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PRINT: ISSN 0970-9274 ONLINE: ISSN 2456-6322
J Hum Ecol, 85(1-3): 1-12 (2024)
DOI: 10.31901/24566608.2024/85.1-3-.3357

Energy Patterns and Socioeconomic Conditions of Non-electrified Rural Households in the Eastern Cape Province, South Africa

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KEYWORDS Correlation. Energy Access. Energy Insecurity. Poverty. Quality of Life

ABSTRACT This research paper examines the relationship between energy patterns and socioeconomic conditions in the Upper Blinkwater community. Data from 53 respondents was analysed using Pearson's correlation test. Results showed low education levels among the respondents, with most having completed only primary school. High unemployment rates, low income levels and dependence on social grants were observed. Firewood, LPG gas, paraffin, and candles emerged as the primary energy sources used by the participants. The analysis indicated significant, albeit weak, correlations between education and the use of firewood, as well as household income and the use of a diesel generator. This suggests that the community's existing energy patterns alone may not be solely responsible for their poor socioeconomic conditions. Therefore, a comprehensive approach that acknowledges the complex relationship between energy access, living conditions, and the multifaceted factors influencing energy choices, ultimately aiming to enhance community well-being is crucial.

INTRODUCTION

Literature analysing the quantitative associations between the choice of fuels and socioeconomic conditions of South African rural households is limited. This paper aims to fill this research gap by providing quantified empirical evidence of the correlation between energy sources used by rural poor households and their socioeconomic conditions. The research conducted in this study will serve as a valuable benchmark for the South African government to assess its efforts in providing basic services and creating a harmonious environment for all citizens. This is particularly relevant given the ongoing challenges and progress in service delivery in South Africa. The country is currently at a critical juncture, with increasing local discontent and signs of impatience among the population regarding service delivery, including energy provision and access to electricity (Southall 2019).

Energy plays a crucial part in facilitating economic progress and enhancing the overall welfare of society. The advantages of having dependable, affordable, and consistent energy services have been universally observed in industrialized economies, serving as the bedrock for their growth and success (Mulugetta et al. 2019). In developing countries, access to reliable and affordable energy services is increasingly recognized as a vital catalyst for improving quality of life (Guzman-Rosas 2023; Mulugetta et al. 2019). While South Africa has made progress in energy provision and has a commendable energy infrastructure compared to other African countries, disparities in access to reliable and affordable energy services persist and household energy in particular is emerging as an issue of concern (Mukumba and Chivanga 2023). There are approximately 3.5 million households in South Africa without access to electricity (General Household Survey (GHS) 2021). About 60 percent of these households are predominantly located in rural and remote regions where expanding the main

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grid infrastructure poses logistical and financial challenges (Meyer and Overen 2021).

The Eastern Cape Province, with a 64.5 percent energy connectivity rate, stands as the least connected and one of the poorest provinces in the country. Approximately 67.3 percent of people in the province live in poor households (Mukumba and Chivanga 2023), and around 36 percent of the population relies solely on social grants (Ningi et al. 2020). Within the province, there are two severely underprivileged and underdeveloped settlements, formerly known as "homelands," where no electricity exists, and access to the grid is unlikely to be available for the next 8–15 years (Ravabanchz et al. 2020). In these communities, households continue to rely on biomass for cooking and lighting (Van Niekerk et al. 2022). However, the burning of biomass energy like wood poses not only a health hazard but also has long-term effects, particularly on women and children, who are often responsible for household duties (Ngavara et al. 2022). For instance, women spend between 2 and 9 hours a day gathering wood and cooking, limiting their time for productive activities and decreasing their quality of life (Sule et al. 2022; Longe 2021).

Previous studies conducted in South Africa have demonstrated how individuals lacking access to energy often experience social and economic exclusion, limiting their potential for economic advancement and improved quality of life (Mukumba and Chivanga 2023; Ngavara et al. 2022; Ningi et al. 2020; Kuhnel et al. 2020; Shambira et al. 2020; Ravanbach et al. 2020; Odeku and Meyer 2019). These studies emphasize that energy access, particularly clean energy, is essential for achieving various sustainable development goals beyond the energy sector.

