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Household Energy Choices and Health Risks: A Socioeconomic Analysis of Rural Women in Tehsil Mirpur

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Abstract: *The energy sector plays a vital role in socio-economic development, and this study examines the factors influencing cooking fuel choices and their associated health impacts in rural Tehsil Mirpur, AJK. Using data from 400 households and employing multinomial and binary logistic regressions, the study finds that household income, age, and education of the household head, and the number of children under five are positively linked to using Liquefied Petroleum Gas (LPG). Conversely, household size, gender of the head, and poverty are associated with traditional fuel use. Health outcomes, such as COPD, asthma, and respiratory infections, are inversely related to income, education, and good ventilation. The study suggests government policies focus on increasing access to clean cooking fuels to improve public health.*

Key Words: Cooking Fuel Choices, Women's Health Impacts, Liquefied Petroleum Gas (LPG), Multinomial Logistic Regression, Binary Logistic Regression.

JEL Classification:

Introduction

The energy sector is crucial for global economic and social development, providing the foundation for addressing numerous challenges like health, inequality, education, and climate change. Access to affordable, reliable, and clean energy is essential for household welfare and economic growth. However, many developing countries, including Pakistan, face severe energy poverty, particularly in rural areas. This leads to heavy reliance on traditional fuels such as biomass and coal, resulting in indoor air pollution (IAP) that disproportionately impacts women and contributes to environmental harm.

Globally, around 3 billion people rely on solid fuels for their domestic needs, while approximately 1.5 billion lack access to electricity (International Energy Agency, 2021). In Pakistan, the rural population is particularly affected by the energy crisis, with frequent load shedding and high energy costs limiting access to clean fuel. As a result, 86% of households use traditional fuels, with firewood being the predominant choice, especially in rural regions (HESS, 2023). Indoor air pollution caused by burning dirty

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fuels contributes to a range of health issues, including respiratory diseases, asthma, and even lung cancer. The economic burden is also significant, as time spent collecting fuelwood reduces productivity and educational opportunities, particularly for women and children.

Research indicates that socioeconomic factors, such as education level, wealth, and access to credit, strongly influence fuel choices. Households with higher education and income are more likely to adopt clean energy sources like liquefied petroleum gas (LPG) (World Bank, 2022).

The review of literature on household cooking fuel choice reveals that various demographic and socio-economic factors, such as education, income, fuel availability, and infrastructure, significantly influence the choice of cooking fuels across different countries including Nigeria, Bangladesh, India, Ghana, China, Ghana and Pakistan (Moeen et al., 2016; Hou et al., 2017; Ali et al., 2019., Twumasi et al., 2021). These studies highlight the importance of factors like household size, distance to fuel supply, and public awareness in determining fuel preferences. These studies collectively highlight the complex interplay of socio-economic, infrastructural, and educational factors in determining household fuel choices and underscore the importance of promoting cleaner energy sources to improve health and environmental outcomes.

Indoor air pollution from solid fuels is a major contributor to respiratory problems, especially among women and children (WHO, 2016). Studies such as Pope et al. and Smith et al. (2017) demonstrated the health benefits of using cleaner cooking fuels. Recent studies have highlighted the significant health impacts of household air pollution from cooking fuels, particularly on respiratory health and mortality in young children. Furthermore, research on the health impacts of cooking fuels indicates that the type of fuel used is closely linked to respiratory diseases such as chronic obstructive pulmonary disease, asthma, and upper respiratory tract infections (Naz et al., 2017; Capuno et al., 2016; Khan et al., 2018; Simkovich et al. (2019). Studies from Sri Lanka, India, China, and the Philippines show that indoor air pollution from traditional fuels contributes to these health issues, underscoring the need for cleaner energy sources. These studies underscore the crucial role of clean cooking fuels in improving respiratory health and reducing mortality in children, highlighting the need for policies to promote cleaner energy sources and better cooking practices.

