (UNDP, 2024).

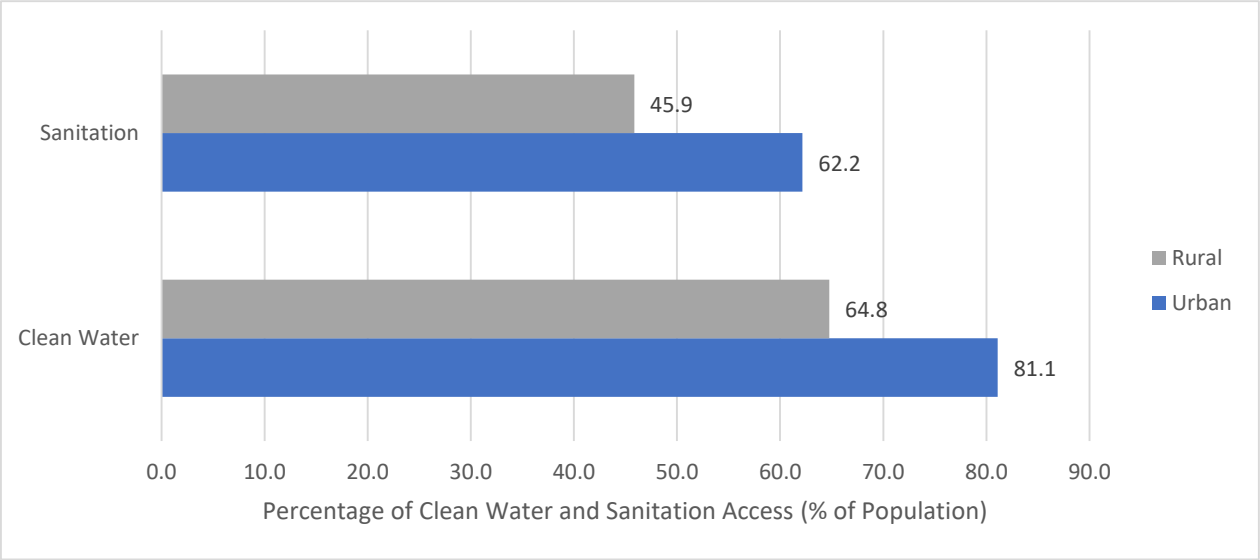

Figure 2 Global Clean Water and Sanitation Access (% of Population)
Source: Worldbank

Access to water, sanitation, and hygiene is a fundamental human right, but political rather than technological or economic barriers often prevent it, and urban climate change exacerbates the urgency of such access, especially for the urban poor and vulnerable (Corburn, 2022). Better sanitation is associated with lower mortality, reduced risk of diarrhea, and reduced stunting in children, while improved access to clean water is associated with lower risk of diarrhea and stunting, but not significantly with non-child mortality (Fink et al., 2011). Water and sanitation are important for health as they relate to contaminated water, water shortages, and poor hygiene, which cause various diseases such as parasites, fungi, skin diseases, eye infections, and diarrhea (M. Smith & Reed, 1991).

II. LITERATURE REVIEW

A. Social Infrastructure and Social Ecology Theory

The development of social infrastructure, particularly in the health sector, is crucial for economic growth and the improvement of people's living conditions (Goswami, 2012). Socially oriented infrastructure is essential for social development, meeting basic needs, and supporting activities required under current socioeconomic conditions (Alpeeva et al., 2018). Social infrastructure plays an important role in regional development and is linked to the quality of life and social well-being of the population, with investment in this area seen as preparation for future social and economic prosperity (Balan, 2023).

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The social-ecological theorem refers to the interrelationships and dependencies between social systems and ecological systems, emphasizing the mutual influence and feedback mechanisms between human activities and the environment (Wu et al., 2024). Social ecology is presented as a critical transdisciplinary science that conceptualizes and analyzes the complex relationship between nature and society, focusing on the patterns and modes of regulation of society (Bailey, 1998).

Social-ecological studies include examining how people adapt to their environment and how these adaptations, in turn, affect the environment, with Living Systems Theory providing a model for understanding these processes (Hummel et al., 2017). Social-ecological models are used to guide public health practice, focusing on the interactions between individual behavior and different levels of the environment, although implementation at broader institutional, community, or policy levels is less common (Stokols,

2000). Social ecology provides a framework for understanding health problems and designing interventions at the educational, therapeutic, and policy levels to improve people's well-being (Golden & Earp, 2012).