The studies by Ravanbach et al. (2020) and Odeku and Meyer (2019) underscore the significance of energy access in fulfilling socioeconomic needs and improving livelihoods. They suggest that energy is necessary to eradicate poverty, increase food production, provide clean water, enhance public health, improve education, and open up new economic opportunities. Without access to modern energy services, energy-poor households are severely disadvantaged and remain trapped in a cycle of poverty.

On the other hand, studies conducted by Ngavara et al. (2022) and Ningi et al. (2020) highlight socioeconomic factors such as marital status, household size, electricity affordability, and source of income as drivers of energy poverty. These factors influence the choice of energy sources and consumption patterns among individuals and households.

Netshipise and Semenya (2022) suggest that socioeconomic factors, including marital status, household size, electricity affordability, income source, education level, employment status, and income level, can influence energy choices and consumption patterns. These factors shape individuals' preferences for different energy sources.

While these studies have provided valuable insights into the impacts of energy insecurity[1] and the relationship between energy access and socioeconomic conditions, further research is needed to delve deeper into this relationship. Specifically, exploring the type of fuels used by energy-poor households and their socioeconomic conditions can provide a more comprehensive understanding of how energy choices impact economic well-being. This knowledge can inform policy decisions and targeted interventions aimed at promoting equitable and sustainable energy access.

Acknowledging the wealth of research and knowledge accumulated on this topic allows us to further appreciate the urgency and significance of addressing energy insecurity and ensuring equitable energy access in South Africa. Exploring the relationship between the type of fuels used by energy-poor households and their socioeconomic conditions allows for a deeper understanding of how energy choices impact the economic well-being of individuals and communities. This understanding can provide insights that inform policy decisions and targeted interventions aimed at promoting sustainable energy transitions and improving socioeconomic conditions. For instance, policymakers may focus on initiatives that promote access to cleaner energy sources, provide financial incentives for clean energy adoption, or invest in education and training programs to enhance skills and opportunities related to renewable energy technologies, all working towards sustainable development and improving the quality of life for communities affected by the lack of access to clean energy.

The paper is organized as follows: The starts off with the introduction which addresses the gap in the literature and outlines the study's objectives. It then discusses the methodologies em-

ployed in the study including the data type and tools for analysis. Then follows the results, discussion of the findings conclusions and the recommendations for policy and further research.

Objectives

The study aimed to examine the correlations between the energy used by rural households and their socioeconomic status. Specifically, the paper sought to establish whether there was a relationship between the impoverished socioeconomic conditions of households in the Upper Blinkwater community and their energy choices.

METHODOLOGY

Data Material

The primary data was collected through a survey. A survey was conducted in the Upper Blinkwater community, which is a small, remote rural community in the Raymond Mhlaba municipality of the Eastern Cape Province. The purpose of the survey was to gather primary data. The community of Upper Blinkwater is characterized by its disadvantaged status, with widely scattered settlements and a lack of basic amenities such as electricity, infrastructure, clean water, toilets, and access to healthcare facilities (Ravanbach et al. 2020). This primary data included information on socioeconomic indicator, namely; education, employment and income and the types of fuel used by households in the community.

Methods

In this analysis, a quantitative method was used. Using a quantitative method provided the benefit of producing exact and quantifiable data that could be statistically evaluated, allowing us to draw reasonable inferences from the findings. The data collected includes variables such as respondents' demographics, income levels, education levels, job status, and the types of fuel utilised by the respondents. These variables were assigned numerical values and statistical analysis was performed, allowing us to identify relationships within the data, and providing valuable insights into the socioeconomic position of the Upper Blinkwater community and its association with existing energy patterns.

Sample

Upper Blinkwater is a small community comprising approximately 67 households (Ravanbach et al. 2020). When sampling from such a small population, the resulting sample size may be even smaller, posing challenges in drawing meaningful conclusions about the entire population (Kohnel 2018). That is why Kohnel (2018) proposes that when dealing with small populations, it is preferable to evaluate the entire population to avoid distorting the data. In that light, it was technically feasible for the study to include all 67 families in the survey. However, in the end, only 53 households were successfully interviewed, as some members were temporarily away from the community due to various reasons, such as relocation in search of better opportunities (Shambira et al. 2020).

