Understanding Household Energy Consumption Choice: Logit Model Estimates on the Role of Poverty, Health Status and Socio-economic Drivers in Turkey

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Abstract

In this article, the structure of demand for different types of energy among Turkish households is examined. This issue is of critical importance for ensuring economic stability, energy security, and sustainable development. The study is based on cross-sectional data obtained from the Household Budget Surveys published by the Turkish Statistical Institute (TURKSTAT), covering approximately 45,000 households over the period 2015–2019. Using a multidimensional household poverty index together with income-based poverty thresholds set at 50%, 60%, and 70% of median incomes, this study investigates, for the first time in the existing literature, the relationship between household poverty status, the health status of the head of the household, and energy demand in Turkey. The findings show that electricity and natural gas consumption increases as the poverty level decreases; furthermore, wealthier individuals prefer to use electricity while households in the lower 50% of median income choose to use cheaper types of fuel such as dried dung. Moreover, household characteristics, income level, and the education level of the head of the household are important factors in energy choice, but age and the marital status of the head of the household do not play a very crucial role in household energy consumption. The findings indicate that households' socio-economic characteristics, together with health status and poverty, are significant determinants of energy consumption behaviour and, consequently, environmental sustainability.

Key words

household energy demand, poverty, health, logit model, household budget survey, Turkey.

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Introduction

A better understanding of consumer behaviour, including how residential end-users make energy consumption decisions, is important not only for academics, but also for policymakers (Borozan, 2018). Although energy is vital for the modern economy, household energy usage – including cooling, heating, air conditioning and powering electrical appliances – contributes significantly to CO_2 emissions. Improving energy efficiency at the household level requires a better understanding of the link between energy consumers, energy sources, the economy, and the environment (Abubakar et al., 2024). Household energy use accounts for a significant proportion of worldwide energy consumption, responsible for 32% of total energy use and 19% of energy-related greenhouse gas emissions (GHG) (Xu et al., 2020). Furthermore, rising income levels, population growth, and urbanisation have led to an increase in energy demand, making energy a vital resource for power and economic growth. The growing world demand for energy sources is deteriorating the environment and raising the incidence and severity of energy poverty among households (Simsek et al., 2020). With the International Energy Agency (IEA) projecting a 50% increase in final energy demand by 2050, analysing energy efficiency and transitioning from traditional to modern and/or environmentally friendly energy sources is becoming increasingly important (Zhang et al., 2024).

The United Nations' Sustainable Development Goals (SDGs), specifically SDG7 and its target 7.1, highlight the importance of ensuring "universal access to affordable, reliable, and modern energy services" by 2030. Furthermore, the United Nations (UN) emphasises the importance of knowing the proportion of the population that relies primarily on clean fuels and technologies, broken down by major types of households and uses (e.g. cooling, heating and lighting) (UN, 2022). In this context, disaggregating energy usage provides decision makers with the necessary information to identify where efforts should be employed to improve overall access to clean and modern fuels. Although there are complex, multidimensional linkages between household energy consumption and several SDG targets beyond SDG7 – such as SDG1, SDG5, SDG8, SDG11, SDG13, and SDG16 – the determinants of household energy consumption have not been sufficiently examined empirically (An et al., 2025).

Moreover, the UN (2025) highlights the importance of analysing household energy consumption based on household surveys and censuses in order to evaluate progress towards the SGD targets. Despite this, little is known about the factors affecting energy consumption in the residential sector, since studies generally focus on the macroeconomic aspects of household energy consumption, such as the relationship between energy and/or electricity usage and economic growth, or the forecasting of future energy consumption in different countries using different methods such as time series analysis, bottom-up models, etc. (Hsu & Chen, 2003; Carpinteiro et al., 2007; Truong et al., 2008; Pai, 2006; Tsani, 2010; McLoughlin et al., 2013; Kim et al., 2023). Information about residential energy choices according to gender, wealth, education, whether the person lives in a rural or urban area, and the type of dwelling is essential for comparing populations and locations, and enables policymakers to monitor progress towards achieving SDG7. It also allows policymakers to intervene in marginalised regions and populations, providing more equitable access to modern energy sources for all (Abubakar et al., 2024).

The literature contains a limited number of empirical microeconomic studies on household energy consumption and the socioeconomic determinants of residential energy use. Furthermore, many of these studies test the energy ladder hypothesis (Kumar, 2024; Vo et al., 2024; Tinta, 2024), or analyse the income or price elasticities of different types of energy (Huang et al., 2024; Szép & Kashour, 2024) and investigate energy poverty issues (Liu & Hu, 2024; Masuku, 2024). Therefore, the current research will contribute to the existing body of literature examining the impact of household poverty status and the health condition of the head of the household on energy consumption, while considering several other socio-economic factors (e.g. income, gender, dwelling factors, marital status, education, age, and employment). Although research emphasises that demographic changes such as income levels, poverty, and well-being will affect the type and quantity of energy used, no study in the relevant literature has investigated the role of poverty status, as determined by different levels of median income, or the role of health status on energy use. In this context, identifying which factors influence energy consumption is critical for developing efficient energy and environmental policies.

Like many other countries, Turkey has an increasing demand for energy to power its activities. However, its reliance on imported energy sources is putting pressure on the country's balance of payments and domestic price stability. In Turkey, the share of households in final energy consumption reached 32.1% in 2023, surpassing the manufacturing industry, which had a 31.8% share (TURKSTAT, 2024). This makes the residential sector one of the country's biggest energy consumers. According to the Energy Market Regulation Authority (EPDK), the share of households in final electricity use is 22.6%, whereas the related figure for natural gas consumption is around 28% (Energy Market Regulatory Authority, 2024). The proportion of energy derived from fossil fuels remains high at 83.5%, and final electricity demand is increasing by around 9% per year (TEIAS, 2024). Furthermore, the growth rate of natural gas usage by households was approximately 4% in 2020–2023. Hence, the type and quantity of energy are putting pressure on energy demand and sustainable economic development in Turkey. Energy-related emissions accounted for the largest proportion of greenhouse gas emissions in the country (in terms of CO_2 equivalent), reaching 71.3% in 2021 (TURKSTAT, 2023). For this reason, the household sector, as the main energy consumer, is an important consideration in formulating appropriate energy policies to ensure sustainability.

Despite the dynamic nature of the energy market and the critical role of energy in areas such as planning, investment, and environmental impact, there are very few academic studies based on microdata examining the factors affecting the energy demand of households, which account for a significant share of consumption in Turkey. Using micro-economic data from household surveys like "Longitudinal Micro Data Set of Income and Living Conditions Survey" and "Household Budget Surveys" there are some empirical studies investigating the role of individual or household characteristics on energy consumption (Özcan et al., 2013; İpek & İpek, 2022; Karaaslan & Algül, 2023). These studies confirmed the significant role of socio-economic characteristics such as gender, age, marital status, employment status, dependent children (İpek & İpek, 2022), dwelling features (Özcan et al., 2013; Karaaslan et al., 2022; Kayalica et al., 2020), household size (Ari et al., 2016) on residential energy and/or electricity use.

To date, no Turkish case study has simultaneously employed two distinct measures of poverty status or incorporated the health status of the household head in the analysis of household energy demand. According to certain researches (Bingdong et al., 2018; Li et al., 2024) economic poverty and health situation are very important drivers for energy choice and transition from traditional to clean energy. In this context, affordability and availability play a significant role in energy preferences and usage. Against the backdrop, using the microdata set from the TURKSTAT 2015-2019 Household Budget Survey, this study analyze the socio-economic factors determining household energy demand, as well as the impact of household poverty and the head of household's health status on household energy demand for heating purposes.

The current study makes several contributions to existing literature. Firstly, while most studies on residential energy in Turkey generally focus on the macroeconomic dimension and energy demand forecasting, the current research provides a micro-econometric analysis of the residential energy sector. Secondly, while some studies have empirically analyzed household energy demand, they have ignored the effects of poverty and the health status of residents on energy usage. However, it has been argued that poverty and the personal health status of individuals have a significant influence on energy consumption patterns and the choice of energy sources, thereby contributing to environmental degradation (Bingdong et al., 2018; Li et al., 2024). Therefore, by constructing the relevant poverty index and using binary variables related to health status and poverty status, respectively, the current study examines the impact of household poverty and the health status of the household head on residential energy demand levels and energy type preferences for the first time in Turkey. Thirdly, it has been evaluated the impact of poverty on residential energy demand using two variables: 1-the poverty index and 2- binary variables that represent being below three different poverty lines (estimated based on 50%, 60% and 70% of the median income, respectively). Fourthly, whereas previous empirical studies have investigated the effects of energy consumption and its environmental consequences on individual health, this study instead examines the effect of health status on energy consumption. Distinct from most prior research emphasizing cooking fuel choices in Asian and African households (Karaaslan & Algül, 2023), the current study contributes by analyzing heating fuel selection, which exerts a greater influence on overall energy demand and environment impact.

The rest of the paper is structured as follows: Section 2 provides a review of the literature on residential energy demand. Section 3 presents the data and econometric procedure. Section 4 summarizes the results and discussions. Section 5 concludes with some policy recommendations and Section 6 presents the limitations of the study and directions of future research.

