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From traditional to modern fuels: heating energy choices of poor and non-poor households in Türkiye

Abstract

Background/aim: Energy, an indispensable component of daily life, is of paramount importance to all people worldwide. Daily energy supply for household needs is a fundamental factor in the stable development of any country. The aim of this study is to determine the differences in fuel type preferences used for heating purposes by poor and non-poor households in Türkiye.

Methods: This study utilizes a micro dataset obtained from the Income and Living Conditions Survey (ILCS) conducted by the Turkish Statistical Institute (TÜİK) between 2014 and 2019. Multinomial probit regression analysis was employed to identify factors associated with the fuel type preferences used for heating by both poor and non-poor households.

Results: According to the analysis results, in the model established to identify the factors influencing the preference for advanced fuel among poor households, the following variables were found to be significant: marital status, education level, occupation, years of service, age, gender, presence of individuals aged 65 and over in the household, number of children in the household, number of working individuals in the household, home ownership, and number of rooms in the home. In the model established to identify the factors influencing the preference for traditional fuel among non-poor households, the following variables were also found to be significant: marital status, education, occupation, years of service, age, gender, equivalent number of family members in the household, presence of individuals under five years of age in the household, presence of individuals aged 65 and over in the household, number of children in the household, home ownership, and number of rooms in the home.

Conclusion: The study findings indicate that heating fuel preferences are influenced by the socioeconomic and demographic characteristics of the head of household. Accordingly, subsidies, financial support, and information programs should be developed to increase the use of advanced fuels in poor and married households. Widespread training programs to improve energy literacy and mechanisms to encourage the use of advanced fuels should be implemented for households with low levels of education.

Keywords: Household heating fuel choice, poor and non-poor households, Clean and traditional fuels, multinomial probit regression, Türkiye.

1. Introduction

Energy, a vital element of everyday existence, represents a significant concern for individuals across the globe [1]. The consumption of energy is regarded as an excellent indicator of living standards, as it mirrors the availability of durable consumer goods and services that fulfill a household's diverse requirements, including cooking, lighting, heating, and entertainment [2]. Additionally, it serves as a means to assess the economic status of households, particularly in identifying poverty levels [3]. The daily provision of energy for both residential and industrial purposes is a crucial determinant for the sustainable growth of any nation. Energy plays a pivotal role in numerous facets of contemporary life, supplying warmth and illumination in residences while facilitating the manufacturing of essential goods for society [4]. Heating constitutes the largest segment of global energy consumption. The demand for heating in residential, industrial, and commercial sectors is known to account for nearly half of the total final energy consumption worldwide. Approximately 90% of this heating is sourced from fossil fuels and high-carbon energy resources [5]. In 2021, heat emerged as the predominant end-use of energy, representing around half of the global final energy consumption, primarily sourced from fossil fuels. Heating of space and water accounts for 46% of the energy consumed for heating [6].

11 In the residential sector, fossil fuels and electricity are the main energy sources utilized for heating, hot water, and cooling production. Despite efforts to promote the use of renewable 11 energy technologies, heating and cooling systems that depend on fossil fuels remain dominant. Consequently, it is becoming increasingly crucial for policymakers in every nation to comprehend the factors influencing household fuel preferences [7]. Households dedicate a substantial and, in recent times, an increasing share of their budgets to direct energy consumption within their residences. In temperate climate regions, around three-quarters of the energy utilized in homes is allocated to space heating [8].

Heating is a basic requirement for all households. However, economic, geographical and infrastructure factors are decisive in the fuel choices of poor households [9]. Poor households generally tend to opt for low-cost and easily accessible fuel types [10]. These fuel types can be listed as follows:

Wood and biomass: One of the most common options for households living near forested areas [11].

Coal: Commonly used in low-income areas and small towns.

LPG (Bottled Gas): An alternative used in areas without natural gas infrastructure.

Electricity: Generally less preferred by poor households due to high electricity prices.

Natural Gas: Limited use in areas where infrastructure is available but income levels are low [12].

Energy consumption differs significantly from the consumption of other types of goods. In the short term, a household is generally reluctant to renew fixed capital inputs due to the long lifespan and high cost of heating systems [8]. For this reason, low-income households generally turn to lower-cost energy options, while a shift to cleaner and more efficient energy sources is observed as income levels increase. The choice of fuel for heating is shaped not only by economic factors but also by energy infrastructure, government subsidies, environmental awareness, and cultural habits [13]. In this context, highlighting the differences in the types of energy used for heating by poor and non-poor households is of great importance for evaluating energy policies in terms of social justice and sustainability. In developing countries, low-income households mainly turn to traditional fuels such as wood, coal, and biomass to meet

their heating needs. It has been argued that in order for impoverished people to escape poverty and have a sustainable, high quality of life, they must have access to clean, affordable, and sufficient energy [14]. However, burning conventional biomass, such as firewood and agricultural waste, often results in indoor air pollution, which is a serious health hazard, especially for women and children [15, 16]. Furthermore, gathering firewood is a labour-intensive chore that prevents impoverished people from participating in other economic activities [17]. As a result, a household's energy consumption habits can be used to determine the relative poverty threshold and are an indirect measure of that household's welfare status and living standards [3].

On the other hand, with the increase in income levels and the development of energy infrastructure, there is a trend towards switching to cleaner and more efficient energy sources (natural gas, electricity, renewable energy) [18]. This transition process is affected not only by household income levels but also by government subsidies, energy prices and regional access opportunities. However, fluctuations in energy prices, government subsidy policies and regional factors also play a decisive role in the fuel choice of households [12].

2. Literature Review

Household fuel preferences for heating are shaped by economic, geographical, socio-demographic, and environmental factors. Studies on these preferences in the literature have generally examined them in the context of developed and developing countries, and it has been observed that factors such as income level, energy prices, access to infrastructure, and environmental awareness are decisive [19, 20]. Simultaneously, analyzing the factors influencing heating preferences at the micro level can enhance the comprehension of individual energy behaviors and aid in the meticulous formulation of policies designed to decrease energy usage or reduce carbon intensity in households [19-22].

Income level and energy prices are among the determining factors in households' fuel choices for heating purposes. Households that are not poor, in particular, consider different fuel options due to the opportunities provided by their income levels and their sensitivity to price fluctuations in energy markets [23]. The literature indicates that households with higher income levels generally tend to gravitate towards more efficient and environmentally friendly energy sources. As income levels increase, investments in systems that improve the energy efficiency of homes and in renewable energy sources also increase. For example, households in higher income groups prefer cleaner energy sources such as electric heating systems or natural gas [24]. The tendency to invest in renewable energy solutions such as geothermal and solar energy is observed more frequently among individuals with higher income levels. Furthermore, energy-saving solutions such as insulation and smart thermostat systems are more commonly used among high-income households [25]. It is observed that households with higher income levels generally prefer cleaner and more efficient energy sources [26, 27]. Studies in developing countries show that low-income households mostly use traditional biomass (wood, dung, coal), but as income increases, there is a shift towards cleaner energy sources such as natural gas and electricity [28].

Energy prices are another factor that directly influences preferences. High prices can lead low-income households to use cheaper but less efficient or environmentally harmful energy sources. Poor households generally prefer the most economical fuel options [10]. Furthermore, it is stated that government subsidies lower energy prices, leading to significant changes in household fuel preferences [29]. Increases in energy prices and market fluctuations drive consumer behavior. The literature shows that increases in energy prices cause consumers to turn to more cost-effective and efficient alternatives [30].

