International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2026, 16(1), 499-506.

Determinants of Household Energy Choices in Somalia: Applied Multinomial Logistic Regression Model

Dahir Abdi Ali[1]*, Mohamed Ali Mohamud[2], Richard Tuyiragize[3]

[1]Faculty of Economics, SIMAD University, Mogadishu, Somalia, [2]Department of Statistics and Planning, Faculty of Economics, SIMAD University, Mogadishu, Somalia, [3]Department of Planning and Applied Statistics, Makerere University, Kampala, Uganda. *Email: daahir@simad.edu.so

Received: 16 March 2025 **Accepted:** 27 September 2025 **DOI:** https://doi.org/10.32479/ijeep.19826

ABSTRACT

This paper aims to examine the predictors that influence household energy choices for lighting and cooking in Somalia. Energy is one of the essential commodities that are strongly tied to household's quality-of-life. The paper uses a multinomial logistic regression model to analyze data from the Somalia Integrated Household Budget Survey (SIHBS) 2022. The findings indicate that electricity and torches are the most common energy sources for lighting while charcoal and firewood are the predominant cooking energy sources. In Somalia, household's choice of energy for lighting and cooking is influenced by the household head's age, level of education, gender, geographical location, access to electricity, housing quality and per capita consumption. From the findings, it is recommended that policymakers should address the underlying barriers that prevent households from adopting sustainable energy solutions that result in improved health outcomes, environmental sustainability and economic development.

Keywords: Households, Energy, Multinomial Logit, Somalia
JEL Classifications: Q42; Q58

1. INTRODUCTION

Energy is one of the most important commodities, and the type and amount consumed by a household are significantly related to quality-of-life factors such as poverty levels and human development (Acharya et al., 2019). Concerns about global warming and climate change have resulted in a movement in energy policies away from "dirty energy," such as solid fuels and biomass, and toward clean sources like electricity and Liquefied petroleum gas (LPG), particularly in poor countries. The rapid growth of the human population, paired with the rapid advancement of technology, has increased energy consumption and demand over time (Das et al., 2014). Rapid depletion of energy supplies, combined with an increasing demand for energy, foreshadows future issues that humanity will face. Energy demand has surged six fold since 1950, as the world's population has doubled. According to UN Department of Economic and Social Affairs forecasts, the total world population, which is currently predicted to be 8 billion, will increase to 9.8 billion in 2050 (UNDESA, 2017). Natural population expansion will lead to an increase in energy usage. Developing economies, particularly China, will use more energy than other countries. Hence, the global energy demand is predicted to increase between 11% (in the Continued Momentum scenario) and 18% (in the Slow Evolution scenario) by 2050 (McKinsey, 2024). The goal will be to create balanced energy blends that meet demand while also fostering social well-being in urban, rural, and distant areas. Programs and activities involving schools, local businesses, and shops can assist educate and raise awareness about the benefits of reducing energy use (Özcan et al., 2013). While rural households utilize more biomass fuels than urban households, over half of all urban households in Sub-Saharan Africa cook with fuel wood, charcoal, or wood waste (IEA, 2006). As rising countries' populations and cities expand, urban residential energy becomes an increasingly critical issue. Urban households in Sub-Saharan Africa rely extensively on biomass fuels, which contribute to deforestation, forest degradation, and soil erosion. This is due in part to the fact that the usage of these fuels generates a significant amount of income for people in both rural and urban areas. Similarly, (Mekonnen et al., 2008) claim that the use of woody biomass for fuel and construction causes deforestation and forest degradation. Additionally, utilizing dung as fuel prevents it from being used as fertilizer, which contributes to land degradation and, as a result, affects agricultural production.

Energy consumption in Somalia predominantly relies on traditional biomass fuels, with charcoal and firewood serving as the primary sources for cooking. Charcoal accounts for 47.9%, while firewood makes up 41.3% of cooking energy use, with gas and electricity being used minimally. Notably, urban areas primarily use charcoal (60.6%), whereas rural and nomadic households rely more on firewood—55.8% for rural households and 94.3% for nomadic households (SNBS, 2023). This reliance of biomass fuel contributes to deforestation and environmental degradation, further exacerbating food insecurity and health issues.

Currently, there is no empirical evidence regarding the drivers of household energy consumption for lighting and cooking in Somalia. Therefore, this paper aims to examine the socioeconomic and demographic factors that influence household energy choices in Somalia, reflecting the specific context of fragile state.

The rest of the paper is structured as follows: Section 2 presents a literature review on the determinants related to household energy choice. Section 3 outlines the methods, including data sources, while Section 4 presents the results and discussion. Finally, Section 5 presents the conclusions, including policy recommendations.

