Socioeconomic Expressions of Energy Poverty

Sreya Rapolu, Sean Franco, and Linsie Zou

Background

Do you turn off appliances when not in use?

Do you wear layers indoors instead of using heat?

Do you use a cold rag when it's hot out instead of turning on the AC?

Research Questions

- How do poverty status in 2020 and other socioeconomic factors impact people's ability to manage their energy consumption and, consequently, their health?
- Does energy poverty status relate to demographics such as race and income status?
- Do respondents require medical attention due to extreme heat or cold in their homes?

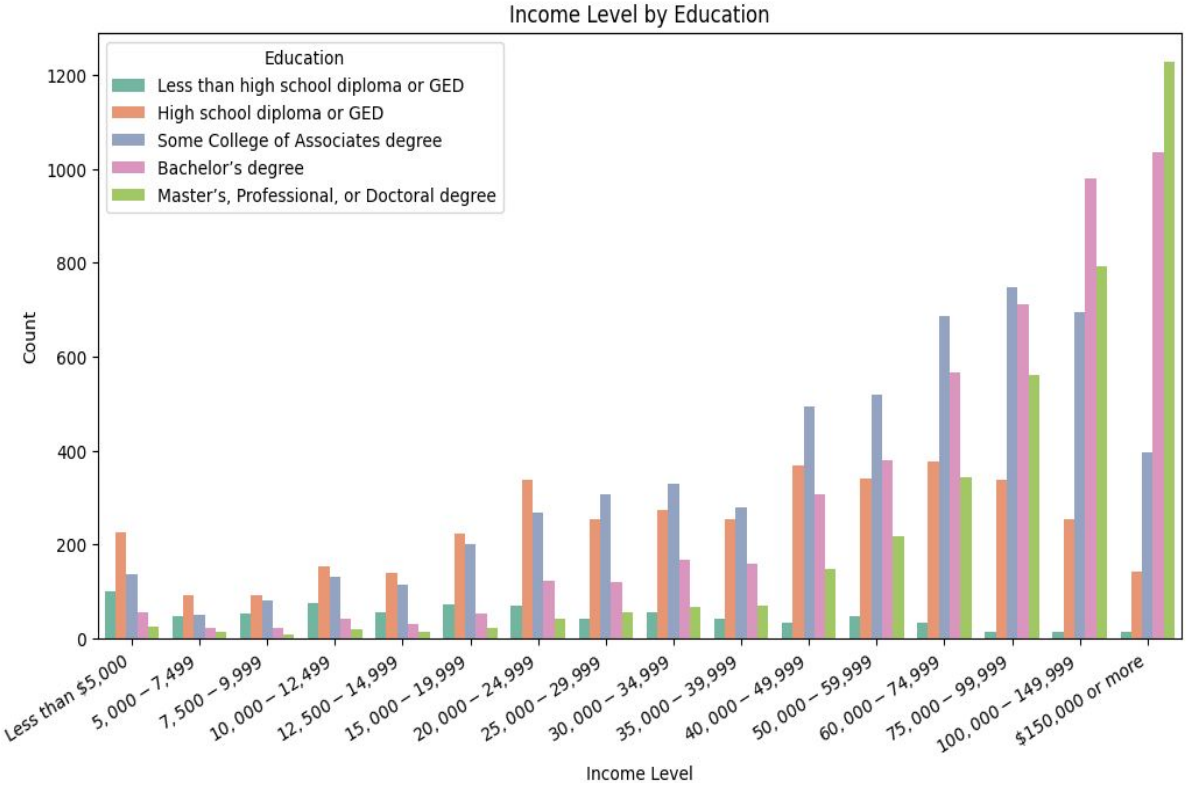
Literature

- Li et al. (2021):
  - Studied the relationship between energy poverty and energy efficiency; discovered that energy poverty reduces GDP
  - Over time, results in sharp declines in a nation's social welfare and low-income families are typically the ones who are directly affected
- Halkos and Gkampoura (2021):
  - Energy poverty was linked to energy prices, unemployment, and the number of persons at risk of poverty
  - GDP is inversely associated to energy poverty, which supports the findings of Li et al. (2021)
- Recalde et al. (2019):
  - Introduced Structural Energy Poverty Vulnerability (SEPV) index
  - Countries with lower SEPV scores experienced significantly higher rates of energy poverty and increased risk of excess winter mortality
- Pan, Biru, and Lettu (2021):
  - Energy poverty has a harmful impact on public health
  - Higher living standards lessen the effects

