

Low-income Households' Experiences and Perception of Home Energy Cost Burdens in Cheongju, South Korea

청주시 저소득 가구의 가정 에너지 비용 부담 경험과 인식

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Abstract

This study explored low-income households' experiences and perception of home energy cost burdens and determinants of the perceived home energy cost burdens. Between March and July 2014, a questionnaire survey was administered in Cheongju, South Korea. Among the 434 useable responses collected, responses from 218 households with monthly income less than 2,500,000 Korean Won (KRW) were compared with those of 216 households with higher incomes. The main findings are as follows. In the past three years, more than 10 percent of low-income households had had their electricity cut off; 5.7 percent had had their city gas cut off. To pay for their home energy expenses, nearly 70 percent of the low-income households had had to limit their heating, cooling or spending for other necessities; 38.3 percent had to borrow money. Low-income households reported more problems paying for home energy than higher-income households did. Households with more negative evaluation of rainwater leak, no one staying at home all day, monthly income less than 1,500,000 KRW and householders in their 40s and 50s tended to perceive a heavier home energy cost burden. Finally, the most popular support programs were fuel assistance and discounts on energy bills.

Keywords : Home Energy Cost, Energy Cost Burden, Low-income Households, Questionnaire Survey, Regression Analysis

주요어 : 가정 에너지 비용, 에너지 비용 부담, 저소득 가구, 설문조사, 회귀분석

I. Introduction

Home energy consumption is not only an important energy and environmental issue, but also a major household expense. As Lee et al. (2013) insisted, proper heating and cooling is essential for residents' physical and mental health.

In addition, for households with limited income, home energy costs could be critical for household finance, residents' health and their quality of life. In South Korea, "the energy poor" household has difficulty paying its home energy bills. More specifically, energy poor households that pay 10 percent or more of their income for electricity, gas and other fuels (Jin et al., 2010). Many energy poor people are elderly people who live alone and who are more vulnerable to extreme heat or

cold (Korea NGO's Energy Network, 2014).

The purpose of this study was to explore low-income households' experiences and perception of home energy cost burdens and determinants of the perceived home energy cost burdens. In order to pursue the study purpose, this study was focused on comparisons of low-income households' situation with that of households with higher income.

II. Literature Review

1. Definition of Low-income Household

In general, low-income status could be defined in relationship with income distributions of households in a specific society. Area median income (AMI) and income percentile are some of the most frequently used criteria to define household income levels.

The U.S. Department of Housing and Urban Development (HUD) defines low-income or very low-income households based on their AMI. According to the HUD definition, low-income households earn 80 percent or less of AMI; and very low-income households earn 50 percent or less of the AMI.

In the official final report of the 2012 Korea Housing Survey (KHS), household income levels were classified as

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low-, mid- and high-income based on the income percentile (Ministry of Land, Transport and Maritime Affairs, 2012, p. 47). In this classification, households whose incomes fell within the bottom 40 percent of the income rank order were defined as low-income. The low-income households defined in the 2012 KHS final report had monthly income of 2.2 million KRW or less.

In the report of the 2014 Household Income and Expenditure Survey (HIES), the most recent national statistics with household income information, household income quintile of households with two or more persons was reported (Statistics Korea, 2015). The upper limits of household monthly incomes in the lowest and second-lowest income quintiles in 2014 were 2,300,000 and 3,404,800 KRW, respectively. The upper limits of household monthly income in the lowest and second-lowest income quintiles in 2013 were 2,222,800 and 3,300,800 KRW, respectively.

As income quintile reported in the 2014 HIES official report did not include incomes of single-person households, a public-use microdata set of the 2013 HIES was consulted to define the income ranges of low-income households for this study. There were two reasons for using 2013 rather than 2014 data. First, the 2013 HIES microdata was the most recent microdata of HIES officially released for public use. Second, as the questionnaire survey of this study was administered in the first half of 2014, it was assumed that the respondents might have reported their income based for the previous year. According to the income distribution of the households responded to the 2013 HIES analyzed by the researcher of this study, upper limit of the monthly household income within bottom 40 percent was 2,572,853 KRW.

