

Article

Understanding Energy Poverty among the Elderly: Insights from a Household Survey in Greece

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Abstract: Understanding the determinants of energy poverty among the elderly is crucial for shaping energy policies with significant economic and social implications. This research provides valuable insights into the factors influencing energy poverty among the elderly in Greece. To achieve the study's objectives, household survey data from 3651 elderly individuals for the year 2022 were utilized. The empirical findings, based on statistical and econometric analysis, affirm the influence of socioeconomic factors on the ability of the elderly to meet their energy needs and address energy poverty challenges. The analysis suggests that both household size and work-related pensions positively impact their ability to address their heating requirements. Elderly individuals with a higher level of education are less likely to experience energy poverty. Additionally, it is found that as perceived health status declines, elderly individuals are more likely to encounter difficulties in covering utility payments. These results underscore the importance of tailoring strategies to promote the adoption of energy poverty measures that cater to diverse demographic and income groups. This information is vital for ensuring that the elderly can afford to maintain a comfortable living environment without sacrificing other essential needs.

Keywords: energy poverty; socioeconomic profile; elderly; survey; Greece



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1. Introduction

The pursuit of the United Nations Sustainable Development Goals (SDGs) emphasizes the link between sustainable development and the endeavor to eradicate energy poverty. Specifically, SDG 7 aims to ensure access to affordable, reliable, and sustainable energy, recognizing the crucial role of energy in fostering broader socioeconomic progress [1]. As evidenced by recent studies, energy poverty not only impedes socioeconomic development but also hinders progress towards multiple SDGs, including those related to health, education, and economic well-being [2,3]. Therefore, by tackling energy poverty, societies not only contribute to the realization of SDG 7 but also fulfill the broader agenda of sustainable development, fostering resilient and equitable communities. Other studies emphasize the importance of addressing energy poverty as a global challenge and proposing policy measures to enhance energy access [4] and provide insights into the key challenges, and proposing strategies for addressing the energy poverty issues within the broader context of sustainable development [5].

Despite the European Union's (EU) commitment to promote sustainable energy policies, energy poverty remains a pressing issue. The EU experienced significant challenges, including a price spike and heightened volatility in global energy markets, primarily influenced by Russia's invasion of Ukraine. Eurostat reports indicate that 9.3% of the EU population faced challenges in adequately heating their homes in 2022. Additionally, nearly 7% of the EU population experienced utility bill arrears, and approximately 15% resided in dwellings with issues such as leaks, dampness, or rot in 2020 [6]. In the end of 2022, Greece recorded the highest energy poverty rate among EU countries, reaching 18.7% [6]. Additionally, 26.3% of the population experienced difficulties in paying their

utility bills [7]. Addressing energy poverty is a significant challenge for the Greek government. As outlined in Greece's National Energy and Climate Plan (NECP), the goal is to decrease energy poverty by at least 50% by 2025 and bring it below the EU average by 2030 [8]. To attain this goal, a cohesive and efficient strategy is necessary, focusing on sustained and thorough combat against energy poverty rather than temporary and short-term mitigation measures [9]. In September 2021, Greece unveiled an Action Plan aimed at tackling energy poverty, featuring a comprehensive strategy supported by specific measures. A primary policy instrument within this framework is the social tariff, which offers discounted electricity rates to economically or socially vulnerable residential consumers [10]. Between September 2021 and November 2022, Greece allocated 9 billion euros to energy subsidies, including measures like a Fuel Pass and a Power Pass, to assist consumers in covering utility bills. The Energy Transition Fund, established in 2021 to provide various subsidies for electricity, natural gas, heating oil, and transportation fuels, plays a crucial role in providing various subsidies to combat energy poverty and alleviate the impact of elevated energy prices [10]. However, research conducted by the EKPIZO Consumers Organization in 2022 indicates dissatisfaction among 92.3% of Power Pass beneficiaries with the subsidy amount [11]. Within the realm of the energy poverty and sustainability-related concept, several researchers have studied the field of energy poverty and its socioeconomic determinants, providing a comprehensive framework to address energy poverty based on household survey data [9–19]. A plethora of researchers have investigated how sociodemographic variables such as age [14,20,21], gender [22,23], educational attainment [24,25], and social networks [26], economic parameters such as income [26–28], employment status [29,30], and energy price fluctuations [31], and residence characteristics [16,17] such as ownership and residence type contribute to disparities in energy poverty.