Data Overview

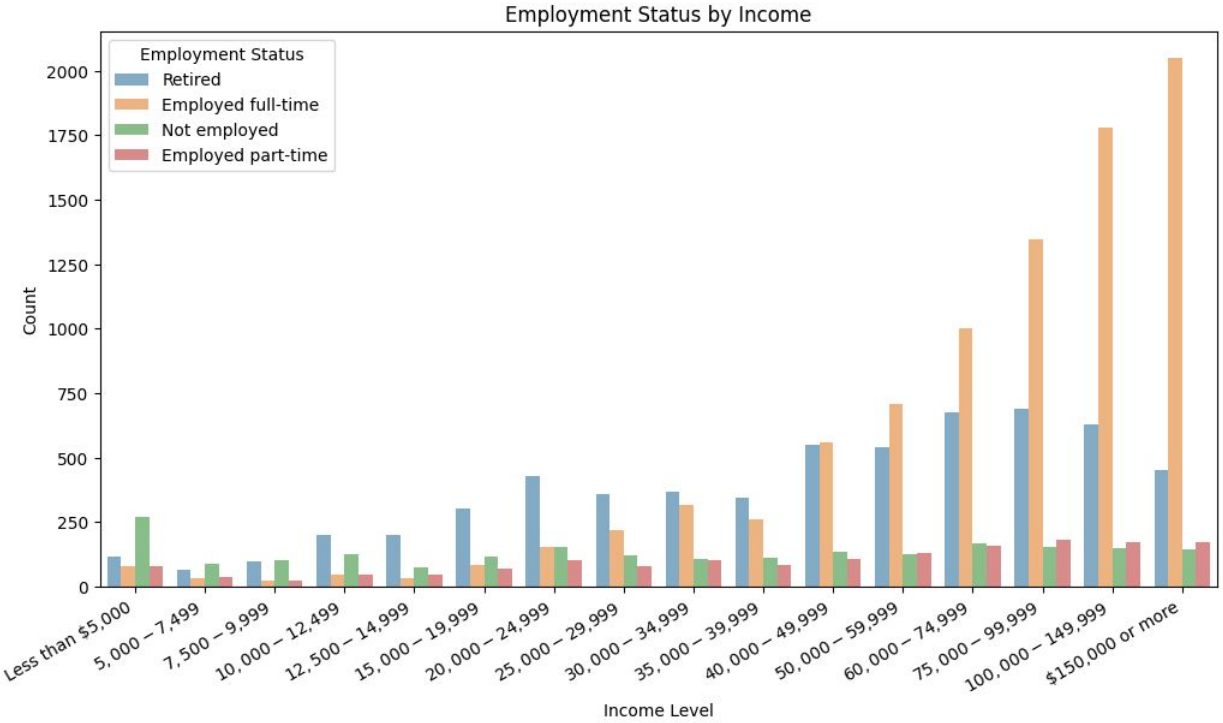
- US Energy Information Administration's (EIA)
- Residential Energy Consumption Survey (RECS)
  - Survey conducted every 5 years
  - 700 variables
  - ~18,500 households surveyed
  - 2020 Survey