Combining the household income distribution of the 2013 HIES and low-income classification of the 2012 KHS final report, low-income households in this study were defined as those with a monthly income less than 2.5 million KRW.

2. Home Energy Costs of Low-income Households

Home energy costs are a major household expenditure. According to findings from the 2014 HIES, energy expenditure of the households with two or more persons comprised average 42.5 percent of total housing costs and approximately 4.4 percent of total household expenditure in South Korea in 2014 (Statistics Korea, 2015).

According to the 2011 energy consumption survey, households indicated that energy cost including home energy cost was the third-heaviest financial burden, followed by expenditures for food and education (Korea Energy Economics Institute, 2012).

Home energy cost could be more critical for households

with limited income. Lee et al. (2013) indicated that average energy costs-to-income ratio of households in the lowest income percentile was 13.2 percent while that of households in the top income percentile was only 1.8 percent.

Households with limited incomes were more likely to be negatively affected by home energy cost burdens because paying too much of their income for energy costs leaves little money for other necessities.

According to a previous study of the home energy cost burdens of low-income households in the United States, many of these households reported that they had to negotiate expenditures for grocery, medicine and other necessities to pay their energy bills (Emmel et al., 2010). Furthermore, low-income households perceived that energy-saving behaviors such as turning off lights or faucets when not in use would not be lower their home energy costs (Lee & Emmel, 2008).

According to a study of the home energy costs burdens of urban monthly renter households in Korea and the United States using microdata of the 2011 HIES, some low-income renter households in the bottom 25 percent in Korea were found to have spent up to 49 percent of their household income on their home energy costs (Lee, 2012).

In January and February, the coldest months in Korea, Kim (2012) conducted a survey of very low-income elderly in Seoul, South Korea, who were making their living by collecting recycling waste. Kim found that average indoor air temperature of their respondents' homes was only 16.5°C (61.7°F) and 32.4 percent were at or below 15°C (59°F). Kim concluded that as most of the respondents were renters, it was difficult to improve the situation through structural repairs.

According to Korea NGO's Energy Network's home energy survey of low-income households in winter and summer (2013, 2014), the majority of the energy poor were living without adequate heating or cooling and were therefore suffering from health problems.

III. Research Methods

1. Instrument

Data were collected through on-site questionnaire survey. The questionnaire was based on a review of a previous study (Emmel et al., 2010) and a questionnaire survey by the Citizens' Movement for Environmental Justice. After a pretest, a final questionnaire was confirmed. The final questionnaire includes four parts: A. Experience and perception of home energy cost burdens; B. Evaluation of physical condition of residence; C. Experience and preference of support programs; and D. General information.

2. Study Subjects

Subjects of this study were general households¹⁾ living in Cheongju, South Korea. Cheongju is a mid-sized city located in Chungbuk province, with 830,961 residents and 331,563 households as of February 2015 (Cheongju City Government, 2015). On July 1, 2014, which was in the middle of this study's survey period, City of Cheongju and Cheongwon-goon were consolidated as Cheongju. Thus, the survey area was the consolidated Cheongju including the areas that had previously been Choengwon-goon.

This study's target was low-income households as they were assumed to have a greater home energy cost burdens. Low-income households have a monthly household income less than 2.5 million KRW. A group of households with a higher income compared to the low-income households.

As it was difficult to sample low-income households and conduct the questionnaire survey, low-income households meeting this study's condition were sampled purposively by social workers at social welfare centers, self-sufficiency centers, and a home support service center for elderly. Higher-income households were sampled using convenience sampling.

3. Data Collection and Analysis

An on-site questionnaire survey was conducted between March and July 2014. When conducting a survey of low-income households that were purposively sampled, the survey was administered in interview style by social workers, because many of the respondents were elderly, illiterate or vision-impaired. For higher-income households, a self-administered questionnaire survey was used.

According to the results, 434 useable responses were collected. Among households sampled using convenience sampling, some households reported a monthly income of less than 2.5 million KRW. Regardless of sampling methods, households with monthly income less than 2.5 million KRW were classified as low-income. There were 218 responses from low-income households, and 216 from higher-income households.

