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THE IMPACT OF ENERGY POVERTY ON ECONOMIC GROWTH THROUGH ITS EFFECTS ON EDUCATIONAL ATTAINMENT AND HEALTH OUTCOMES[1]

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Energy poverty has acquired substantial devotion worldwide, adversely affecting income, education, health, and the environment. The impact of energy poverty on economic growth is manifold and demonstrated beyond various paths. The research aims to qualitatively investigate how energy poverty impacts economic growth by evaluating its documented effects on educational attainment and health outcomes. The significance of this research is that it addresses a critical gap by emphasizing how poor energy access limits educational opportunities and deteriorates health outcomes, both essential pillars of human capital. The qualitative method was used to analyze the results, specifically focusing on the document analysis approach. The various document analysis tools such as journal articles, websites, reports, book chapters, data banks etc. are used for the analysis. The main findings show that energy poverty leads to lower education attainment and inferior health outcomes, which in turn scrawnier human capital. On the other hand, the electrification rate has a positive correlation with GDP per capita. Moreover, aggravated energy poverty reduces life expectancy and also diminishes literacy rate. Furthermore, economic performance considerably drags by the accumulated effect of these deficits. Nations with high energy poverty levels progressively exhibit lower GDP per capita, abrupt life expectancy, and stunted educational outcomes, effectively trapping populations in cycles of poverty and underdevelopment. In conclusion, educational attainment is rigorously faltered by inadequate access to clean energy and power. Also, predominant health deterioration, especially among women and children, is caused by the reliance on traditional biomass fuels and the lack of thermal comfort infrastructure. Nevertheless, in energy-poor nations, this limits the demographic dividend, improves healthcare rates, and lowers employee output.

Keywords: economic growth, educational attainment, energy poverty, health outcomes.

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Introduction and formulation of the problem

Energy poverty, the lack of access to reliable and affordable energy remains a critical barrier to economic development and economic growth in many parts of the world. The impact of energy poverty on economic growth is multifaceted and manifests through various channels. According to both theoretical and empirical literature, economic growth has a clear relationship with energy poverty.

This research undertakes an investigation into the multifaceted impact of energy poverty on economic growth, specifically analysing its documented effects on educational attainment and health outcomes. The study's significance lies in elucidating the pathways through which energy poverty constrains educational opportunities and negatively impacts health, thereby hindering sustainable economic progress. Consequently, a comprehensive understanding and

[1] This article was produced from the PhD thesis entitled The relationship between energy poverty and economic growth: a panel data analysis of emerging market economies" under supervison of Prof. Dr. Rustu Yayar

effective mitigation of energy poverty are critical for policymakers seeking to promote inclusive economic growth and enhance overall quality of life.

The study employed qualitative document analysis methodology, systematically revising and rendering scholarly literature, institutional reports, and statistical databases to examine how energy poverty indirectly constrains economic growth via its opposing impacts on educational attainment and health outcomes. One method of qualitative research that has been underutilized is document analysis. The findings are presented in two core thematic domains: (1) Energy Poverty and Educational Attainment, and (2) Energy Poverty and Health Outcomes, with subsequent implications for economic growth.

Purpose of the article

The purpose of this article is to shed light on the significant yet often overlooked impact of energy poverty on economic growth, with a keen focus on its effects on the role of education and healthcare as facilitators. The analysis explore how limited access to sustainable and cost-effective sources of energy detrimentally impacts the delivery and caliber of both education and healthcare. By examining these interrelated pathways, this paper illuminates the far-reaching consequences of energy poverty on economic progress. A thorough comprehension of this connection is essential for policymakers, researchers, and the local community alike, as it not only addresses energy poverty but also serves as a catalyst for long-term economic growth. The discourse presented here offers readers a more nuanced perception of the significance of addressing energy poverty in order to cultivate healthier and better-educated populations that serve as the foundation for robust and resilient economies.

The current study is important for several reasons. First, it contributes to a better understanding of the field of energy poverty. Second, it will show different paths that energy poverty hinders economic situation. Finally, the study adds to the energy poverty literature at the methodological level and the results from this study will contribute valuable insights to the existing literature on energy poverty and its economic impacts.