In previous studies, numerous researchers have focused on the economic dynamics of household energy choices [31]. From this perspective, the energy ladder model assumes that as income increases, households will switch from traditional fuels to modern fuels (accelerating the energy ladder) [29, 32]. Empirical research conducted at the household level has demonstrated that income plays a crucial role in determining fuel selection [33, 34]. Consequently, to empirically evaluate the energy ladder hypothesis, it is essential to investigate socio-economic factors beyond income. Conversely, the energy ladder model has faced criticism for suggesting that the energy transition occurs in a linear fashion; in reality, it is a process characterized by the concurrent utilization of various fuels. This phenomenon is referred to as fuel stacking, and the energy stacking model posits that as income rises, households are likely to adopt modern fuels while simultaneously retaining their use of traditional fuels. Numerous empirical studies have examined and confirmed fuel hoarding behaviors in developing nations [10, 27, 35, 36].

When geographical and infrastructural factors are examined, it is seen that geographical location and access to infrastructure also play an important role in fuel preferences. Households living in rural areas generally prefer traditional fuels such as wood and coal because they have difficulty accessing natural gas and electricity [37]. In other words, wood and biomass are more common in rural areas, while coal and LPG are more preferred in urban areas [9]. In contrast, households living in cities have easier access to more modern and clean energy sources. In addition, households living in cold climates have a more intensive heating need and therefore prefer to use fuels with high energy efficiency. Some studies indicate that households in regions with limited access to energy experience energy poverty and that this negatively affects their quality of life [38]. For example, the lack of natural gas infrastructure causes households to turn to other fuels [12]. However, in regions with natural gas pipelines, the use of natural gas is becoming widespread regardless of income level. However, in places without infrastructure, the tendency to use alternative fuel types increases [25]. Households living in milder climates use systems that require less energy, such as electric heating [39]. However, where electricity prices are high, low-income households are turning to cheaper and locally available fuels [30]. At the same time, natural gas, electricity and central heating systems are more widely used in urban areas because energy infrastructure is more developed [33].

Studies on the environmental impacts of fuel choices reveal that traditional biomass and coal use threatens environmental sustainability by increasing air pollution and carbon emissions [40]. Indoor air pollution, in particular, leads to health problems in low-income households and causes the spread of respiratory diseases [41]. While energy policies and incentives for environmentally friendly fuels accelerate the transition to clean energy in developed countries, it is stated that the energy transition process is progressing more slowly in developing countries [42]. Therefore, government support, the expansion of renewable energy sources, and energy efficiency policies are of great importance. Because fuel subsidies can ensure the increased use of certain energy types [11].

According to international organizations such as the OECD and IEA, ensuring access to affordable, clean, and safe energy services for households is essential for sustainable social and economic development [36]. The effects of conventional energy sources on human health are a critical factor in this context. Approximately 2.6 billion individuals in low-middle-income countries (LMICs) primarily depend on stoves that utilize highly polluting solid fuels (such as biomass and coal) for cooking at home. Exposure to indoor air pollution from solid fuel stoves is linked to negative pregnancy and childbirth outcomes, cardiovascular diseases, and mortality rates among both children and adults, contributing to an estimated 2.31 million premature deaths annually [43]. Additionally, reliance on solid fuels adversely affects local natural ecosystems (for instance, through deforestation) and has global repercussions (both through

direct emissions and effects on forest carbon stocks), thereby influencing climate change [44]. Consequently, the transition to clean fuels for household use and the reduction, ultimately leading to the complete elimination of solid fuel use in homes, presents significant potential for promoting at least five Sustainable Development Goals. These include: 3. Good health and well-being; 5. Gender equality; 7. Affordable and clean energy; 13. Climate action; 15. Life on land [45].

Energy plays a vital role in the advancement of any economic activity, and it is equally important for enhancing the quality of life within households. Access to fundamental services, such as energy, significantly impacts individuals' quality of life, influencing both their health and socio-economic standing [46]. Space heating is considered to constitute a large part of the total energy demand of households. Therefore, identifying the factors influencing the choice of space heating type at the household level is important in terms of guiding climate change, environmental and energy policies [47]. Energy consumption for residential space heating has experienced a remarkable increase due to the continuous increase in income and the demand for thermal comfort [48]. Increasing energy efficiency in the residential sector provides many benefits such as environmental protection, mitigation of the harmful effects of climate change, reduction of energy costs and alleviation of energy poverty. In order to use limited resources in the most efficient way, the main factors behind energy consumption in homes must first be understood [49].

The selection and transition of household energy sources offer a significant viewpoint for the development of future energy policies. Initiatives that promote more efficient and environmentally sustainable energy usage should be supported [50]. Consequently, the regulation of effective public policies requires an examination of the energy choices and consumer behaviors of both impoverished and non-impoverished households [33]. This study aims to identify the variations in fuel type preferences for heating between poor and non-poor households in Türkiye, utilizing metadata from the Turkish Statistical Institute's Income and Living Conditions Surveys conducted from 2014 to 2019.

3. Material and Methods

3.1. Data

The Income and Living Conditions Survey (ILCS), which was carried out by the Turkish Statistical Institute between 2014 and 2019, provided the data used in this study. Since 2006, the ILCS survey, which employs the "panel survey" method, has been carried out yearly to measure people's living conditions, social exclusion, and poverty in terms of income, as well as to identify their profile and reveal the distribution of income among households and individuals in Türkiye [51].

This study used data from a total of 139,707 household heads, including 17,220 poor and 122,487 non-poor individuals who participated in the ILCS between 2014 and 2019.

3.2. Outcome Variables

The dependent variable of the study is the primary fuel type preference used by poor and non-poor households for heating purposes. The categories of the dependent variable are Traditional (Wood and Derivatives - Dung, other/No heating system), Transitional (Coal), and Advanced (Natural Gas, LPG, Fuel Oil, Electricity, and Renewable Energy Sources).

3.3. Independent variables

The independent variables of the study are marital status, education level, occupation, year, age, gender, household size, number of children under five, presence of individuals aged 65 and

over in the household, number of children in the household, number of working individuals in the household, home ownership, and number of rooms in the home.

3.4. Research method

For a sophisticated sampling design and weighting, Stata 17 employed survey statistics to conduct a weighted analysis [52]. First, the frequencies and percentages regarding the fuel preferences of poor and non-poor households participating in the study were obtained. Multinomial probit regression analysis was also used to investigate the relationship between households' heating fuel preferences and independent variables. The multinomial probit model was selected due to the unordered nature of the fuel choice data as well as its usefulness in predicting the probability of numerous selections [33].

4. Results and Discussion

4.1. Descriptive statistics

Findings related to factors associated with fuel type preferences for heating among poor and non-poor households in Türkiye are presented in Table 1.

Table 1. Findings on Factors Affecting Fuel Preferences for Household Heating Types

Variables		Fuel Type					
		Poor			Non-poor		
		Traditional	Transition	Advanced	Traditional	Transition	Advanced
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Marital status	Married	5950(42.1)	6636(46.9)	1556(11.0)	16833(17.1)	31126(31.6)	50412(51.2)
	Single	1189(38.6)	1463(47.5)	426(13.8)	4245(17.6)	7544(31.3)	12327(51.1)
Educational level	Illiterate	2740(48.4)	2615(46.2)	306(5.4)	5007(34.6)	5724(39.6)	3721(25.7)
	Elementary school	3458(42.7)	3821(47.2)	817(10.1)	11408(23.4)	17813(36.5)	19583(40.1)
	Middle school	560(30.7)	901(49.4)	362(19.9)	2063(13.9)	4853(32.7)	7943(59.5)
	High school	345(25.1)	661(48.1)	369(26.8)	1760(8.0)	5864(26.8)	14275(65.2)
	University	36(13.6)	101(38.1)	128(48.3)	840(3.7)	4416(19.7)	17217(76.6)
Occupation	Managers	47(35.1)	62(46.3)	25(18.7)	406(6.7)	1276(21.2)	4335(72.0)
	Professionals	18(24.7)	31(42.5)	24(32.9)	316(3.5)	1986(22.1)	6676(74.4)
	Technicians. Technicians and Assistant Professionals	26(25.0)	36(34.6)	42(40.4)	264(5.2)	1023(20.2)	3769(74.5)
	Office Staff	13(13.1)	47(47.5)	39(39.4)	186(4.8)	928(24.1)	2742(71.1)
	Service and Sales Staff	409(28.4)	749(51.9)	284(19.7)	1596(11.2)	4618(32.3)	8084(56.5)
	Qualified Agriculture, Forestry, and Aquaculture Workers	1920(69.7)	796(28.9)	39(1.4)	6180(56.2)	4022(36.6)	799(7.3)
	Artists and Related Workers	498(29.3)	915(53.9)	285(16.8)	1431(12.7)	3875(34.5)	5926(52.8)
	Plant and Machine Operators and Assemblers	319(35.2)	425(47.0)	161(17.8)	1172(12.8)	3025(33)	4959(54.2)
	Workers in Non-Skilled Jobs	800(36.2)	1195(54.1)	215(9.7)	1396(19.4)	3031(42.2)	2763(38.4)
	Not working	3089(39.6)	3843(49.3)	868(11.1)	8131(17.8)	14886(32.6)	22686(49.6)
Year	2014	1356(45.1)	1456(48.5)	193(6.4)	3862(19.6)	7462(37.8)	8406(42.6)