Tools for Data Collection

A questionnaire was developed for primary data collection. The questionnaire included various topics of interest, such as household energy sources, socioeconomic indicators (education, employment and income), respondents' demographics; age, gender and marital status and they respondents are categorised as married if they live with a partner or spouse or single if they are never married or widowed), and household characteristics (family size). The survey was conducted using face-to-face interviews, meaning that the researchers personally administered the questionnaires and interacted with the respondents in person.

Data Analysis

The study conducted a descriptive analysis using percentages, mean, and standard deviation to analyse the demographics, socioeconomic characteristics, and existing household energy sources of the respondents. These descriptive statistics offer summary measures that can aid in understanding the central tendencies, variations, and distributions of the variables under consideration. Such analysis provides valuable insights into the characteristics and energy profiles of the surveyed households, helping to inform further discussions and investigations into the association between socioeconomic status and energy patterns.

One common approach to examining this relationship is through statistical analysis, such as correlation studies. Correlation analysis can establish whether or not there is a relationship between the two variables, as well as the strength of that relationship. IBM SPSS Statistics 26.0 software was used to obtain results for the data. The Pearson correlation coefficient, often denoted as "r," is a commonly used measure to assess the strength and closeness of the relationship between two variables (Ratner 2009). It is calculated under the assumption that the relationship between the variables is linear. The coefficient "r" ranges theoretically from -1 to +1, where values closer to +1 or -1 indicate a stronger and closer relationship (Xiao et al. 2021). If the value of "r" is equal to 1, it signifies a perfect positive correlation between the energy patterns and the household covariates. This suggests that the energies used by a particular household have a significantly positive impact on their socioeconomic status. Conversely, if "r" equals -1, it indicates a perfect negative correlation, suggesting that the energy type used by a household has a substantial negative impact on their socioeconomic status. If "r" equals zero, there is no correlation between the variables. To interpret the strength of a relationship based on the "r" value, a general rule is to consider the absolute value of "r" and classify it as weak, moderate, or strong (Schober et al. 2018). According to the conventional method, if $|r| < 0.3$, the correlation is considered very weak; $0.3 < |r| < 0.5$ indicates a weak correlation; $0.5 < |r| < 0.7$ suggests a moderate correlation; and $|r| > 0.7$ indicates a strong correlation. However, it is important to note that correlation analysis does not imply a causal cause-and-effect relationship between the variables (Ratner 2009).

By applying the Pearson correlation analysis, the study is able to measure the strength and direction of the relationship between the types of energies used by households and their as income, education and employment status. The p-value is calculated alongside "r" to determine the statistical significance of the correlations. The p-value depends on the strength of the correlation observed in the data.

RESULTS

Demographic Characteristics of the Respondents

The descriptive analysis in Table 1 provides valuable insights into the demographic overview of the respondents, highlighting gender distribution, age composition, marital status, and household size within the Upper Blinkwater community. It reveals that 55 percent of households were headed by male respondents, while 45 percent were headed by females. The average age of the respondents was 52 years, with a significant portion falling within the age range of 45 to 54 years. The majority of respondents reported being single (68%), while 32 percent indicated being married or living with a partner. On average, each household consisted of at least three persons, indicating a typical household size in the community.