1. Literature review

Analysing and managing energy demand is becoming imperative as it contributes to planning for future demand, energy security and supply, identifying conservation measures and designing strategies for a low-carbon economy (Suganthi & Samuel, 2012). A large body of literature has analysed household energy demand in both developed and developing countries, using different methodologies. These studies are commonly classified into four categories. The first branch basically forecasts the future demand for energy sources, including the residential sector, using models such as Autoreggressive Integrated Moving Average (ARIMA), Seasonal Autoreggressive Integrated Moving Average (SARIMA), Artificial Neural Network (ANN), Neural Network (NN), Wavelet non-linear multiscale decomposition, Fuzzy Logic etc. (Cao et al., 2024; Ediger et al., 2006; Aydinalp et al., 2002; Hsu & Chen, 2003; Carpinteiro et al., 2007; Truong et al., 2008; Pai, 2006). The second branch discusses the symmetric or asymmetric causalities between energy consumption (fossil energy, renewable energy or aggregate energy use) and economic growth and/or income levels using macro level data (Odhiambo, 2009; Tsani, 2010; Tuna & Tuna, 2019). The third branch evaluates the preferences of households from traditional energy types to modern energy sources (Energy ladder hypothesis) (Hosier & Dowd, 1987; Farsi et al., 2007; Mensah & Adu, 2015; Acharya & Marhold, 2019). Finally, the fourth branch investigates the determining factors of household energy and/or electricity consumption and highlights the important role of socio-economic characteristics such as income, education, dwelling size, behavioural efficiency, etc. on energy use in residential sector (Özcan et al., 2013; Karatasou & Santamouris, 2019; Ekholm et al., 2010; Wang et al., 2020; İpek & İpek, 2022; Yarbaşı & Çelik, 2023; Rao & Reddy, 2007; Weyman-Jones & Boucinha, 2024). Studies in this strand have revealed that household demand for energy and/or electricity is influenced by weather conditions (Chan, 2011), specific building characteristics such as floor area, age, building type etc. (Yohanis et al., 2008; Bartusch et al., 2012), stock of electrical appliances (Koç et al., 2015; Bedir et al., 2013), income level of the end user (Özcan et al., 2013; Yarbaşı & Çelik, 2023) and characteristics of household head such as age, education, marital status etc. (İpek & İpek, 2022; Karaaslan & Algül 2023). In this context, Suganthi & Samuel (2012) and Ferrari et al. (2019) have provided detailed reviews on empirical studies on energy demand. These empirical studies show that energy, economy, and environment are highly interrelated and energy management and/or modelling is essential for the economic prosperity and sustainability of the nations in the world.

Although analyzing and forecasting the energy consumption is vital for Turkey as the country is highly dependent on imported energy sources and faces increasing need for energy demand for sustainable economic growth, the academic studies on energy demand gained momentum in Turkey after the 2000s when energy market reforms were initiated. For example, using Household Budget Surveys (2002-2006) Özcan et al. (2013) have investigated how underlying socio-economic and dwelling factors change household energy consumption. The authors have found that factors such as monthly income, age, health concerns and type of dwelling are found to be important factors explaining the energy choices in Turkey. Similarly, Koç et al. (2015) have estimated the income elasticity of residential electricity and some demographic variables such as gender, education and income using the 2007-2009 Household Budget Survey and assessed the welfare impact of the electricity tariff adjustment resulting from the electricity market reform.

Using Household Budget Survey (TURKSTAT, n.d.), Ari et al. (2016) have examined the link between household electricity consumption and 22 socio-economic variables in the residential sector, and they have demonstrated that the type and quantity of the electrical appliances, household size, household income, and dwelling type are important drivers of the household electricity consumption. Similarly, Kayalica et al. (2020) have compared the impact of household socio-economic status and expenditure characteristics on energy use using statistical optimization methods such as principal component analysis (PCA) and ANN. The authors have found that dwelling factors have a stronger impact on household energy use than other socio-economic and expenditure factors. Using the Income and Living Conditions Survey, İpek & İpek (2022) examined the role of socio-economic and dwelling factors on residential energy choice in the period of 2016-2019. The authors have found that residential space heating type preferences are influenced by socio-economic factors like education and dwelling factors such as dwelling age, and the energy ladder hypothesis is valid for Turkey. Again, İpek & İpek (2024) analyzed the energy poverty on health situation of Turkish residentials.

Table 1. Empirical results of residential energy and electricity demand studies in Turkey.

Source	Period	Method	Variables	Results
Hamzaçebi (2007)	1970-2004	Artificial Neural Network (ANN)	Residential Electricity consumption	Residential electricity use will reach around 257 Twh in 2020.
Özcan et al. (2013)	2002-2006	Multinominal Logit Model	Household energy consumption (all kinds) and 9 socio-economic variables	Monthly income, health, age and type of dwelling are determining factors of energy use
Koç et al. (2015)	Household Budget Survey (2007-2009)	Working Leser	Household electricity use, household income, household size and electrical appliances ownership	The income elasticity ranges from 0.74 to 0.91 based on the income strata.
Ari et al. (2016)	Houshold Budget Survey (2012)	Ordered Logit Model	Residential Electricity consumption, 22 socio-economic variables	The type and number of electrical appliances, household size, household income, housing type positively affects residential electricity consumption.
Kayalica et al. (2020)	Houshold Budget Survey (2002-2017)	Principal Component Analysis (PCA), Artificial Neural Network (ANN)	Household energy use, 9 socio-economic variables and 10 expenditure groups.	Among the others dwelling characteristics have a strong effect. The effect of household expenditure on energy use is limited.
İpek & İpek (2022)	Income and Living Conditions Survey (2016-2019)	Random Effect Ordered Logit	Energy consumption of households for space heating, 19 socio-economic variables and dwelling variables	Energy type choice of household is affected by socio-economic and dwelling factors. Energy Ladder Hypothesis is valid for Turkey.
Yarbaşı & Çelik (2023)	Household Budget Survey (2019)	Heckman Sample Election Model	Electricity expenditures of households and 22 socio-economic factors and dwelling variables	The income level, demographic variables (like age, education level, marital status), characteristics of the dwelling (area) and stock of electrical devices (like air conditioner, tumble dryer, deep freezers) are important determinants of residential electricity use.
Karaaslan et al. (2022)	Household Budget Survey (2015-2018)	Multinominal Probit and Nested Logit	Household energy choice for heating and different socio-economic factors and dwelling variables	The socio-economic variables such as income, household size and education level of household, having a job, marital status, credit card ownership are key factors for energy choice.
Karaaslan & Algül (2023)	Household Budget Survey (2015-2018)	Quantile regression	Entire energy expenditure of household and different socio-economic factors and dwelling variables	The income level, demographic characteristics of household such as age, education level, marital status and properties of dwelling are important for energy expenditure of residential sector.

İpek & İpek (2024)	Income and Living Conditions Survey (2018-2021)	Ordered Model	Logit	Energy poverty, health status	Support policies considering the income status of residentials will not be sufficient.

Source: Developed by authors.

As shown in Table 1, there are limited studies on residential energy demand and determinants of energy consumption in the household sector based on micro-data sets in Turkey. Furthermore, among these studies, no academic energy demand study has evaluated the role of poverty and health status on household energy type choice. On the contrary, only İpek & İpek (2024) analyzed the energy poverty on health situation of Turkish residentials. In this context, the present study fills a research gap in the energy economics literature.

2. Methodology

2.1. Data

In this study, it has been used micro-level data from the Turkish Household Budget Survey (TURKSTAT, n.d.) available from the TURKSTAT for the period of 2015-2019. Data from the period during and after the Covid-19 pandemic are excluded. The COVID-19 pandemic led to significant disruptions in daily life, including prolonged lockdowns, increased work-from-home practices, and changes in mobility patterns. These factors resulted in an unusual spike in residential energy consumption that does not reflect the normal trends observed in prior years. Including this data skews the results and leads to biased conclusions. The survey includes rich and detailed information for three main groups of variables: variables related to household assets (type of dwelling owned, ownership of durable goods and transport vehicles), consumption expenditures (food and health expenditures), and variables related to individuals (age, marital status, employment status, and education, among others). The dependent variables are defined as binary variables of the consumption of specific type of energy, namely electricity, natural gas, coal, wood and dung. The main independent variables are the poverty index, a binary variable for households being below the poverty line, and the health status of the household head. The regression models also include a set of additional control variables capturing characteristics of the household and the household head. Table 2 presents summary statistics, including the mean, standard deviation, minimum, and maximum values, for the continuous covariates and main independent variables used in the analysis.

Table 2. Summary statistics for continuous variables.

	Mean	Std. Dev.	Min.	Max.
Household Income	23942.17	23613.83	3.214286	1017949
Household head age	50.55703	14.68839	16	99
Dwelling size	107.7617	35.27619	10	870
Poverty Index	0.0278376	0 .9567713	-3.171375	4.247945

Source: Authors estimations from TURKSTAT Household Budget Survey (TURKSTAT, n.d.).

Table 3 presents the descriptive statistics for the categorical variables included in the analysis, based on data from the Turkish Household Budget Survey for the period 2015–2019. The variables capture household energy characteristics, dwelling features, household composition, and key socio-demographic attributes of the household head, including gender, marital status, education level, employment status, and health status. In addition, the table reports indicators of poverty status, defined using alternative thresholds of 50%, 60%, and 70% of median income.

Table 3. Summary statistics for categorical variables.

	Categorical Variables				
Energy Type	Electric 5.58	Dung 1.67	Wood 31.82	Coal 21.15	Natural Gas 38.78

Residential heating system	Radiator	Stove	Air conditioner					
	44.83	51.9	3.27					
Age of Dwelling	Pre-1945	1946-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2005	post-2005
	1.89	4.13	6.62	13.93	19.63	22.53	10.71	20.56
Household Type	Couple without resident children	Couple with at least one resident children	Lone parents with at least one resident child	At Least One Nuclear Family and Other Persons	Multiple Persons without a Nuclear Family			
	19.22	51.4	13.59	14.72	1.07			
Ownership	Homeowner	Tenant	Lodging	Not owner but also not paying rent				
	62.44	22.02	1.72	13.82				
Gender	Male	Female						
	85.7	14.3						
Marital Status	Single	Married	Divorced	Widowed				
	3.68	82.59	3.98	9.75				
Education Level	Not completed any school	Primary School	Secondary School	High School	Vocational School	Bachelor	Master's Degree	PhD
	11.91	42.93	13.2	16.86	4.5	8.83	1.38	0.39
Employment Status	Employed	Not Working (But Still Connected to Work)	Unemployed					
	66.67	0.47	32.86					
Probability of being under poverty lines constructed based on 50%, 60% and 70% of median income	d50	d60	d70					
	10.7	15.94	22.03					
Health Status	Poor	Good						
	5.53	94.47						

Source: Authors estimations from TURKSTAT Household Budget Survey (TURKSTAT, n.d.).