Responses of high- and low-income households were compared using a series of chi-square tests of independence, independent sample *t*-test, and bivariate correlation analysis. A multiple regression analysis was used to explore determinants of perceived home energy cost burden of low-income households. For the entire data analysis procedure, IBM SPSS 21.0 was used.

1) In statistical terminology in Korea, general households include family (related), single-person and unrelated households with five or fewer members.

IV. Findings

1. Overview of Respondents

Demographic characteristics of low-income respondents whose monthly household incomes were less than 2.5 million KRW were compared with those of respondents with higher household incomes <Table 1>. Respondents from low-income households showed larger proportions of female respondents, and respondents aged 50 and over. Especially, 34.4 percent of low-income respondents were 70 years or older.

Table 1. Overview of Respondents

Characteristic	Income group		
	Low-income ^A	Higher-income ^B	TOTAL
Gender			
Male	74 (34.4%)	104 (48.1%)	178 (41.3%)
Female	141 (65.6%)	112 (51.9%)	253 (58.7%)
TOTAL	215 (100.0%)	216 (100.0%)	431 (100.0%)
Age (years)			
20-29	15 (7.0%)	16 (7.4%)	31 (7.2%)
30-39	30 (14.1%)	54 (25.0%)	84 (19.6%)
40-49	37 (17.4%)	64 (29.6%)	101 (23.5%)
50-59	53 (24.9%)	77 (35.6%)	130 (30.3%)
60-69	24 (11.3%)	3 (1.4%)	27 (6.3%)
70+	54 (25.4%)	2 (.9%)	56 (13.1%)
TOTAL	213 (100.0%)	216 (100.0%)	429 (100.0%)

Note. Percentages are valid percentages within each income group.

^AMonthly household income less than 2.5 million KRW

^BMonthly household income 2.5 million KRW or more

According to household characteristics <Table 2>, low-income households showed a greater proportion of single- or

Table 2. Household Characteristics

Characteristic	Group		
	Low-income	Higher-income	TOTAL
Household size			
1 person	68 (33.0%)	4 (1.9%)	72 (17.1%)
2 persons	34 (16.5%)	29 (13.5%)	63 (15.0%)
3-4 persons	91 (44.2%)	152 (70.7%)	243 (57.7%)
5 persons or more	13 (6.3%)	30 (14.0%)	43 (10.2%)
TOTAL	206 (100.0%)	215 (100.0%)	421 (100.0%)
Monthly household income (KRW)			
Less than 1.5 million	134 (61.5%)	0 (.0%)	134 (30.0%)
Less than 2.5 million	84 (38.5%)	0 (.0%)	84 (19.4%)
Less than 3.5 million	0 (.0%)	82 (38.0%)	82 (18.9%)
3.5 million or more	0 (.0%)	134 (62.0%)	134 (30.9%)
TOTAL	218 (100.0%)	216 (100.0%)	434 (100.0%)
Person staying at home all day			
Exist	99 (45.4%)	77 (35.6%)	176 (40.6%)
Not exist	119 (54.6%)	139 (64.4%)	258 (59.4%)
TOTAL	218 (100.0%)	216 (100.0%)	434 (100.0%)

Note. Percentages are valid percentages within each group.

two-person households than higher-income households. Nearly 70 percent of the low-income households were found to earn less than 1 million KRW monthly and 45.4 had one or more members who stayed at home all day.

According to tenure and structure types, low-income households showed a greater percentage of monthly renters with deposit and households living in single-family structures <Table 3>.

Jeon-se and *Sa-geul-se* are unique Korean rental types. A *Jeon-se* renter pays only a deposit to a landlord instead of monthly rent. The landlord keeps the interest on the deposit and returns the original deposit to the renter when the lease expires. *Sa-geul-se* is a kind of pre-paid monthly rental. A *Sa-geul-se* renter pays several months or a year's rent when the lease begins. Both *Jeon-se* and *Sa-geul-se* requires a lump sum.