Socioeconomic Conditions of the Respondents

Table 2 provides insights into the educational attainment, employment status, and household income of the respondents in Upper Blinkwater. The majority had only completed primary education (62.3%), with a small percentage having sec-

Table 1: Demographic characteristics of the respondents

Variable	*Frequency*	*Percentage*	*Mean*	*Standard Deviation*
Male	29	55	-	.503
Female	24	45		
< 24	2	3.8	52.43	17.573
25-34	9	17.0		
35-44	5	9.4		
45-54	15	28.3		
55-64	10	18.9		
65 +	12	22.6		
Live with partner/spouse	17	32	-	1.497
No partner or spouse	36	68		
Average size of household	-	-	3.36	2.039

Source: Author's own computation based on survey data, 2019

Table 2: Socioeconomic characteristics of the respondents

Socioeconomic indicators	*Frequency*	*Percentage*	*Mean*	*Standard Deviation*
No schooling	6	11.3	-	.643
Primary	33	62.3		
Secondary	13	24.5		
Tertiary	1	1.9		
Unemployed	31	58.5	-	.772
Employed	15	28.3		
Self-employed	1	1.9		
Retired	6	11.3		
Monthly Income	-	-	2046.51	2206.3
Salary	14	26.4	-	1.336
Grant	31	58.4		
Remittance	6	11.3		
Own business	2	3.8		

Source: Author's own computation based on survey data, 2019

ondary (24.5%) or tertiary education (1.9%). A significant proportion of respondents were unemployed (58.5%), while a smaller portion were employed (28.3%) or self-employed (1.9%). Social grants were the primary source of income for households (58%), followed by salaries (26.4%), remittances (11.3%), and small businesses/sales (3.8%). The average household income was 2046.51 ZAR, indicating a reliance on social welfare support. These findings align with the broader trend in the region, with a high dependence on social grants and incomes below the poverty line.

Energy Patterns of the Respondents

The study examined the energies used by households in Upper Blinkwater for domestic purposes. The data in Table 3, revealed 96.2 percent of households primarily used firewood for heating and cooking. Paraffin was another significant source, used by 92.5 percent of households primarily for lighting, and moderately for cooking and heating. Candles were commonly used for lighting by 94.3 percent of households. Some households (13.2%) employed diesel generators, while a few (3.8%) used solar energy mainly for lighting and charging phones. These findings confirm the heavy reliance on traditional fuels like firewood and paraffin, but also indicate a small uptake of cleaner alternatives such as solar energy and diesel generators for specific purposes.

Relationship between Energy Patterns and Socioeconomic Indicators

To determine whether the impoverished socioeconomic conditions of Upper Blinkwater households are associated with their current energy status, Pearson correlation analysis was conducted and the results are presented in this section.

Energy Patterns and Education

The correlation analysis in Table 4 examined the relationship between household energy patterns and the education level of respondents. Weak correlations were observed, ranging from 0.076 to 0.414. A negative correlation (-0.414) was found

Table 3: Energy patterns of the respondents

Energy source	*Freq.*	*Percent*	*Mean*	*Std. Dev*	*Cooking*	*Heating*	*Lighting*
Wood	51	96.2	.96	.192	73.6	79.2	-
Paraffin	49	92.5	.92	.267	41.5	18.9	98.1
LPG	45	84.9	.85	.478	79.2	-	-
Candles	50	94.3	.94	.233	-	-	94.3
Diesel (Generator)	7	13.2	.13	.361	-	-	7.5
Solar	2	3.8	.04	.342	-	-	3.8

Source: Author's own computation based on survey data, 2019

Table 4: Correlations between education and energy pattern

Variables	*Education*	*Wood*	*Paraffin*	*LPG gas*	*Candles*	*Diesel generator*	*Solar energy*
Education	1						
Wood	-.414**	1					
Paraffin	0.076	-0.057	1				
LPG gas	-0.219	0.193	-0.120	1			
Candles	-0.063	-0.049	-0.070	.353**	1		
Diesel Generator	0.071	-0.215	0.111	0.164	-0.146	1	
Solar	-0.053	0.039	0.057	0.083	0.049	.508**	1

Note: **. Correlation is significant at the 0.01 level (2-tailed).
Source: Author's own computation based on survey data, 2019

between the education of household heads and the use of firewood, indicating that lower educational attainment is associated with a higher likelihood of using firewood as the primary energy source. Conversely, a positive correlation (0.359) was found between education and the use of a diesel generator, suggesting that higher educational attainment is linked to a greater likelihood of using diesel generators. The use of paraffin showed a positive but insignificant correlation (0.076) with education. Interestingly, a negative and insignificant correlation (-0.219) was observed between education and the use of liquefied petroleum gas (LPG), with lower education levels associated with a higher likelihood of LPG usage. These findings suggest complex relationships between education, household fuel choices, and factors such as financial capabilities and access to cleaner energy options.