B. Access to Electricity, Clean Water, Sanitation and Malnutrition

Malnutrition refers to a deficiency or excess intake of nutrients, an imbalance of essential nutrients, or impaired nutrient utilization. The double burden of malnutrition consists of undernutrition and overweight, and also obesity, as well as diet-related non-communicable diseases (WHO, 2024). The prevalence of malnutrition is divided into 3, namely, wasting (weight to height), stunting (height to age), and underweight (weight to age) (WHO, 2024). Malnutrition can occur in obese individuals due to insufficient supply or improper absorption of essential nutrients, despite excessive energy consumption, leading to a paradoxical state of malnutrition with micronutrient deficiencies (Kobylińska et al., 2022).

Malnutrition is a condition that affects individuals differently based on age, health status, and socioeconomic factors (Duggal & Petri, 2018). It can result from both under and over-nutrition, with serious implications for health and well-being (Soeters et al., 2017). Addressing malnutrition requires a comprehensive approach that includes screening, intervention, and consideration of underlying causes, such as inflammation and genetic predisposition (Chen et al., 2001).

Electricity, water, and sanitation are interconnected resources that play an important role in the functioning of communities (Bartram & Cairncross, 2010). Electricity is used to pump and treat water, which is essential for drinking and sanitation purposes. The availability of these resources can also impact literacy and community well-being (Neunteufel et al., 2015). Research shows that electricity is an important component of water service provision, with most electricity consumption dedicated to water-related activities (Bürgmann et al., 2018). Furthermore, the presence of adequate sanitation and electricity plays an important role in increasing literacy rates, suggesting that efforts to improve access to these resources can have a positive impact on education and overall quality of life (Rautanen et al., 2010).

III. RESEARCH METHOD

A. Data

This study uses secondary data from 10 samples of developing countries (Indonesia, India, Pakistan, Burkina Faso, Bolivia, Botswana, Gabon, Guinea, Myanmar, and Bulgaria). Data sourced from the World Bank Indicator Open Data and United Nations Children's Fund (UNICEF) Data with a period from 2020 to 2022. The use of panel data was chosen to be able to determine differences in estimates between countries and between times.

Table 1. Variables and Data Sources

Variable Name	Description	Source
Dependent Variable		
Stunting	Point Estimate Stunting Proportion	UNICEF Data
Independent Variable		
Electricity	Percentage of Population Access to Electricity	World Bank Indicator Open Data
Water	Percentage of Population Access to Clean Basic Drinking Water	World Bank Indicator Open Data
Sanitation	Percentage of Population Access to San	World Bank Indicator Open Data

The dependent variable used in this research is stunting proportion. Malnutrition is seen by several factors ranging from wasting, overweight, and stunting. Stunting is the most closely related to malnutrition indicators for children. (WHO, 2024). The independent variables in the study are proxied by several variables based on previous research. The social infrastructures are proxied by access to electricity, clean drinking water, and sanitation of the population.

B. Empirical Model

This study applies regression on panel data. Panel data, also known as longitudinal data, is a data set that includes characteristics of the same observation at various points in time. The characteristics of these observations may involve heterogeneity across time, especially at the individual, household, and firm levels. Panel data allows the analysis of heterogeneity for an observation, taking into account variations that occur across time.

In analyzing panel data, there are two commonly used estimation methods, namely fixed effect and random effect. The fixed effect method is used under the assumption that the unobserved variables are correlated with the independent variables. On the other hand, the random effect method is used under the assumption that the unobserved variables do not correlate with the

independent variables. A formal Hausman test can be conducted to measure the difference in correlation between fixed effect and random effect to choose the more appropriate method. (Wooldridge, 2018).

This study uses panel data regression analysis with a random effect model. The selection of the random effect model is based on the results of the Hausman test with the hypothesis that if the chi-square probability value is greater than the significance limit (0.05), the random effect model will be used. The test results show that the chi-square probability (0.5362) is greater than the significance limit (0.05) so the selected model is a random effect.

Table 2. Random Effect

Test	Significance Limit	Prob > chi2
Hausman Test	0,05	0,0837

The random effect model assumes that the effects on specific individuals are random variables that are not interrelated with the explanatory variables. In other words, the variance of the error between time variables and the variance of the predictor variables are not interrelated and the time-invariant variables can play the role of explanatory variables.