2. LITERATURE REVIEW

Researchers commonly utilize two major strands of theories to explain household energy choices and the energy transition process: the “energy ladder” and “energy stacking” (Campbell et al., 2003; Heltberg, 2005). The energy ladder (fuel-switching) model suggests that when households are presented with a variety of energy use options, they switch from one type of fuel to another as their income level increases (Hosier et al., 1987). The model ranks household energy sources into three levels, climbing up the energy ladder from the bottom to the top: (1) Primitive, which includes mainly fuelwood, crop residues, and dung cakes; (2) Transitional, consisting of charcoal, kerosene, and coal; and (3) Advanced or modern, comprising electricity, Liquefied Petroleum Gas (LPG), biogas, and other biofuels (Hosier and Dowd, 1987). The gist of the energy ladder model is that household energy choices are primarily influenced by income levels. As households’ incomes rise, they tend to make a linear switch to higher-quality fuels.

In contrast, the energy-stacking model posits that household energy choices and transition processes, particularly in developing countries, do not necessarily adhere to a straightforward, unidirectional transition from one energy source to another, as illustrated by the energy ladder model. This model argues that households are likely to diversify their energy sources rather than completely transition from traditional fuels to modern ones, even as their income levels rise (Masera et al., 2000). The primary reason for households to use multiple fuels is to maximize their energy utility and take advantage of the complementarities between traditional and modern fuels (Kebede et al., 2002; Nansaior et al., 2011; Narain et al., 2008). The energy-stacking model suggests that household energy transition is an incremental process shaped by complex interactions among economic, technological, and sociocultural factors, rather than being driven solely by income in a one-way fuel-switching approach (Muller et al., 2018).

A growing body of empirical evidence indicates that household energy choices are influenced not only by income but also by various other factors, such as the age, education, and marital status of the household head, household size, place of residence, access to electricity, floor material of the building, toilet facilities and per capita household consumption (PCE). For instance, studies by (Abrahamse et al., 2009; Danlami, 2017; Das et al., 2014; Gould et al., 2020; Heltberg, 2005; Lee, 2013; Mensah et al., 2015; Nzabona et al., 2021; Özcan et al., 2013; Rao et al., 2007) found that age, education level, marital status, and household size influence household energy choices.

Similarly, studies by (Hosier and Dowd, 1987; Mensah and Adu, 2015; Özcan et al., 2013; Suliman, 2010) concluded that a households’ place of residence had a significant influence on energy choices of the households.

In the same way, access to electricity greatly influences the energy choices of the households. for instance, studies conducted by (Das et al., 2014; Makonese et al., 2018) found that households with access to electricity are more likely to adopt cleaner energy fuels compared to those without electricity access. Finally, study conducted by (Kowsari et al., 2011; Nzabona et al., 2021) considered the effect of the physical environment such as floor material of the building and toilet facility on the household energy choices.

Although the literature discussed above illuminates some of the major determinants of household energy choices, it lacks a comprehensive examination of the context in fragile countries like Somalia, where 89.2% of households rely on traditional energy sources (charcoal and firewood) for cooking, significantly impacting the environment. Many prior studies have concentrated on analyzing the factors that determine the choice of a single fuel type or group, rather than simultaneously estimating the likelihood of selecting multiple energy sources. Therefore, this study contributes to the existing literature in several ways. Firstly, it is the first to investigate the determinants of household energy choices in the unique context of Somalia, with the aim of enhancing access to renewable and modern energy sources in comparison to traditional energy options. Secondly, as household energy choices are influenced by context-specific factors, this study examines how variables such as place of residence, access to electricity, physical environment (including building floor material), and toilet facilities impact these decisions. Thirdly, by using multivariate logit model, this study estimates the probability of selecting multiple energy sources simultaneously, providing a clearer analysis of the relationship between traditional fuels and clean energy choices and its implications for policymakers regarding the energy transition for households in Somalia and other fragile countries. Therefore, the objective of this study is to analyze the factors that influence households' energy choices for cooking and lighting in Somalia.

3. MATERIAL AND METHODS

3.1. Data Source

This study examines household energy use in Somalia using the Somalia Integrated Household Budget Survey (SIHBS)-2022 (SoNADA, 2023). The SIHBS collects detailed socioeconomic information on Somali households such as access to basic assets, facilities, services as well as expenditure and consumption of goods and services. The survey provides data on a nationally representative sample of 7,212 households both at regional and national level. The survey followed a stratified multistage probability cluster sampling design. The selection of urban and rural areas followed three-stage stratified cluster sampling design, while in nomadic areas, a two-stage stratified cluster sampling design was used. The primary sampling units (PSUs) were selected with a probability proportional to the number of dwelling structures which constituted the sampling frame. The secondary sampling units (SSUs) for rural and urban areas were selected with a probability proportional to the number of listed households which constituted the frame. The ultimate sampling units (USUs) for rural, urban and nomadic areas were randomly selected from listed households in the cluster.