Considering socio-economic status of the household heads, the gender distribution is notably skewed, with males comprising 85.7% and females only 14.3%. Marital status data shows that a vast majority (82.59%) of the population is married. Singles account for 3.68%, divorced individuals represent 3.98%, and widowed persons make up 9.75%.

Educational levels vary widely among the population. Primary school education is the most common, with 42.93% having completed this level. Secondary school graduates account for 13.2%, high school graduates 16.86%, and 2-year university graduates 4.5%. Higher education degrees are less common, with 8.83% holding 4-year university degrees, 1.38% with master's degrees, and a mere 0.39% possessing doctorates. Additionally, 11.91% have not completed school. Employment data indicates that 66.67% of the population is employed. A small fraction (0.47%) is not working but still connected to work, while 32.86% are not working. The probability of being below the poverty line varies based on the certain percentage of median income used to measure the poverty line. 10.7% of the households are under poverty line based on the 50% of the median income, while 15.94% and 22.03% of the households are under the poverty line measured using 60% and 70% of the median income respectively. Household heads who report a bad health status are 5.53% of the entire sample while the others report good health status.

2.2. Econometric Model

Households in Turkey do not make mutually exclusive choices among energy sources. Instead, they often use more than one type of energy simultaneously (electricity and wood, electricity and LPG, natural gas and electricity). Consequently, the multinomial logit model, which assumes mutually exclusive alternatives, is not suitable for the data structure and is therefore not employed.

In contrast, estimating separate binary logit models for each energy source allows us to capture households' simultaneous use of multiple energy types and avoids imposing the Independence of

Irrelevant Alternatives (IIA) restriction required by the multinomial logit model. Therefore, separate logit models were the more appropriate methodological approach for this analysis.

Using the variables described in Section 3.1, the role of poverty and health status in the use of different energy types is examined. To investigate this, it has been employed binary logistic regression models. These models are particularly appropriate for the analysis because the dependent variables in the current study are binary, indicating whether a household consumes a specific type of energy (electricity, natural gas, coal, wood, or dried dung). The use of separate logistic regression models for each dependent variable reflects the assumption that decision regarding the use of each energy type are made independently. Households either use or do not use a given type of energy independently of others' energy choices, making the logit model suitable for modeling the binary outcome of energy usage while accounting for the influence of various explanatory variables on each energy type individually.

The general form of the logistic regression model is expressed as follows:

$$log\left(\frac{P(Y_i = 1)}{P(Y_i = 0)}\right) = \beta_0 + \beta_1 PovertyIndex_i + \beta_2 UnderPovertyLine_i + \beta_3 HealthStatus_i + \sum(\beta_k ControlVariables_{ik}) + \varepsilon_i \quad (1)$$

where $P(Y_i = 1)$ – the probability that household i uses the given type of energy; $P(Y_i = 0)$ – the probability that household i does not use the given type of energy; $log\left(\frac{P(Y_i = 1)}{P(Y_i = 0)}\right)$ – the log-odds (logit) of energy use for household i; β_0 – the intercept term, representing the baseline level of the log-odds when all explanatory variables take a value of zero; β_1 – the coefficient associated with the Poverty Index variable; $PovertyIndex_i$ – a variable measuring the level of poverty for household i; β_2 – the coefficient associated with the Under Poverty Line indicator; $UnderPovertyLine_i$ – a binary variable indicating whether household i lives below the poverty line; β_3 – the coefficient associated with the Health Status variable; $HealthStatus_i$ – a variable capturing the health status of household i; β_k – the coefficients associated with the control variables, accounting for additional factors influencing energy use; $ControlVariables_{ik}$ – a summation term representing the combined effect of additional control variables; ε_i – the error term, capturing unobserved factors affecting energy use for household i.

For each energy type (electricity, natural gas, coal, wood and dung), the following logit models are specified:

$$log\left(\frac{P(Electricity_i = 1)}{P(Electricity_i = 0)}\right) = \beta_0 + \beta_1 PovertyIndex_i + \beta_2 UnderPovertyLine_i + \beta_3 HealthStatus_i + \sum(\beta_k ControlVariables_{ik}) + \varepsilon_i \quad (2)$$

$$log\left(\frac{P(Wood_i = 1)}{P(Wood_i = 0)}\right) = \beta_0 + \beta_1 PovertyIndex_i + \beta_2 UnderPovertyLine_i + \beta_3 HealthStatus_i + \sum(\beta_k ControlVariables_{ik}) + \varepsilon_i \quad (3)$$

$$log\left(\frac{P(Dung_i = 1)}{P(Dung = 0)}\right) = \beta_0 + \beta_1 PovertyIndex_i + \beta_2 UnderPovertyLine_i + \beta_3 HealthStatus_i + \sum(\beta_k ControlVariables_{ik}) + \varepsilon_i \quad (4)$$

$$log\left(\frac{P(NaturalGas_i = 1)}{P(Natural\ Gas_i = 0)}\right) = \beta_0 + \beta_1 PovertyIndex_i + \beta_2 UnderPovertyLine_i + \beta_3 HealthStatus_i + \sum(\beta_k ControlVariables_{ik}) + \varepsilon_i \quad (5)$$

$$log\left(\frac{P(Coal_i = 1)}{P(Coal_i = 0)}\right) = \beta_0 + \beta_1 PovertyIndex_i + \beta_2 UnderPovertyLine_i + \beta_3 HealthStatus_i + \sum(\beta_k ControlVariables_{ik}) + \varepsilon_i \quad (6)$$

where $log\left(\frac{P(Electricity_i = 1)}{P(Electricity_i = 0)}\right)$ – logarithm of the odds (log-odds) of electricity use by a household; $log\left(\frac{P(Wood_i = 1)}{P(Wood_i = 0)}\right)$ – logarithm of the odds (log-odds) of wood use by a household; $log\left(\frac{P(Dung_i = 1)}{P(Dung = 0)}\right)$ – logarithm of the odds (log-odds) of dung use by a household; $log\left(\frac{P(NaturalGas_i = 1)}{P(Natural\ Gas_i = 0)}\right)$ – logarithm of the odds (log-odds) of natural gas use by a household; $log\left(\frac{P(Coal_i = 1)}{P(Coal_i = 0)}\right)$ – logarithm of the odds (log-odds) of coal use by a household.

In equations, the first independent variable of interest is the povertyindex. The poverty index was constructed using multidimensional indicators reflecting household living standards. The variables included in the index were selected from the Household Budget Survey to represent different aspects of poverty. These indicators cover housing quality—such as the presence of a bathroom, toilet, kitchen, balcony, garden, children's play area, sauna, jacuzzi, security system, elevator, garage, swimming pool, generator, underfloor heating, central heating, natural gas, piped water systems and hot water availability. They also include ownership of durable goods and technological equipment, such as waste grinders, refrigerators, deep freezers, washing machines, tumble dryers, microwave ovens, air conditioners, carpet cleaners, game consoles, panel televisions, video cameras, satellite dishes, telephones, mobile phones, computers and internet connections. In addition, indicators of property ownership (including residences, apartments, summer houses, land, fields, greenhouses, vineyards, shops and hotels) and vehicle ownership (cars, motorcycles and watercraft) were incorporated. Finally, the index reflects broader aspects of living standards, including household expenditure capacity, savings behaviour, and the ability to take holidays. These indicators were coded as 0 = owned, 1 = not owned. Factor analysis was then applied to summarize this large number of variables into a single latent poverty dimension, and a poverty score was predicted for each household. The resulting score indicates that higher values correspond to higher levels of poverty. This method is widely used in the literature for multidimensional poverty measurement and provides a more comprehensive reflection of household living standards compared to income- or consumption-based measures alone. It is expected that households with a higher poverty index (indicating better economic status) are less likely to use traditional energy sources such as wood or dung, and more likely to use modern energy sources such as electricity and natural gas. Underpovertyline is the second independent variable of interest which also represents the poverty status of the household. It is a binary variable indicating whether a household is below a poverty line. It is hypothesised that being below the poverty line increases the likelihood of using cheaper and more traditional energy sources, such as wood and dung, while decreasing the likelihood of using more expensive energy sources like electricity and natural gas. The third main independent variable of interest is the healthstatus of the household head, whose influence on energy consumption types is examined. For instance, households with poor health status often show a preference for cleaner energy sources such as electricity and natural gas, as these reduce exposure to health risks associated with traditional fuels like coal and dung. The health status variable is self-reported, based on the household head's own assessment of their overall health. Although self-reported measures are subject to perceptual bias, they still offer valuable insight into the relationship between health conditions and household energy choices.

In modelling household energy choices, it has been controlled socio-economic, demographic and dwelling characteristics that the literature identifies as key determinants of residential energy demand. Household income is incorporated to reflect affordability constraints central to the energy ladder hypothesis, where higher-income households transition toward modern fuels (Hosier & Dowd, 1987). Dwelling-related variables—heating system type, dwelling size and building age—capture technological constraints and structural features shaping feasible fuel use, as older or poorly insulated homes typically rely more on solid fuels, while newer buildings are linked to modern systems and natural gas infrastructure (Yohanis et al., 2008; Ari et al., 2016). Household composition and housing tenure are included to reflect differences in energy needs and investment incentives, as families with children, extended households and tenants demonstrate systematically different heating practices (Koç et al., 2015; İpek & İpek, 2022). Likewise, the gender, age, marital status, education and employment status of the household head account for behavioural and socio-economic factors influencing technology adoption, awareness of health risks and heating routines (Suganthi & Samuel, 2012; Karaaslan & Algül, 2023).