Exploratory Data Analysis



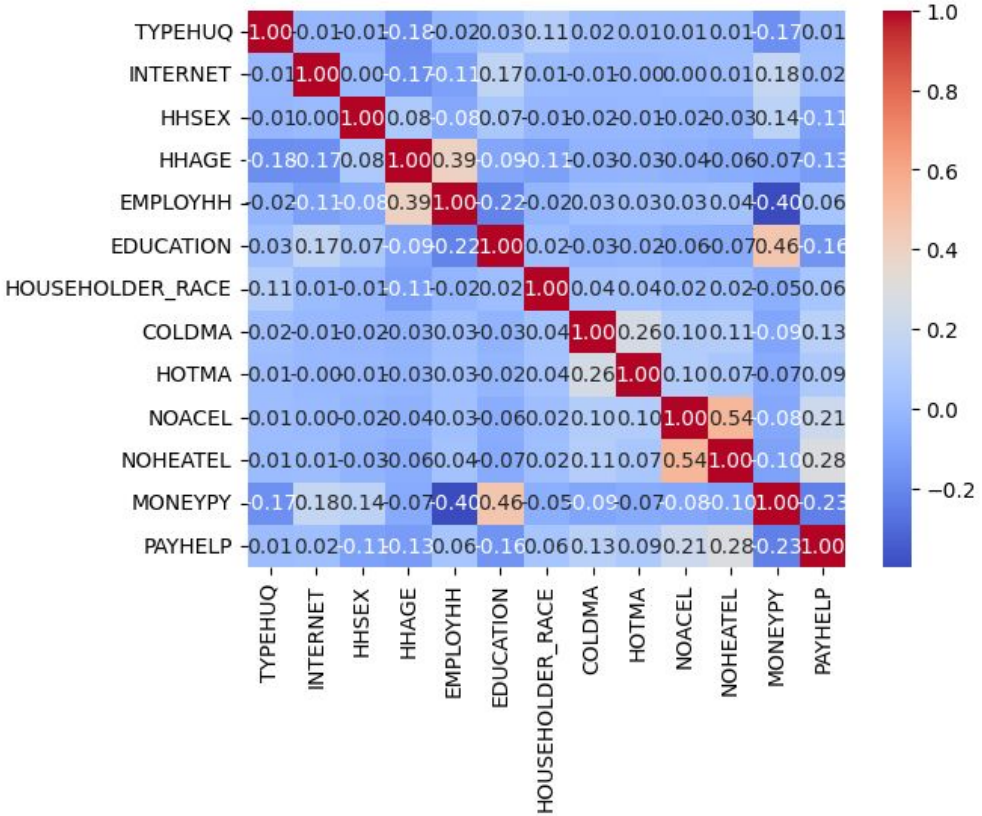
- The plot shows the correlation between education and income.
    a. Higher incomes correlated with advanced degrees.
    b. “$100,000 - $149,999”; “$150,000 or more,” are strongly correlated with “Bachelor’s,” “Master’s,” or “Doctoral” degrees.

Exploratory Data Analysis: cont.



- The plot between employment status and income.
    a. Higher incomes correlated with full-time employment.
    b. Upper incomes are strongly correlated with “Employed Full Time” and “Retired” statuses.

Correlation Matrix



Random Forest

Payhelp = α + 'MONEYPY' + 'HOUSEHOLDER_RACE' + 'EDUCATION' + 'TYPEHUQ' + 'INTERNET' + 'HHSEX' + 'HHAGE' + 'EMPLOYHH' + 'COLDMA' + 'HOTMA +, 'NOACEL' + 'NOHEATEL' + ϵ

Accuracy 88.78%

[[**3258**, FP: **95**, FP: **14**],

[FN: **204**, **23**, FP: **13**],

[FN: **71**, FN: **18**, **4**]]

Logistic Regression

Table 6: Results: Generalized linear model

Model:	GLM	AIC:	1672.1472
Link Function:	Logit	BIC:	-10272.9646
Dependent Variable:	['PAYHELP[No]', 'PAYHELP[Yes]']	Log-Likelihood:	-817.07
Date:	2023-12-07 21:18	LL-Null:	-910.23
No. Observations:	1629	Deviance:	1634.1
Df Model:	18	Pearson chi2:	1.61e+03
Df Residuals:	1610	Scale:	1.0000
Method:	IRLS		