3.2. Model Specification

The multinomial logit model (MNL) was applied to identify the determinants of household fuel choices—fuelwood, kerosene, gas, and electricity. This analysis follows several other studies on household energy uses (Jumbe et al., 2011; Rao and Reddy, 2007; Vaage, 2000). According to (McFadden, 1976) if M error terms ε_{ij} for $j = 1,\ldots,M$ are independently and identically distributed with Weibul distribution $F\left(\varepsilon_{ij}\right) = e^{e^{-\varepsilon_{ij}}}$, then the probability that household/individual i choices option m can be expressed as function in the function of household characteristics Z as:

$$P\left(Y_i = m\right) = \frac{e^{\left(Z_{im}\right)}}{\sum_{j=1}^{M} e^{Z_{ij}}} \tag{1}$$

The multinomial logit model is now defined by Equation (1) but with the caveat that:

$Z_{ij} = \sum_{r=1}^{R} \beta_{jr} X_{ir}$. Because the probabilities $pr\,(Y_i = j)$ sum to 1 over all the choice (i.e., $\sum_{j=1}^{m} p\left(Y_i = j\right) = 1$, only $M-1$ of the probabilities can be independently determined. As a result, the multinomial logit model described in Equation (1) is indeterminate, consisting of M equations but only $M-1$ independent unknowns. To resolve this issue, a common normalization is to set $\beta 1r = 0$ for $r=1,\ldots,R$.

With this normalization, $Z_{i1} = 0$, simplifying Equation (1):

$$P\left(Y_i = 1\right) = \frac{1}{1 + \sum_{j=2}^{M} e^{Z_{ij}}} \tag{2}$$

$$P\left(Y_i = m\right) = \frac{e^{\left(Z_{im}\right)}}{1 + \sum_{j=2}^{m} e^{\left(Z_{ij}\right)}} \qquad m = 2,\ldots, \tag{3}$$

Due to the normalization, the probabilities are uniquely specified, turning Equation (3) into a system of $M-1$ equations for the $M-1$ unknown probabilities $P(Y_i = 1)$, which are defined by Equation (1) through the applied normalization. From Equations (2) and (3), the logarithm of the ratio of the probability of outcome ($j = m$) to that of outcome $j = k$ is:

$$\log \frac{P(Y_i = m)}{P(Y_i = k)} = \sum_{r=1}^{R} \left(\beta_{mr} - \beta_{kr}\right) X_{ir} = Z_{im} - Z_{ik} \tag{4}$$

So that the logarithm of the risk ratio (i.e., the logarithm of the ratio of the probability of outcome m to that of outcome k), or $\log(P(Y_i = \mathrm{m})/P(Y_i = k))$ does not depend on other choices. The risk ratio or, as it is sometimes referred to, the relative risks ratio $\log(P(Y_i = \mathrm{m})/P(Y_i = k))$, can easily be calculated from the risk ratio by taking its exponential. If $k = 1$, the log risk ratio is,

$$\log\left(\frac{P\left(Y_i = m\right)}{P\left(Y_i = 1\right)}\right) = \sum_{r=1}^{R} \beta_{mr} X_{ir} = Z_{im} \quad (m = 2,\ldots,m) \tag{5}$$

And the risk ratio is,

$$\log\left(\frac{P\left(Y_i = m\right)}{P\left(Y_i = 1\right)}\right) = e^{\sum_{r=1}^{R} \beta_{mr} X_{ir}} = e^{Z_{im}} \quad \left(m = 2,\ldots,m\right) \tag{6}$$

The risk ratio should be distinguished from the odds ratio. The odds ratio refers to the probability of an outcome divided by the probability of that outcome not occurring (1 minus the probability). The odds ratio for ($j = m$) is,

$$OR = \frac{P\left(Y_i = m\right)}{1 - P\left(Y_i = m\right)} = \frac{P\left(Y_i = m\right)}{P\left(Y_i = 1\right)} \frac{P\left(Y_i = 1\right)}{1 - P\left(Y_i = m\right)}$$
$$= \frac{RR_m P\left(Y_i = 1\right)}{1 - RR_m P\left(Y_i = 1\right)} \tag{7}$$

where the OR and RR are odds ratio and risk ratio, respectively associated with outcome ($j = m$), the latter is relative to base outcome ($j = 1$).

3.3. Explanation of the Study Variables

The dependent variables for this study are the energy sources for lighting and cooking. The SIHBS (20220) collected data on sources of energy for lighting by asking respondents in each sampled household the question "What is the main source of energy the household uses for lighting?" The sources of energy for lighting captured during the survey were electricity, solar, kerosene, firewood, torch, candles and others. For this study, the sources energy for lighting are categorized as electricity, solar, torch and others.

The survey also collected information on sources of energy for cooking by asking respondents "What is the household's main source of energy for cooking food, making tea/coffee and boiling drinking water?" The sources of energy for cooking captured during the survey were electricity, solar, gas, charcoal, firewood, farm residuals, animal dung and others. For this study, the sources of energy for cooking are categorized as gas, charcoal, firewood and others.