Pakistan faces significant energy poverty, particularly in rural areas where 71% of households and 29% of urban households lack adequate access to clean energy. A substantial portion of rural households, around 69%, rely on traditional cooking fuels such as firewood, dung cakes, and crop residues. According to the Pakistan Social and Living Standards Measurement Survey (PSLSMS) 2019-20, out of 66,000 surveyed rural households, 43,000 use firewood, 14,000 use dung cakes and crop residues, and only 9,000 have access to gas for cooking. This heavy reliance on traditional fuels results in severe indoor air pollution, posing serious health risks.

The Pakistan Demographic and Health Survey 2017-18 highlights that households using traditional fuels are 1.5 times more likely to report symptoms of acute respiratory infections than those using clean fuels. The health impacts are particularly concerning for women and children, who are most exposed to indoor air pollution. Given these challenges, it is critical to examine the factors influencing household cooking fuel choices in rural Pakistan.

This study is significant as it compares traditional and modern fuel preferences and provides a comprehensive analysis of cooking fuel choices and their health impacts in rural Pakistan, specifically in Azad Kashmir. By comparing traditional and modern fuels in terms of usage and health impacts, particularly respiratory diseases. It fills a research gap in understanding the demand for clean energy and the health implications of traditional fuel use, offering insights into household awareness of the demand for clean energy (Sui gas) and the need for sustainable energy solutions. This study investigates whether

households adhere to the fuel-stacking or energy ladder hypotheses and analyzes the prevalence of respiratory diseases among those using traditional fuels. Additionally, it will explore the role of socioeconomic factors in determining fuel choice and test the hypothesis Households with better socio-economic conditions are more likely to choose clean cooking fuels, which leads to improved health outcomes.

This study aims to bridge the gap in the existing literature by integrating the examination of both fuel choice determinants and health impacts in a single analysis. By comparing 200 households using modern cooking fuels with 200 using traditional fuels, this research provides valuable insights into fuel-related health disparities and the demand for clean cooking fuels, offering a pathway for future research and policy development. Moreover, this study highlights the need for policies promoting the use of clean energy for sustainable development. By understanding the socioeconomic and environmental drivers behind fuel choices, the study seeks to inform policy recommendations that encourage cleaner, more sustainable energy solutions in rural areas.

Methods

Study Design and Population

Data was collected at the household level from the rural areas of Tehsil Mirpur, AJK, with multistage cluster sampling. Mirpur has a population of 277,560 spread across 11 union councils and 3 town committees. A sample survey was carried out. Sample selection and descriptive analysis of collected data were extracted based on information assembled about fuel choice and disease from different respondents' samples.

In the first stage, all union councils and town committees were selected. In the second stage, two villages were randomly chosen from each union council. In the final stage, households were selected based on their usage of clean and traditional cooking fuels. To ensure an equal comparison, half of the sample consisted of clean fuel users and the other half of traditional fuel users. The sample size was determined using Cochran's (1963) formula, ηo=Z2PQ/e2\eta_o = Z^2 PQ / e^2ηo =Z2PQ/e2, which considers a 95% confidence level, maximum variability (p = 0.5), and a desired level of precision. Based on this, the calculated sample size was 384, but a sample of 400 households was taken to ensure an equal representation of fuel types across villages.

Data Collection

This study was based on questionnaire data examining cooking fuel choices, the factors influencing these choices, and the associated health conditions linked to different fuel types. Data was collected from all clusters of Tehsil Mirpur, focusing on household heads, as they possess comprehensive knowledge of household characteristics. A structured questionnaire was administered to 400 households to collect primary data on cooking fuel choices and health conditions. The study compared 200 households using modern cooking fuels with 200 using traditional fuels. Close-ended questions were posed to gather information on socio-economic variables.