Regarding sociodemographics, the influence of age on energy poverty is a pivotal factor [14,20,21]. The elderly often experience energy poverty due to income limitations, reduced mobility, and heightened vulnerability to health issues [29–34]. Research stresses that advancing age is a significant determinant of energy poverty, affecting the capacity of the elderly to afford and access sufficient heating or cooling services [20,21]. The socioeconomic circumstances of older populations differ from those of other age groups, necessitating a nuanced understanding of the unique challenges they encounter in securing affordable and reliable energy. Specifically, factors related to age, such as retirement and potential declines in income, contribute to the complexities of meeting energy-related expenses [31,33]. Gender dynamics in energy poverty are also a critical dimension that intersects with socioeconomic factors, influencing disparities in access to, and affordability of, energy services; this has received increased attention [21,22]. Analysis has shown that gender inequalities in income, employment, and education contribute to variations in energy poverty levels between men and women [23,24]. Research confirms gender disparities in energy poverty experiences [22], indicating that women, particularly in low-income households, may bear a larger burden in managing energy-related responsibilities, such as cooking and heating, which can be exacerbated by limited access to cleaner and more efficient energy sources [15]. Moreover, the analysis of household size and composition has shed light on the role of shared financial resources within larger families, contributing to enhanced energy affordability [24]. Larger households may face increased challenges in managing energy costs due to higher energy consumption demands [28]. This holds because the sharing of financial resources within larger families can contribute to better heating affordability, yet the overall impact depends on the balance between increased energy needs and the collective financial capacity of the household. Several studies have underscored the role of educational attainment [24,25]. Individuals with higher educational levels tend to have improved access to energy resources [25]. Similarly, other researchers focus into the significance of educational attainment, uncovering a positive association between higher educational levels and improved energy access [24].

When it comes to economic parameters, studies based on household surveys stress the link between income and energy poverty. More precisely, there is a pronounced association between lower income levels and a heightened risk of energy poverty among vulnerable populations by [14,34,35]. The economic crisis has also been recognized as a factor contributing energy poverty in households [36], with low-income households being more vulnerable to energy poverty [19]. Finally, studies shed light on the implications of policy interventions, emphasizing the effectiveness of targeted subsidies and financial assistance programs in alleviating energy poverty [37,38]. Research explores the impact of energy efficiency measures and finds that households with access to government-sponsored energy-saving initiatives are better equipped to mitigate energy poverty [26]. Low-income households are at a heightened risk of energy poverty due to insufficient funds to acquire energy-efficient, yet more expensive, equipment [13]. Occupational status also emerges as a pivotal factor of energy poverty. Studies have focused to including the impact of occupation on energy poverty, revealing that individuals in precarious employment conditions face heightened vulnerability [30]. The role of energy market dynamics is demonstrated, since fluctuations in energy prices can significantly impact the vulnerability of certain demographic groups. Scholars have expanded their focus beyond income to consider employment stability, revealing heightened vulnerability among households with precarious employment conditions [30]. The intricate relationship between employment stability and energy affordability is confirmed by the work of [29], concluding that job insecurity can exacerbate energy poverty. Furthermore, research has shed light on the geographical dimension [39,40]. Studies investigate the relationship between energy use and income in Indian households, providing insights into regional variations and shedding light on the socioeconomic factors influencing energy consumption patterns [41]. Others emphasize that rural households often experience higher levels of energy poverty due to limited infrastructure [42] and underscore that policy measures to alleviate energy poverty should follow a regional approach [40].

Authors also point out the role of housing characteristics, demonstrating that individuals residing in poorly insulated or substandard housing are more likely to experience energy poverty [16,18]. Moreover, studies have highlighted the influence of technological access, indicating that households lacking modern energy-efficient appliances may face higher energy costs [17]. Another study revealed that racial disparities can exacerbate energy poverty [43]. Finally, studies stress the importance of community dynamics, indicating that social networks and community-based programs play a pivotal role in enhancing energy affordability [44]. Finally, the analysis of health-related parameters suggests a reciprocal relationship wherein energy poverty contributes to health challenges, and vice versa [45].