Also collected in the survey were household's socioeconomic and demographic characteristics, such as household head age, gender, education level and marital status, household size, area of residence, access to electricity, whether sharing toilet facility, floor materials and per capita consumption.

3.4. Data Analysis

The data analysis involved several key steps to assess household energy choice in Somalia. Initially, frequency distributions of energy sources for both lighting and cooking were compiled based on the type of residence, allowing for an understanding of the prevalence of different energy types across urban, rural, and nomadic households. Subsequently, a multinomial logistic regression model was employed to isolate the predictors of energy use. This model enabled the examination of various household characteristics, such as the age, education level, and gender of the household head, along with geographical location, per capita consumption, access to electricity, floor material of the building and toilet facilities. The coefficients from the regression analysis were expressed as Relative Risk Ratios (RRR), to analyze the determinants of household energy choices.

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics

Table 1 shows the distribution of energy access across different areas in Somalia. It reveals that out of the 7,212 households surveyed, 80.1% of urban households have access to electricity, suggesting that urbanization significantly influences energy use patterns, characterized by higher access to electricity and modern energy sources. In contrast, only 39.4% of rural households have access to electricity, leading them to rely predominantly on traditional energy sources such as firewood and kerosene due to limited electricity infrastructure. Additionally, 8.7% of nomadic households have access to electricity, highlighting their reliance on portable and readily available energy sources like torches and solar power, which are essential for their mobile lifestyle.

Table 1: Access to electricity by place of residence

Electricity access	Type of residence			Total
	Rural	Urban	Nomadic	
Yes	39.4	80.1	8.7	61.9
No	60.6	19.9	91.3	38.1
Total	100.0	100.0 0	100.0	100.0

According to Table 2, 52.37% of the households were headed by females, while 47.63% were headed by males. Regarding marital status, the majority of household heads are married (77.81%), with smaller proportions being divorced (8.41%), never married (1.43%), or widowed (12.35%). The educational attainment of household heads varies, with the largest group having no formal education (67.92%), followed by those with primary education (13.52%). Secondary and university education are less common, accounting for 7.09% and 4.42% of the population, respectively, while 7.05% have received Quranic education. In terms of sanitation, the vast majority of households (71.18%) do not share toilet facilities, while 28.82% do. Among flooring materials, the most common are earth/sand (45.77%) and cement (40.97%), with fewer houses utilizing tiles (9.62%), wood (2.04%), or other materials (1.61%). These factors provide a comprehensive picture of the surveyed households' demographic, educational, and living situation profiles, which are critical for understanding their energy consumption and other socioeconomic habits.

Table 3 illustrates the energy sources used for lighting and cooking. The primary energy sources for illumination in Somalia are electricity (54.1%), torches (35.2%), and solar (9.7%). Urban residents use electricity (76.5%), whereas nomads primarily use torches (91.1%). Almost half of rural residents (47.5%) use torches, one-third use electricity (30.34%), and one-fifth use solar (21.4%). For cooking, charcoal (47.9%) and firewood (41.3%) are most common, with minimal use of gas or electricity. Urban areas primarily use charcoal (60.6%), while rural and nomadic households rely more on firewood (55.8% and 94.3%, respectively).

Table 2: Background characteristics of household heads

Characteristics	Frequency	Percent
Sex		
Male	3,435	47.63
Female	3,777	52.37
Type of residence		
Rural	1,908	26.46
Urban	4,344	60.23
Nomadic	960	13.31
Marital status		
Married	5,387	77.81
Divorced	582	8.41
Never married	99	1.43
Widowed	855	12.35
Educational level		
No education	4,702	67.92
Primary	936	13.52
Secondary	491	7.09
University	306	4.42
Quranic	488	7.05
Sharing toilet facility		
Yes	1,662	28.82
No	4,105	71.18
Floor material		
Cement	2,755	40.97
Tiles	647	9.62
Wood	137	2.04
Earth/sand	3,078	45.77
Other (specify)	108	1.61

4.2. Factors Affecting Household Energy Choice for Lighting

We analyze the predictors of the household energy choice for cooking fuel using the Multinomial Logit (MNL) model, with electricity as the reference category (Table 4). The significant determinists of household energy choices for lighting were sex, marital status, education, place of residence, per capita consumption, main building material and toilet facility.

Table 3: Main sources of energy for lighting and cooking by place of residence

Main source of energy	Rural (N=1908)	Urban (N=4344)	Nomadic (N=960)	Total 7212
Main source energy for lighting				
Electricity	30.3	75.5	0.5	54.1
Solar	21.4	5.0	8.0	9.7
Torch	47.5	18.5	91.1	35.4
Others	0.8	1.00	0.4	0.8
Total	100	100	100	100
Main source of energy for cooking				
Gas	1.0	8.9	0.0	5.7
Charcoal	39.7	60.6	4.3	47.9
Firewood	55.8	24.0	94.3	41.3
Others	3.5	6.5	1.4	5.1
Total	100.0	100.0	100.0	100.0

Sex of the household head: Female-headed households are more likely to utilize lighting sources such as solar power, torches, and other alternatives. They are 2.011, 2.54, and 3.38 times more likely to use solar lighting, flashlights, and other lighting options, respectively, compared to male-headed households.