Presentation of the main material

One of the major global problems today is energy poverty. The definition of energy poverty is still up for debate, but the notion is widely accepted worldwide. The fact that there isn't a single, widely accepted definition illustrates how related methods, goals, and indicators are always changing. Designing and executing successful interventions to guarantee fair access to contemporary, inexpensive, and clean energy requires an understanding of energy poverty. However, access to energy services is emphasized in a number of different definitions of energy poverty. Energy poverty is defined by Garba and his colleagues defines energy poverty "the inability of an individual or group of individuals to safely acquire sustainable, clean, efficient, and reliable energy services that adequately satisfy their basic needs, such as lighting, cooking, and heating/cooling, at affordable costs" [5]. According to Jayasinghe and his colleagues, energy poverty is also determined by energy budget shares, which are the percentage of household income or expenses that go toward fuel and electricity [7].

Regarding to the concept of economic growth, an increase in total production and consumption of goods and services is referred to as economic growth, which is a primary goal for most countries. Growth in the Gross Domestic Product (GDP), which is the market worth of all goods and services produced inside a nation's borders, is a typical way to quantify it. A key component of national income accounting, this measurement entails tracking income, expenditures, and production using monetary units while accounting for inflation [6].

Beyond the immediate inconvenience and hardship, it causes, energy poverty has far-reaching effects that deeply undermine a country's growth prospects. Most notably, it hinders access to quality education and essential healthcare, two pillars of human capital development (e.g., lower productivity due to sickness, lesser educational access). There is a link between energy poverty and health because it is also connected to an individual's health. According to Nguyen C. P., Dinh Thanh S. [8] conduct that energy poverty negatively affect people's physical and mental health, pointing to its connection to insulation issues and physical limitations.

The impact of energy poverty on economic growth is largely mediated through its detrimental effect on human capital, the lifeblood of any thriving society. The concept of "human capital," is estimated by knowledge, skills, attitudes, abilities and other acquired characteristics that contribute to production. The critical role of human capital lies in its direct link to productivity and there is a linear positive effect of human capital on economic growth in both the short and long term [2]. Energy poverty negatively impacts human well-being primarily through its detrimental effects on health and education. As Durlauf and Blume [3] emphasize, health and education are crucial determinants of individual productivity. Energy poverty, in turn, affects both health and education via multiple pathways.

There is a clear causal relationship between energy poverty and deteriorating health outcomes, according to document analysis. People's health will

be negatively impacted by energy poverty in a number of ways. First of all, the inability to obtain the energy required to heat homes might result in health issues brought on by energy poverty. Most of energy expenditure in the home goes toward heating, which is obviously the most significant strategy to keep people comfortable and healthy. It has been demonstrated that living in homes experiencing energy poverty has a negative impact on one's health, as evidenced by the high rate of lung disease, the high number of winter fatalities, and poor mental health [10]. Households in areas with limited access to modern heating and electrical infrastructure face a variety of health consequences, from minor injuries sustained while gathering fuel or wood to more serious problems with indoor air pollution and inadequate medicine storage due to a lack of refrigeration. Furthermore, candles or diesel/kerosene lanterns are frequently used to provide lighting in energy-poor households without access to electricity. These options provide health and safety hazards to residents, such as burns, explosions, and fuel poisoning [11].

Additionally, lack of latest energy forces reliance on biomass (wood, charcoal, dung) for cooking. This causes toxic smoke, leading to chronic respiratory diseases, especially among women and children. Widespread health problems are caused by reliance on traditional energy sources such carbon, coal, biomass, wood, agriculture, fiber, and animal feces. A fifth of the fuel may be diverted as byproducts of incomplete combustion since biomass is frequently utilized in inadequate stoves, posing health risks. When coal is utilized for domestic energy, air pollution is another issue. Particulate matter and harmful pollutants are released by coal smoke [1].

Furthermore, energy poverty will also have an impact on human health since it will prevent individuals from having access to broadcasting equipment and, as a result, health information. According to El-Katiri [4], households should be aware of the potentially disastrous health and environmental consequences of relying too much on biomass and subpar liquid fuels like kerosene. This is especially true for households with low educational attainment or without access to radio or other forms of media. Lack of access to electricity has the secondary impact of preventing radio access. In rural Jordan, for example, a number of studies complain about the harmful health impacts of the extensive use of kerosene and biomass for heating and cooking, as well as the general lack of knowledge about the health concerns associated with those fuels. Finally, households experiencing energy poverty are also more vulnerable to extreme temperatures due to lack of cooling or heating systems, exacerbating cardiovascular and respiratory diseases, especially among the elderly and infants [12].