Energy Patterns and Employment

The correlation analysis in Table 5 examined the relationship between household energy patterns and the employment status of the respondents. The results indicated weak correlations, ranging from 0.017 to 0.255. Positive but very weak correlations were found for LPG (0.243) and candles (0.181), indicating that respondents with better employment status were more likely to use LPG and candles as energy sources. Conversely, a negligible positive correlation (0.017) was observed between employment status and the use of firewood. This suggests that regardless of employment status, firewood remained a commonly used energy source. On the other hand, weak negative correlations were found for paraffin (-0.255) and solar energy (-0.147), indicating that higher employment status was associated with a lower likelihood of using paraffin and solar energy. A negligible negative correlation (-0.070) was observed between employment status and the use of diesel generators. Overall, the findings suggest that the employment status of the respondents has a weak influence on their choice of household energy patterns. While improved employment status was linked to a higher likelihood of using LPG and candles, it had no significant impact on the use of firewood. Additionally, higher employment status was associated with a reduced likelihood of using paraffin, solar energy, and diesel generators.

Table 5: Correlations between employment and energy pattern

Variables	*Education*	*Wood*	*Paraffin*	*LPG gas*	*Candles*	*Diesel generator*	*Solar energy*
Employment	1						
Wood	0.017	1					
Paraffin	-0.255	-0.057	1				
LPG gas	0.243	0.193	-0.120	1			
Candles	0.181	-0.049	-0.070	.353**	1		
Diesel generator	-0.070	-0.215	0.111	0.164	-0.146	1	
Solar	-0.147	0.039	0.057	0.083	0.049	.508**	**1**

Note: **.Correlation is significant at the 0.01 level (2-tailed).*Source:* Author's own computation based on survey data, 2019

Energy Patterns and Household Income

The correlation analysis in Table 6 examined the relationship between household energy patterns and the income of the respondents. The results indicated various associations between income and fuel choices. A negative and weak correlation (-0.177) was found between the use of firewood and household income, suggesting that as household income increases, the likelihood of using firewood decreases. This aligns with previous research, indicating a shift towards cleaner energy sources as socioeconomic conditions improve. Positive but weak correlations were observed between household income and the use of paraffin (0.037), Liquefied Petroleum Gas (LPG) (0.044), and candles (0.111). This implies that as household income increases, there is a higher likelihood of using modern energy sources such as paraffin, LPG, and candles. Furthermore, a positive and significant association (0.359) was found between the use of a diesel generator and household income, indicating that as income increases, the likelihood of using a generator also increases. However, the use of solar energy showed a negative and negligible correlation (-0.036) with household income, suggesting that as income increases, respondents are less likely to rely on solar energy. These findings highlight the influence of income levels on the choice of energy sources. Higher household income was associated with a reduced likelihood of using firewood and an increased likelihood of using modern energy sources such as paraffin, LPG, and candles. The use of a diesel generator also correlated positively with household income. However, the use of solar energy showed a negative association with household income.

DISCUSSION

The purpose of this study was to examine the link between respondents' energy use and their socioeconomic position. The data reveals significant challenges faced by the respondents, suggesting their low socioeconomic position. The central issue identified is the lack of access to education, the high number of unemployed, and poor income levels. This implies that the respondents are less educated. Being less educated means they lack marketable skills and qualifications, which limits their employment prospects and makes it difficult for them to secure stable sources of income. In line with Khuluvhe et al. (2022) most uneducated and unskilled rural individuals can only secure unskilled jobs with poor remuneration, which is likely to result in a poor quality of life. Meanwhile, social grants remain the primary source of income for a substantial portion of the community (GIZ Report 2020). Ravanbach et al. (2020) analysed the financial situation of households in the same community and found that 90 percent of the population in Upper Blinkwater depended on social grants for their livelihoods. In agreement with the findings of this current study, this confirms their poor socioeconomic status.