Education level: Having a secondary education significantly decreases the likelihood of using torches (RRR = 0.393) and other lighting options (RRR = 0.274). Households led by individuals with a university education are also less likely to use solar lighting (RRR = 0.3698) and torches (RRR = 0.271). Conversely, Quranic education is associated with an increased likelihood of using solar lighting (RRR = 1.584) and torches (RRR = 1.748).

Marital status of the household head: Widowed household heads are significantly more likely to use torch lighting (RRR = 1.79)

Table 4: Multinomial logit estimation of household's energy choice for lighting

Variable	Choice options (dependent variable)		
	Solar	Torch	Others
Electricity (base)			
Age	0.998 (0.005)	0.997 (0 0.004)	0.997 (0.005)
Sex			
Male	1	1	1
Female	2.011*** (0.358)	2.543*** (0.542)	3.38*** (1.17)
Household size	1.017 (0.028)	0.997 (0 0.034)	0.949 (0.053)
Education			
No education#	1	1	1
Primary	1.26 (0.248)	1.178 (0.304)	1.140 (0.461)
Secondary	0.615(.193)	0.393**(0.163)	0.274*(0.208)
University	0.3698**(0.170)	1.748*(0.541)	0.545 (0.409)
Quranic	1.584**(0.379)	1.748*(0.541)	0.545 (0.409)
Marital status			
Married#	1	1	1
Widowed	0.982 (0.306)	1.173 (0.431)	0.665 (0.454)
Never married	1.026 (0.663)	1.055 (0.929)	3.161 (2.589)
Divorced	1.112(.297)	1.79*(0.575)	1.544 (0.803)
Place of residence			
Rural#	1	1	1
Urban	0.126***(.020)	0.1908***(0.037)	0.811 (0.306)
Nomadic	25.33***(26.800)	34.059***(36.910)	22.943**(34.288)
Per capita consumption	0.9939 (0.001)	0.998***(0.003)	0.999(.0015)
Access to electricity			
No#	1	1	1
Yes	6.69e-10 (4.18e-07)	1.65e-11 (1.03e-08)	6.3e-10 (3.9e-07)
Main building materials (floor)			
Cement#	1	1	1
Tiles	0.307***(0.127)	0.0283***(0.026)	0.475 (0.317)
Woods	3.043**(1.723)	5.392***(3.55)	1.12e-08 (0.000)
Earth/sand	2.593***(0.421)	2.044***(0.414)	1.607 (0.525)
Other (specify)	2.30 (1.684)	5.133***(4.18)	6.478***(5.58)
Toilet facility			
Shared#	1	1	1
Not shared	0.993 (0.182)	0.751 (0.161)	3.098 (1.366)
Log likelihood	-1747.51		
No of observations	7212		
Wald Chi^2 (54)	6105.03		
Prob>Chi^2	0.000		

The coefficients show the relative risk ratios (RRR). #Indicates reference category, ***, **, and * indicate significance level at the 1%, 5%, and 10%, respectively than married household heads, while divorced and never married individuals show no significant impact on lighting choices.

Place of residence: Urban households are significantly less likely to use solar (RRR = 0.126) and torch (RRR = 0.1908) lighting compared to rural households, with no significant impact on other lighting options. Nomadic households are substantially more likely to use solar (RRR = 25.33) and torch (RRR = 34.059) lighting.

Per capita consumption (PCE): The likelihood of using torches for lighting decreases by about 0.011% as PCE increases, which is statistically significant. This indicates that higher PCE is associated with a lower likelihood of using torches compared to electricity. This finding supports the energy ladder hypothesis, which posits that as income levels rise, households transition from utilizing inefficient fuels to cleaner energy alternatives.

Main building material of the floor: Households with tile flooring are significantly less likely to use solar (RRR = 0.307) and torch (RRR = 0.0283) for lighting. Households with wood flooring are significantly more likely to use solar (RRR = 3.043) and torch (RRR = 5.392). Households with earth/sand flooring are significantly more likely to use solar (RRR = 2.592) and torch (RRR = 2.044). Households using other floor materials are significantly more likely to use torch (RRR = 5.133) and other lighting options (RRR = 6.478).

Overall, the model's Wald chi-square statistic (6105.03, $P < 0.001$) demonstrates a highly significant fit, indicating strong predictive power regarding household lighting choices.

4.3. Factors Affecting the Household Energy Choice for Cooking

The results of the multinomial logistic regression model assessing the factors that influence household energy decisions for cooking, with charcoal as the base outcome, are presented in Table 5. The key factors influencing household energy choices for cooking include sex, age, household size, marital status, education, place of residence, per capita consumption, electricity access, the main building material, and toilet facilities.