3. Research results

In this study, it has been aimed to investigate the role of poverty status and health status on household energy consumption in Turkey using equations (2)-(6). The results of this analysis provide a basis for the development of policy measures, such as energy subsidies or incentives for clean fuel, targeted at households according to their poverty and health conditions. In regressions, poverty situation is represented by two different variables. The first is the povertyindex that is a continuous variable and the second is a binary variable (underpovertyline), indicating whether the household is below a poverty line or not. It has been measured three different poverty lines based on 50%, 60% and 70% of the median income respectively. Therefore, each equation (2)-(6) is estimated using three different binary variables so that a total of 15 models are analyzed to examine the role of poverty in the consumption of five different types of energy, which are electricity, dried dung, wood, coal and natural gas. Moreover, the health-status of the household head is also included in the models as an additional covariate of interest. In addition to poverty status, the relationship between health status and fuel type preferences is analysed. When energy and health policies are considered jointly, the separate inclusion of health status in the model supports the development of more effective policy strategies. All logit models are estimated using heteroskedasticity-robust standard errors. Since the Household Budget Survey is a cross-sectional dataset in which each observation represents an independent household unit, there are no repeated household observations or a panel structure that would require the use of clustered standard errors. Therefore, robust standard errors are methodologically more appropriate for this analysis.

To account for macro-level shocks arising across years, year fixed effects are included in all models. This approach strengthens the explanatory power of the models and isolates the influence of time-specific factors.

The entire set of estimation results has been presented in six different tables. Tables 4 and 5 present the estimation results for the models in which the binary poverty indicator is defined using a poverty line set at 50% of the median income. Table 4 reports the marginal effects derived from logit models (2)–(4), where the dependent variables correspond to electricity, dung and wood consumption. These results provide insights into how poverty status and other socio-economic characteristics influence the use of energy sources.

Table 4. Marginal effects from logit models for electricity, dried dung and wood using poverty variable defined by 50% of median income.

Independent Variables	(1) Electricity	(2) Electricity	(3) Dung	(4) Dung	(5) Wood	(6) Wood
Household Income	0.469***	0.464***	-0.136	-0.135	0.022	0.021
	(0.09)	(0.09)	(0.12)	(0.12)	(0.04)	(0.04)
Base Category: Heating system (radiator)						
Heating system (Stove)	0.166***	0.166***	0.017***	0.017***	0.467***	0.467***
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Heating system (Air conditioner)	0.963***	0.962***	0.000	0.000	-0.014***	-0.014***
	(0.01)	(0.01)	(.)	(.)	(0.00)	(0.00)
Dwelling size -m2	-0.000***	-0.000***	0.000***	0.000***	0.000***	0.000***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Age of Dwelling - (Pre-1945)						
Age of Dwelling -(1946-1960)	-0.000	-0.000	-0.012**	-0.012**	0.009	0.008
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of Dwelling – (1961-1970)	-0.000	-0.000	-0.012**	-0.012**	0.007	0.007
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)

Age of Dwelling – (1971-1980)	0.000	0.000	-0.012**	-0.012**	-0.003	-0.003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of Dwelling – (1981-1990)	0.004	0.004	-0.012**	-0.012**	-0.002	-0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of Dwelling – (1991-2000)	0.009	0.008	-0.006	-0.006	-0.002	-0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of Dwelling –(2001-2005)	0.009	0.009	-0.009*	-0.009	-0.003	-0.003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of Dwelling –(Post 2005)	0.015**	0.015**	-0.003	-0.003	-0.025*	-0.025*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Base Category: Couple without resident children						
Couple with at least one resident child	-0.004	-0.004	0.010***	0.010***	-0.007	-0.006
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lone parents with at least one resident child	0.019***	0.019***	-0.001	-0.001	-0.022**	-0.022**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
At Least One Nuclear Family and Other Persons	-0.008***	-0.008***	0.014***	0.014***	-0.016**	-0.016**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Multiple Persons without a Nuclear Family	0.027**	0.026**	-0.003	-0.003	-0.056*	-0.056*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Base Category: Homeowner						
Tenant	0.029***	0.029***	-0.017***	-0.017***	-0.045***	-0.044***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lodging	0.006	0.006	0.000	0.000	0.023	0.024
	(0.01)	(0.01)	(.)	(.)	(0.02)	(0.02)
Not owner but also not paying rent	0.002	0.002	-0.002	-0.002	0.010*	0.010*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Gender-Male						
Female	-0.004	-0.004	-0.006	-0.006	0.004	0.003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Base Category: Single						
Married	-0.015**	-0.015**	0.003	0.003	0.016	0.016
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Divorced	0.006	0.005	-0.008	-0.007	-0.019	-0.019
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Widowed	-0.014**	-0.014**	0.001	0.001	0.015	0.015
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age	0.000	0.000	-0.001***	-0.001***	0.001***	0.001***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Not completed any school						
Primary School	-0.004	-0.004	-0.014***	-0.013***	0.036***	0.035***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Secondary School	0.007*	0.007*	-0.018***	-0.017***	0.024***	0.024***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
High School	0.010**	0.010**	-0.021***	-0.021***	0.016*	0.015*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Vocational School	0.012*	0.012*	-0.028***	-0.028***	0.005	0.005
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Bachelor	0.019**	0.018**	-0.027***	-0.027***	-0.029*	-0.030*
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Masters Degree	0.041**	0.040**	0.000	0.000	-0.066	-0.066
	(0.01)	(0.01)	(.)	(.)	(0.04)	(0.04)
Ph.D	-0.022***	-0.022***	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(.)	(.)	(.)	(.)
Base Category: Employment Status (Employed)						
Not Working (But Still Connected to Work)	0.001	0.001	0.007	0.007	-0.014	-0.014
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Unemployed	0.011***	0.011***	-0.003*	-0.004*	-0.026***	-0.025***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Poverty Index	0.025***	0.025***	-0.026***	-0.026***	-0.067***	-0.067***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Being above 50% of the median income						
d_50 (Being below 50% of the median income)	-0.001	-0.001	0.007**	0.006**	-0.013*	-0.013*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Base Category: Health Status (Poor)						
Health Status (good)		0.007*		-0.004		0.009
		(0.00)		(0.00)		(0.01)

N	45704	45704	42707	42707	45523	45523
Log-likelihood	-3782.83	-3780.40	-2667.14	-2665.83	-15098.64	-15097.61
Pseudo R^2	0.615	0.616	0.302	0.303	0.471	0.471
AIC	7639.67	7636.81	5400.29	5399.65	30269.29	30269.23
BIC	7962.68	7968.54	5686.14	5694.16	30583.42	30592.09
Mean VIF	3.27	3.21	3.27	3.21	3.27	3.21

Notes: *, **, *** symbols indicate the significance of the coefficients at the 10%, 5% and 1% levels of significance, respectively. (1)–(6) refer to different model specifications. Each model uses the same set of independent variables, presented in the first columns of the tables. Each column display both the model number and its corresponding dependent variable (wood, dung etc). Model (2), model (4), and model (6) aim at estimating additionally the role of health status (good health) of household head on the consumption of electricity, dung and wood. Year fixed effects are controlled.
Source: Own calculations.

Table 5 presents the marginal effects from logit models (5)–(6), focusing on coal and natural gas consumption as dependent variables. The estimates reported in this table highlight the role of poverty and household characteristics in shaping the choice between relatively cleaner fuels, such as natural gas, and more polluting alternatives, such as coal.

Table 5. Marginal effects from logit models for coal and natural gas using the poverty variable defined by 50% of median income.

Independent Variables	(1)	(2)	(3)	(4)
	Coal	**Coal**	**Natural Gas**	**Natural Gas**
Household Income	-0.013**	-0.013**	-0.016***	-0.016***
	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Heating system (radiator)				
Heating system (Stove)	0.036***	0.036***	-0.166***	-0.166***
	(0.01)	(0.01)	(0.00)	(0.00)
Heating system (Air conditioner)	-0.777***	-0.777***	-0.493***	-0.493***
	(0.10)	(0.10)	(0.06)	(0.06)
Dwelling size -m2	0.001***	0.001***	-0.001***	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Age of Dwelling - (Pre-1945)				
Age of Dwelling -(1946-1960)	0.015	0.015	0.011	0.011
	(0.01)	(0.01)	(0.02)	(0.02)
Age of Dwelling – (1961-1970)	0.031*	0.031*	0.021	0.022
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling – (1971-1980)	0.039**	0.039**	0.026	0.026
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling – (1981-1990)	0.037**	0.037**	0.021	0.022
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling – (1991-2000)	0.039**	0.039**	0.014	0.014
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling –(2001-2005)	0.065***	0.065***	-0.012	-0.012
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling –(Post 2005)	0.080***	0.080***	-0.030*	-0.030*
	(0.01)	(0.01)	(0.01)	(0.01)
Base Category: Couple without resident children				
Couple with at least one resident child	0.016**	0.016**	-0.017***	-0.017***
	(0.01)	(0.01)	(0.00)	(0.00)
Lone parents with at least one resident child	0.001	0.001	-0.011	-0.011
	(0.01)	(0.01)	(0.01)	(0.01)
At Least One Nuclear Family and Other Persons	0.026***	0.026***	-0.024***	-0.024***
	(0.01)	(0.01)	(0.00)	(0.00)
Multiple Persons without a Nuclear Family	0.016	0.016	-0.012	-0.012
	(0.02)	(0.02)	(0.01)	(0.01)
Base Category: Homeowner				
Tenant	0.024***	0.024***	0.038***	0.038***
	(0.01)	(0.01)	(0.00)	(0.00)
Lodging	0.097***	0.097***	-0.088***	-0.088***
	(0.01)	(0.01)	(0.01)	(0.01)
Not owner but also not paying rent	0.006	0.006	0.023***	0.023***
	(0.01)	(0.01)	(0.00)	(0.00)
Base Category: Gender-Male				