The Model

To find the impacts of independent variables on dependent variables following model was constructed for Fuel Choice, Chronic Obstructive Pulmonary Disease (COPD), ASTHMA, and Demand for Clean Water (D_CF).

$$FUEL\ CHOICE = \beta_0 + \beta_1 HHI_i + \beta_2 AGE_i + \beta_3 H\_SIZE_i + \beta_4 EDU_i + \beta_5 GDR_i + \beta_6 NOC_i + \beta_7 Poverty_i + u_i \quad (1)$$

$$COPD = \beta_0 + \beta_1 HHI_i + \beta_2 AGE_i + \beta_3 H\_SIZE_i + \beta_4 EDU_i + \beta_5 GDR_i + \beta_6 NOC_i + \beta_7 C\_CP_i + \beta_8 FD_i + \beta_9 DC_i + \beta_{10} LPG_i + u_i \quad (2)$$

$$ASTHMA = \beta_0 + \beta_1 HHI_i + \beta_2 AGE_i + \beta_3 H\_SIZE_i + \beta_4 EDU_i + \beta_5 GDR_i + \beta_6 NOC_i + \beta_7 C\_CP_i + \beta_8 FD_i + \beta_9 DC_i + \beta_{10} LPG_i + u_i \quad (3)$$

$$D\_CF = \beta_0 + \beta_1 HHI_i + \beta_2 AGE_i + \beta_3 H\_SIZE_i + \beta_4 EDU_i + \beta_5 GDR_i + u_i \quad (4)$$

Data Analysis

The study utilized multinomial logistic regression to analyze factors influencing the choice of cooking fuels, considering fuel choice as a polytomous variable. Binary logistic regression was used to examine health impacts, treating disease prevalence as a dichotomous variable.

In the analysis, the dependent variable *fuel choice* consists of three categories: dung cake, firewood, and LPG as the primary cooking fuel sources, represented by values 1, 2, and 3, respectively. Given that the dependent variable is polytomous, it cannot be modeled using binary logistic regression. Therefore, the study applied multinomial logistic regression to identify the determinants of fuel choice. Previous studies, such as Nasir et al. (2015), Schei et al. (2004), Ogwumike et al. (2014), Buba et al. (2017), Khan et al. (2018), Imran and Ozcatalbas (2020), and Ali et al. (2019), have similarly utilized multinomial logistic regression to examine cooking fuel preferences.

Next, the study estimated logistic regression models for health outcomes such as COPD, asthma, and demand for clean fuel, as these dependent variables have binary outcomes (1 or 0). In these cases, binary logistic regression was appropriate for determining the factors influencing these outcomes. The study computed odds ratios and marginal effects to interpret the results.

Results and Discussion

Based on the proposed methodology, the study estimates fuel choice using multinomial logistic regression. For the health conditions and demand for clean cooking fuel, binary logistic regression has been employed.

Table 1

Estimates of Multinomial Logistic model for Household Cooking fuel Choice Reference Group=Dung Cake/Crop Residue

Exogenous Variables	Firewood	LPG
Constant	-3.156***	11.617***
	(1.376)	(2.086)
HHI	-3.94e-06*	0.0001***
	(0.0043)	(0.0000)
AGE	-0.0307**	0.0753***
	(0.0226)	(0.0270)
H_SIZE	0.0978*	-0.6636***
	(0.1107)	(0.1783)
EDU	-0.0986*	0.5855***
	(0.0773)	(0.1224)
GDR	0.4758**	-0.8361
	(0.6745)	(0.1077)
NOC	-0.1633**	0.3204**
	(0.1755)	(0.2628)
POVERTY	0.3926***	-1.4964*
	(0.5399)	(0.9499)
	400	
	413.81	Log-likelihood -178.20879
	0.5373	Prob > chi2 0.0000

The results from the multinomial logistic regression model for household cooking fuel choice are depicted in Table which provides key insights into the determinants of cooking fuel choice. These findings highlight the role of socio-economic characteristics such as income, age, household size, education, gender, number of children, and

poverty in shaping household fuel preferences. The results align with existing literature, reinforcing the understanding of fuel choice behavior within the energy transition framework.