	2015	1198(41.4)	1456(50.3)	239(8.3)	3520(17.7)	7160(36.1)	9176(46.2)
	2016	992(38.2)	1314(50.6)	292(11.2)	3342(16.9)	6493(32.8)	9985(50.4)
	2017	1023(40.5)	1184(46.8)	322(12.7)	3370(16.6)	6239(30.7)	10711(52.7)
	2018	1297(43.8)	1277(43.1)	387(13.1)	3493(16.6)	5827(27.6)	11773(55.8)
	2019	1273(39.4)	1412(43.7)	549(17.0)	3491(16.1)	5489(25.3)	12688(58.6)
Age	34 and under	992(34.6)	1347(47.0)	530(18.5)	2115(10.0)	6164(29.3)	12767(60.7)
	35-54	3623(39.3)	4442(48.2)	1155(12.5)	7923(14.5)	170001(31.10)	29767(54.4)
	55 and above	2524(49.2)	2310(45.0)	297(5.8)	11040(23.6)	15505(33.2)	20205(43.2)
Gender	Men	5933(42.5)	6507(46.6)	1532(11.0)	17411(17.4)	31944(31.8)	50996(50.8)
	Women	1206(37.1)	1592(49.0)	450(13.9)	3667(16.6)	6726(30.4)	11743(53.0)
Equivalent number of persons in the household	1-2.5	3561(38.7)	4399(47.8)	1249(13.6)	16698(16.2)	31415(30.4)	55130(53.4)
	2.6 and above	3578(44.7)	3700(46.2)	733(9.1)	4380(22.8)	7255(37.7)	7609(39.5)
Individuals aged five and under	Yes	2876(40.3)	3382(47.4)	882(12.4)	17039(18.1)	29395(31.2)	47646(50.6)
	No	4263(42.3)	4717(46.8)	1100(10.9)	4039(14.2)	9275(32.7)	15093(53.1)
Individuals aged 65 and over	Yes	2119(49.9)	1913(45.1)	211(5.0)	7588(25.8)	10091(34.4)	11691(39.8)
	No	5020(38.7)	6186(47.7)	1771(13.6)	13490(14.5)	28579(30.7)	51048(54.8)
Number of Children in the Household	No children	2103(45.6)	2062(44.7)	444(9.6)	12207(19.4)	19186(30.6)	31369(50.0)
	1-2	1906(35.6)	2621(49.0)	821(15.4)	6324(13.1)	15078(31.2)	26925(55.7)
	3 and above	3130(43.1)	3416(47.0)	717(9.9)	2547(22.3)	4406(38.7)	4445(39.0)
Number of employees	No employees	2286(39.3)	2911(50.1)	617(10.6)	5656(18.6)	10149(33.4)	14546(47.9)
	1	2518(34.7)	3635(49.9)	1120(15.4)	6558(12.4)	16546(31.4)	29669(56.2)
	2 and above	2325(56.4)	1553(37.7)	245(5.9)	8864(22.5)	11975(30.4)	18524(47.1)
Home ownership	Yes	4807(51.3)	4054(43.3)	504(5.4)	15340(20.5)	23006(30.8)	36346(48.7)
	No	2332(29.7)	4045(51.5)	1478(18.8)	5738(12.0)	15664(32.8)	26393(55.2)
Number of rooms in the residence	2 and under	2096(51.3)	1799(44.0)	194(4.7)	3395(36.9)	3583(38.9)	2221(24.1)
	3	3203(41.9)	3688(48.3)	752(9.8)	9636(20.8)	16176(34.9)	20549(44.3)
	4 and above	1840(33.5)	2612(47.6)	1036(18.9)	8047(12.0)	18911(28.3)	39969(59.7)

Among poor households participating in the survey, 42.1% of those using traditional fuel types were married, while 38.6% had never married. In terms of education level, 48.4% were illiterate, 42.7% were elementary school graduates, 30.7% were middle school graduates, 25.1% were high school graduates, and 13.6% were university graduates. When examined in terms of household occupation, 35.1% are managers, 24.7% are professionals, 25% are technicians, technical staff, and support staff, 13.1% are office workers, 28.4% are service and sales personnel, 69.7% are skilled agricultural, forestry, and fishery workers, 29.3% are artisans and related workers, 35.2% are plant and machine operators and assemblers, 36.2% are unskilled workers, and 39.6% are not working. 45.1% used traditional fuel types in 2014, 41.4% in 2015, 38.2% in 2016, 40.5% in 2017, 43.8% in 2018, and 39.4% in 2019. Among poor households participating in the survey, 11% of those using advanced fuel types were married, while 13.8% had never been married. In terms of education level, 5.4% are illiterate, 10.1% are elementary school graduates, 19.9% are middle school graduates, 26.8% are high school graduates, and 48.3% are university graduates. When examined in terms of household occupation, 18.7% are managers, 32.9% are professionals, 40.4% are technicians, technical staff, and support staff, 39.4% are office workers, 19.7% are service and sales workers, 1.4% are skilled agricultural, forestry, and fishery workers, 16.8% are artisans and related workers, 17.8% are plant and machine operators and assemblers, 9.7% are unskilled workers, and 11.1% are not working.

Among non-poor households participating in the survey, 17.1% of those using traditional fuel types were married, while 17.6% had never married. Among non-poor households participating in the survey, 51.2% of those using advanced fuel types were married, while 51.1% had never been married. In terms of education level, 25.7% are illiterate, 40.1% are elementary school graduates, 59.5% are middle school graduates, 65.2% are high school graduates, and 76.6% are university graduates. When examined in terms of household occupation, 72% are managers, 74.4% are professionals, 74.5% are technicians, technical staff, and support staff, 71.1% are office workers, 56.5% are service and sales personnel, 7.3% are skilled agricultural, forestry, and fishery workers, 52.8% are artisans and related workers, 54.2% are plant and machine operators and assemblers, 38.4% are unskilled workers, and 49.6% are not working.

4.2. Model Estimation

The parameters linked to the heating fuel preferences of the study's poor and non-poor families were identified using multinomial probit regression analysis. Table 2 displays the estimated model findings. In order to incorporate the independent variables in the multinomial probit model, the study examined if there was multicollinearity. Moderate multicollinearity is thought to result from variance inflation factor (VIF) values of 5 and higher, whilst high multicollinearity is thought to result from values of 10 and higher [53]. There are no factors in this study that are causing multicollinearity issues.

The models established for fuel preferences of poor and non-poor households are shown in Table 2.