Given the ongoing aging of societies, understanding the distinct challenges faced by older individuals in meeting their energy needs has gained significance for formulating effective policies to mitigate energy poverty. Existing empirical research on energy poverty in Greece primarily examines how socioeconomic factors impact energy poverty indicators for the general population [13,14,18,19,26,31,36,40]. However, these studies do not focus on specific demographic groups, such as the elderly, and the factors influencing energy poverty within this particular group. Several reasons justify the increased importance of analyzing socioeconomic variables in the context of energy poverty among the elderly. Specifically, elderly individuals often experience heightened susceptibility to health issues, reduced mobility, and fixed incomes, amplifying the impact of energy poverty on their well-being. Understanding these determinants is essential for crafting targeted interventions and policies that address the specific needs of older populations [20]. Inadequate heating or cooling can have severe health consequences for the elderly, particularly in terms of respiratory issues and increased susceptibility to illnesses [32]. The socioeconomic circumstances of the elderly may differ from other age groups, necessitating a tailored approach to ensure social equity in access to affordable energy sources [21]. Additionally, as societies undergo energy transitions, it becomes crucial to consider how older individuals adapt to new technologies and cope with changes in energy pricing [33]. Ad-

addressing energy poverty among the elderly not only promotes their quality of life but also contributes to environmental sustainability by encouraging the use of efficient energy sources [46,47]. As the proportion of elderly individuals in populations continues to grow, research focusing on the exploratory socioeconomic variables of the energy-poor elderly households becomes increasingly vital for developing inclusive policies. Understanding the distinctive challenges faced by older individuals in meeting their energy needs has gained interest [48,49]. However, to the best of the authors' knowledge, estimating the determinants of energy poverty within elderly households has gained little attention in the existing literature [50–55]. The present research aims to enrich the existing literature by specifically focusing on the factors influencing energy poverty among older individuals, shedding light on the interconnected relationships among socioeconomic status, housing conditions, and health-related variables.

To address this gap, the present research aims to profile the energy-poor elderly households, focusing on socioeconomic determinants, housing conditions, and health-related variables. This study analyzes household survey data obtained from 3651 elderly individuals, sourced by the Hellenic Statistical Authority (ELSTAT) for the year 2022 in Greece [56]. The objective is to reveal disparities in energy affordability among the elderly. The conclusion and policy implications embark on a comprehensive statistical and econometric exploration of energy poverty determinants among the elderly. By scrutinizing the specific challenges that the elderly encounter in relation to energy poverty, this research seeks to provide practical insights that can guide the development of policies and programs designed to improve their overall well-being.

The remainder of the paper is organized as follows: The Section 2 presents the materials and methods utilized in the empirical analysis, while the Section 3 presents and discusses the empirical findings of the study. Moving forward, the Section 4 provides concluding remarks and includes a recapitulation of the study's limitations and suggestions for future research.

2. Materials and Methods

The survey investigates the incidence of energy poverty among elderly consumers in Greece, utilizing annual household survey data of 2022 provided by the Hellenic Statistical Authority (ELSTAT), General Directorate of Statistical Surveys [56]. According to the Organisation for Economic Co-operation and Development (OECD), “elderly” refers to a person aged 65 years or more [57]. Similarly, the World Health Organisation (WHO) defined the elderly population as people aged 65 and over [48]. To address the research questions of the study, 3651 elderly individuals are chosen to comprehensively analyze the diverse impact of their socioeconomic characteristics on energy poverty. Table 1 summarizes the descriptive statistics of the variables related to the elderly used in the empirical analysis.

More specifically, taking into consideration previous studies that have focused on the general population, the present study opts to analyze the effect of socioeconomic characteristics of the elderly on the following two situations: (i) financial ability to have adequate heating (RQ1) and (ii) difficulties paying for utilities such as electricity and gas (RQ2). To do so, regression models are estimated using as independent variables the socioeconomics of the elderly.