Accordingly, poor health outcomes not only weaken quality of life but also completely affect labor productivity, absenteeism, and national healthcare burdens further delaying economic performance. According to Bhattacharyya and Yang [1] energy-poor households are 40% more likely to incur catastrophic health expenditures, diverting resources away from productive investments. The resulting health burden weakens the labour force, drives up healthcare costs, and reduces productivity, all of which restrains macroeconomic productivity.

Statistics from the Fig. 1 reveal that indoor air pollution claims over three million lives prematurely every year. The issue of indoor air pollution is prevalent globally, mainly caused by the use of solid fuels like crop waste, dung, wood, and charcoal for fuel during cooking. This hazardous practice primarily affects low-income areas, with widespread use by some of the world's poorest individuals, releasing dangerous chemicals into their homes.

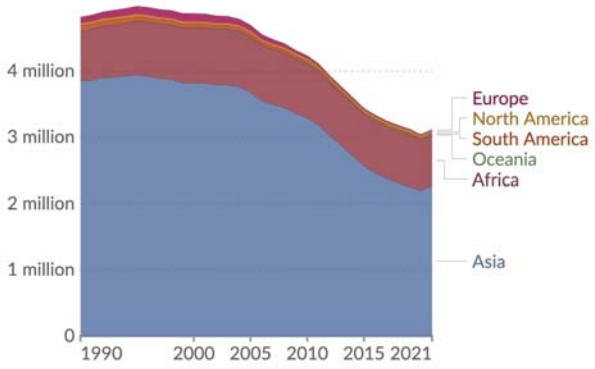

Fig. 1. Household air pollution deaths by region
Source: [9]

Examination of the data showcases a disproportionate number of deaths due to indoor air pollution in Asia and Africa, mainly due to limited access to cleaner energy options. In contrast, the European Union and North America have considerably low mortality rates caused by this environmental risk. Although there have been efforts to reduce deaths by promoting the use of cleaner cooking fuels, the overall burden of disease remains high. Therefore, it is crucial to make clean energy options more readily available to prevent a significant number of premature deaths worldwide.

By the same way, education also emerges as a vital driver of human capital accumulation, positively impacting output growth. However, energy poverty impedes access to high-quality education in a variety

of ways, including learning results, school attendance, and ultimately the ability of people and communities to prosper. The impact of energy poverty on societal educational results is complex. First of all, relying solely on conventional biomass fuels binds a large number of kids to the daily grind of gathering firewood and other laborious physical duties, depriving them of time for homework and school attendance [13]. Additionally, excessive energy heating expenditures may also have a negative impact on children’s schooling by its impact on absenteeism from school and a higher rate of illness are two effects of energy poverty on education. Accourding to Sovacool [12] acute respiratory infections are the leading cause of school absences in many nations, and numerous medical research has shown a substantial correlation between indoor air pollution and these illnesses in children [12]. Furthermore, due to limited access to electricity and associated gadgets, energy poverty has a substantial impact on educational attainment. Jayasinghe and his colleagues found that the consequences of COVID-19-related learning loss and, consequently, long-term educational barriers on children and tertiary level students due to the lack of access to computers, mobile phones, TVs, and radios are an equally significant aspect of energy poverty arising from this analysis [7].

Accordingly, these impacts lowering secondary school completion rates and underline intergenerational poverty cycles, ultimately suppressing national human capital development and, by extension, economic growth, because it restricts access to contemporary educational resources, impedes digital learning opportunities, and limits lighting for late study sessions. Empirical data from the World Bank [15] show that students in households deprived of consistent electricity access have on average, 15–30% lower academic performance compared to peers with reliable access.

In Fig. 1 below, Fig. 2 illustrates the relationship between school attendance and access to electricity. Electrification demonstrably influences a student’s capacity to engage in nighttime study, utilize digital learning resources, and maintain consistent school attendance. While the correlation between school attendance and electricity access varies significantly by region, marked disparities are evident. For instance, in Sub-Saharan Africa and South Asia, school attendance rates are approximately 20% lower in areas without electricity compared to those with access. Conversely, the difference in attendance is substantially smaller in East Asia, at around 5%. These data suggest that in energy-poor environments, children, particularly girls, are often burdened with tasks such as firewood collection and manual labour, thereby limiting their educational opportunities. This eventually restricts national skill formation and reduces long-term GDP potential.