Household income (HHI) has a negative and significant effect on firewood use (at the 10% level), indicating that higher income decreases the likelihood of using firewood. Conversely, it has a positive and highly significant effect on LPG use (at the 1% level), showing that higher income increases the likelihood of choosing LPG. The inverse relationship between household income and firewood use, as well as the positive relationship with LPG use, is consistent with the energy ladder hypothesis. This is based on the assumption that with rising household income, households substitute old traditional biomass fuel sources like firewood with more recent, cleaner, and efficient modern fuels, such as LPG. Studies conducted by Ogwumike et al. (2014), Mottaleb et al. (2017), and Hou et al. (2017) have established that, indeed, one crucial determinant of fuel switching is income as more affluent households, rather than preferring firewood or dung cakes, opt for LPG in view of its convenience and health benefits. Our findings are supported further by Karimu (2015) "Higher income households tend to use LPG as their primary cooking fuel ".While Age affects (AGE) negatively, firewood use is 5% revealing that the older the household head, the less likely to use firewood. It has a positive and highly significant effect on LPG use at 1%, indicating that the older a person is, the more likely he or she would opt for LPG. The positive and significant association of age with LPG use along with the negative relationship with firewood use depicts that older household heads tend to shift towards cleaner fuels. This could be as a result of a better understanding of the health risk levels that come with solid fuel burning, and also due to the necessity of keeping dear ones healthy. Similar results are reported by Ogwumike et al. (2014) and Buba et al. (2017), who found that the elderly are likely to change their energy sources to cleaner ones. This trend also may reflect that aging is associated with greater affluence or greater concern for health, and in consequence, shifting towards fuels like LPG, which reduce indoor air pollution and reduce the incidence burden of respiratory diseases.

H SIZE greatly increases the probability of wood fuel being used (at 10%) but reduces the likelihood of LPG use to statistically significant levels of 1%. A larger household size has a higher probability of using firewood, while the probability of adopting LPG use is smaller. There is a rational logic to this as larger families need higher energy; hence, though fossil fuels such as firewood have very negative impacts on the environment and human health, they become economic for households with multiple members. In this regard, the findings also support Gupta and Köhlin (2005), who found that the households with more members use biomass because of cost considerations. Besides, Mottaleb et al. (2017) and Pundo and Fraser (2006) indicated that the trends are similar as large households are less likely to switch to cleaner fuels because cooking more people requires more energy. However, Education (EDU) reduces the likelihood of using firewood but increases the likelihood of using LPG significantly by 1%.

Education is highly correlated with the choice of fuel, and a higher level of education has a lower possibility of the use of firewood and a higher possibility of the use of LPG. Educated households are likely to know about the health adversities caused by traditional cooking fuels and have better prospects of cleaner alternatives. These findings are consistent with other studies conducted by Rahut et al. (2017), which showed that education is positively associated with awareness of new sources of clean energy, hence increasing the adoption rate of modern

fuels. Contrarily, Imran, and Ozcatalbas (2020) also showed that education enhances the preference of a household for health and convenience, thus outlining a preferred use of LPG over biomass. More, Gender (GDR) Male-headed households are likely to use firewood (significant at 5%) but no impact was found on LPG.

More children (NOC) reduce the probability of firewood use (significant at 5%) but increase the chances of LPG use (significant at 5%). Firewood is more frequently used by households with male heads of household, though gender itself isn't a significant factor in the usage of LPG. This may be due partly to cultural and traditional roles in fuel choice, through which men are involved in maintaining customary traditions like gathering firewood. Other studies, such as Buba et al. (2017) and Makonese et al. (2017), have also found that gender influences the choice of fuel: male-headed households are more likely to prefer traditional biomass fuels rather than modern fuels. A greater number of children within a household lowers the chances of firewood use and increases the likelihood of LPG adoption.

This may reflect greater health concerns among households with children as parents become more conscious of the adverse health impacts of indoor air pollution from biomass fuels. Similar findings were reported by Buba et al. (2017), where households with children were more likely to transition to cleaner fuels to protect their children from respiratory diseases. Finally, variable Poverty significantly increases the likelihood of firewood use (at 1%) and decreases LPG use possibility at (10%).

The positive relation between poverty and firewood usage and the negative correlation in LPG usage underlines the fact that poorer households are constrained by stringent limits in their choice of fuels. Again, due to limited financial capabilities, these households are more likely to use free or cheap biomass fuels despite their environmental and health costs. This goes in tandem with what Karimu (2015) as well as Ogwumike et al. (2014), did by making a case that poverty has been identified as the main constraint in adopting the use of modern fuels, since not only do poor households lack the finances that can enable them to use LPG, but also the affordability of these alternatives. The model fitted well, with a pseudo-$R^2 = 0.5373$, and the likelihood ratio chi-square test confirmed the general goodness of fit ($p < 0.01$).