More specifically, the following empirical models are estimated, respectively: First, a binary logistic regression model is estimated to predict the effect of socioeconomics on the elderly's financial ability to have adequate heating (Equation (1)) as follows:

$$\begin{aligned} \text{Logit}[Pr(Y = 1)] = & \alpha_0 + \alpha_1 \text{Age}_i + \alpha_2 \text{Gender}_i + \alpha_3 \text{Main occupation}_i + \alpha_4 \text{Elementary} \\ & + \alpha_5 \text{High school}_i + \alpha_6 \text{University degree}_i + \alpha_7 \text{Household size}_i + \alpha_8 \text{Ownership status}_i \\ & + \alpha_9 \text{Type of residence}_i + \alpha_{10} \text{Number of rooms}_i + \alpha_{11} \text{Work-related pensions}_i \\ & + \alpha_{12} \text{Pensions or allowances from spouse}_i + \alpha_{13} \text{General health}_i \\ & + \alpha_{14} \text{Chronic health problem}_i + \alpha_{15} \text{Feeling of socially excluded/isolated}_i + \varepsilon_i \end{aligned} \quad (1)$$

where the dependent variable Y is a binary variable indicating whether the elderly i is financially able to have adequate heating or not; specifically, the variable takes the value 1 when the respondent is able and zero otherwise;

Next, the following logistic regression expression is estimated to predict the effect of the socioeconomics on the elderly's having difficulties to pay for utilities such as electricity and gas (Equation (2)):

$$\begin{aligned} \text{Logit}[Pr(Y = 1)] = & \beta_0 + \beta_1 \text{Age}_i + \beta_2 \text{Gender}_i + \beta_3 \text{Main occupation}_i + \beta_4 \text{Elementary}_i \\ & + \beta_5 \text{High school}_i + \beta_6 \text{University degree}_i + \beta_7 \text{Household size}_i + \beta_8 \text{Ownership status}_i \\ & + \beta_9 \text{Type of residence}_i + \beta_{10} \text{Number of rooms}_i + \beta_{11} \text{Work-related pensions}_i \\ & + \beta_{12} \text{Pensions or allowances from spouse}_i + \beta_{13} \text{General health}_i \\ & + \beta_{14} \text{Chronic health problem}_i + \beta_{15} \text{Feeling of socially excluded/isolated}_i + \varepsilon_i \end{aligned} \quad (2)$$

where the dependent variable Y is a binary variable indicating whether the respondent i is facing difficulties to pay for utilities such as electricity and gas, taking the value 1 when the respondent is facing difficulties and zero otherwise;

Table 2 analytically presents the description of the independent socioeconomic variables included in Equations (1) and (2). The empirical results from the estimation of Equations (1) and (2) are presented in the next section of this study.

Table 1. Descriptive statistics of the elderly used in the empirical analysis ($n = 3651$).

Title 1	Minimum	Maximum	Mean	Std. Deviation
Age	66	84	74.25	5.393
Gender	0	1	49	0.500
Main occupation	0	1	0.74	0.437
Level of education completed	0	3	1.16	0.970
Household size	1	5	1.75	0.749
Ownership status	0	1	0.81	0.101
Type of residence	0	1	0.45	0.498
Number of rooms	1	6	3.17	0.928
Work-related pensions	0	42,000	7140.10	5399.75
Pensions or allowances from spouse	0	16,072	1187.41	2705.40
General health	1	5	2.61	0.865
Chronic health problem	0	1	0.54	0.498
Feeling of being socially excluded/isolated	1	5	3.33	0.932
Is there a financial ability to have adequate heating?	0	1	0.79	0.409
Having difficulties meeting payments for utilities such as electricity, gas, etc.?	0	1	0.25	0.434 ¹

¹ Source: ELSTAT, (2022) Household Annual Survey and author's calculations [56].

Table 2. Description of the independent variables of Equations (1) and (2) ($n = 3651$).

Independent Variables	Minimum
Age	Qualitative variable expressing the respondent's age
Gender	Dummy variable taking the value 1 if the respondent is male and zero if female
Main occupation	Dummy variable taking the value 1 if the respondent is retired and zero otherwise
Elementary	Dummy variable taking the value 1 if the respondent has completed elementary studies and zero otherwise
High school	Dummy variable taking the value 1 if the respondent has completed high school studies and zero otherwise
University degree	Dummy variable taking the value 1 if the respondent has a university degree and zero otherwise
Household size	Qualitative variable expressing the households' number of members
Ownership status	Dummy variable taking the value 1 if the respondent owns his/her residence and zero otherwise

Table 2. Cont.