	Coef.	Std.Err.	z	P> |z|	[0.025	0.975]
Intercept	-0.2442	0.3090	-0.7904	0.4293	-0.8498	0.3614
(MONEYPY)[Less than $5,000]	0.2766	0.2766	1.0001	0.3173	-0.2655	0.8186
(MONEYPY)[$5,000 - $7,499]	0.2048	0.3678	0.5569	0.5776	-0.5161	0.9258
(MONEYPY)[$7,500 - $9,999]	-0.5109	0.3700	-1.3808	0.1673	-1.2361	0.2143
(MONEYPY)[$12,500 - $14,999]	0.3755	0.3321	1.1304	0.2583	-0.2755	1.0264
(MONEYPY)[$15,000 - $19,999]	0.5219	0.3166	1.6482	0.0993	-0.0987	1.1425
(MONEYPY)[$20,000 - $24,999]	0.8487	0.3014	2.8155	0.0049	0.2579	1.4394
(MONEYPY)[$25,000 - $29,999]	1.0136	0.3057	3.3156	0.0009	0.4144	1.6128
(MONEYPY)[$30,000 - $34,999]	0.7587	0.3039	2.4967	0.0125	0.1631	1.3543
(MONEYPY)[$35,000 - $39,999]	1.1165	0.3189	3.5017	0.0005	0.4916	1.7415
(MONEYPY)[$40,000 - $49,999]	1.3453	0.3013	4.4650	0.0000	0.7548	1.9359
(MONEYPY)[$50,000 - $59,999]	1.6126	0.3134	5.1458	0.0000	0.9984	2.2268
(MONEYPY)[$60,000 - $74,999]	1.9722	0.3358	5.8731	0.0000	1.3140	2.6303
(MONEYPY)[$75,000 - $99,999]	2.5634	0.4249	6.0332	0.0000	1.7306	3.3961
(MONEYPY)[$100,000 - $149,999]	2.9280	0.5558	5.2682	0.0000	1.8387	4.0174
(MONEYPY)[$150,000 or more]	2.0196	0.5694	3.5471	0.0004	0.9036	3.1355
(HOTMA)[Yes]	0.2156	0.4007	0.5379	0.5906	-0.5698	1.0009
(COLDMA)[Yes]	-0.8172	0.2914	-2.8048	0.0050	-1.3882	-0.2461
HHAGE	0.0082	0.0042	1.9796	0.0477	0.0001	0.0164