Table 2. Model Coefficient Estimates

Variables	Poor				Non-poor			
	Traditional		Advanced		Traditional		Transition	
	β	S.E	β	S.E	β	S.E	β	S.E
Constant term	-0.003	0.089	-1.622[a]	0.117	1.133[a]	0.047	1.263[a]	0.041
Marital status (reference:single)								
Married	0.014	0.056	-0.286[a]	0.071	0.074[a]	0.024	0.055[a]	0.020
Educational level (reference: illiterate)								
Elementary school	-0.133[a]	0.037	0.346[a]	0.056	-0.761[a]	0.023	-0.522[a]	0.021
Middle school	-0.269[a]	0.057	0.564[a]	0.072	-1.172[a]	0.029	-0.807[a]	0.026
High school	-0.370[a]	0.065	0.751[a]	0.076	-1.556[a]	0.029	-1.072[a]	0.025
University	-0.547[a]	0.151	1.177[a]	0.134	-1.963[a]	0.035	-1.351[a]	0.028
Occupation (reference: not working)								
Managers	0.036	0.170	-0.025	0.199	-0.221[a]	0.042	-0.159[a]	0.032
Professionals	0.089	0.249	-0.212	0.248	-0.106[b]	0.046	0.142[a]	0.032
Technicians. Technicians and Assistant Professionals	0.203	0.208	0.542[a]	0.200	-0.340[a]	0.047	-0.213[a]	0.035
Office Staff	-0.407[c]	0.230	0.209	0.198	-0.310[a]	0.053	-0.031	0.037
Service and Sales Staff	-0.206[a]	0.068	0.006	0.081	-0.044	0.029	0.114[a]	0.024
Qualified Agriculture, Forestry, and Aquaculture Workers	0.760[a]	0.060	-0.805[a]	0.109	-2.268[a]	0.033	1.559[a]	0.031
Artists and Related Workers	-0.233[a]	0.065	-0.060	0.079	-0.101[a]	0.031	0.053[b]	0.026
Plant and Machine Operators and Assemblers	0.028	0.077	0.070	0.093	-0.062[c]	0.032	0.030	0.027
Workers in Non-Skilled Jobs	-0.141[b]	0.059	-0.375[a]	0.079	0.385[a]	0.033	0.455[a]	0.029

Year (reference: 2014)								
2015	-0.094[c]	0.048	0.125[c]	0.074	-0.122[a]	0.023	-0.095[a]	0.019
2016	-0.106[b]	0.050	0.280[a]	0.072	-0.232[a]	0.023	-0.238[a]	0.019
2017	0.013	0.050	0.424[a]	0.072	-0.268[a]	0.023	-0.327[a]	0.019
2018	0.141[a]	0.048	0.501[a]	0.070	-0.299[a]	0.023	-0.451[a]	0.019
2019	0.080[c]	0.048	0.624[a]	0.067	-0.371[a]	0.023	-0.564[a]	0.019
Age (reference: 34 and under)								
35-54	-0.188[a]	0.046	-0.071	0.55	-0.149[a]	0.023	-0.077[a]	0.018
55 and above	-0.128[b]	0.060	-0.161[b]	0.080	-0.063[b]	0.028	-0.004	0.023
Gender (reference: Men)								
Women	-0.137[b]	0.054	0.173[b]	0.067	-0.375[a]	0.025	-0.285[a]	0.021
Equivalent number of persons in the household (reference: 1-2.5)								
2.6 and above	0.087[b]	0.042	-0.033	0.053	0.108[a]	0.023	0.177[a]	0.019
Individuals aged five and under (reference: no)								
Yes	0.050	0.038	-0.013	0.050	0.046[b]	0.022	0.025	0.018
Individuals aged 65 and over (reference: no)								
Yes	0.047	0.042	-0.251[a]	0.066	0.187[a]	0.019	0.083[a]	0.017
Number of Children in the Household (reference: no children)								
1-2	-0.167[a]	0.050	-0.102	0.066	0.027	0.020	0.113[a]	0.016
3 and above	-0.042	0.062	-0.247[a]	0.083	0.445[a]	0.034	0.387[a]	0.029
Number of employees (reference: no employees)								
1	0.063	0.050	0.284[a]	0.065	-0.150[a]	0.023	-0.166[a]	0.020
2 and above	0.287[a]	0.059	0.133[c]	0.081	0.023	0.027	-0.212[a]	0.023
Home ownership (reference:no)								
Yes	0.381[a]	0.317	-0.425[a]	0.043	0.137[a]	0.015	-0.105[a]	0.012
Number of rooms in the residence (reference: 2 and under)								
3	-0.224[a]	0.0367	0.268[a]	0.059	-0.791[a]	0.026	-0.497[a]	0.024
4 and above	-0.457[a]	0.041	0.726[a]	0.060	-1.304[a]	0.026	-0.793[a]	0.024

[a]p <.01; [b]p <.05; [c]p <.10

The marginal effects of factors related to the heating fuel preferences of poor households are presented in Table 3.

Table 3. Marginal Effect Values for Fuel Preferences in Heating Among Low-Income Households

Variables	Poor Households						VIF
	Traditional		Transition		Advanced		
	M.E	S.E	M.E	S.E	M.E	S.E	
Marital status (reference: single)							
Married	0.670[c]	0.040	0.041	0.033	-0.434[a]	0.096	2.25
Educational level (reference: illiterate)							
Elementary school	-0.141[a]	0.024	0.025	0.022	0.661[a]	0.088	1.74
Middle school	-0.290[a]	0.041	0.050	0.032	1.063[a]	0.103	1.50
High school	-0.423[a]	0.051	0.051	0.035	1.363[a]	0.103	1.41
University	-0.743[a]	0.141	-0.008	0.077	1.923[a]	0.138	1.21
Occupation (reference: not working)							
Managers	0.321	0.119	-0.012	0.096	-0.060	0.266	1.08
Professionals	0.102	0.165	-0.009	0.138	-0.376	0.355	1.12
Technicians. Technicians and Assistant Professionals	0.025	0.142	-0.212	0.132	0.576[a]	0.217	1.07
Office Staff	-0.402[c]	0.205	0.115	0.102	0.504[b]	0.226	1.08
Service and Sales Staff	-0.168[a]	0.052	0.086[b]	0.035	0.136	0.104	1.70

Qualified Agriculture, Forestry, and Aquaculture Workers	0.535[a]	0.033	-0.365[a]	0.042	-2.094[a]	0.205	2.45
Artists and Related Workers	-0.175[a]	0.050	0.107[a]	0.034	0.062	0.103	1.82
Plant and Machine Operators and Assemblers	0.007	0.549	-0.025	0.044	0.079	0.120	1.47
Workers in Non-Skilled Jobs	-0.044	0.043	0.116[a]	0.031	-0.463[a]	0.113	1.98
Year (reference: 2014)							
2015	-0.087[b]	0.034	0.031	0.027	0.282[b]	0.117	1.64
2016	-0.121[a]	0.035	0.015	0.028	0.532[a]	0.112	1.59
2017	-0.058[c]	0.035	-0.063[b]	0.029	0.663[a]	0.111	1.58
2018	0.020	0.323	-0.139[a]	0.029	0.683[a]	0.107	1.66
2019	-0.049	0.033	-0.131[a]	0.028	0.902[a]	0.102	1.72
Age (reference: 34 and under)							
35-54	-0.124[a]	0.031	0.104[a]	0.028	0.035	0.079	2.52
55 and above	-0.063	0.04	0.089[b]	0.036	-0.149	0.118	3.64
Gender (reference: men)							
Women	-0.137[a]	0.04	0.036	0.03	0.356[a]	0.092	2.17
Equivalent number of persons in the household (reference: 1-2.5)							
2.6 and above	0.07[b]	0.029	-0.037	0.024	-0.115	0.077	2.13
Individuals aged five and under (reference: no)							
Yes	0.039	0.026	-0.022	0.022	-0.057	0.072	1.72
Individuals aged 65 and over (reference:no)							
Yes	0.075[a]	0.029	0.012	0.025	-0.428[a]	0.102	1.68
Number of Children in the Household (reference:no children)							
1-2	-0.105[a]	0.035	0.096[a]	0.03	-0.031	0.093	2.60
3 and above	0.014	0.043	0.058	0.037	-0.347[a]	0.12	4.68
Number of employees (reference:no employees)							
1	-0.004	0.036	-0.072[b]	0.028	0.387[a]	0.094	3.09
2 and above	0.181[a]	0.04	-0.162[a]	0.035	-0.014	0.121	3.23
Home ownership (reference:no)							
Yes	0.352[a]	0.022	-0.119[a]	0.018	-0.917[a]	0.062	1.25
Number of rooms in the residence (referans kategorisi: 2 and under)							
3	-0.181[a]	0.023	0.09[a]	0.023	0.638[a]	0.097	1.70
4 and above	-0.458[a]	0.028	0.114[a]	0.024	1.446[a]	0.095	1.77