Table 3. *Housing Characteristics*

Characteristic	Income group		
	Low-income	Higher-income	TOTAL
Tenure type			
Own	97 (45.1%)	186 (86.1%)	283 (65.7%)
Rent			
<i>Jeon-se</i>	40 (18.6%)	22 (10.2%)	62 (14.4%)
Monthly rent			
w/ deposit	45 (20.9%)	4 (1.9%)	49 (11.4%)
w/o deposit	10 (4.7%)	0 (0.0%)	10 (2.3%)
<i>Sa-geul-se</i>	9 (4.2%)	0 (0.0%)	9 (2.1%)
Other	14 (6.5%)	4 (1.9%)	18 (4.2%)
TOTAL	156 (100.0%)	215 (100.0%)	216 (100.0%)
Structure type			
Single-unit	79 (36.7%)	20 (9.3%)	99 (23.1%)
Multi-unit ^A	136 (63.3%)	194 (90.7%)	330 (76.9%)
TOTAL	215 (100.0%)	214 (100.0%)	429 (100.0%)

Note. Percentages are valid percentages within each income group.

^AMultifamily housing, *Da-ga-gu* housing and housing units in non-residential buildings

2. Experiences of Home Energy Cost Problems

To measure problems paying home energy bills, two types of questions were asked. The first question was whether or not the electricity or the gas had been cut off in the past three years (experienced, not experienced).

It was found that 10.8 percent of low-income households had had their electricity cut off and 5.7 percent had had their city gas cut off. <Table 4> compares the electricity and city gas cut-off experiences of low- and higher-income households using chi-square tests of independence. A significantly higher percentage of low-income households had experienced electricity or city gas cut-offs than higher-income households.

Five statements related to experiences of home energy cost burdens were then given and respondents were asked to respond to each one on a four-point scale: never (1);

Table 4. *Experiences of Electricity and City Gas Cut-offs by Income Group*

Item	Income group			χ^2
	Low-income	Higher-income	TOTAL	
Electricity cut-off				
Experienced	23 (10.8%)	9 (5.5%)	32 (7.4%)	
Not experienced	193 (89.4%)	207 (95.8%)	400 (92.6%)	6.615*
TOTAL	216 (100.0%)	216 (100.0%)	432 (100.0%)	
City gas cut-off				
Experienced	12 (5.7%)	1 (.5%)	13 (3.1%)	
Not experienced	198 (94.3%)	215 (99.5%)	413 (96.9%)	9.925**
TOTAL	210 (100.0%)	216 (100.0%)	426 (100.0%)	

Note. Percentages are valid percentages within each income group.

* $p < .05$, ** $p < .001$

sometimes (2); very often (3); and almost always (4). The five statements were as follows²⁾:

- In the past three years, I felt burdened by home energy costs [Burdened].
- In the past three years, I had to limit heating because of home energy cost [Heating].
- In the past three years, I had to limit cooling because of home energy cost [Cooling].
- In the past three years, I had to reduce spending on other necessities (e.g., groceries, medicine) in order to pay home energy bills [Necessities].
- In the past three years, I had to borrow money from a financial institution or from other people in order to pay home energy bills [Borrow].

According to low-income households' responses to these five statements <Table 5>, 87.0 percent felt burdened by their home energy costs in the past three years and 16.2 percent thought that their home energy cost burdens were constant.

Table 5. *Low-income Households' Frequencies to Experience Home Energy Cost Burdens*

Item	Never	Some-times	Very often	Almost always	TOTAL
Burdened	28 (13.0%)	98 (45.4%)	55 (25.5%)	35 (16.2%)	216 (100.0%)
Heating	65 (30.2%)	89 (41.4%)	39 (18.1%)	22 (10.2%)	215 (100.0%)
Cooling	64 (30.2%)	81 (38.2%)	39 (18.4%)	28 (13.2%)	212 (100.0%)
Necessities	64 (30.0%)	93 (43.7%)	41 (19.2%)	15 (7.0%)	213 (100.0%)
Borrow	132 (61.7%)	57 (26.6%)	15 (7.0%)	10 (4.7%)	214 (100.0%)

Note. Percentages are valid percentages within each income item.