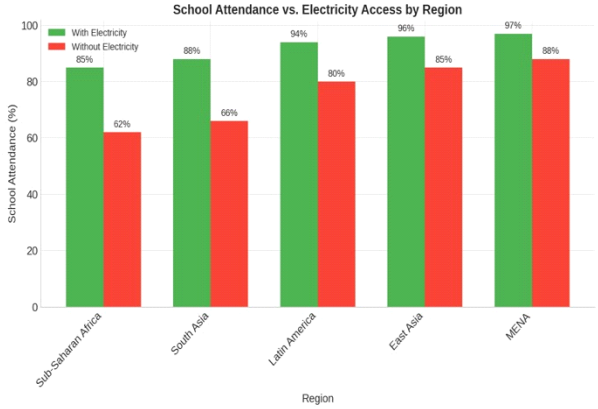

Fig. 2. School Attendance vs Electricity Access (%) by region
Source: [15]

Therefore, energy poverty employs a multi-dimensional strain on economic growth by arbitrating both education and health outcomes. its negative effects on income, health, and education lead to economic vulnerability, undermines human, and trapping individuals and communities in a cycle of deprivation. States with high energy poverty levels report significantly lower GDP per capita and slower Human Development Index (HDI) progression. Documented cross-country analyses indicate that every 10% increase in household electrification correlates with a 0.8–1.2% increase in GDP growth [14].

The connection between access to electricity and the Gross Domestic Product (GDP) per capita can be seen in Fig. 3. For the purpose of this discussion, access to electricity refers to having a reliable source of electricity for basic necessities such as lighting, phone charging, or radio usage for a minimum of 4 hours per day. The GDP per capita is presented in constant international dollars, adjusted for purchasing power parity in order to neutralize any differences in cost of living.

The data from the figure clear positive correlation countries with >90% electrification exhibit significantly higher GDP/capita. The data reveals that most countries in Africa have limited access to electricity, and these same countries tend to have lower GDP per capita. This suggests a positive correlation between GDP per capita and access to electricity. Overall, there is a general trend whereas the GDP per capita of a country increase, the percentage of the population with access to electricity also increases. This aligns with our expectations considering the usual investment and economic development that accompanies newfound wealth.

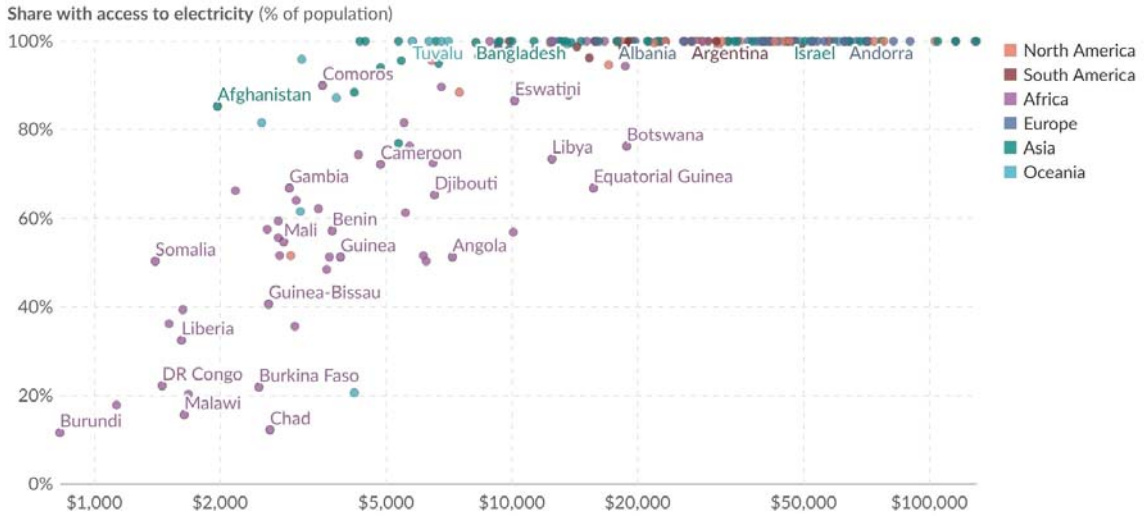

Fig. 3. Access to electricity vs. GDP per capita, 2023

Source: [9]

Moreover, European countries typically have higher values of GDP per capita and access to electricity (Fig. 3). However, there are some exceptions to this trend. While we may predict a positive correlation between electrification rate and GDP per capita, there are cases like Afghanistan and Bangladesh where the electrification rate is higher despite lower GDP per capita. This divergence indicates that these countries have prioritized access to electricity, potentially due to historical factors, government support, external aid, or special economic conditions. Therefore, gaining a thorough understanding of this phenomenon requires a closer examination of the specific context for each country and its individual case.