[a]p <.01; [b]p <.05; [c]p <.10

According to Table 3, a married household head is 67% more likely to choose traditional fuel than a single household head, while being 43.4% less likely to choose advanced fuel. Pachauri and Jiang [28] note that married individuals tend to have larger households, which leads to cost-focused decisions in energy consumption. Particularly in poor households, married individuals' motivation to protect the family budget leads to the preference for traditional fuels, which are cheaper but pose health risks. Similarly, Heltberg [54] emphasizes that low-income households progress more slowly in energy transition and that married individuals may remain more attached to traditional habits due to responsibilities within the family. This may result in a more limited transition to modern fuels compared to single individuals. Furthermore, a meta-analysis by van der Kroon and Brouwer [29] found that marital status is an influential factor in energy preferences, with married individuals often opting for more economical solutions to meet needs such as cooking and heating, largely due to having children.

A household with a high school graduate head is 42.3% less likely to choose traditional fuel than a household with an illiterate head, while 136.3% more likely to choose advanced fuel. Households with a university-educated head of household are 74.3% less likely to choose traditional fuels and 192.3% more likely to choose advanced fuels than households with an illiterate head of household. As the level of education increases, a tendency to move away from traditional fuels and toward more advanced fuels, which are cleaner, healthier, and more

efficient, has been observed. This finding is consistent with the "energy transition" theory, which is frequently emphasized in the energy consumption literature. Lewis and Pattanayak [55] state that educated individuals are both more aware of health risks and have greater access to information. This enables educated individuals to better assess the negative health effects of traditional fuels and more clearly see the advantages of modern fuels. Pachauri [56], in his study on rural households in India, showed that as the level of education increases, the rate of use of traditional fuels such as biomass decreases, and advanced energy sources such as electricity and LPG begin to be preferred. Similarly, Rahut and Behera [57], in their comparative analysis of poor households in Nepal, India, and Bangladesh, found that educated heads of households adopted more environmentally friendly and healthier alternatives in their energy consumption preferences.

Households where the head of household is a technician, technologist, or assistant professional are 57.6% more likely to choose advanced fuels than households where the head of household is not employed. A household where the head of the household works in office services is 40.2% less likely to choose traditional fuel and 50.4% more likely to choose advanced fuel than a household where the head of the household is not employed. A household where the head of the household is a service and sales worker is 16.8% less likely to choose traditional fuel and 8.6% more likely to choose transition fuel than a household where the head of the household is unemployed. A household where the head of the household is a skilled agriculture, forestry, and fisheries worker is 53.5% more likely to choose traditional fuel than a household where the head of the household is not working, while the likelihood of choosing transitional fuel is 36.5% lower and the likelihood of choosing advanced fuel is 209.4% lower. Households where the head of the household is employed in arts and related occupations are 17.5% less likely to choose traditional fuels than households where the head of the household is not employed, while they are 10.7% more likely to choose transitional fuels. Households where the head of the household works in unskilled jobs are 11.6% more likely to choose transition fuels than households where the head of the household does not work, but 46.3% less likely to choose advanced fuels. The study by van der Kroon and Brouwer [29] states that occupational status influences energy preferences and that individuals with regular income in particular tend to choose healthier and more efficient energy sources. Heltberg [54] also considered occupational status as a "socioeconomic status indicator" and noted that individuals with a regular source of income move away from traditional energy sources and turn to transitional and modern forms of energy. Household heads working in less formal occupational fields, such as agriculture and unskilled labor, are seen to be in a more vulnerable position in terms of both income and social security; therefore, they lag behind in modern energy use. Furthermore, the ease of access to traditional biomass (wood, dung, etc.) in the agricultural sector may contribute to this preference becoming a structural element [9].

In 2015, the likelihood of choosing traditional fuels was 8.7% lower than in 2014, while the likelihood of choosing advanced fuels was 28.2% higher. In 2016, the likelihood of choosing traditional fuels was 12.1% lower than in 2014, while the likelihood of choosing advanced fuels was 53.2% higher. In 2017, compared to 2014, the likelihood of choosing traditional fuels was 5.8% lower and the likelihood of choosing transitional fuels was 6.3% lower, while the likelihood of choosing advanced fuels was 66.3% higher. In 2018, compared to 2014, the likelihood of choosing transitional fuels was 13.9% lower, while the likelihood of choosing advanced fuels was 68.3% higher. In 2019, compared to 2014, the likelihood of choosing transitional fuels was 13.1% lower, while the likelihood of choosing advanced fuels was 90.2% higher.

A household where the head of household is aged 35-54 is 12.4% less likely to choose traditional fuel and 10.4% more likely to choose transition fuel compared to a household where

the head of household is aged 34 or younger. A household where the head of the household is aged 55 and above is 8.9% more likely to choose transitional fuels than a household where the head of the household is aged 34 and below. van der Kroon and Brouwer [29] state that age is effective in energy preferences and that as age increases, households generally tend toward safer and healthier fuel types. Heltberg [54] states that although older individuals tend to be more stable and traditional in their energy preferences, they are more likely to switch to transition fuels that are less harmful to the environment and health because they begin to pay more attention to health risks. Furthermore, Pachauri and Jiang [28] argue that the experience and household management responsibilities that come with age lead individuals toward more rational energy choices. In this context, it is suggested that younger individuals with limited experience in household management may be more inclined to choose cheaper or more readily available traditional fuels.

Households with individuals aged 65 and over are 7.5% more likely to prefer traditional fuels than households without individuals aged 65 and over, while they are 42.8% less likely to prefer advanced fuels. Households with elderly individuals use traditional fuels at a higher rate than households without elderly individuals. Pachauri and Jiang [28] emphasize that older individuals are not open to innovation in their energy preferences and tend to stick to traditional practices. Similarly, van der Kroon and Brouwer [29] note that although the tendency of older individuals to turn to traditional fuels conflicts with health awareness, factors such as cost, habit, and ease of access prevail in this preference. Furthermore, Heltberg [54] argues that poor households with elderly individuals are generally concentrated in rural areas, and this situation facilitates access to traditional fuels, thereby slowing down the energy transition.

Households headed by women are 13.7% less likely to use traditional fuels and 35.6% more likely to use modern fuels than households headed by men. This finding can be based on a previous study conducted on a Turkish sample, which found that having a male head of household increases the likelihood of the household being poor [58]. A household with an equivalent number of members of 2.6 or above is 7% more likely to prefer traditional fuel than a household with an equivalent number of members of 1-2.5. This can be based on previous studies that found households with an equivalent number of members of "2.6 and above" were more likely to be poor than households with an equivalent number of members of "1-2.5" [59]. Households with 1-2 children are 10.5% less likely to choose traditional fuels than households with no children, but 9.6% more likely to choose transition fuels. A household with 3 or more children is 34.7% less likely to choose advanced fuels than a household with no children. Pachauri [56] states that household size and number of children are important determinants of energy consumption, and that households with more children increase their energy consumption but have difficulty accessing modern energy sources due to economic constraints. Lewis and Pattanayak [55] emphasize that despite awareness of health risks in households with children, economic constraints hinder the transition to clean energy. Additionally, Heltberg [54] notes that energy needs increase exponentially with the number of children, but households struggle to switch to transition and advanced fuels due to income constraints. A household with only one worker is 7.2% less likely to choose transition fuels than a household with no workers, but 38.7% more likely to choose advanced fuels. A household with two or more workers is 18.1% more likely to choose traditional fuels than a household with no workers, but 16.2% less likely to choose transition fuels. Pachauri [56] states that household size and number of workers are decisive factors in energy consumption, that energy needs increase in households with more individuals and a higher number of workers, and that this situation affects energy preferences. Lewis and Pattanayak [55] state that the income level of employed individuals facilitates energy transition, but an increase in household size raises energy needs, which can sometimes trigger a return to traditional fuels.