- Household Head Age: The age of the household head has no significant effect on the likelihood of using gas or firewood.

Table 5: Multinomial logit assessment of households' energy preferences for cooking

Variable	Choice options (dependent variable)		
	Gas	Firewood	Others
Charcoal (Base)			
Age	0.998 (0.003)	1.000 (0 0.001)	1.001 ***(0.001)
Sex			
Male#	1	1	1
Female	1.38** (0.201)	1.341*** (0 0.112)	0.964 (0.13)
Household size	0.987 (0.021	1.081 ***(0.0156)	0.942***(0.021)
Education			
No education#	1	1	1
Primary	1.822 ***(0.301)	0.737 ***(0 0.0851)	0.85956 (0.1499)
Secondary	1.94 ***(0.356)	0 0.477***(0.0842)	1.069 (0.2084)
University	4.220***(0.793)	0.332***(0.100)	1.199 (0.279)
Quranic	0.949***(0.291)	1.025***(0 0.148)	0.549*(0.178)
Marital status			
Married#	1	1	1
Widowed	1.747***(0.382)	0.992 (0 0.141)	1.0614 (0.2316)
Never married	1.25 (0.466)	0.745 (0.314)	2.123*(0.704)
Divorced	1.358 (0.282)	1.15 (0.145)	0.76 (0.155)
Place of residence			
Rural#	1	1	1
Urban	4.31*** (1.19)	0 0.351*** (0.0309)	1.413** (0.2495)
Nomadic	0 0.000 (0.032)	4.3073*** (1.689)	4.0748* (3.351)
Per capita consumption	0.0294***(0.0005)	0.0067 (0.0004)	0.0211 (0.006)
Access to electricity			
No#	1	1	1
Yes	7.213*** (4.26)	0.174*** (0.014)	1.4922* (0.320)
Main building materials (floor)			
Cement#	1	1	1
Tiles	3.167*** (0.401)	0.5187*** (0.1157)	0.835 (0 0.151)
Woods	0.934 (0.695)	2.277*** (0.569)	1.218 (0.597)
Earth/sand	0.123*** (0.045)	3.23*** (0.271)	0.498 *** (0.0869)
Other (specify)	0.323 (0.335)	1.584*** (0.538)	1.633 (0.752)
Toilet facility			
Shared#	1	1	1
Not shared	1.925*** (0.363)	0.644*** (0.0549)	1.925* (0.363)
Log likelihood	−4120.09		
No of observations	7212		
Wald Chi^2 (54)	2893.56		
Prob>Chi^2	0.000		

The coefficients show the relative risk ratios (RRR). #indicates reference category, ***, **, and * indicate significance level at the 1%, 5%, and 10%, respectively

However, the likelihood of using other types of energy increases with each one-unit increase in the age of the household head (RRR 1.001).

- Sex: Households headed by females are more likely to use gas (RRR = 1.38) and firewood (RRR = 1.341) compared to charcoal. However, these households are less likely to use other energy types (RRR = 0.964).
- Household Size: Larger household sizes are associated with a higher likelihood of using firewood (RRR = 1.081) and a lower likelihood of using other energy types (RRR = 0.942) compared to charcoal.
- Education Level: Education significantly influences energy choices. Individuals with primary education are more likely than those without formal education to use gas (RRR = 1.822) and less likely to use firewood (RRR = 0.737) or other forms of energy (RRR = 0.859). Secondary education increases the likelihood of using gas (RRR = 1.94) and decreases the likelihood of using firewood (RRR = 0.477). University education has a strong positive effect on gas use (RRR = 4.220) and a significant negative effect on firewood use (RRR = 0.332). Quranic education shows a mixed impact, increasing the likelihood of using firewood (RRR = 1.025) while decreasing the likelihood of using other energy types (RRR = 0.549).
- Marital status of the household head: Divorced individuals are more likely to use gas (RRR = 1.747) compared to their counter parties.
- Place of residence: Urban families are substantially more likely to utilize gas (RRR = 4.31) than firewood (RRR = 0.351). Nomadic households have no significant likelihood of utilizing gas but are more likely to use firewood (RRR = 4.307) and other energy sources (RRR = 4.075).
- Access to Electricity: Households with access to electricity are much more likely to use gas (RRR = 7.213) and other energy types (RRR = 1.492), but less likely to use firewood (RRR = 0.174) compared to charcoal.
- Per capita consumption (PCE): The likelihood of using gas compared to charcoal increases by approximately 0.029% for each unit increase in PCE, which is statistically significant. This implies that as household consumption or expenditure increases, which serves as a proxy for household income, the likelihood of using cleaner energy for cooking also increases.
- Main building material of the floor: Households with tiled floors are more likely to use gas (RRR = 3.167) and less likely to use firewood (RRR = 0.519) compared to charcoal. Wooden floors increase the likelihood of using firewood (RRR = 2.277), while earth/sand floors are associated with a significantly lower likelihood of using gas (RRR = 0.123) but a higher likelihood of using firewood (RRR = 3.23). Other floor materials increase the likelihood of adopting firewood (RRR = 1.584).
- Sharing toilet facility: Households that share a toilet facility are more likely to use gas (RRR = 1.925) and other energy sources (RRR = 1.942), but less likely to use firewood (RRR = 0.644) compared to charcoal.