The multinomial logistic regression analysis identified that higher household income, older age of the household head, greater education level of the head, and the presence of fewer young children positively influence the adoption of LPG. Conversely, larger household sizes, male household heads, and poverty increase the likelihood of using traditional fuels.

Results of Determinants of Chronic Obstructive Pulmonary Disease (COPD) Using Logistic Model

The logistic regression results for the determinants of Chronic Obstructive Pulmonary Disease (COPD) are presented in Table 2 which highlights several key factors influencing its occurrence.

Table 2

Determinants of COPD Using Logistic Results

Dependent Variable: COPD Method: Binary Logit					
Variables	Coefficient	Odd Ratio	Marginal Effects	Standard Errors	P Values
Constant	-1.2748	0.2794	…….	-0.0150	0.025
HHI	-0.8701	0.9999	-0.0921	0.0000	0.000
AGE	-0.0068	0.9494	-0.0062	0.0148	0.219

Dependent Variable: COPD Method: Binary Logit					
Variables	Coefficient	Odd Ratio	Marginal Effects	Standard Errors	P Values
H_SIZE	0.0011	1.0006	0.0094	0.0794	0.071
EDU	-0.0041	0.8135	-0.0021	0.0508	0.042
GDR	0.2487	1.2823	0.0455	0.0434	0.120
NOC	0.0017	1.0017	0.0031	0.0304	0.012
C_CP	-0.0119	0.9881	-0.0029	0.0033	0.030
FD	1.2022	1.1451	0.2996	0.0408	0.038
DC	1.2022	1.3275	0.2199	0.0963	0.058
LPG	-0.9353	0.5490	-0.0730	0.0072	0.082
Number of obs: 400		Prob. chi2 : 0.0000		Pseudo R2 : 0.48	

Source: Computed by the authors using survey data.

Household income (HHI) has a negative and significant effect on COPD, with a coefficient of -0.8701 and an odds ratio close to 1 (0.9999), implying that as household income increases, the likelihood of developing COPD decreases. The marginal effect of -0.0921 reinforces this, showing that higher income reduces the probability of COPD. This result is consistent with studies indicating that wealthier households can afford cleaner cooking fuels, reducing exposure to harmful smoke (Gupta & Köhlin, 2005).

Whereas the age variable has a small, insignificant negative effect on COPD (coefficient: -0.0068), suggesting that the likelihood of developing COPD does not significantly change with age in this sample, despite some studies showing that older age is typically associated with higher COPD risk (Ogwumike et al., 2014). However (H size) size shows a positive effect on COPD, with a coefficient of 0.0011 and a marginal effect of 0.0094, suggesting larger households have a slightly higher probability of COPD, although this effect is not highly significant (p-value: 0.071). Larger households may use more biomass fuels, increasing exposure to pollutants.

Moreover, Education has a negative and significant effect on COPD, with a coefficient of -0.0041 and an odds ratio of 0.8135. This indicates that higher education reduces the likelihood of developing COPD, likely due to increased awareness of the health risks associated with traditional fuels and a higher propensity to use cleaner fuels (Rahut et al., 2017). The effect of gender is positive but not significant at 5%. This means that households headed by men have about a 0.2487 probability (or 24.87%) that they may have a problem with COPD. Children have a very small and insignificant positive effect on COPD. It means the children do not contribute many effects to the level of COPD in this model.

Cooking Practices and Fuel Type

The C_CP variable illustrates the impact of cooking within an enclosed space; it is negatively signed but insignificantly so. This would indicate that households experiencing a cooking problem in enclosed spaces would have a slight probability of suffering from COPD. Firewood has a strong positive and significant effect on COPD with a coefficient of 1.2022 and an odds ratio of 1.1451. This would depict that households using firewood for cooking have a higher tendency to suffer from COPD. This agrees with literature indicating that the smoke from firewood poses harmful effects (Gupta & Köhlin, 2005).