C. Model Specifications

$Stunting_{it} = \beta_0 + \beta_1 Electricity_{it} + \beta_2 Water_{it} + \beta_3 Sanitation_{it} + u$

Where $Stunting_{it}$ denotes the stunting proportion from 10 samples of developing countries. $Electricity_{it}$ denotes the percentage of access to electricity of the population. $Water_{it}$ denotes the percentage of access to electricity of the population. $Sanitation_{it}$ denotes the percentage of access to electricity of the population.

IV. RESULT AND DISCUSSION

Table 3. Estimation Result

VARIABLES	(1) Stunting
Electricity	-0.136**
	(0.0610)
Water	-0.326**
	(0.137)
Sanitation	-0.0920*
	(0.0546)
Constant	63.94***
	(9.038)
Observations	30
Number of Country	10

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

This study analyzes the influence of social infrastructure proxied by access to electricity, access to clean drinking water, and access to sanitation on child malnutrition which is indicated by stunting proportion significantly. Column one shows a negative relationship between the three social infrastructures and stunting. The first row shows that a one-percent increase in access to electricity will generally decrease the stunting proportion sector by 0.136% significantly. Then, a one percent increase in access to clean drinking water also has a negative and significant effect on stunting proportion, whereas a one percent increase in access to clean drinking water will decrease stunting by 0.326%. The access to sanitation variable has a negative and significant effect on stunting by 0.0920%. This result is also the same as in previous studies, namely that access to electricity, clean water, and sanitation has a significant effect on malnutrition.

Water and sanitation interventions impact malnutrition through biological mechanisms such as reducing stunting which is associated with undernutrition (Bekele et al., 2020). Poor water and sanitation contribute to malnutrition through mechanisms such as stunting, wasting, and overweighting, which impact the nutritional status of children (Patlán-Hernández et al., 2022). Lack of improved sanitation is significantly associated with child stunting (Mudadu Silva et al., 2023). Clean water and sanitation

interventions improved mean height-for-age scores in children. Combined water and sanitation interventions were more effective than single interventions (Gizaw & Worku, 2019).

Lack of access to electricity is associated with an increased likelihood of undernutrition in households (Prakash & Munyanyi, 2021). Lack of electricity for lighting is associated with a higher likelihood of overnutrition unless biofuels are used (Jesmin et al., 2011). Households with lower electricity access may suffer from undernutrition but are less likely to be overnourished, emphasizing the impact of energy access on malnutrition outcomes (Dake & Christian, 2023). There is also a strong association between lack of electrical energy and poorer health status (Oliveras et al., 2020).

Low socioeconomic status, low household income, and lack of access to basic amenities such as toilets are significant determinants of malnutrition (O'Keeffe et al., 2019). Large family size and household density are associated with an increased risk of malnutrition (Harris & Nisbett, 2020). Maternal factors such as age at delivery, education level, and health status, including mental health, are determinants of child malnutrition. Suboptimal breastfeeding practices, inappropriate complementary feeding and the inability of mothers to shop, prepare and cook food due to various constraints are associated with malnutrition (Aheto et al., 2015).

V. CONCLUSION

This research found a negative relationship between access to electricity, clean water and, sanitation, and malnutrition, which means that increasing access to electricity, clean water and, sanitation can reduce malnutrition indirectly. This research uses panel data from 10 developing countries from 2020 to 2022. This research is likely to analyze the impact of access to electricity, clean water, and sanitation on the proportion of stunting which indicates malnutrition. We used panel data least squares regression with a random effects model. The results show that access to electricity, clean water, and sanitation have a negative and significant linear relationship with malnutrition. Our results show that countries with higher access to electricity, clean water, and sanitation percentage points will decrease malnutrition by 0.136; 0.326; and 0.0920 percentage points, respectively. This suggests that access to electricity, clean water, and sanitation are likely to need attention due to their impact on malnutrition.

Lack of access to electricity is associated with an increased likelihood of malnutrition in households, emphasizing the importance of energy access to address malnutrition. Water and sanitation interventions play an important role in influencing malnutrition by reducing stunting all of which are associated with malnutrition. Investment in social infrastructure, particularly in the health sector, is essential for economic growth and improved living conditions. Socially oriented infrastructure is essential to meet the basic needs and support activities required under current socio-economic conditions, emphasizing the linkages between infrastructure development and people's well-being.

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