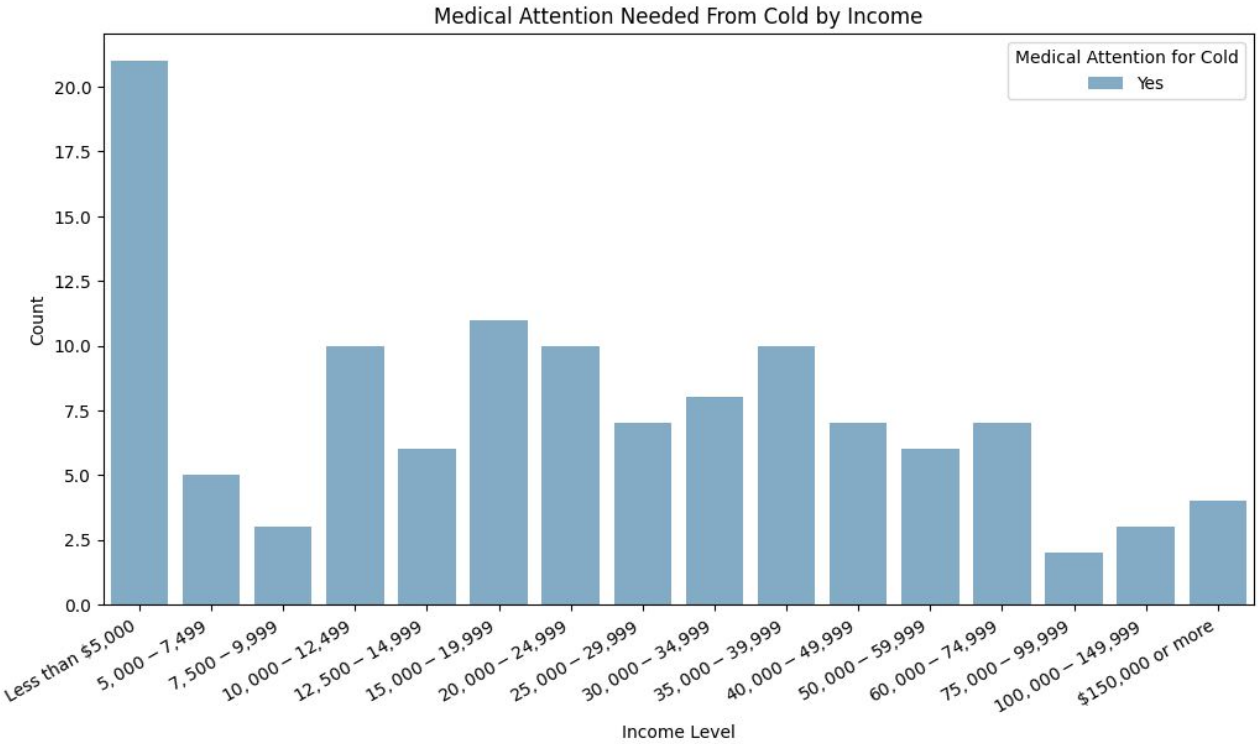
Not Large Enough

168% - 275% for "Yes"

305% - 1869% for "No"