Dung cakes have a positive and significant effect on COPD (coefficient: 1.2022), which implies that the use of DC remarkably increases the risk of COPD due to high indoor air pollution. LPG, conversely, has a negative and significant effect on COPD (coefficient: -0.9353), which implies that those using LPG experience a lower risk of having COPD,

possibly due to cleaner combustion and lower emission rates of harmful particles.

The study further confirms the importance of household income, education, and fuel choice as predictors of COPD prevalence. Overall, with lower income and biomass fuels use, such as firewood and dung cakes, risks for COPD are indeed multiplied, but with higher income, education, and the use of LPG, risks are reduced. These results underscore the need for policies that promote cleaner fuel use and raise awareness of health risks associated with traditional fuels.

Results of Determinants of Asthma Using Logistic Model

The binary logistic regression results for the determinants of asthma identify key variables affecting the likelihood of asthma occurrence are presented in Table 3.

Table:3

Determinants of Asthma using Logistic regression Results

Dependent variable: Asthma Method: Binary Logit					
Variables	Coefficient	Odd Ratio	Marginal Effects	Standard Errors	P Values
Constant	4.0630	0.0171	……	1.0045	0.997
HHI	-0.0037	0.9918	-0.0267	0.0000	0.011
AGE	-0.0025	0.8825	-0.0002	0.0195	0.895
H_SIZE	0.0298	1.3706	0.0032	0.1003	0.773
EDU	-0.0476	0.9534	-0.0051	0.0635	0.047
GDR	0.1965	1.2127	0.0213	0.6688	0.902
NOC	0.0196	1.1805	0.0021	0.1596	0.074
C_CP	-0.4932	0.6106	-0.0535	0.3357	0.037
FD	1.2734	1.5732	0.0882	2.7176	0.094
DC	1.3578	1.8877	0.1473	3.1064	0.089
LPG	-0.9901	0.8950	-0.0021	-2.2709	0.023
Number of obs: 400		Prob. chi2 : 0.0000		Pseudo R2 : 0.41	

Source: Computed by the authors using survey data.

Household income (HHI) has a negative and statistically significant impact on asthma (coefficient: -0.0037). The odds ratio of 0.9918 indicates that as income increases, the probability of asthma decreases. The marginal effect of -0.0267 supports this, showing a reduction in the likelihood of asthma with higher income, consistent with the idea that wealthier households can afford cleaner cooking fuels, reducing exposure to pollutants. Whereas the age of the household head has a small, negative, and insignificant effect on asthma (coefficient: -0.0025), suggesting no substantial relationship between age and asthma in this sample. This contrasts with some studies that show age can be a risk factor for respiratory illnesses (Ogwumike et al., 2014).

Household Size (H_Size) has a positive but insignificant effect on asthma (coefficient: 0.0298), suggesting that larger households may slightly increase the likelihood of asthma, though the effect is not statistically significant. Larger families may rely more on traditional fuels, increasing exposure to indoor air pollution. Education (EDU) has a negative and significant impact on asthma (coefficient: -0.0476), indicating that higher education levels reduce the likelihood of asthma. The marginal effect (-0.0051) further suggests that educated households are more likely to use cleaner cooking methods, reducing respiratory issues.

Gender (GDR) has a small, positive but insignificant effect on asthma (coefficient: 0.1965), suggesting that male-headed households may have a slightly higher probability of asthma, though this effect is not

statistically significant. The number of children (NOC) has a positive but marginally significant effect on asthma (coefficient: 0.0196). Larger families might have higher exposure to indoor air pollution due to the increased use of traditional fuels, contributing to respiratory conditions like asthma.

Cooking Practices and Fuel Type

Cooking in an enclosed space (C_CP) has a significant and negative effect on asthma (coefficient: -0.4932), indicating that households cooking in enclosed spaces are less likely to experience asthma. This could suggest better ventilation practices in such households.

Fuel Type

Firewood (FD) has a strong, positive, and marginally significant effect on asthma (coefficient: 1.2734), indicating that households using firewood are more likely to suffer from asthma due to high levels of indoor air pollution. Dung Cakes (DC) also have a positive and significant effect on asthma (coefficient: 1.3578), showing an increased likelihood of asthma for households using dung cakes as fuel. LPG has a negative and significant effect on asthma (coefficient: -0.9901), suggesting that using cleaner fuels like LPG reduces the probability of developing asthma.