Female	0.015 (0.01)	0.015 (0.01)	-0.010 (0.01)	-0.010 (0.01)
Base Category: Single				
Married	0.032* (0.01)	0.032* (0.01)	-0.011 (0.01)	-0.011 (0.01)
Divorced	-0.003 (0.01)	-0.003 (0.01)	0.012 (0.01)	0.012 (0.01)
Widowed	0.029* (0.01)	0.029* (0.01)	0.011 (0.01)	0.011 (0.01)
Age	-0.000* (0.00)	-0.000* (0.00)	-0.001*** (0.00)	-0.001*** (0.00)
Base Category: Not completed any school				
Primary School	0.004 (0.01)	0.005 (0.01)	-0.013** (0.00)	-0.013* (0.01)
Secondary School	0.017* (0.01)	0.017* (0.01)	-0.019** (0.01)	-0.018** (0.01)
High School	0.048*** (0.01)	0.048*** (0.01)	-0.050*** (0.01)	-0.050*** (0.01)
Vocational School	0.079*** (0.01)	0.079*** (0.01)	-0.078*** (0.01)	-0.077*** (0.01)
Bachelor	0.075*** (0.01)	0.075*** (0.01)	-0.088*** (0.01)	-0.087*** (0.01)
Masters Degree	0.064** (0.02)	0.064** (0.02)	-0.091*** (0.01)	-0.091*** (0.01)
Ph.D	0.012 (0.04)	0.012 (0.04)	-0.065*** (0.02)	-0.064*** (0.02)
Base Category: Employment Status (Employed)				
Not Working (But Still Connected to Work)	0.034 (0.02)	0.034 (0.02)	-0.011 (0.02)	-0.012 (0.02)
Unemployed	0.008 (0.00)	0.008 (0.00)	0.022*** (0.00)	0.022*** (0.00)
Poverty Index	-0.109*** (0.00)	-0.109*** (0.00)	0.188*** (0.00)	0.188*** (0.00)
Base Category: Being above 50% of the median income				
d_50 (Being below 50% of the median income)	-0.050*** (0.01)	-0.050*** (0.01)	-0.046*** (0.01)	-0.046*** (0.01)
Base Category: Health Status (Poor)				
Health Status (good)		-0.001 (0.01)		-0.012* (0.01)
N	45704	45704	45704	45704
Log-likelihood	-20976.59	-20976.59	-9316.58	-9314.55
Pseudo R^2	0.111	0.111	0.695	0.695
AIC	42027.19	42029.17	18707.15	18705.10
BIC	42350.19	42360.91	19030.16	19036.83
Mean VIF	3.27	3.21	3.27	3.21

Notes: *, **, *** symbols indicate the significance of the coefficients at the 10%, 5% and 1% levels of significance, respectively. (1)–(4) refer to different model specifications. Each model uses the same set of independent variables, presented in the first columns of the tables. Each column display both the model number and its corresponding dependent variable (coal, natural gas etc). Model (2) and model (4) aim at estimating additionally the role of health status (good health) of household head on the consumption of coal and natural gas. Year fixed effects are controlled.
Source: Own calculations.

As explained in the previous section, there are two indicators of poverty in the models. The first one is the binary variable (underpovertyline), constructed using three different poverty lines and the second one is the poverty index. Tables 4 and 5 show that an increase in wealth (positive coefficient estimate of poverty index means increase in wealth or reduction in poverty) is associated with higher consumption of electricity and natural gas, while demand for dung, coal and wood declines as wealth rises or poverty decreases.

Considering the binary variable for being below the poverty line (based on 50% of the median income) also reduces the consumption of coal and wood, indicating that people who are below the poverty line calculated based on the 50% median income choose to use the cheapest energy types such as dried dung.

Tables 6 and 7 present the marginal effects where the binary poverty variable is created using the poverty line established based on 60% of the median income.

Table 6. Marginal effects from logit models for electricity, dried dung and wood using poverty variable defined by 60% of median income.

Independent Variables	(1) Electricity	(2) Electricity	(3) Dung	(4) Dung	(5) Wood	(6) Wood
Household Income	0.009***	0.009***	-0.002	-0.002	0.002	0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Heating system (radiator)						
Heating system (Stove)	0.166***	0.166***	0.017***	0.017***	0.467***	0.467***
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Heating system (Air conditioner)	0.962***	0.962***	0.000	0.000	-0.014***	-0.014***
	(0.01)	(0.01)	(.)	(.)	(0.00)	(0.00)
Dwelling size -m2	-0.000***	-0.000***	0.000***	0.000***	0.000***	0.000***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Age of Dwelling - (Pre-1945)						
Age of Dwelling -(1946-1960)	-0.000	-0.000	-0.012**	-0.012**	0.009	0.008
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of Dwelling – (1961-1970)	-0.000	-0.000	-0.012**	-0.012**	0.008	0.008
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of Dwelling – (1971-1980)	0.000	-0.000	-0.012**	-0.012**	-0.003	-0.003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of Dwelling – (1981-1990)	0.004	0.004	-0.012**	-0.012**	-0.002	-0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of Dwelling – (1991-2000)	0.008	0.008	-0.007	-0.007	-0.002	-0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of Dwelling –(2001-2005)	0.009	0.009	-0.009*	-0.009*	-0.002	-0.003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Age of Dwelling –(Post 2005)	0.015**	0.015**	-0.003	-0.003	-0.025*	-0.025*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Base Category: Couple without resident children						
Couple with at least one resident child	-0.004	-0.004	0.010***	0.010***	-0.006	-0.006
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lone parents with at least one resident child	0.019***	0.020***	-0.001	-0.001	-0.022**	-0.022**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
At Least One Nuclear Family and Other Persons	-0.008***	-0.008***	0.014***	0.014***	-0.016**	-0.016**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Multiple Persons without a Nuclear Family	0.027**	0.027**	-0.003	-0.003	-0.056*	-0.056*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Base Category: Homeowner						
Tenant	0.029***	0.029***	-0.017***	-0.017***	-0.044***	-0.044***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lodging	0.006	0.006	0.000	0.000	0.023	0.023
	(0.01)	(0.01)	(.)	(.)	(0.02)	(0.02)
Not owner but also not paying rent	0.002	0.002	-0.002	-0.002	0.010*	0.010*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Gender-Male						
Female	-0.004	-0.004	-0.006	-0.006	0.004	0.003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Base Category: Single						
Married	-0.015**	-0.015**	0.003	0.003	0.016	0.016
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Divorced	0.006	0.005	-0.008	-0.007	-0.019	-0.019
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Widowed	-0.014**	-0.014**	0.001	0.002	0.015	0.015
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age	0.000	0.000	-0.001***	-0.001***	0.001***	0.001***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Not completed any school						
Primary School	-0.004	-0.004	-0.013***	-0.013***	0.036***	0.035***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Secondary School	0.007*	0.007*	-0.017***	-0.017***	0.024***	0.024***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)

High School	0.010**	0.010**	-0.021***	-0.021***	0.016*	0.015*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Vocational School	0.012*	0.012*	-0.028***	-0.027***	0.005	0.004
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Bachelor	0.019**	0.019**	-0.027***	-0.027***	-0.030*	-0.030*
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Masters Degree	0.041**	0.041**	0.000	0.000	-0.066	-0.067
	(0.01)	(0.01)	(.)	(.)	(0.04)	(0.04)
Ph.D	-0.022***	-0.022***	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(.)	(.)	(.)	(.)
Base Category: Employment Status (Employed)						
Not Working (But Still Connected to Work)	0.001	0.001	0.007	0.007	-0.014	-0.014
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Unemployed	0.011***	0.011***	-0.003*	-0.004*	-0.026***	-0.025***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Poverty Index	0.025***	0.025***	-0.026***	-0.026***	-0.067***	-0.067***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Being above 50% of the median income						
d_50 (Being below 50% of the median income)	-0.003	-0.003	0.006**	0.006**	-0.012*	-0.012*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Base Category: Health Status (Poor)						
Health Status (good)		0.007*		-0.004		0.009
		(0.00)		(0.00)		(0.01)
N	45704	45704	42707	42707	45523	45523
Log-likelihood	-3782.33	-3779.92	-2667.74	-2666.27	-15099.03	-15097.95
Pseudo R^2	0.615	0.616	0.302	0.303	0.471	0.471
AIC	7638.66	7635.83	5401.48	5400.55	30270.05	30269.91
BIC	7961.66	7967.57	5687.33	5695.06	30584.19	30592.77
Mean VIF	3.28	3.22	3.28	3.22		

Notes: *, **, *** symbols indicate the significance of the coefficients at the 10%, 5% and 1% levels of significance, respectively. (1)–(6) refer to different model specifications. Each model uses the same set of independent variables, presented in the first columns of the tables. Each column display both the model number and its corresponding dependent variable (wood, dung etc). Model (2), model (4), and model (6) aim at estimating additionally the role of health status (good health) of household head on the consumption of electricity, dung and wood. Year fixed effects are controlled.
Source: Own calculations.

Similarly, Table 6 shows the results for electricity, dung and wood consumption, while Table 7 represents the marginal effects where dependent variables are natural gas and coal consumption. Similar to the previous results, households below 60% of the median income experience an increase in dried dung consumption in comparison to those above this income level.

Table 7. Marginal effects from logit models for coal and natural gas using poverty variable defined by 60% of median income.