4.4. Discussion of Results

The findings of this study highlight several key determinants influencing household energy use for cooking and lighting in Somalia. The analysis reveals that factors such as the age, education level, and gender of the household head, as well as geographical location and access to electricity, significantly impact energy choices.

The findings of this study align with previous studies on household energy use. For instance, education was found to be statistically significantly related to the household energy choices. Hence, this finding is consistent with the studies by (Heltberg, 2005; Mensah and Adu, 2015) showing that households led by educated individuals are more inclined to adopt cleaner energy sources. This correlation can be attributed to increased awareness of the health benefits associated with modern energy options and enhanced economic capacity to afford them. Additionally, larger households tend to rely more on traditional energy sources, consistent with findings from (Lee, 2013; Onoja et al., 2012). This trend arises from higher energy demands and financial constraints, often leading to a preference for cheaper, less sustainable fuels. Geographical location also significantly impacts energy choices, with urban households more likely to utilize cleaner energy sources than their rural counterparts, confirming the findings by (Eakins, 2013; Hosier and Dowd, 1987). Urban areas typically have better access to modern energy infrastructure, facilitating the use of electricity and LPG. Furthermore, access to electricity was found to be a significant determinant of household energy use for cooking. This finding corroborates a study by of (Özcan et al., 2013), emphasizing that access to electricity is a crucial determinant of energy choice. Households with electricity are more likely to employ electric lighting and modern cooking methods, underscoring the urgent need for improved energy infrastructure in rural areas.

Similarly, per capita consumption significantly influences the choice of clean energy for cooking. However, the analysis of per capita consumption's effect on the selection of clean energy for lighting is insignificant. The result confirms and supports the energy ladder hypothesis (Das et al., 2014; Heltberg, 2005; Ouedraogo, 2006; Rao and Reddy, 2007).

In terms of the flooring material of the building, households with tile flooring or concrete flooring was associated with a lower likelihood of using traditional fuel. This finding suggests that the quality of housing influences energy usage. The findings also indicate that households with private toilet facilities were more likely to use gas for cooking than those that shared their toilet facilities (Nzabona et al., 2021).

5. CONCLUSION AND POLICY IMPLICATIONS

The primary objective of this study was to examine the factors influencing household energy choices in Somalia, using data from Integrated Household Budget Survey 2022. The findings revealed that several factors significantly affect household energy choices, including sex, marital status, education level, household size, place of residence, access to modern energy, per capita consumption (PCE), building floor material, and toilet facility. The results confirm that as household income levels rise, access to education, modern energy sources, the likelihood of choosing cleaner and more modern fuels for cooking and lighting increases. Furthermore, the findings indicated that the location of the household significantly influences energy choices for cooking and lighting.

The study underscores the need for customized energy policies to improve access to modern energy sources. For example, the government should implement electrification programs aimed at enhancing access to modern energy, particularly renewable energy, for rural and nomadic households. In Somalia, only 39% of the rural population has access to electricity. Additionally, the cost of electricity in Somalia is among the highest globally, reaching approximately $1/kWh (World Bank, 2018), and household income is a statistically significant factor influencing household energy choices. This situation indicates that in Somalia, where the Multidimensional Poverty Index (MPI) is 67%, a significant portion of households cannot afford to transition to cleaner energy sources. Therefore, the government should not only increase the availability of modern energy sources but also lower costs to enable poorer households to shift to cleaner energy options.

6. FUNDING ACKNOWLEDGEMENT

We would like to thank SIMAD University for supporting this research.

REFERENCES

Abrahamse, W., Steg, L. (2009), How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings? Journal of Economic Psychology, 30(5), 711-720.

Acharya, B., Marhold, K. (2019), Determinants of household energy use and fuel switching behavior in Nepal. Energy, 169, 1132-1138.

Campbell, B.M., Vermeulen, S.J., Mangono, J., Mabugu, R. (2003), The energy transition in action: Urban domestic fuel choices in a changing Zimbabwe. Energy Policy, 31(6), 553-562.

Danlami, A.H. (2017), Determinants of household electricity consumption in Bauchi State, Nigeria. Hyperion Economic Journal, 5(1), 16-28.

Das, S., De Groote, H., Behera, B. (2014), Determinants of household energy use in Bhutan. Energy, 69, 661-672.

