# Adequate Energy Consumption and Children's Education Outcomes in Indonesia

## INTRODUCTION

Energy poverty constrains the fulfilment of multidimensional household needs, including education, making it a critical issue to address in efforts to support distance learning, modernize educational processes, and promote sustained school participation among children. As access to reliable and affordable energy becomes increasingly central to daily life, a growing body of research highlights its importance for improving social welfare, economic growth, and human development, particularly through education. However, despite this expanding literature, the specific impacts of energy poverty on children remain relatively underexplored. Most existing studies focus on aggregated populations, thereby overlooking the distinct vulnerabilities and experiences of children, who are particularly sensitive to energy deprivation due to their developmental stage.

Children's exposure to energy poverty can affect their well-being through multiple channels, including poor lighting for studying, limited access to information and communication technologies, and increased health risks associated with dirty energy use. Adequate energy access is essential for enabling distance learning, supporting educational activities beyond school hours, and facilitating the adoption of modern learning tools. Previous studies have established a significant relationship between a lack of energy and educational outcomes, showing that limited energy access restricts exposure to knowledge sources and learning opportunities. Nevertheless, much of this evidence is concentrated in developed contexts, with relatively limited focus on emerging economies where energy poverty rates remain high.

In Indonesia, energy poverty is evident in the continued reliance on traditional fuels for cooking and uneven access to reliable electricity, particularly in rural and remote areas. According to the Central Bureau of Statistics in 2019 at least 2,281 rural households remain without electricity access, with the largest concentrations found in eastern Indonesia, Kalimantan, and Sulawesi. This issue is especially salient given Indonesia's demographic structure: the 2020 Population Census reports that approximately 79.71 million individuals, or 29 percent of the population, are children aged 0–17 years. Indonesia's archipelagic geography further intensifies disparities in energy access, as regions outside Java continue to face higher costs and logistical barriers to energy provision, despite ongoing infrastructure expansion.

Responding to these gaps, this study aims to provide empirical evidence on the relationship between energy poverty and children's educational outcomes in Indonesia. Beyond energy-related indicators, the analysis accounts for key household socioeconomic characteristics, including income levels, parental education, household size, housing conditions, and access to safe water, to better isolate the role of energy poverty in shaping educational attainment.

## METHODOLOGY

The study draws on data from the 2019–2023 National Socioeconomic Survey (Susenas) KOR module and adopts a two-stage approach to identify energy-poor households. First, high-share and low-share energy poverty indices are constructed based on household energy expenditure patterns. Second, electricity consumption is benchmarked using standards derived from

Presidential Regulation No. 47 of 2017, which governs the provision of solar panel lighting systems for households without electricity access. These systems, with a capacity of 20-watt peak and four light emitters, provide energy equivalent to 32.4 kWh per month per household. Following (Sambodo & Novandra, 2019) households consuming less than this threshold are classified as energy-poor.

The dependent variable is children's average length of schooling, with children defined as individuals aged 0–19 years following the World Health Organization (2014). The analysis employs a pseudo-panel framework using independent cross-sections and applies Pooled OLS, Pooled OLS with Driscoll–Kraay standard errors, and Generalized Estimating Equations (GEE). To ensure sample homogeneity, the cohort focuses exclusively on single-family households, excluding apartments and rental units.

## RESULT AND DISCUSSION

Overall, 7.83 percent of the population is classified as energy-poor based on monthly electricity consumption below 32.4 kWh, while 13.78 percent experience poor absolute energy conditions. Notably, the high-share energy group exhibits the highest concentration of energy-poor individuals, reaching 23.06 percent. These findings suggest that energy poverty is not solely an issue of access but also reflects inefficient or constrained energy use within households. Children living in energy-poor households exhibit substantially lower educational outcomes. On average, they complete only six years of schooling, equivalent to primary education, and a striking 33 percent receive no formal education at all. Using electricity consumption as a measure of energy poverty, the study finds that the average proportion of energy-poor households is 8.5 percent. Energy poverty is most concentrated among the poorest households, with 27.5 percent located in the first income decile. However, the persistence of energy-poor households even among the richest decile (1 percent) indicates that energy deprivation is not exclusively driven by income, but also by structural and behavioral factors.

Econometric results consistently show that energy poverty has a negative and statistically significant effect on children's average length of schooling across all model specifications. When comparing two otherwise similar households, children from energy-poor households attain approximately six months or one semester less schooling than those from non-energy-poor households. This adverse effect is also observed in low-share energy households, reinforcing the conclusion that insufficient energy access constrains educational investment. Interestingly, high-share energy poverty exhibits a positive and significant association with schooling in both the Pooled OLS and GEE models, with children attaining approximately 0.3 additional years of education. This counterintuitive result may reflect compensatory behavior among households that allocate a larger share of resources to energy to support educational activities such as lighting, studying at night, or access to information. The study further highlights the critical role of energy type.

The use of modern energy sources for cooking is positively associated with children's schooling outcomes. In contrast, reliance on dirty energy sources such as such as firewood, charcoal, kerosene, and fossil fuels used for motorized vehicles has a pronounced negative impact. The findings indicate that just one month of using dirty energy sources can reduce children's average schooling by 0.5 years, a magnitude even larger than the positive effect of

modern energy use. This underscores the health, time, and cognitive burdens imposed by dirty energy, which ultimately hinder children's educational progress. Regional disparities further exacerbate educational inequality. Compared to Java, households in Sumatra, Bali and Nusa Tenggara, Sulawesi, and Maluku attain 0.1–0.2 fewer years of schooling, while Kalimantan exhibits a larger gap of 0.4 years. Papua faces the most severe disadvantage, with a one-year deficit in schooling.

## CONCLUSION

Overall, this study underscores the importance of integrated policy interventions that simultaneously address energy poverty and educational inequality. Improving access to reliable electricity, promoting clean cooking technologies, and reducing regional disparities are essential steps to ensure that children's educational opportunities are not constrained by household energy conditions.

## REFERENCES

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