2) Words in brackets at the end of the sentences are abbreviations to be used in tables.

Approximately 69.8 percent responded that they had to limit heating in order to pay home energy bills and 69.8 percent had to limit cooling. Seventy percent of low-income households reported that they had to negotiate spending for other basic needs in order to pay home energy bills; 38.3 percent had to get loans from financial institution or borrow money to pay their home energy bills.

Responses to the five home energy cost burden items were compared across the income groups using chi-square tests of independence. For ease of comparison, responses were recoded into dichotomous variables: "Never" was recoded as "not experienced" and "sometimes," "very often," and "almost always" were recoded as "experienced." According to <Table

Table 6. Experiences of Home Energy Cost Burdens by Income Group

Item	Income group			χ^2
	Low-income	Higher-income	TOTAL	
Burdened				
Experienced	135 (87.0%)	245 (89.3%)	380 (88.2%)	.530
Not experienced	28 (13.0%)	23 (10.7%)	51 (11.8%)	
TOTAL	216 (100.0%)	215 (100.0%)	431 (100.0%)	
Heating				
Experienced	150 (69.8%)	123 (57.5%)	273 (63.6%)	7.001**
Not experienced	65 (30.2%)	91 (42.5%)	156 (36.4%)	
TOTAL	215 (100.0%)	214 (100.0%)	429 (100.0%)	
Cooling				
Experienced	148 (69.8%)	130 (61.0%)	278 (65.4%)	3.619
Not experienced	64 (30.2%)	83 (39.0%)	147 (34.6%)	
TOTAL	212 (100.0%)	213 (100.0%)	425 (100.0%)	
Necessities				
Experienced	149 (70.0%)	86 (40.4%)	235 (55.2%)	37.669***
Not experienced	64 (30.0%)	127 (59.6%)	191 (44.8%)	
TOTAL	213 (100.0%)	213 (100.0%)	426 (100.0%)	
Borrow				
Experienced	82 (38.3%)	25 (11.8%)	107 (25.1%)	39.839***
Not experienced	132 (60.0%)	187 (83.4%)	319 (74.9%)	
TOTAL	214 (100.0%)	212 (100.0%)	426 (100.0%)	

Note. Percentages in parentheses are valid percentages within each group. ** $p < .01$, *** $p < .001$

>, significant group differences were found in three out of the five items. In summary, compared with higher-income households, significantly larger proportions of low-income households that had to limit heating, spending for other necessities, or borrow money to afford home energy costs.

Scores of each of the five energy cost burden items are never (1); sometimes (2); very often (3); and almost always (4). The average scores of the five items were compared across income groups using independent sample *t*-tests. According to the results, significant group differences were found in five out of the six items <Table 7>. Same as chi-square test results, independent sample *t*-test results showed that low-income households tended to have more problems paying their home energy costs.

Table 7. Comparisons of Energy Cost Burden Scores Between Income Groups

Item	<i>n</i>	Mean	<i>t</i>
Burdened			
Low-income	213	2.45	1.068
Higher-income	215	2.36	
Heating			
Low-income	215	2.08	3.473**
Higher-income	214	1.79	
Cooling			
Low-income	212	2.15	3.519***
Higher-income	213	1.84	
Necessities			
Low-income	213	2.03	6.800***
Higher-income	213	1.51	
Borrow			
Low-income	214	1.55	5.448***
Higher-income	212	1.18	
Average^A			
Low-income	217	2.06	5.298***
Higher-income	215	1.74	

Note. Never (1), sometimes (3), very often (3), almost always (4)

** $p < .01$, *** $p < .001$

^AAverage score of the five energy cost burden items: Burdened, Heating, Cooling, Necessities and Borrow

Relationships between low-income households' average home energy cost burden scores and eight characteristics of respondent, household and housing were compared using a series of independent sample *t*-tests, one-way ANOVA and Pearson's correlation analysis. Eight characteristics compared are respondents gender (female, male), age (30 years or younger, 40-59 years, 60+ years), household size, household income (less than 1.5 million KRW, 1.5 million KRW or more), presence of someone staying in the home all day (exist, not exist), tenure type (owner, *Jeon-se* renter, monthly renter, other), structure type (single-unit structure, multi-unit

structure) and age of structure (less than 10 years, 10-19 years, 20+ years).