Independent Variables	Minimum
Type of residence	Dummy variable taking the value 1 if the respondent resides in detached houses and zero otherwise
Number of rooms	Qualitative variable expressing the number of rooms
Work-related pensions	Qualitative variable expressing the work-related pensions of the respondents in euros
Pensions or allowances from spouse	Qualitative variable expressing the pensions or allowances from the spouse of the respondents in euros
General health	Qualitative variable expressing the perceived general status of the respondents, taking the values from 1 as very good to 5 as very bad
Chronic health problem	Dummy variable taking the value 1 if the respondent reporting having a chronic health problem and zero otherwise
Feeling of being socially excluded/isolated	Dummy variable taking the value 1 if the respondent reporting feelings of being socially excluded/isolated and zero otherwise

Source: ELSTAT, (2022) Household Annual Survey and author's calculations [56].

3. Results

The results of the statistical and econometric analyses regarding the energy poverty profile of the elderly are presented below.

3.1. Frequency Statistics

3.1.1. Socioeconomic Profile

The distribution of gender among the surveyed elderly population is relatively balanced, with females representing 50.9% and males 49.1%. The age distribution covers a broad range from 66 to 84 years old, with the average age of the respondents to be 75 years old, ensuring a representative view across different stages of elderly life. The educational background of the elderly varies significantly. A notable percentage of the elderly, accounting for 25.7%, have not attended school. Additionally, a substantial portion, constituting 47.2%, has only completed elementary school, indicating a basic level of education. Further, 12.5% of the elderly have successfully finished high school, reflecting a higher educational attainment. Finally, only 14.6% of the elderly participants hold a university degree. The majority of respondents (74.3%) are retired, while 25.7% have occupations categorized as economically inactive. The majority of the households of the elderly surveyed have a size of 2, with 50.3%, while households with 1 elderly person represent 39.4%. More than half of the respondents (54.7%) live in apartment buildings, while the remaining 45.3% reside in detached houses. The great majority of the elderly (85.3%) are homeowners. Regarding the number of rooms in residences, the most common response is three rooms (49.5%), followed by four rooms (22.9%). Smaller residences with one or two regular rooms have lower percentages, 1.7% and 18.8%, respectively.

The respondents' self-reported general health responses shed light on diverse attitudes among the elderly. A significant majority of the elderly, comprising 39.3%, characterize their health as good or fine (39.5%), while 11.4% reported a bad health status and 2.1% reported a very bad health status. Only a small fraction, 7.7%, mentioned a very good health status. The majority of respondents (54.5%) report having a chronic health problem, highlighting the prevalence of health issues among the elderly population. Finally, regarding the statement "I feel socially excluded/isolated", the responses exhibit a diverse range of sentiments among the elderly individuals. A minority, comprising 4.0%, expressed total agreement with the idea of social exclusion or isolation. Furthermore, 12.1% of respondents acknowledged agreement with the statement, and a substantial percentage of 38.9% neither agreed nor disagreed, suggesting a nuanced perception of social inclusion. Conversely, 36.8% disagreed with the statement, implying having no feelings of social exclusion or isolation. Finally, 8.1% of the elderly firmly reject the idea of experiencing social exclusion or isolation. These findings emphasize the complexity and diversity of experiences related to social connectedness among the surveyed elderly.

3.1.2. Energy Poverty Insights

The majority of respondents (78.8%) report having the financial ability for proper heating. However, a notable 21.2% of the elderly states a lack of financial means for adequate heating (Figure 1). In the last 12 months, a substantial portion of respondents faced challenges in meeting payments for utilities, including electricity and gas. Approximately 25% of the surveyed population reported experiencing difficulties in covering these essential expenses, indicating a notable financial strain (Figure 2). This finding underscores the importance of understanding and addressing economic factors that contribute to challenges in meeting basic utility payment.

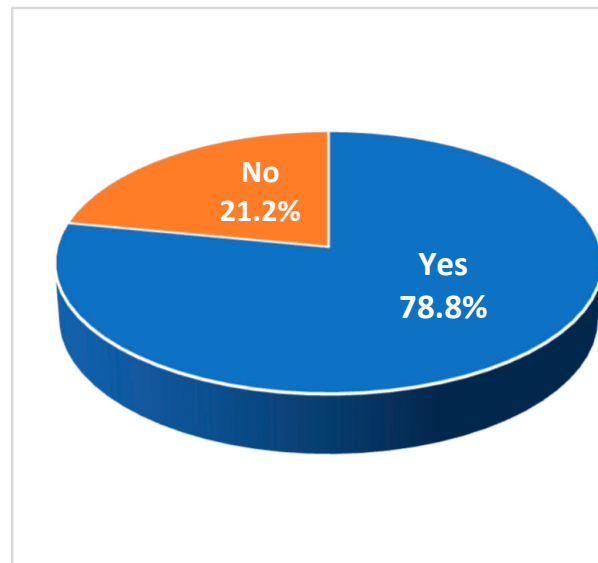


Figure 1. Can you afford adequate heating?