The results indicate that higher income, education, and the use of LPG reduce the risk of asthma, while the use of traditional fuels like firewood and dung cakes increases it. The findings align with previous studies, reinforcing the importance of transitioning to cleaner fuels to improve respiratory health outcomes.

Demand for Clean Cooking Fuel

To find out the determinants of D_FC (demand for clean fuel) or the variables that are affecting the D_FC we used the logistic regression model because our dependent variable is binary. The result of this model is presented in Table 4

Table 4

Demand for Clean Cooking Fuel Logistic Regression Results

Dependent Variable: D_CF Method: Binary Logit Variables	Coefficient	Odd Ratio	Marginal Effects	Standard Errors	P Values
Constant	0.1866	1.2052	……	1.0802	0.993
HHI	0.0318	1.0000	0.0427	0.0000	0.071
AGE	0.0135	1.0135	0.0020	0.0155	0.005
H_SIZE	0.0529	1.0484	0.0082	0.0591	0.113
EDU	0.0118	1.2182	0.0018	0.0500	0.047
GDR	-0.5226	0.6864	-0.0811	0.9567	0.021
Number of obs: 400		Prob. chi2 :	0.0077	Pseudo R2 :	0.53

Source: Computed by the authors using survey data.

The logistic regression results for the demand for clean cooking fuel (D_CF) reveal several important determinants:

The coefficient for household income (HHI) is positive (0.0318), and the odds ratio is close to 1 (1.0000), suggesting that higher household income slightly increases the likelihood of demanding clean cooking fuel. The marginal effect of 0.0427 indicates that higher-income households are more likely to demand cleaner fuels, although the result is only marginally significant (p-value: 0.071). The coefficient for age is positive (0.0135) with an odds ratio of 1.0135, indicating that as the age of the household head increases, the probability of demanding clean cooking fuel also increases. The marginal effect of 0.0020 confirms this, showing that older individuals

are more likely to opt for cleaner fuels. The result is statistically significant (p-value: 0.005).

Household size (H_Size) has a positive coefficient (0.0529) and an odds ratio of 1.0484, suggesting that larger households are more likely to demand clean cooking fuel. However, the marginal effect (0.0082) is not significant (p-value: 0.113), indicating that household size has a less consistent impact on the demand for clean cooking fuel. Education (EDU)has a positive coefficient (0.0118) and an odds ratio of 1.2182, indicating that higher education levels increase the likelihood of demanding clean cooking fuel. The marginal effect (0.0018) supports this, showing that educated households are more inclined to use cleaner fuels. This result is statistically significant (p-value: 0.047).

The coefficient for gender (GDR) (male-headed households) is negative (-0.5226) with an odds ratio of 0.6864, suggesting that male-headed households are less likely to demand clean cooking fuel compared to female-headed households. The marginal effect (-0.0811) is statistically significant (p-value: 0.021), indicating a notable gender disparity in the demand for clean cooking fuels.

Further analysis also shows that, on average, household incomes, age, and education influence the demand for clean cooking fuel positively while gender produces a negative outcome. Regarding income, education levels, and age, higher values will increase the probability of demanding clean cooking fuels while older ages show a higher likelihood of using cleaner fuels. Male-headed households have fewer chances of demanding clean cooking fuel compared to female-headed households. In general, the results suggest an overall impact on the level of adoption of clean cooking technologies and especially emphasize the necessity of income and educational improvement targets.

Results of the binary logistic regression revealed that higher incomes, ages, education, and ventilation were correlated with a lesser prevalence of respiratory diseases such as COPD, asthma, and upper respiratory tract infection. Among these factors, it was found that a higher household size, male head of household, existence of young children, and poverty were highly significant predictors of those health conditions.

The findings underscore the impact of socioeconomic factors on cooking fuel choices and their subsequent impact on health. Households with higher income and better education are likely to use clean cooking fuels, which reduces the incidence of respiratory diseases. Traditional fuels, associated with poorer health outcomes, are more commonly used by larger, poorer households.