Independent Variables	**(1)**	**(2)**	**(3)**	**(4)**
	Coal	**Coal**	**Natural Gas**	**Natural Gas**
Household Income	-0.012**	-0.012**	-0.015***	-0.015***
	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Heating system (radiator)				
Heating system (Stove)	0.038***	0.038***	-0.303***	-0.303***
	(0.01)	(0.01)	(0.01)	(0.01)
Heating system (Air conditioner)	-0.193***	-0.193***	-0.493***	-0.493***
	(0.01)	(0.01)	(0.01)	(0.01)
Dwelling size -m2	0.001***	0.001***	-0.001***	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Age of Dwelling - (Pre-1945)				
Age of Dwelling -(1946-1960)	0.014	0.014	0.011	0.011
	(0.01)	(0.01)	(0.02)	(0.02)
Age of Dwelling – (1961-1970)	0.029*	0.029*	0.021	0.021
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling – (1971-1980)	0.037**	0.037**	0.024	0.025
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling – (1981-1990)	0.034**	0.034**	0.020	0.021
	(0.01)	(0.01)	(0.01)	(0.01)

Age of Dwelling – (1991-2000)	0.036**	0.036**	0.013	0.013
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling –(2001-2005)	0.063***	0.063***	-0.012	-0.012
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling –(Post 2005)	0.078***	0.078***	-0.030*	-0.030*
	(0.01)	(0.01)	(0.01)	(0.01)
Base Category: Couple without resident children				
Couple with at least one resident child	0.016**	0.016**	-0.017***	-0.017***
	(0.01)	(0.01)	(0.00)	(0.00)
Lone parents with at least one resident child	0.001	0.001	-0.011	-0.011
	(0.01)	(0.01)	(0.01)	(0.01)
At Least One Nuclear Family and Other Persons	0.027***	0.027***	-0.023***	-0.023***
	(0.01)	(0.01)	(0.00)	(0.00)
Multiple Persons without a Nuclear Family	0.016	0.016	-0.012	-0.012
	(0.02)	(0.02)	(0.01)	(0.01)
Base Category: Homeowner				
Tenant	0.025***	0.025***	0.037***	0.037***
	(0.01)	(0.01)	(0.00)	(0.00)
Lodging	0.109***	0.109***	-0.107***	-0.107***
	(0.02)	(0.02)	(0.01)	(0.01)
Not owner but also not paying rent	0.006	0.006	0.023***	0.023***
	(0.01)	(0.01)	(0.00)	(0.00)
Base Category: Gender-Male				
Female	0.016	0.016	-0.010	-0.010
	(0.01)	(0.01)	(0.01)	(0.01)
Base Category: Single				
Married	0.031**	0.031**	-0.011	-0.011
	(0.01)	(0.01)	(0.01)	(0.01)
Divorced	-0.003	-0.003	0.011	0.011
	(0.01)	(0.01)	(0.01)	(0.01)
Widowed	0.028*	0.028*	0.011	0.011
	(0.01)	(0.01)	(0.01)	(0.01)
Age	-0.000*	-0.000*	-0.001***	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Not completed any school				
Primary School	0.004	0.004	-0.012**	-0.011**
	(0.01)	(0.01)	(0.00)	(0.00)
Secondary School	0.016*	0.016*	-0.016***	-0.016**
	(0.01)	(0.01)	(0.00)	(0.00)
High School	0.048***	0.048***	-0.046***	-0.046***
	(0.01)	(0.01)	(0.00)	(0.00)
Vocational School	0.082***	0.082***	-0.076***	-0.076***
	(0.01)	(0.01)	(0.01)	(0.01)
Bachelor	0.076***	0.076***	-0.087***	-0.087***
	(0.01)	(0.01)	(0.01)	(0.01)
Masters Degree	0.064**	0.064**	-0.091***	-0.091***
	(0.02)	(0.02)	(0.01)	(0.01)
Ph.D	0.010	0.010	-0.062**	-0.061**
	(0.04)	(0.04)	(0.02)	(0.02)
Base Category: Employment Status (Employed)				
Not Working (But Still Connected to Work)	0.034	0.034	-0.012	-0.013
	(0.03)	(0.03)	(0.02)	(0.02)
Unemployed	0.008	0.008	0.022***	0.021***
	(0.00)	(0.00)	(0.00)	(0.00)
Poverty Index	-0.109***	-0.109***	0.187***	0.187***
	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Being above 50% of the median income				
d_50 (Being below 50% of the median income)	-0.040***	-0.040***	-0.029***	-0.029***
	(0.01)	(0.01)	(0.00)	(0.00)
Base Category: Health Status (Poor)				
Health Status (good)		-0.000		-0.012*
		(0.01)		(0.01)
N	45704	45704	45704	45704
Log-likelihood	-20982.43	-20982.43	-9325.59	-9323.60
Pseudo R^2	0.11	0.11	0.69	0.70
AIC	42038.85	42040.85	18725.17	18723.20

BIC	42361.86	42372.59	19048.18	19054.94
Mean VIF	3.28	3.22	3.28	3.22

Notes: *, **, *** symbols indicate the significance of the coefficients at the 10%, 5% and 1% levels of significance, respectively. (1)–(4) refer to different model specifications. Each model uses the same set of independent variables, presented in the first columns of the tables. Each column display both the model number and its corresponding dependent variable (coal, natural gas etc). Model (2) and model (4) aim at estimating also the role of health status (good health) of household head on the consumption of coal and natural gas. Year fixed effects are controlled.
Source: Own calculations.

In contrast, households that earn less than 60% of the median income have a lower consumption of wood, coal, and natural gas than those that earn more than this amount. Those different types of energy consumption for households that earn less than 70% of the median income is similar as well. Results for binary poverty variable established using 70% of the median income are available at Tables 8 and 9.

Table 8. Marginal effects from logit models for coal and natural gas using poverty variable defined by 70% of median income.

Independent Variables	(1) Electricity	(2) Electricity	(3) Dung	(4) Dung	(5) Wood	(6) Wood
Household Income	0.008*** (0.00)	0.007*** (0.00)	-0.004* (0.00)	-0.004* (0.00)	0.007 (0.00)	0.007 (0.00)
Base Category: Heating system (radiator)						
Heating system (Stove)	0.166*** (0.01)	0.165*** (0.01)	0.017*** (0.00)	0.017*** (0.00)	0.468*** (0.01)	0.468*** (0.01)
Heating system (Air conditioner)	0.962*** (0.01)	0.962*** (0.01)	0.000 (.)	0.000 (.)	-0.014*** (0.00)	-0.014*** (0.00)
Dwelling size -m2	-0.000** (0.00)	-0.000*** (0.00)	0.000*** (0.00)	0.000*** (0.00)	0.000*** (0.00)	0.000*** (0.00)
Base Category: Age of Dwelling - (Pre-1945)						
Age of Dwelling -(1946-1960)	-0.000 (0.00)	-0.000 (0.00)	-0.012** (0.00)	-0.012** (0.00)	0.009 (0.01)	0.009 (0.01)
Age of Dwelling – (1961-1970)	-0.000 (0.00)	-0.000 (0.00)	-0.012** (0.00)	-0.012** (0.00)	0.008 (0.01)	0.008 (0.01)
Age of Dwelling – (1971-1980)	0.000 (0.00)	-0.000 (0.00)	-0.012** (0.00)	-0.012** (0.00)	-0.002 (0.01)	-0.003 (0.01)
Age of Dwelling – (1981-1990)	0.004 (0.00)	0.004 (0.00)	-0.012** (0.00)	-0.012** (0.00)	-0.001 (0.01)	-0.002 (0.01)
Age of Dwelling – (1991-2000)	0.008 (0.00)	0.008 (0.00)	-0.007 (0.00)	-0.007 (0.00)	-0.002 (0.01)	-0.002 (0.01)
Age of Dwelling –(2001-2005)	0.009 (0.00)	0.009 (0.00)	-0.009* (0.00)	-0.009* (0.00)	-0.002 (0.01)	-0.002 (0.01)
Age of Dwelling –(Post 2005)	0.015** (0.00)	0.015** (0.00)	-0.003 (0.00)	-0.003 (0.00)	-0.024* (0.01)	-0.025* (0.01)
Base Category: Couple without resident children						
Couple with at least one resident child	-0.004 (0.00)	-0.004 (0.00)	0.010*** (0.00)	0.010*** (0.00)	-0.007 (0.00)	-0.007 (0.00)
Lone parents with at least one resident child	0.020*** (0.00)	0.020*** (0.00)	-0.001 (0.00)	-0.001 (0.00)	-0.023** (0.01)	-0.023** (0.01)
At Least One Nuclear Family and Other Persons	-0.008*** (0.00)	-0.008*** (0.00)	0.014*** (0.00)	0.014*** (0.00)	-0.016** (0.01)	-0.016** (0.01)
Multiple Persons without a Nuclear Family	0.027** (0.01)	0.027** (0.01)	-0.003 (0.01)	-0.003 (0.01)	-0.057* (0.02)	-0.057* (0.02)
Base Category: Homeowner						
Tenant	0.029*** (0.00)	0.029*** (0.00)	-0.017*** (0.00)	-0.017*** (0.00)	-0.044*** (0.00)	-0.044*** (0.00)
Lodging	0.005 (0.01)	0.005 (0.01)	0.000 (.)	0.000 (.)	0.024 (0.02)	0.024 (0.02)
Not owner but also not paying rent	0.002 (0.00)	0.002 (0.00)	-0.002 (0.00)	-0.003 (0.00)	0.010* (0.00)	0.010* (0.00)
Base Category: Gender-Male						
Female	-0.004 (0.00)	-0.004 (0.00)	-0.006 (0.00)	-0.006 (0.00)	0.004 (0.01)	0.003 (0.01)