The data also shows that the respondents rely largely on firewood as their primary source of energy, showing a significant lack of access to more modern and environmentally friendly energy sources such as electricity. Despite the availability of alternatives, including gas, solar, and diesel generators, their use is restricted due to financial constraints, emphasising the community's ongoing struggle to acquire and finance greener energy sources. Recent research, such as Netshipise and

Table 6: Correlations between income and energy patterns

Variables	*Education*	*Wood*	*Paraffin*	*LPG gas*	*Candles*	*Diesel generator*	*Solar energy*
Income	1						
Wood	-0.177	1					
Paraffin	0.137	-0.057	1				
LPG gas	0.244	0.193	-0.120	1			
Candles	0.111	-0.049	-0.070	.353**	1		
Diesel generator	.359**	-0.215	0.111	0.164	-0.146	1	
Solar	-0.036	0.039	0.057	0.083	0.049	.508**	1

Note: **.Correlation is significant at the 0.01 level (2-tailed).
Source: Author's own computation based on survey data, 2019

Semenya (2022), Lavhelani (2021), Masekela and Semenya (2021), and Semenya and Machete (2019), to name a few, discovered comparable findings, attributing this inclination to the challenging financial circumstances of residents and the ready availability of wood. In the case of the Upper Blinkwater community, firewood is both affordable and easily accessible, making it the primary energy source, while economic constraints make conventional energy sources relatively expensive. In general, these data point to severe energy scarcity and wide differences in energy availability across rural South Africa. However, Chidembo et al. (2022) extend these findings by indicating that, despite potentially appealing incentives for conventional energy sources, rural South Africans continue to use firewood owing to not only economic and infrastructural barriers but also cultural ones. According to Shackleton et al. (2022), most South African rural households do not necessarily abandon the use of fuelwood even after gaining access to electricity. Rural households continue to rely on fuelwood, with usage rates ranging from 82 percent to 100 percent. Interestingly, this study examined the period both before and after electrification at the same location and observed minimal changes in the proportion of households using fuelwood. While electricity primarily serves lighting purposes, the transition away from traditional energy sources like fuelwood is not always immediate.

The correlation analysis has revealed significant connections between respondents' socioeconomic status and their choice of energy sources. Specifically, a negative correlation between reliance on firewood as the primary energy source and the education levels of the respondents suggests that households with lower levels of education among their heads are more likely to use firewood for their daily energy needs. Similarly, those with a higher level of education prefer cleaner and more contemporary energy choices, such as gas. This is supported by the findings, which also demonstrated a favourable association between respondents' education levels and their usage of diesel generators. These findings could have several implications. In line with the analysis, the identified negative correlation between educational levels and energy source choices hints at potential challenges faced by individuals with limited access to education. One of the primary challenges is economic constraint. According to Piao and Managi (2023) and the Organisation for Economic Co-operation and Development (OECD) (2022), people with lower levels of education may often find themselves in economically disadvantaged situations, which can limit their ability to transition to cleaner energy sources. These alternatives, such as electricity or gas, often come with higher upfront costs or monthly bills, which can be challenging for households with limited financial resources.

Furthermore, the correlation points to a lack of awareness about cleaner energy alternatives among those with lower educational attainment. Education not only empowers individuals economically, but Piao and Managi (2023) also opined that it plays a crucial role in raising awareness about sustainability, health, and environmental issues associated with energy choices. It equips individuals with knowledge about the advantages of cleaner energy sources, both in terms of personal health and the broader environmental impacts. Therefore, those with lower education levels may not be fully informed about the benefits of transitioning to cleaner energy sources, and they might continue relying on traditional but more polluting options like firewood.