Significant relationships were found in five out of the eight characteristics. A summary of the results follows:

- Gender ($t(212)=-2.597, p=.010$): Female (2.14) > Male (1.88)
- Age ($F=8.027, p=.000$): 40-59 years old (2.23) > 60+ years old (1.99) > 30 years old or younger (1.75)
- Households size ($r(205)=.108, p=.123$): No significant correlation
- Household income ($t(215)=2.401, p=.017$): Less than 1.5 million KRW (2.15) > 1.5 million KRW or more (1.91) (compared with Duncan's Posthoc test)
- Existence of persons staying at home all day ($t(2152)=-3.262, p=.001$): Not exist (2.19) > exist (1.89)
- Tenure type ($F=3.021, p=.031$): *Jeon-se* renter (2.21) \approx Monthly renter (2.17) \approx Other (2.19) > Owner (1.90) (compared with LSD Posthoc test).
- Structure type ($t(212)=-.766, p=.445$): No significant relationship
- Age of structure ($F=.053, p=.948$): No significant relationship

3. Evaluation of Physical Conditions of Home Structure

Respondents were asked to rate quality of eight structural conditions provided using a six-point scale ranging from "very poor (1)" to "very good (6)." Eight conditions given were wall and roof insulation, door and window insulation, indoor temperature in summer, indoor temperature in winter, rainwater leak, humidity/mold, ventilation, and natural lighting.

<Table 8> compares the structure evaluation between two income groups using independent sample *t*-tests. Significant differences were found in all eight items. In summary, low-income households tended to evaluate their structural quality worse than higher-income households did.

Correlations between eight home structure evaluation scores and six home energy cost burden scores were reviewed. <Table

Table 8. Evaluation of Home Structure Condition by Income Group

Item	<i>n</i>	Mean	<i>t</i>
Wall/roof insulation			
Low-income	213	3.53	
Higher-income	215	3.92	-2.978**
Door/window insulation			
Low-income	209	3.66	
Higher-income	216	4.06	-3.218**
Indoor temperature in summer			
Low-income	204	3.54	
Higher-income	215	4.06	-4.292***
Indoor temperature in winter			
Low-income	205	3.37	
Higher-income	215	3.89	-4.170***
Humidity/mold			
Low-income	206	3.65	
Higher-income	215	4.05	-2.270**
Rainwater leak			
Low-income	206	4.24	
Higher-income	214	4.76	-3.884***
Ventilation			
Low-income	207	4.15	
Higher-income	214	4.65	-3.875***
Natural lighting			
Low-income	211	4.00	
Higher-income	216	4.46	-3.368**

Note. Very poor (1)–very good (6)

** $p < .01$, *** $p < .001$

9) summarizes significant Pearson's correlation coefficients.

It shows that low-income households' evaluation of home structure condition had a significant negative relationship with home energy cost burdens. In general, the worse low-income households' home structure evaluation was, the heavier their perceived home energy cost burdens.

Especially, evaluation of wall or roof insulation showed significant negative correlation with all six home energy cost burden scores; and average home energy cost burden score

Table 9. Correlations Between Home Structure Evaluation and Home Energy Cost Burden

Evaluation of home structure condition	Perceived home energy cost burden					
	Burdened	Heating	Cooling	Necessities	Borrow	Average burden
Wall/roof insulation	-.175**	-.192**	-.157*	-.205**	-.193**	-.238***
Door/window insulation	.	-.154*	.	.	.	-.140*
Indoor temperature in summer	.	-.184**	.	.	.	-.174**
Indoor temperature in winter	-.186**	-.250***	-.182*	-.156*	.	-.230**
Humidity/mold	-.186**	-.172*	-.194**	-.146*	.	-.210**
Rainwater leak	.	-.191**	-.180*	-.172*	-.194**	-.217**
Ventilation	.	.	-.162*	-.188**	-.235**	-.208**
Natural lighting	.	.	.	-.156*	-.149*	-.144*