Base Category: Single						
Married	-0.015**	-0.015**	0.003	0.003	0.016	0.016
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Divorced	0.006	0.005	-0.008	-0.007	-0.019	-0.019
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Widowed	-0.014**	-0.015**	0.001	0.001	0.016	0.016
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age	0.000	0.000	-0.001***	-0.001***	0.001***	0.001***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Not completed any school						
Primary School	-0.004	-0.004	-0.014***	-0.013***	0.036***	0.036***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Secondary School	0.007*	0.007*	-0.018***	-0.018***	0.025***	0.024***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
High School	0.010**	0.010**	-0.021***	-0.021***	0.016*	0.016*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Vocational School	0.012*	0.011*	-0.028***	-0.028***	0.005	0.004
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Bachelor	0.019***	0.019**	-0.027***	-0.027***	-0.031*	-0.031*
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Masters Degree	0.042**	0.042**	0.000	0.000	-0.068	-0.068
	(0.01)	(0.01)	(.)	(.)	(0.04)	(0.04)
Ph.D	-0.022***	-0.022***	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(.)	(.)	(.)	(.)
Base Category: Employment Status (Employed)						
Not Working (But Still Connected to Work)	0.001	0.001	0.006	0.006	-0.014	-0.014
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Unemployed	0.011***	0.011***	-0.003	-0.003*	-0.026***	-0.025***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Poverty Index	0.025***	0.025***	-0.026***	-0.026***	-0.066***	-0.067***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Being above 50% of the median income						
d_50 (Being below 50% of the median income)	-0.005*	-0.005*	0.003	0.003	-0.001	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
Base Category: Health Status (Poor)						
Health Status (good)		0.007*		-0.004		0.009
		(0.00)		(0.00)		(0.01)
N	45704	45704	42707	42707	45523	45523
Log-likelihood	-3780.65	-3778.24	-2672.27	-2670.84	-15101.46	-15100.38
Pseudo R^2	0.616	0.616	0.301	0.301	0.471	0.471
AIC	7635.31	7632.49	5410.53	5409.68	30274.92	30274.76
BIC	7958.31	7964.22	5696.38	5704.19	30589.06	30597.62
Mean VIF	3.29	3.23	3.29	3.23	3.29	3.23

Notes: *, **, *** symbols indicate the significance of the coefficients at the 10%, 5% and 1% levels of significance, respectively. (1)–(4) refer to different model specifications. Each model uses the same set of independent variables, presented in the first columns of the tables. Each column display both the model number and its corresponding dependent variable (coal, natural gas). Model (2) and model (4) aim at estimating also the role of health status (good health) of household head on the consumption of coal and natural gas. Year fixed effects are controlled.
Source: Own calculations.

Tables 8 and 9 present the marginal effects from logit models of electricity, dung, wood, coal, and natural gas consumption, based on a 70% median income poverty threshold. The results are consistent with broader evidence linking poverty status to household energy choices.

Table 9. Marginal effects from logit models for coal and natural gas using poverty variable defined by 70% of median income.

Independent Variables	**(1)**	**(2)**	**(3)**	**(4)**
	Coal	**Coal**	**Natural Gas**	**Natural Gas**
Household Income	-0.009	-0.009	-0.017***	-0.017***
	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Heating system (radiator)				
Heating system (Stove)	0.039***	0.039***	-0.302***	-0.302***
	(0.01)	(0.01)	(0.01)	(0.01)

Heating system (Air conditioner)	-0.193***	-0.193***	-0.493***	-0.493***
	(0.01)	(0.01)	(0.01)	(0.01)
Dwelling size -m2	0.001***	0.001***	-0.001***	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Age of Dwelling - (Pre-1945)				
Age of Dwelling -(1946-1960)	0.015	0.015	0.011	0.011
	(0.01)	(0.01)	(0.02)	(0.02)
Age of Dwelling – (1961-1970)	0.030*	0.030*	0.021	0.021
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling – (1971-1980)	0.038***	0.038***	0.025	0.025
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling – (1981-1990)	0.035**	0.035**	0.021	0.021
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling – (1991-2000)	0.037**	0.037**	0.014	0.014
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling –(2001-2005)	0.064***	0.064***	-0.011	-0.011
	(0.01)	(0.01)	(0.01)	(0.01)
Age of Dwelling –(Post 2005)	0.079***	0.079***	-0.030*	-0.030*
	(0.01)	(0.01)	(0.01)	(0.01)
Base Category: Couple without resident children				
Couple with at least one resident child	0.016**	0.016**	-0.016***	-0.017***
	(0.01)	(0.01)	(0.00)	(0.00)
Lone parents with at least one resident child	0.000	0.000	-0.011	-0.011
	(0.01)	(0.01)	(0.01)	(0.01)
At Least One Nuclear Family and Other Persons	0.027***	0.027***	-0.023***	-0.023***
	(0.01)	(0.01)	(0.00)	(0.00)
Multiple Persons without a Nuclear Family	0.015	0.015	-0.012	-0.012
	(0.02)	(0.02)	(0.01)	(0.01)
Base Category: Homeowner				
Tenant	0.026***	0.026***	0.037***	0.037***
	(0.01)	(0.01)	(0.00)	(0.00)
Lodging	0.109***	0.109***	-0.107***	-0.107***
	(0.02)	(0.02)	(0.01)	(0.01)
Not owner but also not paying rent	0.006	0.006	0.024***	0.023***
	(0.01)	(0.01)	(0.00)	(0.00)
Base Category: Gender-Male				
Female	0.016	0.016	-0.010	-0.010
	(0.01)	(0.01)	(0.01)	(0.01)
Base Category: Single				
Married	0.031**	0.031**	-0.011	-0.011
	(0.01)	(0.01)	(0.01)	(0.01)
Divorced	-0.002	-0.002	0.012	0.012
	(0.01)	(0.01)	(0.01)	(0.01)
Widowed	0.028*	0.028*	0.011	0.011
	(0.01)	(0.01)	(0.01)	(0.01)
Age	-0.000*	-0.000*	-0.001***	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Not completed any school				
Primary School	0.005	0.005	-0.012**	-0.012**
	(0.01)	(0.01)	(0.00)	(0.00)
Secondary School	0.017*	0.017*	-0.017***	-0.016**
	(0.01)	(0.01)	(0.00)	(0.00)
High School	0.048***	0.048***	-0.047***	-0.046***
	(0.01)	(0.01)	(0.00)	(0.00)
Vocational School	0.081***	0.081***	-0.077***	-0.076***
	(0.01)	(0.01)	(0.01)	(0.01)
Bachelor	0.075***	0.075***	-0.088***	-0.087***
	(0.01)	(0.01)	(0.01)	(0.01)
Masters Degree	0.061**	0.061**	-0.091***	-0.091***
	(0.02)	(0.02)	(0.01)	(0.01)
Ph.D	0.006	0.006	-0.061**	-0.060**
	(0.04)	(0.04)	(0.02)	(0.02)
Base Category: Employment Status (Employed)				
Not Working (But Still Connected to Work)	0.034	0.034	-0.012	-0.013
	(0.03)	(0.03)	(0.02)	(0.02)
Unemployed	0.008	0.008	0.022***	0.021***

	(0.00)	(0.00)	(0.00)	(0.00)
Poverty Index	-0.109***	-0.109***	0.187***	0.187***
	(0.00)	(0.00)	(0.00)	(0.00)
Base Category: Being above 50% of the median income				
d_50 (Being below 50% of the median income)	-0.028***	-0.028***	-0.027***	-0.027***
	(0.01)	(0.01)	(0.00)	(0.00)
Base Category: Health Status (Poor)				
Health Status (good)		0.000		-0.012*
		(0.01)		(0.01)
N	45704	45704	45704	45704
Log-likelihood	-20991.39	-20991.39	-9322.23	-9320.08
Pseudo R^2				
AIC	42056.78	42058.78	18718.45	18716.16
BIC	42379.79	42390.52	19041.46	19047.90
Mean VIF	-0.009	-0.009	-0.017***	-0.017***

Notes: *, **, *** symbols indicate the significance of the coefficients at the 10%, 5% and 1% levels of significance, respectively. (1)–(4) refer to different model specifications. Each model uses the same set of independent variables, presented in the first columns of the tables. Each column display both the model number and its corresponding dependent variable (coal, natural gas etc). Model (2) and model (4) aim at estimating also the role of health status (good health) of household head on the consumption of coal and natural gas. Year fixed effects are controlled.
Source: Own calculations.

4. Discussion

The findings reveal that poor households generally tend to opt for cheaper and more traditional fuel types and avoid more modern and expensive fuel types. These results are consistent with those reported by Karaaslan et al. (2022), Karaaslan & Algül (2023) and Özcan et al. (2013). These results are also consistent with the broader energy poverty literature, which shows that low-income households worldwide tend to rely on traditional, low-cost fuels due to affordability constraints. This situation plays an important role in the planning of energy policies and social assistance. Developing strategies specifically aimed at improving energy access for low-income households enhance their quality of life.

With regard to the results concerning the role of the health status of the household head in the use of different types of energy, individuals in good health have a higher electricity demand than those in poor health. This pattern aligns with the energy ladder hypothesis, suggesting that healthier individuals tend to rely more on modern, electricity-intensive appliances.

Households with poor health status often prefer cleaner energy sources such as electricity. Contrary to these expectations, findings indicate that people in good health tend to use a greater number of electrical appliances. Healthy individuals frequently have higher income levels, providing them with better access to electrical products and devices. Moreover, those in better health participate more often in activities that require the use of various electrical appliances. For instance, they spend more time using exercise equipment, home entertainment systems and other technological devices that enhance overall well-being. Good health is associated with maintaining a comfortable living environment, which typically includes the use of air conditioning, heating and lighting. Healthier people also adopt new technologies more readily, many of which are electricity-intensive.

However, the demand for natural gas is lower for healthy household heads than for those in poor health. This lower demand appears to reflect a fuel substitution effect, with households in better socioeconomic and health conditions replacing natural gas with electricity-intensive technologies. This interpretation is supported by the behavioral economics of energy choice, which highlights convenience and usability as key drivers of household fuel substitution (Frederiks et al., 2015).