Conclusion and discussion

This study has scientifically examined the indirect yet deep impact of energy poverty on economic growth, drawing on documented evidence across diverse geographic and socio-economic contexts, focusing on educational attainment and health outcomes.

The findings, which used a document analysis methodology, highlight that energy poverty is more than just a technical or infrastructure issue; it is a structural impediment to human capital development by its impacts on education attainment and health situation of populations. Students suffering from energy-poor households also lack the conditions required for academic accomplishment, digital literacy, and regular school attendance, all of which are essential to national labour force learning and modernization capability. This can be more visible in low-income countries. Furthermore, the analysis shows that there is a significant negative influence of energy poverty on educational attainment because of having limited access to power and clean energy. Similarly, the use of archaic biomass fuels and a deprivation of thermal luxury setup resulted in significant health problems, particularly among women and children. This increases healthcare costs, lowers labour productivity, and diminishes the demographic surplus in energy-deprived nations.

Moreover, the economic performance drops because of the combined effect of these deficits (educational attainment & health outcomes). Nations with high levels of energy poverty consistently exhibit lower GDP per capita, shorter life expectancy, and stunted educational outcomes, effectively trapping populations in cycles of poverty and underdevelopment.

To sum up, addressing energy poverty must be eminent from a marginal development objective to a central pillar of economic strategy. Moreover, any long-term plan for inclusive growth, poverty eradication, and social equity must prioritize energy access as a non-negotiable enabler. However, energy justice is not only a moral constraint but also a prerequisite for sustainable economic transformation. Remarkably, investment in energy infrastructure particularly universal access to reliable, clean, and affordable electricity delivers will accelerate educational attainment, improve population health, and unlock underlying economic potential by enabling a more productive, skilled, and healthy labour force.

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ВПЛИВ ЕНЕРГЕТИЧНОЇ БІДНОСТІ НА РІВЕНЬ ОСВІТИ ТА СТАН ЗДОРОВ'Я НАСЕЛЕННЯ ЯК СКЛАДОВІ ЕКОНОМІЧНОГО ЗРОСТАННЯ

Тахер І. Х., Яяр Р.

Енергетична бідність набула значної уваги в усьому світі, негативно впливаючи на доходи, освіту, здоров'я та навколишнє середовище. Вплив енергетичної бідності на економічне зростання є багатогранним і підтверджується різними дослідженнями. Метою статті є якісне вивчення впливу енергетичної бідності на економічне зростання шляхом оцінки її документально підтверджених наслідків для рівня освіти та показників здоров'я населення. Важливість даного дослідження полягає в тому, що воно заповнює важливу прогалину, підкреслюючи, як обмежений доступ до енергії обмежує можливості здобуття освіти та погіршує показники здоров'я, які є ключовими складовими людського капіталу. Для аналізу результатів було використано якісний метод, зокрема, метод аналізу документів. Використано різноманітні інструменти аналізу документів, такі як статті з наукових журналів, веб-сайти, звіти, розділи книг, банки даних тощо. Основні результати дослідження показують, що енергетична бідність призводить до зниження рівня освіти та погіршення показників здоров'я, що, в свою чергу, призводить до зменшення людського капіталу. З іншого боку, рівень електрифікації має позитивну кореляцію з ВВП на душу населення. Крім того, посилення енергетичної бідності знижує очікувану тривалість життя та зменшує рівень грамотності. Більше того, економічні показники значно погіршуються через накопичений ефект цих недоліків. Країни з високим рівнем енергетичної бідності поступово демонструють нижчий ВВП на душу населення, меншу очікувану тривалість життя та гірші показники освіти, ефективно утримуючи населення в циклах бідності та відсталості. Як наслідок, здобуття освіти відчутно ускладнюється через недостатній доступ до чистої енергії та електроенергії. Також, значне погіршення здоров'я, особливо серед жінок і дітей, спричинене залежністю від традиційних видів біопалива та відсутністю інфраструктури для забезпечення теплового комфорту. Тим не менш, у країнах з низьким рівнем енергозабезпечення це обмежує демографічний дивіденд, погіршує показники охорони здоров'я та знижує продуктивність праці.

Ключові слова: економічне зростання, рівень освіти, енергетична бідність, показники здоров'я.

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