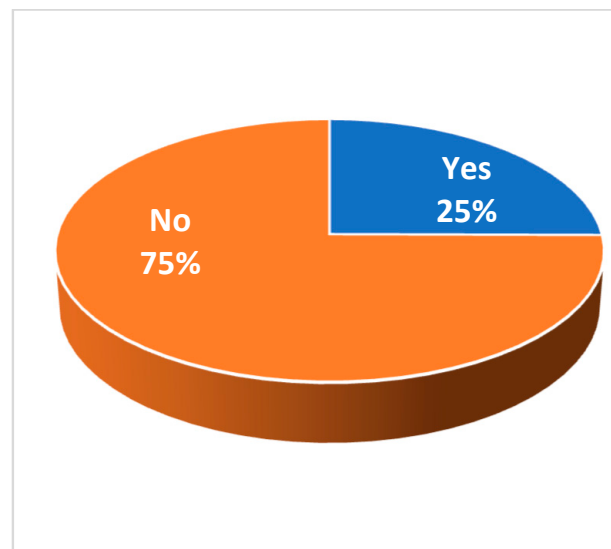


Figure 2. Are you struggling to pay for utilities like electricity and gas?

3.2. Econometric Analysis Results

Several results regarding the socioeconomic profile of the energy-poor elderly are obtained from the empirical estimations of Equations (1) and (2). Results of the fitted binary regressions estimations are summarized in Tables 3 and 4, respectively. Models I in each case present the initials estimations where all the independent variables of the Equations

(1) and (2) are included. Next, all statistically insignificant variables are omitted and results are presented in Models II.

Table 3. Estimated binary regressions results toward the socioeconomic determinants of the financial ability of the elderly for proper heating ($n = 3651$).

Independent Variables	Model I	Model II	
	Estimated Coefficients	Estimated Coefficients	Odds Ratio
Age	0.024 *** (7.782)	0.025 *** (8.191)	1.025
Gender	−0.062 (0.341)		
Main occupation	0.032 (0.096)		
Elementary	−0.214 ** (4.196)	−0.153 * (2.806)	0.857
High school	−0.160 (1.121)		
University degree	0.349 * (3.317)	0.405 ** (4.900)	1.499
Household size	0.375 *** (26.754)	0.370 *** (27.815)	1.448
Ownership status	−0.052 (1.711)		
Type of residence	0.023 (0.067)		
Number of rooms	0.163 *** (9.984)	0.173 *** (11.540)	1.888
Work-related pensions	0.0001 *** (73.253)	0.0001 *** (89.900)	1.0001
Pensions or allowances from spouse	0.0001 *** (19.572)	0.0001 *** (22.045)	1.00009
General health	−0.203 *** (9.150)	−0.212 *** (9.999)	0.809
Chronic health problem	−0.228 * (3.774)	−0.213 * (3.316)	0.807
Feeling of being socially excluded/isolated	0.301 *** (42.062)	0.300 *** (42.014)	1.350
Constant	−2.493 *** (12.582)	−2.638 *** (14.972)	0.0715
Log likelihood	3390.396	3400.542	
Nagelkerke R ²	0.151	0.149	

Note that ***, **, * represent levels of significance at 1%, 5% and 10%, respectively. Wald statistics are presented in parentheses.

Table 4. Estimated binary regression results toward the socioeconomic determinants of having difficulties meeting payments for utilities such as electricity, gas, etc. ($n = 3651$).