A household head who owns their residence is 35.2% more likely to choose traditional fuel than a household head who does not own their residence, while they are 11.9% less likely to choose transitional fuel and 91.7% less likely to choose advanced fuel. In their study, Clancy and Skutsch [60] examined the relationship between home ownership and energy choice in rural areas and noted that homeowners tend to continue using wood and other biomass fuels due to long-term structural investments. These households are generally more dependent on local resources and move more slowly toward energy transition. Ahlborg and Hammar [61] addressed the relationship between home ownership and energy preferences from a sustainable development perspective, stating that social and financial support is critical to accelerate the energy transition for poor households that own their homes. The head of a household living in a residence with 3 rooms is 18.1% less likely to choose traditional fuel compared to the head of a household living in a residence with 2 or fewer rooms, while they are 9% more likely to choose transitional fuel and 63.8% more likely to choose advanced fuel. A household head living in a residence with 4 or more rooms is 45.8% less likely to choose traditional fuel than a household head living in a residence with 2 or fewer rooms, while the likelihood of choosing transitional fuel is 11.4% higher and the likelihood of choosing advanced fuel is 144.6% higher. Clancy and Skutsch [60] have stated that housing characteristics influence energy preferences and that households living in larger, more comfortable homes have easier access to modern energy options.

The marginal effects of factors related to fuel preferences for heating among non-poor households are presented in Table 4.

Table 4. Marginal Effect Values for Fuel Preferences in Heating Among Non-Poor Households

	Non-Poor Households						
	Traditional		Transition		Advanced		VIF
Variables	**M.E**	**S.E**	**M.E**	**S.E**	**M.E**	**S.E**	
Marital status (reference: single)							
Married	0.066[b]	0.028	0.029[c]	0.016	-0.040[a]	0.012	2.05
Educational level (reference: illiterate)							
Elementary school	-0.509[a]	0.019	-0.151[a]	0.013	0.534[a]	0.018	3.23
Middle school	-0.859[a]	0.029	-0.284[a]	0.018	0.754[a]	0.020	2.24
High school	-1.241[a]	0.030	-0.441[a]	0.017	0.922[a]	0.019	2.81
University	-1.704[a]	0.043	-0.641[a]	0.021	1.065[a]	0.019	3.46
Occupation (reference: not working)							
Managers	-0.215[a]	0.054	-0.098[a]	0.028	0.097[a]	0.015	1.53
Professionals	-0.217[a]	0.060	0.142[a]	0.025	-0.035[b]	0.017	2.12
Technicians. Technicians and Assistant Professionals	-0.353[a]	0.063	-0.125[a]	0.031	0.134[a]	0.016	1.46
Office Staff	-0.407[a]	0.072	0.033	0.031	0.066[a]	0.018	1.35
Service and Sales Staff	-0.118[a]	0.035	0.107[a]	0.019	-0.035[a]	0.013	1.98
Qualified Agriculture, Forestry, and Aquaculture Workers	1.372[a]	0.024	0.357[a]	0.018	-1.791[a]	0.037	1.79
Artists and Related Workers	-0.161[a]	0.038	0.067[a]	0.020	-0.000	0.013	1.85
Plant and Machine Operators and Assemblers	-0.096[b]	0.039	0.040[c]	0.022	0.001	0.014	1.70
Workers in Non-Skilled Jobs	0.236[a]	0.037	0.284[a]	0.020	-0.277[a]	0.018	1.53
Year (referans kategorisi: 2014)							
2015	-0.098[a]	0.026	-0.045[a]	0.014	0.077[a]	0.013	1.68
2016	-0.161[a]	0.026	-0.136[a]	0.014	0.166[a]	0.013	1.68
2017	-0.16[a]	0.026	-0.203[a]	0.014	0.211[a]	0.012	1.7

2018	-0.139[a]	0.026	-0.306[a]	0.015	0.265[a]	0.012	1.72
2019	-0.178[a]	0.026	-0.394[a]	0.015	0.321[a]	0.012	1.74
Age (referans kategorisi: 34 and under)							
35-54	-0.149[a]	0.027	-0.03[b]	0.014	0.069[a]	0.011	2.56
55 and above	-0.077[b]	0.032	0.012	0.018	0.018	0.014	3.84
Gender (referans kategorisi: men)							
Women	-0.345[a]	0.031	-0.165[a]	0.017	0.198[a]	0.011	2.04
Equivalent number of persons in the household (reference: 1-2.5)							
2.6 and above	0.043[c]	0.026	0.123[a]	0.014	-0.101[a]	0.012	1.6
Individuals aged five and under (reference: no)							
Yes	0.045[c]	0.026	0.01	0.014	-0.022[b]	0.011	1.82
Individuals aged 65 and over (reference:no)							
Yes	0.191[a]	0.02	0.025[b]	0.013	-0.082[a]	0.01	1.57
Number of Children in the Household (reference:no children)							
1-2	-0.024	0.023	0.091[a]	0.013	-0.052[a]	0.01	2.09
3 and above	0.341[a]	0.036	0.208[a]	0.021	-0.289[a]	0.02	2.22
Number of employees (reference:no employees)							
1	-0.104[a]	0.027	-0.104[a]	0.015	0.106[a]	0.012	3.23
2 and above	0.137[a]	0.03	-0.186[a]	0.018	0.08[a]	0.014	3.75
Home ownership (reference:no)							
Yes	0.23[a]	0.018	-0.121[a]	0.096	0.009	0.007	1.2
Number of rooms in the residence (reference: 2 and under)							
3	-0.586[a]	0.021	-0.142	0.015	0.518[a]	0.021	3.88
4 and above	-1.086[a]	0.022	-0.276	0.016	0.758[a]	0.02	4.07

[a]p <.01; [b]p <.05; [c]p <.10

According to Table 4, a married household head is 6.6% more likely to choose traditional fuel and 2.9% more likely to choose transitional fuel than a single household head, while being 4% less likely to choose advanced fuel. The literature generally finds that the transition from traditional fuels to advanced fuels accelerates with increasing income levels [10, 28]. However, this study shows that socio-cultural factors, which cannot be explained by income alone, come into play, as married individuals are more likely to prefer traditional and transitional fuels even in the non-poor group. The likelihood of married individuals living in larger households and the resulting differences in energy usage habits are important factors influencing this situation. Traditional or transitional fuels (e.g., wood, coal, LPG) are often considered more suitable for large-scale needs such as cooking communal meals or heating, and this preference may be reinforced by cultural norms [27]. Furthermore, since married individuals' energy preferences are shaped not only by their own choices but also by the habits and decisions of other household members, it is likely that the institution of marriage transforms energy preferences into a collective structure [55].

A household with a head of household who is a middle school graduate is 85.9% less likely to choose traditional fuel and 28.4% less likely to choose transitional fuel than a household with a head of household who is illiterate, while being 75.4% more likely to choose advanced fuel. A household with a high school graduate head is 124.1% less likely to choose traditional fuel and 44.1% less likely to choose transitional fuel than a household with an illiterate head, while 92.2% more likely to choose advanced fuel. A household with a university-educated head is 170.4% less likely to choose traditional fuel and 64.1% less likely to choose transitional fuel than a household with an illiterate head, while it is 106.5% more likely to choose advanced fuel. Previous studies have also found that households with higher education are more likely to choose modern fuels [8, 62]. This situation can be explained by the fact that households with higher education may have higher incomes and, therefore, their tendency to use modern fuels

may be due to their awareness of the economic and environmental benefits of modern fuel use [42]. For individuals with low levels of education but living above the poverty line, even if they have the economic means to afford advanced fuels, preferences based on habits, traditional knowledge, and low risk perception may delay energy transition [63].