Note. Only significant Pearson's bivariate correlation coefficients are presented ($p < .05$). Home structure condition was evaluated in 6-point scale: Very poor (1)–very good (6). Perceived home energy cost burden was measured in 4-point scale: Never (1), sometimes (2), very often (3), almost always (4). * $p < .05$, ** $p < .01$, *** $p < .001$

showed significant negative correlations with all eight home structure evaluation scores. Evaluation of winter time indoor temperature, humidity/mold and rainwater leak showed significant correlations with five out of six home energy cost burden scores. The strongest correlations were found between evaluation of winter time indoor temperature and experience of using less heat to save money (-.250); and evaluation of wall or roof insulation condition and average score of home energy cost burdens (-.238).

4. Low-income Households' Experience of Support Programs

Among 218 low-income households, 83 (38.1%) had received assistance in the past three years to lighten their home energy cost burdens. Half of the low-income households that have had their electricity cut off in past three years had received assistance. Among low-income households that experienced city gas cut-offs in past three years, 45.5 percent had received assistance.

The most frequently received support programs were fuel support and discount on energy bills; these were selected by 35 households (multiple selections allowed). The relationship between average home energy cost burden score and the acceptance of assistance was examined using an independent sample *t*-test. According to the results, those two variables were found to be not significantly related at $p < .05$.

5. Determinants of Perceived Home Energy Cost Burdens of Low-income Households

To explore the determinants of low-income households' perceived home energy cost burdens, a multiple regression analysis was conducted using a stepwise method. Only 218 low-income households were included in the regression analysis. A dependent variable was average score of five home energy cost burden items. Independent variables are 167 variables encompassing five household and housing characteristics; and home structure evaluation that showed significant relationship with average home energy cost burden scores in previous analysis as shown in <Table 10>. Categorical variables were recoded into dichotomous dummy variables.

According to the final stepwise regression model summarized in <Table 11>, a linear combination of evaluation of rainwater leak, presence of someone staying at home all day, household income of less than 1.5 million KRW and householder's age between 40 and 59 years could explain 14.5 percent of the variance of perceived home energy cost burden.

According to the standardized regression coefficients, households with more negative evaluation of rainwater leak,

Table 10. Independent Variables Used in Regression Analysis

Variable	Description
GENDER	Householder's gender (dummy, 1=female)
AGE1	Householder's age (dummy, 1=40 to 59 years)
AGE2	Householder's age (dummy, 1=60 years or older)
INCOME	Household monthly income (dummy, 1=less than 1.5 million KRW)
STAY	Existence of persons staying at home all day (dummy, 1=exist)
TENURE1	Tenure type (dummy, 1=owner)
TENURE2	Tenure type (dummy, 1= <i>Jeon-se</i> renter)
TENURE3	Tenure type (dummy, 1=monthly renter)
WALL	Evaluation: Wall and roof insulation (numeric) ^A
DOOR	Evaluation: Door and window insulation (numeric) ^A
SUMMER	Evaluation: Summer indoor temperature (numeric) ^A
WINTER	Evaluation: Winter indoor temperature (numeric) ^A
HUMIDITY	Evaluation: Humidity or mold problems (numeric) ^A
LEAK	Evaluation: Rainwater leak (numeric) ^A
VENT	Evaluation: Ventilation (numeric) ^A
LIGHT	Evaluation: Natural lighting (numeric) ^A

^AVery poor (1)~very good (6)

no person staying at home all day, monthly income less than 1.5 million KRW and householder in their 40s and 50s tended to perceive a heavier home energy cost burden. Among the four variables included in the final stepwise model, evaluation on rainwater leak was found to be the best predictor of a household's perceived home energy cost burdens, followed by monthly income less than 1.5 million KRW.