Similar studies, such as Nkosi et al. (2021), also indicate that households reliant on firewood often allocate substantial time to gather it, a task commonly assigned to women and children. Nkosi et al. (2021) found that in KwaZulu-Natal, the average time spent collecting wood per week ranges between seven and nine hours. Outside South Africa, Meried (2021) found out that in the North Gondar zone, in Ethiopia, women often spend one to four hours a day collecting biomass for fuel. This time commitment could divert them from productive activities, including education, and disproportionately affect girls' school attendance and academic performance. According to Williams et al. (2020), the diversion from education and productive endeavours can hinder their personal development and income-generating potential. In addition, as Levison et al. (2018) noted, this situation can render women and children more vulnerable to social and economic exclusion, as their increased involvement in firewood collection can limit their opportunities for education and economic empowerment, perpetuating cycles of disadvantage. Meried (2021) reiterated that not only does the lack of clean and modern energy exacerbate

gender disparities, impacting their productivity and well-being, but they remain vulnerable to social and economic exclusion as a result. Hence, women form the majority of the poor in our societies.

The data further revealed significant and positive correlations between conventional energy consumption patterns and household income. This suggests that transitioning to cleaner energy sources has the potential to enhance the household incomes of respondents. It sheds light on the potential economic benefits associated with transitioning to cleaner energy sources and offers insights into the dynamics of household income and energy choices. Firstly, this correlation suggests that households with higher incomes are more likely to use improved energy sources such as LPG and diesel generators. In line with Netshipise and Semenya (2022), who found that in the Thulamela local municipality, households earning more money tend to drift away from traditional biomass and use more LPG and electricity for cooking and water heating as an alternative energy source, According to Masekela and Semenya (2021), this can be attributed to various factors, including the cost associated with cleaner energy sources. The authors indicate that clean energy alternatives often come with higher costs. In the case of Upper Blinkwater, this includes the purchase of gas cylinders and stoves. While buying diesel might not be expensive, obtaining a generator may be financially prohibitive for households with limited resources. As a result, only wealthier households may be more capable of investing in these cleaner alternatives.

However, the significance of this finding lies in its implications for time savings. This time-saving aspect is a crucial link between cleaner energy adoption and income improvement. Supported by Williams et al. (2020), these improved energy sources can substantially reduce the time spent on tasks like cooking and wood gathering, which, as indicated earlier, are often responsibilities that fall on women within households. Williams et al. (2020) observed that women who used LPG, for example, spent considerably less time on cooking and wood gathering, saving an impressive 3.2 hours per week on cooking and reducing their wood gathering time by at least 1.9 hours. Additionally, they were able to prepare an additional daily meal using these cleaner energy sources. This translated into substantial time savings, allowing women to optimise their time, leading to increased opportunities for engaging in income-generating activities. With more time on their hands, women can engage in income-generating activities or pursue education and skill development, ultimately contributing to higher household incomes. Furthermore, the ability to prepare additional daily meals using cleaner energy sources not only leaves women with ample time but also creates opportunities for income generation. Selling surplus meals or food products in local markets can provide an additional source of income for households.

In essence, the data show a positive correlation between cleaner energy adoption and higher income levels, which is supported by studies such as Williams et al. (2020), indicating the potential for cleaner energy sources to improve overall household well-being and the quality of life for these rural households.

On a different note, Nkosi et al. (2021) argue that household economic status, while significant, is not the sole determinant of fuel choice. Rather, they emphasise that the proximity of households to fuel sources and the availability of alternative fuels play pivotal roles. Nkosi et al. (2021) stated that in rural settings, the distance to local biomass fuel sources significantly influences the decision to use traditional fuels like firewood. When fuel sources like firewood are easily accessible and alternatives like LPG or electricity are scarce or expensive, households are more likely to rely on traditional fuels, regardless of their income. This suggests that economic limitations can hinder transitions to cleaner fuels despite awareness of their benefits. This perspective also highlights the role cultural and embedded practices play in shaping these choices.

In general, the findings highlight the complex relationship between educational attainment, financial resources, and energy choices within the Upper Blinkwater community. Together, these factors contribute significantly to the widespread use of firewood and the limited adoption of cleaner energy alternatives. This aligns with the energy ladder model, which solidifies the links between income levels and energy consumption patterns. The model suggests that as household incomes increase, there is a natural tendency to gravitate towards cleaner and more sustainable energy sources (Meried 2021). These insights highlight the critical importance of addressing underlying socioeconomic factors, particularly education and income levels,

in facilitating the transition to cleaner energy sources in UB and similar contexts, and at the same time, adopting cleaner energy sources can also have positive effects on education and income levels.