A household headed by an employed head of household is 21.5% less likely to choose traditional fuel and 9.8% less likely to choose transitional fuel than a household headed by an unemployed head of household, while it is 9.7% more likely to choose advanced fuel. A household where the head of the household is a professional is 21.7% less likely to choose traditional fuel and 14.2% more likely to choose transitional fuel than a household where the head of the household is not employed, while the likelihood of choosing advanced fuel is 3.5% lower. Households where the head of the household is a technician, technologist, or assistant professional are 35.3% less likely to choose traditional fuel and 12.5% less likely to choose transitional fuel than households where the head of the household is not employed, while they are 13.4% more likely to choose advanced fuel. A household where the head of the household works in office services is 40.7% less likely to choose traditional fuel and 6.6% more likely to choose advanced fuel than a household where the head of the household is not employed. Households where the head of household is a service or sales worker are 11.8% less likely to choose traditional fuels than households where the head of household is not working, 10.7% more likely to choose transitional fuels, and 3.5% less likely to choose advanced fuels. A household where the head of the household is a skilled agriculture, forestry, and fisheries worker is 137.2% more likely to choose traditional fuel and 35.7% more likely to choose transitional fuel than a household where the head of the household is not employed, while being 179.1% less likely to choose advanced fuel. A household where the head of the household is an artisan or related worker is 16.1% less likely to choose traditional fuels and 6.7% more likely to choose transitional fuels than a household where the head of the household is not working. Households where the head of the household is a plant and machine operator and assembler are 9.6% less likely to choose traditional fuels than households where the head of the household is not employed, while they are 4% more likely to choose transition fuels. Households where the head of household works in unskilled jobs are 23.6% more likely to choose traditional fuels and 28.4% more likely to choose transitional fuels than households where the head of household does not work, while they are 27.7% less likely to choose advanced fuels. The finding that the head of household's occupational status is an important determinant of energy preferences in non-poor households shows that energy consumption behaviors depend not only on income level but also on lifestyles, environmental awareness, and socio-cultural value systems associated with one's position in the labor force. It is observed that in households headed by individuals working in skilled jobs such as managers, professionals, technicians, or office workers, dependence on traditional and transitional fuels has decreased, while the preference for advanced fuels has become more widespread. This situation reveals that the level of education, social environment, and lifestyle that come with professional status are directly reflected in energy preferences [64]. Individuals' positions in the workforce shape not only their economic opportunities but also their access to information, technical awareness, and perception of comfort. Individuals working in skilled jobs are more knowledgeable about the long-term advantages of advanced energy sources (cleanliness, time savings, health benefits), and this awareness can translate into energy preferences [12]. Another noteworthy finding is that individuals working in agriculture, forestry, and unskilled labor tend to rely much more heavily on traditional and transitional fuels. These occupational groups are more closely integrated with rural lifestyles and have easier physical access to traditional energy sources. Furthermore, it can be said that energy use in these groups is sustained through practices passed down from older family members, indicating that cultural transmission is also strong [29].

In 2015, compared to 2014, the likelihood of choosing traditional fuels was 9.8% lower and the likelihood of choosing transitional fuels was 4.5% lower, while the likelihood of choosing advanced fuels was 7.7% higher. In 2016, compared to 2014, the likelihood of choosing traditional fuels decreased by 16.1%, the likelihood of choosing transitional fuels decreased by 13.6%, while the likelihood of choosing advanced fuels increased by 16.6%. In 2017, compared to 2014, the likelihood of choosing traditional fuels was 16% lower and the likelihood of choosing transitional fuels was 20.3% lower, while the likelihood of choosing advanced fuels was 21.1% higher. In 2018, compared to 2014, the likelihood of choosing traditional fuels was 13.9% lower and the likelihood of choosing transitional fuels was 30.6% lower, while the likelihood of choosing advanced fuels was 26.5% higher. In 2019, compared to 2014, the probability of choosing traditional fuels was 17.8% lower and the probability of choosing transitional fuels was 39.4% lower, while the probability of choosing advanced fuels was 32.1% higher. The study shows that the year variable exhibits an increase in the preference for advanced fuels [50].

A household where the head of household is aged 35-54 is 14.9% less likely to choose traditional fuel and 3% less likely to choose transitional fuel compared to a household where the head of household is aged 34 or younger, while it is 6.9% more likely to choose advanced fuel. A household where the head of the household is aged 55 and above is 7.7% less likely to choose traditional fuel compared to a household where the head of the household is aged 34 and below. The effect of age on energy preferences is explained in relation to individuals' life experience, health, and environmental awareness levels [29]. Middle-aged individuals' higher sensitivity to both economic stability and quality of life directs them toward cleaner and more efficient energy sources [65]. There are studies that have obtained findings contrary to this finding of our study. Previous studies have found that as the age of the head of the household increases, the likelihood of choosing traditional fuels in households is higher, while the likelihood of choosing modern fuels is lower [65-67]. In these studies, this result has been partly attributed to “conservatism,” meaning that, according to the studies, most older people may be accustomed to using traditional fuels and therefore may be less willing to switch to modern energy types such as LPG [65]. Households headed by women are 34.5% less likely to choose traditional fuels and 16.5% less likely to choose transitional fuels than households headed by men, while they are 19.8% more likely to choose advanced fuels. In developed and urbanized households, it has been observed that as women's decision-making power within the household increases, their energy preferences shift towards more sustainable and efficient fuels [68]. The literature on fuel choice for heating purposes reveals that women exhibit both health- and comfort-oriented approaches in decision-making processes. Modern, clean, and lower-emission heating technologies are particularly embraced by women [69]. In non-poor households, women's educational level, time spent at home, and greater awareness of energy access facilitate the shift toward advanced heating technologies [55].

Households with an equivalent number of members of 2.6 or higher are 4.3% more likely to choose traditional fuels and 12.3% more likely to choose transitional fuels compared to households with an equivalent number of members between 1 and 2.5, while they are 10.1% less likely to choose advanced fuels. As the amount of energy required for heating increases in larger households, the tendency to turn to traditional or transitional fuels with low unit costs strengthens [37]. As household size increases, the heating area expands, which increases energy demand and fuel consumption. Consequently, the fixed-cost structure of advanced energy sources may be less attractive for these households [70].

Households with children under the age of five are 4.5% more likely to choose traditional fuels than households without children under the age of five, while they are 2.2% less likely to choose

advanced fuels. Fuel preferences differ in households with young children, particularly for health and economic reasons [26, 71].

Households with individuals aged 65 and over are 19.1% more likely to choose traditional fuels and 2.5% more likely to choose transitional fuels than households without individuals aged 65 and over, while they are 8.2% less likely to choose advanced fuels. It is noted that older individuals generally have conservative energy consumption habits and adapt more slowly to innovative or advanced energy sources [72].

Households with 1-2 children are 9.1% more likely to choose transitional fuels than households with no children, but 5.2% less likely to choose advanced fuels. A household with 3 or more children is 34.1% more likely to choose traditional fuel and 20.8% more likely to choose transitional fuel than a household with no children, while the likelihood of choosing advanced fuel is 28.9% lower. As the number of children in households increases, the amount of energy required for heating and the associated economic burden also increase [12].

A household with only one worker is 10.4% less likely to choose traditional fuel and 10.4% less likely to choose transitional fuel than a household with no workers, while it is 10.6% more likely to choose advanced fuel. A household with 2 or more workers is 13.7% more likely to choose traditional fuel than a household with no workers, 18.6% less likely to choose transitional fuel, and 8% more likely to choose advanced fuel. In single-worker households, the increase in advanced fuel use may be due to the more stable income in these households compared to other households, as the household economy is more limited. On the other hand, the increase in traditional fuel preferences in multi-worker households is related to household size and increased energy demand [56].