Some intriguing results have been obtained in relation to the control variables. Considering the age of the dwelling, buildings built after 2001 use more electricity than those built before 1945. The buildings built after 2001 aim to use clean energy sources due to their energy efficiency and advanced modern heating systems. The use of traditional fuels such as dried dung, wood and coal is common in older buildings. These fuels are typically used because older buildings are less energy efficient and lack modern heating systems. In this context, the government and/or municipalities might implement energy infrastructure and heating system programs, especially for old buildings. On the other hand, there has been a decrease in the use of natural gas in buildings built after 2001. This change seems linked to the adoption of alternative techniques (electric heating systems) or the installation of new energy systems (solar panels) during this period. Moreover, the use of natural gas is more related to the availability of infrastructure in the neighborhood where the dwelling is located. If there is no available infrastructure for natural gas, even the new buildings would not have access to it. These patterns reflect widely documented relationships between dwelling characteristics and heating fuel selection in the built-environment and residential energy literature.

As the size of the dwelling (in square meters) increases, the demand for electricity and natural gas decreases and the use of wood and coal increases. Improvements in architectural features and insulation systems in larger dwellings lead to a reduction in demand for clean energy sources such as electricity and natural gas, owing to enhanced energy efficiency. Compared to homeowners, tenants show an increase in demand for electricity, coal and natural gas, while their demand for dung and wood decreases. Tenants living in short-term accommodation tend to prefer more widespread and modern energy sources. In comparison with central heating systems with radiators, households with stoves show an increase in demand for electricity, wood, dung and coal. Compared with central heating systems using radiators, households that rely on stoves exhibit higher demand for electricity, wood, dung, and coal, alongside a lower demand for natural gas. This pattern reflects technical compatibility: stoves operate more efficiently with electricity and solid fuels, whereas radiator-based systems function more effectively with natural gas. Similarly, households with air conditioning systems, as opposed to central heating systems, show an increase in electricity demand, which is an expected result. These findings aline with those of İpek & İpek (2022), Karaaslan et al. (2022) and Karaaslan & Algül (2023).

Similar to previous studies in this field, the findings indicate that demographic and economic factors influence residential energy demand. Higher household income is associated with increased electricity demand. This suggests that households with higher incomes prefer to use electricity. In addition, the use of coal and natural gas decreases as household income increases. In other words, higher income households do not prefer to use coal and gas. This finding supports the "energy ladder hypothesis" for households in Turkey. However, Turkish consumers consider electricity more efficient and convenient than natural gas. The individual characteristics of the household head also emerge as influential factors according to the estimates. Compared to illiterate, an increase in the educational level of the head of the household increases the demand for electricity; however, at the Ph.D. level, electricity consumption decreases. Recently, especially following the government's intensified efforts to promote the use of clean energy in both Turkey and the EU, it has been observed that more highly educated people are investing in alternative forms of energy, such as solar panels. As the level of education increases, the use of dung decreases, suggesting that households with higher levels of education do not prefer to use dung, which is common in rural areas from where educated people migrate to urban areas for working purposes. Those results consistent with the consensus in previous studies in literature. Compared to illiterate household heads, those with primary and secondary education have an increased demand for wood, while those with bachelor education have a decreased demand for wood. Coal demand increases as the level of education increases. Normally higher education is associated with an increase in clean energy demand; however, obtained results show that demand for natural gas decreases with the level of education, indicating that households do not prefer to use natural gas as the education level of household head increases. This finding contradicts with the result of İpek & İpek (2022). However, this result arises from the lack of natural gas infrastructure and the low economic pricing of coal in many regions in Turkey. Moreover, higher household education levels improve social resources, identity and income. In this case, they develop luxury-oriented lifestyle, resulting the increase consumption of commodities like automobiles, computer as well as energy in the form fuel, electricity etc. (Wang et al. 2020).

Considering the findings for other socio-economic characteristics, the gender of the household head has no significant effect on the energy demand for heating. This indicates that there is no noticeable difference between male and female heads in their choice of energy sources for heating. The married household heads tend to use less electricity and prefer coal more than singles. This pattern reflects the presence of more household members, such as children and the fact that coal is cheaper than electricity. When examining the impact of employment status on energy demand, it is observed that unemployed individuals have a higher demand for electricity and natural gas compared to employed individuals. However, unemployed individuals use less wood compared to their employed counterparts. Unemployed individuals spend more time at home, increasing demand for electricity and gas for heating, cooking, and appliances, while avoiding labour-intensive fuels such as wood. Finally, in urban areas where unemployment is more prevalent, access to electricity and natural gas infrastructure is typically better, whereas wood use is more common in rural or semi-rural settings.

Conclusions

Household energy preference is key matter for energy policy and sustainability issues since residential sector is a substantial part of the aggregate energy demand and environmental pollution. Sustainability requires that world consider to issues of energy preferences and/or efficiency due to climate change concerns. Hence, better understanding of household's energy choice is a very important issue. Accordingly, this study provides the first analysis in the literature of the impact of poverty, measured using different median income thresholds, as well as health status and other socio-economic factors, on household energy consumption in Turkey, employing logit models based on TURKSTAT's Household Budget Surveys.

Current study concludes that poverty and household health status are important drivers of residential energy consumption and fuel preferences. Accordingly, it is observed that as poverty decreases, households tend to move towards more modern and comfortable energy sources. The assessment of poverty and health status shows that households increase their consumption of electricity and natural gas as the level of poverty decreases. At the 50%, 60% and 70% median income levels, those below the 50% median income line choose to use cheaper types of fuel such as dried dung. In addition, healthier individuals prefer to use electricity as they tend to use more appliances and engage in different activities such as using exercise equipment, home entertainment systems and other technological devices. Overall, the findings point to the need for a just energy transition that simultaneously addresses energy poverty, rising aggregate demand, and environmental pollution. Policies should prioritise targeted support for low-income households to facilitate a shift away from highly polluting fuels such as dried dung towards cleaner energy sources, alongside investments in electricity and natural gas infrastructure in disadvantaged areas. At the same time, as poverty declines and healthier households increase electricity use through greater appliance ownership, progressive tariff structures and energy-efficiency measures are needed to manage demand growth and limit emissions.

The results also indicate that certain characteristics of household heads and dwelling features act as important drivers of household energy choice, energy use and environmental impact. Regarding dwelling characteristics, buildings built after 2001 use more electricity, but older buildings use traditional fuels. In this context, the government and/or municipalities might implement energy infrastructure and heating system programs, especially for old buildings.

Looking at demographic and economic factors, it's generally observed that households with higher income levels prefer better fuel types (cleaner, more convenient and more efficient such as electricity and natural gas) for space heating. Encouraging the use of cleaner energy among low-income households requires the introduction of targeted government subsidies. In addition, the level of education has a positive effect on electricity consumption. In this respect, the use of traditional fuels (such as dung) decreases as the level of education increases. Interestingly, coal demand rises with the level of education, as coal remains a cheaper energy source in many parts of Turkey. These findings highlight that organizing educational programs aimed at households to increase energy literacy and environmental awareness will contribute to conscious energy consumption and reduce the environmental impact of energy consumption.

The findings carry important policy implications. As urbanization (new buildings), education level and income are expected to increase soon, electricity consumption will also increase. Therefore, Turkey should make the necessary investments in electricity generation to meet the additional demand. Furthermore, more effective incentive policies should be introduced to encourage households to invest in renewable energy infrastructure. This would speed up the shift away from fossil fuels and towards cleaner energy sources. All these efforts will contribute towards the country's sustainability targets, such as the National Energy Plan and the Renewable Energy Road Map, which are in line with the UN's SDG targets, such as SDG7. Natural gas demand will increase both due to changing household preferences and to realize increased electricity production. However, given the country's exchange rate problem, this would worsen the already distorted price stability and balance of payments.

Moreover, although significant progress has been made in the field of renewable energy in Turkey in recent years, the desired level of renewable energy development has not yet been achieved. Promoting renewable energy through more effective mechanisms will contribute to both the balance of payments and sustainable economic growth by meeting the country's energy needs with domestic resources. Another important point is that coal consumption will remain important in the energy preferences of Turkish households. As Turkey has experienced a wave of inflation in recent years, high inflation will negatively affect households, especially the poor. For this reason, households experiencing falling real incomes often return to cheaper and lower-quality fuels for economic reasons. Additionally, energy subsidies and incentives for low-income households increase access to cleaner and more efficient energy sources, supporting a more sustainable energy usage structure.

The current study offers new evidence on the determinants of household energy choices in Turkey, but several limitations should be noted. First, the data set does not include local and/or time-varying energy price information, subsidies or tariff structures, which are known to play a central role in shaping household fuel choice. The absence of such price variation limits economic incentives and substitution patterns across fuels. The availability of regional and provincial energy usage data enables future studies to empirically examine regional energy demand, as well as the effects of socio-economic differences and/or incentive policies. Second, despite extensive controls, potential endogeneity remains a concern, particularly in the relationship between income, poverty and energy choice, owing to the presence of unobserved factors affecting these variables. As noted earlier, poverty and health status are shaped by unobserved socio-economic or environmental factors, generating potential omitted-variable bias and limiting the causal interpretation of the results. Third, the Household Budget Survey lacks behavioural or attitudinal variables, such as environmental awareness, cultural norms, risk preferences or energy-saving practices, which shape household preferences. Finally, the analysis does not incorporate regional heterogeneity, despite significant differences in climate, infrastructure and socio-economic conditions across provinces. Future research should address these limitations by combining micro-level survey data with regional energy prices, infrastructure maps and climatic indicators. The use of causal identification strategies such as instrumental variables or natural experiments would help mitigate endogeneity concerns. Finally, the elasticity of energy sources was not calculated due to the unavailability of reliable price information on the types of energy purchased by households. This elasticity would also be important for measuring the effects of energy policies. For these reasons, the findings should be interpreted as associative rather than causal, and future research would benefit from richer data sources that incorporate prices, elasticities behavioural indicators and regional variation.

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