CONCLUSION

The study aimed to investigate the relationship between a community's socioeconomic status and its choice of energy sources, seeking to determine whether the community's energy situation significantly influences its socioeconomic conditions. The findings have illuminated the challenging socioeconomic circumstances prevalent within the community, characterized by low education levels, high unemployment rates, and poorer household incomes. It is evident that the community heavily relies on traditional energy sources such as firewood, paraffin, and candles, with limited adoption of cleaner and more sustainable alternatives. However, the correlations observed between socioeconomic factors and energy consumption patterns revealed relatively weak associations. This shows that the community's poor socioeconomic status may not just be caused by its energy resources. Instead, it becomes obvious that the community's isolation and lack of development significantly contribute to the limitations on economic prospects and lower income levels. In the new South Africa, with its developed economy and energy infrastructure, this demonstrates the ongoing inequalities in service delivery. This represents the urgent requirement for focused efforts at rural development to reduce social isolation and economic suffering among the rural people.

RECOMMENDATIONS

The challenges faced by the Upper Blinkwater community are reflective of many other communities in the Eastern Cape Province. To effectively improve their socioeconomic status and break the cycle of poverty, comprehensive measures need to be implemented. These measures should address energy-related issues, enhance access to modern and sustainable energy sources, and implement targeted interventions to improve education, skills training, and economic development. Firstly, given the limitations in national grid expansion, promoting the installation of renewable energy systems and implementing energy efficiency initiatives can improve access to clean and modern energy sources in these communities. This can include initiatives such as solar panel installations and energy-efficient appliances. Secondly, investing in educational infrastructure and attracting qualified teachers can enhance access to quality education. Improving school facilities, providing adequate resources, and offering professional development opportunities for teachers can contribute to better educational outcomes and opportunities for the community's youth. Thirdly, providing skills training programs tailored to the specific needs of the communities can empower individuals and equip them with the necessary skills for employment and entrepreneurship. These programs should focus on developing practical skills that align with local job market demands, fostering a culture of innovation and creativity. Lastly, creating an enabling environment for economic growth is crucial. This can be achieved by supporting local businesses, attracting investment, and facilitating access to financial services. Initiatives such as microfinance programs, business incubators, and cooperative enterprises can help stimulate entrepreneurship and economic development within the communities.

By implementing these comprehensive measures, the Upper Blinkwater community and other similar communities can work towards improving their socioeconomic conditions and breaking the cycle of poverty.

However, while this study gives valuable insights into the interrelationships between these two variables, it only provides a limited view of the complex issues at hand. Further research is needed to understand the exact causal relationships between energy access and community's socioeconomic status for interventions with a significant impact. In essence, this study serves as a starting point for determining how to address issues that communities like Upper Blinkwater confront as they strive for improved socioeconomic conditions and sustainability.

AUTHOR CONTRIBUTIONS

M.E. Lesala draft of the paper, collected and analysed data; N. Shambira collected and analysed data; G Makaka and P Mukumba supervised and revised the paper.

ACKNOWLEDGEMENTS

This research was supported by the Govern Mbeki Research and Innovation Centre at the University of Fort Hare and the Council for Scientific and Industrial Research (CSIR). We also thank the government of EC Province, the Department of Minerals and Energy, the Department of Social and Economic Development, the Ministry of Environmental Science and Climate Change in the German state of Lower Saxony, Raymond Mhlaba District Municipality, and the Upper Blinkwater community for their cooperation and openness. The authors also thank colleagues My Josi and Thabiso for their assistance with data collection.

DATA AVAILABILITY

Data can be made available on request

NOTE

[1] Energy insecurity can be referred to the lack of access to adequate, affordable, reliable, acceptable, and clean sources of energy for a healthy and sustainable livelihood (Boateng et al. 2021)

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Paper received for publication in September, 2022
Paper accepted for publication in January, 2024