A household head who owns their residence is 23% more likely to choose traditional fuels than a household head who does not own their residence, while they are 12.1% less likely to choose transition fuels. Households living in their own homes, especially if they live in old and uninsulated buildings, may be inclined to use traditional fuels, which are less expensive and easier to obtain [73].

A household head living in a home with 3 rooms is 58.6% less likely to choose traditional fuels than a household head living in a home with 2 or fewer rooms, while being 51.8% more likely to choose advanced fuels. A household head living in a dwelling with 4 or more rooms is 108.6% less likely to choose traditional fuels and 75.8% more likely to choose advanced fuels than a household head living in a dwelling with 2 or fewer rooms. It is noted that housing size is an important variable reflecting economic status in energy consumption and fuel preferences. Households with larger living spaces tend to minimize traditional fuel use, taking into account fuel costs and health risks [12].

5. Conclusion

The study findings reveal that the marital status of the head of household influences fuel preference for heating in both poor and non-poor households, but this effect is much more pronounced in poor households. In poor households, married heads of household are more likely to heat with traditional fuels and less likely to prefer advanced fuels compared to single heads; this difference is much more limited in non-poor households. This situation necessitates the consideration of income level and marital status together in the design of energy policies. Targeted subsidies, financial support, and awareness campaigns should be developed to encourage the use of advanced heating fuels, especially for poor and married households.

The study findings show that the education level of the head of household significantly influences fuel preference for heating purposes, and this effect is observed in both poor and non-poor households, although the pattern of the effect differs. In poor households, as the

education level increases, the shift away from traditional fuels and towards advanced fuels increases remarkably, while in non-poor households, households with higher education levels move away from both traditional and transitional fuel preferences and directly towards advanced fuels. This situation necessitates that fuel policies be differentiated not only according to income level but also according to education level. Especially for poor households with low education levels, widespread educational programs aimed at increasing energy literacy should be developed along with mechanisms that encourage the use of advanced fuels.

While the use of advanced fuels is increasing in low-income households, particularly in occupational groups with regular incomes such as technicians, office workers, and the service sector; traditional fuel use is dominant and the preference for advanced fuels is significantly decreasing in households engaged in agriculture and unskilled jobs. In contrast, in non-poor households, the use of advanced fuels is more evenly distributed according to occupational status, while a tendency towards traditional fuels still exists among those in low-skilled jobs. This situation necessitates that energy policies be differentiated not only on the basis of income level, but also on the basis of job security and job quality. Support that increases access to advanced heating fuels for low-income households, especially those engaged in agriculture and low-skilled jobs, and local infrastructure investments should be prioritized.

In impoverished households, individuals in middle and older age groups tend to move away from traditional fuels and towards transitional fuels more than younger individuals. In contrast, in non-poverty households, both the use of traditional fuels decreases and the shift towards advanced fuels increases with age. This differentiation reveals that age-related energy preferences vary according to socioeconomic conditions. Accordingly, to facilitate the transition from transitional fuels to advanced fuels in impoverished households, infrastructure support, user-friendly technologies, and accessible energy support mechanisms should be implemented, particularly targeting older and middle-aged individuals.

In impoverished households, those headed by women reduce their use of traditional fuels and increase their use of advanced fuels compared to those headed by men. In non-poverty households, female heads of household show lower preferences for both traditional and transitional fuels, while preferring advanced fuels more. These findings suggest that energy policies should incorporate a gender perspective and empower female heads of household with programs that support the use of advanced fuels for heating.

In impoverished households, the tendency to use traditional fuels increases with the number of equivalent family members, while in non-poverty households of similar size, both traditional and transition fuels are preferred more, and the use of advanced fuels is less adopted. This situation highlights the need for energy policies that take household size and income level into account, and for targeted support mechanisms aimed at increasing access to advanced heating fuels, especially in large impoverished households.

In low-income households with elderly individuals, there is a noticeable increase in the use of traditional fuels while there is a significant decrease in the use of advanced fuels. Similar trends are observed in non-low-income households, although the decrease in the use of advanced fuels is more limited, with an increase in the use of traditional and transitional fuels. This situation necessitates the development of age-sensitive and income-targeted support programs to facilitate access to advanced heating fuels, especially in low-income households with elderly individuals.

In impoverished households, an increase in the number of children leads to a decrease in the use of advanced fuels, while a decrease or fluctuation is observed in transition fuel preferences; this reflects a tendency for poor households with children to prefer lower-cost fuels as energy costs increase. On the other hand, in non-poor households, as the number of children increases,

both traditional and transition fuel preferences increase, while the use of advanced fuels decreases; this suggests that families with older children are turning to mid-cost fuels to balance their fuel costs. In this context, in order to alleviate the burden of heating fuel costs due to the increase in the number of children, subsidy programs that encourage the use of advanced fuels, especially in poor households with many children, and energy-efficient housing improvement projects should be developed. In addition, education and support mechanisms should be designed to reduce energy expenditures for families with children, and the negative effects of energy poverty on family health and well-being should be minimized.

In impoverished households, those with only one working member increase their use of advanced fuels, while those with two or more working members increase their use of conventional fuels and decrease their preference for transitional fuels. In contrast, in non-poverty households, an increase in the number of working members increases the use of conventional fuels, but reduces the preference for transitional fuels, while the use of advanced fuels increases moderately. These differences reveal that household income sources are significant determinants of fuel preferences. In this context, it is necessary to develop programs and income support mechanisms that facilitate access to advanced heating fuels, especially for impoverished households with a low number of working members.

In low-income households, while homeowners are increasing their use of traditional fuels, there is a significant decrease in transitional and especially advanced fuel preferences. Similarly, in non-low-income households, homeowners are increasing their use of traditional fuels while decreasing their transitional fuel preferences. This situation reveals that in low-income homeowners, economic constraints persist in the choice of heating fuel type for their homes, and obstacles remain to the use of advanced fuels. In this context, it is necessary to prioritize the design of financial support and infrastructure improvement programs that encourage the use of advanced heating fuels in low-income homeowners.

In low-income households, an increase in the number of rooms leads to a significant increase in the preference for transitional and advanced fuels while reducing the use of traditional fuels; this increase is particularly pronounced in households with four or more rooms. Similarly, in non-high-income households, an increase in the number of rooms results in a greater decrease in traditional fuel use and a higher increase in the use of advanced fuels. These results demonstrate that increased home size and living standards are positive factors in the preference for advanced heating fuels. Policymakers should prioritize affordable and accessible energy solutions and housing improvement support programs to encourage the use of advanced fuels, especially in low-income households with smaller homes.

The study findings indicate that heating fuel preferences are influenced by the socioeconomic and demographic characteristics of the head of household. Accordingly, subsidies, financial support, and information programs should be developed to increase the use of advanced fuels in poor and married households. Widespread training programs to increase energy literacy and mechanisms to encourage the use of advanced fuels should be implemented for households with low levels of education. Infrastructure investments and support to facilitate fuel access should be prioritized for poor households engaged in agriculture and low-skilled work. User-friendly energy technologies and access support should be provided for middle and older age groups. Gender-based energy policies should be strengthened by supporting the use of advanced fuels by female heads of household. Subsidies, housing improvement projects, and training programs should be designed to reduce energy costs in large and multi-child poor households. Income support should be provided to poor households with few working members to facilitate access to advanced fuels. Financial support and improvements should be made to overcome economic and infrastructure barriers in poor households that own property. Priority should be given to affordable and accessible energy solutions and housing improvement support for poor

households with small homes. Energy policies should be designed in a multi-dimensional and targeted manner, taking into account the diverse needs of households; environmental sustainability should be supported while reducing energy poverty.