Independent Variables	Model I	Model II	
	Estimated Coefficients	Estimated Coefficients	Odds Ratio
Age	−0.037 *** (20.710)	−0.037 *** (22.511)	0.963
Gender	0.91 *** (8.539)	0.91 *** (9.950)	1.337
Main occupation	−0.011 (0.012)		
Elementary	−0.038 (0.159)		
High school	0.023 (0.0128)		
University degree	−0.588 *** (12.753)	−0.572 *** (13.980)	0.564
Household size	−0.024 (0.157)		
Ownership status	0.042 (1.206)		
Type of residence	0.157 * (3.566)	0.142 ** (3.134)	1.153
Number of rooms	−0.098 ** (4.463)	−0.103 ** (5.228)	0.901
Work-related pensions	0.0001 *** (46.580)	0.0001 *** (54.66)	1.0001
Pensions or allowances from spouse	0.0001 (0.249)		
General health	0.189 *** (9.146)	0.256 *** (12.862)	1.291
Chronic health problem	0.168 (2.440)		
Feeling of being socially excluded/isolated	−0.168 *** (15.234)	−0.171 *** (15.931)	0.843
Constant	2.215 *** (11.700)	2.146 *** (12.862)	8.550
Log likelihood	3386.938	3389.186	
Nagelkerke R2	0.085	0.084	

Note that ***, **, * represent levels of significance at 1%, 5% and 10%, respectively. Wald statistics are presented in parentheses.

As shown in Table 3, several demographic characteristics of the elderly are suitable to explain the probability of their financial ability for proper heating, with the exception of gender, which is not a statistically significant factor. In particular, the variable “age” is statistically significant with a positive sign, indicating that as age increases, the probability of being able to finance their heating also increases by 25%. This could be attributed to the accumulation of financial resources or maintaining a steady income during later years. Respondents’ occupational status is not estimated as a statistically significant determinant of the ability to finance adequate heating. On the contrary, educational status is found to be a determinant factor. In fact, university-educated elderly are more likely to be able to afford heating. This suggests that a higher level of education is linked to a greater likelihood of

being able to finance heating, reflecting the potential impact of educational achievements on economic well-being in later life. The household size positively affects the probability of the elderly to be able to pay for adequate heating. This result may indicate shared financial resources within larger families, contributing to better heating affordability.

Regarding residence characteristics, ownership status and type of residence are not significant factors to explain the ability of the elderly to have adequate heating. On the contrary, a positive effect of the number of rooms is estimated, indicating that elderly residing in larger houses are more likely than others to be able to finance properly their heating. Further, results highlight the importance of the economic status of the elderly to finance adequately their heating needs. More precisely, work-related pensions of the elderly and the pensions or allowances received from their spouse have a strong and positive impact on the ability to finance heating needs. This implies that high-income groups of elderly are more likely than others to be able to finance adequately their heating needs. This finding is consistent with the idea that a stable and relatively high income has a favorable impact on the ability to cover heating expenses.

Another important result is that the elderly's perceived beliefs toward their health status negatively affect their ability to finance heating adequately. In particular, those reporting chronic health problems are less likely to afford heating. Accordingly, as the perceived general health status of the elderly worsens, the probability of being able to finance adequately their heating decreases. These results may underscore the interdependence of health and financial well-being, as individuals reporting health issues encounter greater challenges in terms of affording heating expenses. Surprisingly, socially excluded or isolated elderly are more likely than others to finance their heating needs, indicating that social support networks or specific interventions targeting isolated elderly contribute to improving heating affordability.

As follows from Table 4, the elderly that recognize themselves as socially excluded or isolated are less likely to face difficulties paying utility bills. Social connections may have a protective role in financing isolated elderly and help them face their economic difficulties. Health-related expenses, especially for those with chronic health problems, can strain financial resources. Thus, as expected, the perceived general health status of the elderly has a positive effect on the inability to pay utility bills such as electricity and gas. This means that as the perceived health image worsens, the more likely the elderly are to face difficulties meeting utility payments. As health deteriorates, individuals may face increased medical expenses, adding to financial difficulties in meeting utility payments.

Regarding the impact of the demographic characteristics of the elderly, age and gender are sufficient to explain the probability of facing difficulties meeting their payments for utilities. In particular, as age increases, the probability of having difficulties decreases. This result contradicts stereotypes that older adults are more financially vulnerable. However, it may be attributed to possible financial support from other household members. Regarding the gender effect, results imply that men, rather than women, have an increased probability of having difficulties meeting payments for utilities by almost 34%. The university-educated elderly are less likely than others to be unable to pay their energy utilities, while the household size does not affect the probability to face difficulties in paying energy costs.