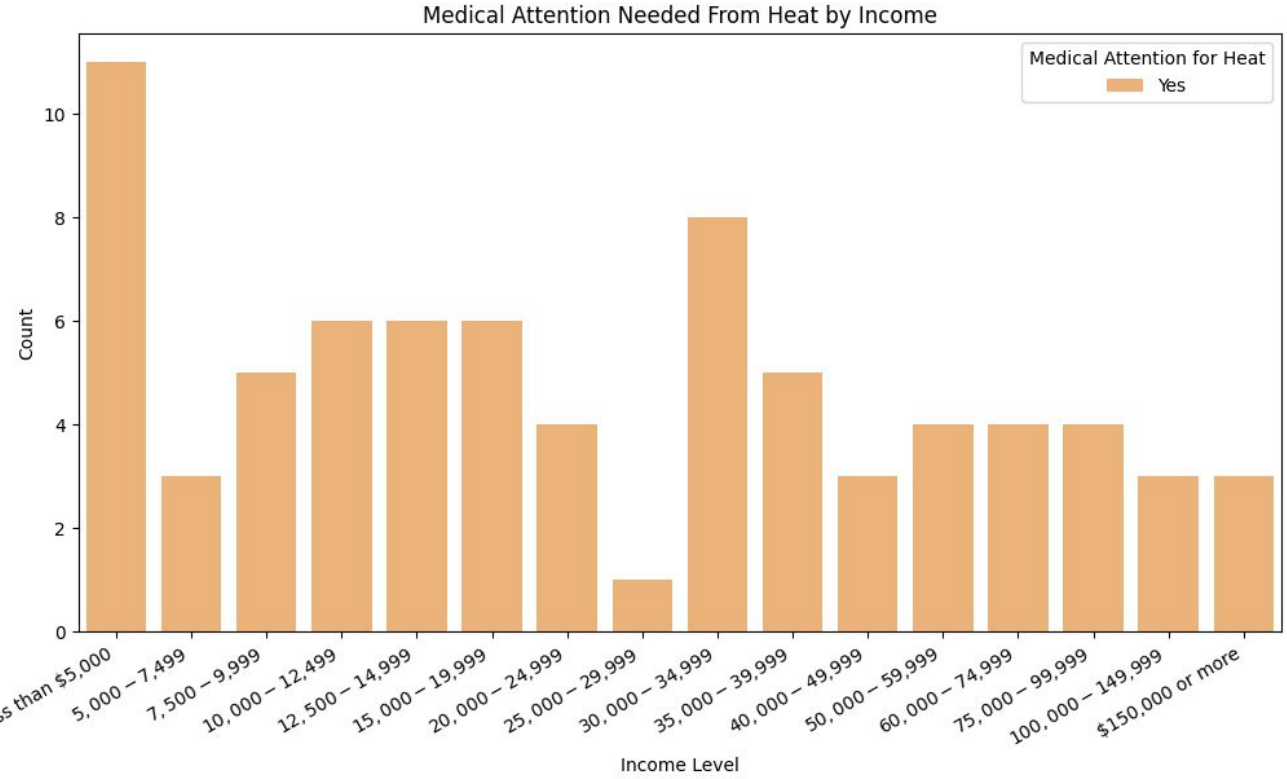
44%

Chi-Square Tests



Chi-squared statistic: 111.83 **Degrees of freedom:** 15 **P-value:** 7.16e-17

Chi-Square Tests



Chi-squared statistic: 185.85; **Degrees of freedom:** 15; **P-value:** 1.56e-31

Other Tests We Tried (but did not use)

Linear Regression:

'COLDMA' = α + 'MONEYPY' + 'HOUSEHOLDER_RACE' + 'EDUCATION' + ϵ

Multi-Linear Regression:

'COLDMA' = α + 'MONEYPY' + 'HOUSEHOLDER_RACE' + 'EDUCATION' + 'NOACEL' + 'NOHEATEL' + 'HHAGE' + 'PAYHELP' + ϵ

Logistical:

'COLDMA' = α + 'MONEYPY' + 'HOUSEHOLDER_RACE' + 'EDUCATION' + 'NOACEL' + ϵ

'HOTMA' = α + 'EDUCATION' + 'HOUSEHOLDER_RACE' + 'NOACEL' + 'MONEYPY' + ϵ

SVM:

'PAYHELP' = α + 'MONEYPY' + 'EDUCATION' + 'EMPLOYHH' + 'TYPEHUQ' + 'NOACEL' + 'NOHEATEL + ϵ

Conclusion

- Lower incomes have higher rates of energy poverty.
- COLDMA has a stronger influence overall than HOTMA.
- This could be due to lower costs and easier access to cooling measures than the various fuels needed for heating.
- Our findings reflect conclusions from the existing literature.

Limitations and Future Steps

- Time series data (panel data)
- Examine COVID-19 effects in the RECS survey
- State or county level could be different

Thank You

References

Chester, Lynne, and Alan Morris. "A New Form of Energy Poverty is the Hallmark of Liberalised Electricity Sectors." *The Australian journal of social issues* 46.4 (2011): 435-59. *CrossRef.* Web.

Halkos, George E., and Eleni-Christina Gkampoura. "Evaluating the Effect of Economic Crisis on Energy Poverty in Europe." *Renewable and Sustainable Energy Reviews* 144 (2021): 110981. Web.

Li, Weiqing, et al. "Nexus between Energy Poverty and Energy Efficiency: Estimating the Long-Run Dynamics." *Resources policy* 72.2 (2021): 102063. *CrossRef.* Web.

Pan, Lei, Ashenafi Biru, and Sandra Lettu. "Energy Poverty and Public Health: Global Evidence." *Energy Economics* 101 (2021): 105423. Web.

Recalde, Martina, et al. "Structural Energy Poverty Vulnerability and Excess Winter Mortality in the European Union: Exploring the Association between Structural Determinants and Health." *Energy Policy* 133 (2019): 110869. Web.