Table 11. Determinant of Low-income Households' Home Energy Cost Burden: Summary of Regression Analysis

Item	Value
Model fit	
ANOVA: <i>F</i>	9.008 ($p=.000$)
R square	.181
Coefficient	
Unstandardized	
LEAK	-.103
STAY	-.234
INCOME	.271
AGE1	.244
(Constant)	2.253
Standardized	
LEAK	-.227
STAY	-.181
INCOME	.211
AGE1	.189

Note. Summary of only final stepwise regression model is presented. Dependent variable was average home energy cost burden ranging from 1 to 4 where a greater score meant that the household perceived home energy cost burdens more frequently. Refer to Table 10 for description of the independent variables.

5. Low-income Households' Preference on Support Programs

Respondents were asked to select up to three support programs they preferred to reduce their home energy cost burdens. According to low-income respondents' responses, the most preferred support program was fuel assistance (54.6%) followed by electricity bill discount (52.3%), weatherization (34.4%) and subsidies (32.1%) <Table 12>.

Table 12. *Low-income Households' Preference of Support Programs to Reduce Home Energy Cost Burden*

Program	n	%
Fuel aids	119	54.6
Electricity bill discount	114	52.3
Weatherization	75	34.4
Subsidies	70	32.1
Discount on district heating bills	58	26.6
Provision of heating appliances	54	24.8
Energy-efficient light bulbs	44	20.2
Grace period for city gas cut-off	9	4.1
Grace period for electricity cut-off	7	3.2
Coal coupons	7	3.2

Note. As respondents selected up to three programs, sum of percentage exceeds 100.

V. Conclusions

This study explores low-income households' experiences and perception of home energy cost burdens and determinants of the perceived home energy cost burdens. In this study, low-income households were defined as those with monthly income of 2.5 million KRW or less. The main findings are summarized as follows.

Many low-income households were found to have experienced energy problems and perceived home energy cost burdens during the past three years. More than 10 percent of low-income households had had their electricity cut off and 5.7 percent had had their city gas cut off. To pay their home energy bills, a majority of households had to keep temperatures low in winter, reduce cooling in summer, or even spend less on grocery and medicines. About 38 percent of the low-income households had to borrow money to pay their home energy bills. About 7.4 percent of the low-income households reported an electricity cut-off in the past three years, but only half of them had benefitted from support programs to lighten their home energy cost burdens.

When low-income households' experiences and perception of home energy cost burdens were compared with those of households with higher income, it was found that low-income households had experienced or perceived significantly more home energy cost burdens over the past three years.

It was also found that low-income households' perceived home energy cost burdens were associated with structural conditions. The poorer the condition of the home, the heavier the perceived home energy cost burden.

Even among low-income households, lower-income households tended to perceive more severe housing cost burdens. Furthermore, multiple regression analysis results indicated that evaluation of rainwater leak and whether or not with monthly income less than 1.5 million KRW had the strongest predictive influence on low-income households' home energy cost burdens.

In addition, the most preferred support programs to reduce home energy cost burdens were fuel assistance, energy bill discounts and weatherization. Grace periods for electricity or city gas cut-offs were less preferred.

Insufficient heating or cooling could have a negative effect on indoor temperature, humidity and mold problems, all which may compromise residents' health. In addition, some households might choose alternate heating methods which could expose the household residents to danger. Thus, energy cost burden of limited income households is not only a problem of individual households but could lead to fatal accidents and social problems.

A safe heating system is required in Korea's national minimum housing standards of Korea. When energy cost is not affordable, however, the heating system is useless. Thus, it is important to develop and implement programs and policies to assist low-income households to afford home energy costs without sacrificing the residents' basic needs and health. The most preferred support programs would be fuel assistance, as it allows low-income households to use the fuel regardless of changes in energy costs; and structural repairs including weatherization and crack sealing to improve the energy efficiency of structures.

In contrast to general assumption, households where no one is home all day reported more burdens than those with someone who is home. In additional analysis with higher-income households, households with someone staying at home all day perceived more home energy cost burdens. Thus, it is suggested to investigate factors in the relationship between perceived home energy cost burdens and the presence of someone who is always in the home, and income in order to understand energy cost burdens better.

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