Based on the estimation results, we conclude that the null hypotheses have been rejected. We rejected the null hypothesis that "better socio-economic conditions do not lead to improved cooking fuel choices" and accepted the alternative hypothesis that "better socio-economic conditions lead to improved cooking fuel choices". Similarly, the null hypothesis that "clean energy choices do not improve the health status of households" was rejected. Therefore, the alternative hypothesis of "clean energy choices improve the health status of households" is accepted. This therefore implies that the condition of socio-economic determines cooking fuel choice and hence that clean energy sources contribute towards the positive positioning of household health outcomes.

Recommendations

This research, therefore, suggests that governmental policies should emphasize efforts aimed at promoting increased access to clean cooking fuels. Initiatives in building the capacity of LPG connections, among other infrastructure enhancements for gas supply, can prevent health risks associated with traditional fuels and promote good health outcomes in rural areas.

Conclusion

The multinomial logistic model results establish that among the socio-economic variables, income, education, and household size are key determinants of the use of cooking

fuels in the rural Mirpur area. The elasticity findings for E55 suggest a positive relationship with respect to LPG use and a negative with firewood use, which upholds the energy ladder hypothesis. The choices for cleaner fuels among the increased incomes of the households correspond to study results by Ogwumike et al. (2014) and Karimu (2015). Age is positively related to LPG usage and negatively to firewood preference meaning older people are more health-conscious and will embrace cleaner fuels as indicated by Ogwumike et al. (2014) and Buba et al. (2017). The Household heads with larger households are likely to have a wider choice of fuels due to their greater energy needs, for studies as such Gupta and Köhlin (2005).

Analyzing the behavior of demand, one would see that higher levels of household incomes, age, and education positively affect the demand for clean cooking fuel, while gender has a negative effect. Higher incomes and education increase the likelihood of demanding clean cooking fuels, while greater age increases the chances of using cleaner fuels. Male-headed households appear to be less likely to demand clean cooking fuel compared to female-headed households. It is discovered that any improvement in income and education will pull up the adoption rates of clean cooking technologies.

Education is a strong determinant where increases in education level reduce firewood and increase LPG. This concurs with Rahut et al. (2017), as educated households have a better awareness of health risks caused by traditional fuels. According to Buba et al. (2017), male-headed households are more likely to employ firewood usage, showing the remnant of traditional roles. Moreover, poverty increases the chances of firewood use and decreases access to LPG, which indicates the existence of financial barriers to adopting cleaner fuels. Such findings go hand in hand with the general course adopted by Karimu (2015) and Ogwumike et al. (2014), centering on the new-found need for policies meant to ensure that better-income households hold access to cleaner fuels.

The study, in alignment with the broader literature on energy use in developing countries, thus supports the energy ladder hypothesis and its health implications through the traditional use of fuels. Transition to cleaner fuels is supported by increased income and education levels, whereas lower income, higher household size, and adherence to traditional roles for gender maintain the dependency on biomass fuels. The study has underlined the need for income inequality policies such as education promotion and cost-friendly access to clean cooking fuels to aid energy transition in rural areas.

The binary logistic regression results show a reduced incidence of respiratory diseases, such as COPD, asthma, and upper respiratory infections, through higher income, age, education, and better ventilation. The other predictors for these conditions are household size, gender of the head of the family, existence of young children, and poverty.

The key findings point out the influence of socioeconomic factors on cooking fuel choices and the latter's impact on health. Households having a better education and larger incomes are more likely to use clean cooking fuels that significantly lower the incidence of respiratory diseases. Larger, poorer households are significantly more likely to use traditional fuels associated with poorer health.

The estimation results have accepted a hypothesis of the form: "Households with better socio-economic conditions are likely to prefer clean cooking fuels, which leads to better health outcomes". Thus, in terms of the general outcomes, these findings indicate that socio-economic conditions constitute one of the primary determinants of the choices households make regarding their cooking fuels. Again, the adoption of clean energy has positive outcomes for household health. Policymakers could tackle public health and maintain rural development by allowing access to clean cooking fuels.

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