Eakins, J. (2013), An Analysis of the Determinants of Household Energy Expenditures: Empirical Evidence from the Irish Household Budget Survey. United Kingdom: University of Surrey.

Gould, C.F., Urpelainen, J., Sais, J.H. (2020), The role of education and attitudes in cooking fuel choice: Evidence from two states in India. Energy for Sustainable Development, 54, 36-50.

Heltberg, R. (2005), Factors determining household fuel choice in Guatemala. Environment Development Economics, 10(3), 337-361.

Hosier, R.H., Dowd, J. (1987), Household fuel choice in Zimbabwe: An empirical test of the energy ladder hypothesis. Resources Energy, 9(4), 347-361.

IEA. (2006), Energy for Cooking in Developing Countries. United States: OECD.

Jumbe, C.B., Angelsen, A. (2011), Modeling choice of fuelwood source among rural households in Malawi: A multinomial probit analysis. Energy Economics, 33(5), 732-738.

Kebede, B., Bekele, A., Kedir, E. (2002), Can the Urban poor afford modern energy? The case of Ethiopia. Energy Policy, 30(11-12), 1029-1045.

Kowsari, R., Zerriffi, H. (2011), Three dimensional energy profile: A conceptual framework for assessing household energy use. Energy Policy, 39(12), 7505-7517.

Lee, L.Y.T. (2013), Household energy mix in Uganda. Energy Economics, 39, 252-261.

Makonese, T., Ifegbesan, A.P., Rampedi, I.T. (2018), Household cooking fuel use patterns and determinants across southern Africa: Evidence from the demographic and health survey data. Energy Environment, 29(1), 29-48.

Masera, O.R., Saatkamp, B.D., Kammen, DM. (2000), From linear fuel switching to multiple cooking strategies: A critique and alternative to the energy ladder model. World Development, 28(12), 2083-2103.

McFadden, D. (1976), Quantal choice analysis: A survey. Annals of Economic Social Measurement, 5(4), 363-390.

McKinsey. (2024), Global Energy Perspective; 2024. Available from https://www.mckinsey.com/industries/energy/and/materials/our/insights/global/energy/perspective

Mekonnen, A., Köhlin, G. (2008), Determinants of Household Fuel Choice in Major Cities in Ethiopia (1403-2465). Swedan: Gothenburg.

Mensah, J.T., Adu, G. (2015), An empirical analysis of household energy choice in Ghana. Renewable Sustainable Energy Reviews, 51, 1402-1411.

Muller, C., Yan, H. (2018), Household fuel use in developing countries: Review of theory and evidence. Energy Economics, 70, 429-439.

Nansaior, A., Patanothai, A., Rambo, A.T., Simaraks, S. (2011), Climbing the energy ladder or diversifying energy sources? The continuing importance of household use of biomass energy in urbanizing communities in Northeast Thailand. Biomass Bioenergy, 35(10), 4180-4188.

Narain, U., Gupta, S., Van't Veld, K. (2008), Poverty and resource dependence in rural India. Ecological Economics, 66(1), 161-176.

Nzabona, A., Tuyiragize, R., Asiimwe, J.B., Kakuba, C., Kisaakye, P. (2021), Urban household energy use: Analyzing correlates of charcoal and firewood consumption in kampala city, Uganda. Journal of Environmental Public Health, 2021(1), 5904201.

Onoja, A.O., Idoko, O. (2012), Econometric analysis of factors influencing fuel wood demand in rural and peri-urban farm households of Kogi State. Consilience, 8, 115-127.

Ouedraogo, B. (2006), Household energy preferences for cooking in Urban Ouagadougou, Burkina Faso. Energy Policy, 34(18), 3787-3795.

Özcan, K.M., Gülay, E., Üçdoğruk, Ş. (2013), Economic and demographic determinants of household energy use in Turkey. Energy Policy, 60, 550-557.

Rao, M.N., Reddy, B.S. (2007), Variations in energy use by Indian households: An analysis of micro level data. Energy, 32(2), 143-153.

SNBS. (2023), 2022 Somalia Integrated Household Budget Survey (SIHBS). Available from: https://nbs.gov.so/wp-content/uploads/2023/07/somalia/integrated/household/budget/survey.pdf

SoNADA. (2023), Somalia Integrated Household Survey Budget (SIHBS) - 2022. California: SoNADA.

Suliman, K.M. (2010), Factors Affecting the Choice of Households' Primary Cooking Fuel in Sudan. Paper Presented at the Research Report Presented to the Economic Research Forum; [Working Paper].

UNDESA. (2017), The 2017 Revision of World Population Prospects. Available from: https://www.un.org/en/desa/world/population/projected//reach/98/billion/2050/and/112/billion/2100

Vaage, K. (2000), Heating technology and energy use: A discrete/continuous choice approach to Norwegian household energy demand. Energy Economics, 22(6), 649-666.

World Bank. (2018), Somali Electricity Access Project (P165497). Washington, DC: World Bank.