Empirical findings highlight the importance of the economic status of the respondent on paying their energy utilities. More precisely, high-income groups of elderly are more likely than others to be unable to pay their energy costs. The unexpected positive impact of work-related pensions on energy payment difficulties raises questions, possibly related to the level of pension received, where higher pensions disqualify individuals from certain financial assistance programs while not providing enough to cover all expenses. Alternatively, there might be other economic factors influencing this relationship, such as increased costs of standard of living or increased energy prices. Respondents' occupational status is not a determinant factor in adequately financing heating.

Finally, regarding the residence's characteristics, ownership status is not suitable to explain the ability of the elderly to pay their energy bills. On the contrary, those elderly

who reside in detached houses are more likely to meet difficulties regarding the payment of their energy utilities, possibly due to higher maintenance costs or property taxes. Finally, a negative effect of the number of rooms is estimated, which means that elderly residing in larger houses are less likely than others to be unable to pay their energy utilities. This result may be attributed to the fact that larger houses might be indicative of higher-income households, and thus, the financial capacity to cover energy utility expenses.

4. Conclusions

The empirical results in this study shed light on the intricate socioeconomic profile of energy-poor elderly in Greece. Demographic characteristics are identified as crucial determinants of the financial capacity of the elderly to meet their energy needs. Specifically, empirical findings suggest a negative relationship between age and the probability of experiencing energy poverty. This might be attributed to the accumulation of financial resources or potential financial support from other household members. Another important factor appears to be elderly's educational status, with the university-educated being less likely than others to be energy-poor. Previous literature indicates that individuals with higher educational levels have improved access to energy resources [24,25].

The pension amount of the elderly emerges as a strong predictor of their capacity to meet both their space heating needs and utilities costs. High-income groups exhibit increased space heating expenses [58]. The present study found that high-pensioned elderly are more likely to afford their heating needs. This result aligns with previous studies indicating that low-income households in the general population are more vulnerable to energy poverty [19]. However, research also concludes that high-income groups among the elderly are more likely to be unable to pay their energy costs. This result can be attributed to the fact that higher pensions render the elderly ineligible for specific financial energy assistance programs. Work-related pensions may not provide enough to cover all the elderly's expenses or the increased cost-of-living standards [59].

Dwelling characteristics play a crucial role in determining energy use and conservation practices [60]. The analyses underscore the importance of residence-related characteristics in understanding energy poverty among the elderly. What is more important is that social factors, including feelings of social exclusion or isolation and perceived health image, are found as influential in shaping the elderly's energy affordability. Previous research has stressed that retirees commonly experience feelings of social exclusion or isolation [61]. A relationship between energy poverty and experiencing health problems is also documented in the literature [62,63], with inadequate heating or cooling conditions having severe consequences for the elderly [32].

The study's results propose various policy recommendations to tackle the complexities linked to energy poverty among the elderly. Specifically, recognizing the substantial impact of residence characteristics, policymakers should consider the development of targeted housing assistance programs. These initiatives might encompass subsidies for energy-efficient home upgrades. Providing financial support to older individuals residing in larger houses would address their housing-related challenges contributing to energy poverty. Accordingly, promoting the adoption of energy-efficient technologies in the homes of the elderly can be valuable policy. Recognizing the importance of economic factors highlighted in the results, policymakers may provide incentives for the installation of energy-efficient heating systems and smart energy meter home technologies for the long-term alleviation of energy poverty. Finally, considering the results towards the importance of social networks and the elderly's sense of the of community and collaboration, policymakers are encouraged to explore community-based energy initiatives. These programs might entail neighborhood partnerships and promotion of energy communities to address energy affordability challenges.

However, the present study is not without limitations. It relies on self-reported data, which may be subject to biases and inaccuracies because the respondents might understate or overstate their financial status or energy affordability. In addition, there may be omitted

factors that influence energy poverty, such as specific regional economic conditions, energy price variations, or cultural influences. The most important is that, due to the nature of the household data, the study does not capture broader socioeconomic changes over time and macroeconomic factors that may impact the elderly population's energy affordability.

Further research should delve into the effectiveness of social interventions and support networks in facing the energy poverty among the elderly. Given the importance of economic factors, which are established from the present study, further examination of the relationship between various pension levels and eligibility for financial assistance programs is crucial. Analyzing potential thresholds and understanding the nuanced impact on energy affordability are essential for addressing the energy poverty of the elderly. Finally, complementing quantitative findings with qualitative insights can contribute to a more comprehensive understanding of the experiences and challenges faced by the energy-poor elderly.

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