

Running head: ENERGY INSECURITY OF PEOPLE WITH DISABILITIES

**Unsafe Temperatures, Going without Necessities, and Unpayable Bills: Energy Insecurity
of People with Disabilities in the United States During the COVID-19 Pandemic**

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Abstract

Energy insecurity disproportionately impacts households of people with disabilities, which is especially harmful for people with disabilities who rely on electric medical devices to live or have difficulties with thermoregulation without access to heating/cooling. The aim of this cross-sectional study was to explore the energy insecurity of people with disabilities during the COVID-19 pandemic, including compared to nondisabled people and differences among people with disabilities themselves. To do so, we analyzed United States Census Bureau *Household Pulse Survey* data from 52,890 people with disabilities and 391,532 people without disabilities; frequency-person weights were applied. During the pandemic, 50.8% of people with disabilities reduced or forwent basic household necessities in order to pay an energy bill, 36.1% kept their home at an unsafe or unhealthy temperature, and 37.5% were unable to pay an energy bill during the last year of the pandemic. People with disabilities were also significantly more likely to be energy insecure during the pandemic than people without disabilities, even when other sociodemographic factors, such as income, were controlled. Energy justice demands everyone, including people with disabilities, have access to safe, affordable, and sustainable energy during the COVID-19 pandemic and beyond.

Keywords: people with disabilities; COVID-19 pandemic; energy insecurity; utilities; electricity

1. Introduction

Energy insecurity is when households do not have the economic resources to pay for electricity or energy utilities [1-4]. Chen, Greig, Nelson and Li [5] describes three main components of energy insecurity:

(1) [Energy burden], which considers the economic burdens of utility bills, or the share of a household's income spent on utility bills; (2) energy hardships, which consider physical dwelling deficiencies, the structure of building materials, and/or access to energy appliances or sources that help meet basic needs; and (3) energy behavior, which includes coping strategies to mitigate the physical, health, and economic impacts of energy insecurity. [5, p2]

Energy insecurity depends not only on economic and financial hardship, but also physical housing conditions, which can increase costs, and behavioral coping strategies used to make up for the fact that one needs electricity [1,2].

As energy is required for ones' basic needs, it is recognized as a social determinant of health and public health concern [2,6]. For example, energy is required for heating and cooling, storing and preparing food, refrigerating medicine, powering medical equipment, and using the internet and other electronic devices [3,6-9]. As such, energy insecurity negatively impacts people's mental and physical health, including by increasing mortality risks [1-3,7,8,10]. For example, living at uncomfortable or unsafe temperatures (either heat or cold) due to energy insecurity can lead to hyperthermia, hypothermia, and increase asthma, among other mental and physical impacts [2,3,8,11]. A lack of electricity can be especially harmful for people with disabilities who rely on durable medical equipment, such as ventilators, power wheelchairs,

perishable medications, and communication devices to not only improve their quality of life, but also to sustain their lives [5,9].

In addition to the harm energy insecurity represents in and of itself, energy insecurity has also been linked to other hardships, such as food insecurity, as people often have to choose between paying an energy bill or buying food, rent, medicine, and/or accessing health care [2,3,7-12]. Energy insecurity may also place people in danger as they turn to alternative and dangerous strategies to keep warm, such as using stoves and space heaters, which not only are the leading cause of house fires, but can also reduce air quality and poison people [1,3,7,8,11].

While utilities, including energy, are one of the top spending categories for people in the United States [1], some groups of people are disproportionately impacted by energy insecurity. For example, low-income households are frequently more energy insecure; they are also more likely to live in less energy efficient homes, thereby intensifying their energy needs [1-3,5,7,13-15]. Black and Hispanic households are also more likely to be energy insecure [1-3,5,7,10,13]. Due to systemic inequalities and racism, including residential segregation and gentrification, Black and Hispanic people not only are less likely to live in energy efficient housing, but also pay more for their energy [1,2,10]. Households with small children, single parents, those without college education, people who live alone, and underemployed people are all more likely to be energy insecure [3,7,14,16]. In addition, energy insecurity is significantly more common in households of people with disabilities and is especially harmful for those people with disabilities who rely on electric medical devices to live and/or have difficulties with thermoregulation without access to heating/cooling [3,5,7,15-17].

While energy insecurity was already a substantial problem in the United States, it was further intensified by the COVID-19 pandemic, which considerably increased material hardship

and unemployment [6,7]. During the COVID-19 pandemic, millions of Americans have struggled to pay for energy services, often facing disconnection [3]. In addition, the significant growth in working from home (telework) shifted many energy expenses from companies to individuals, with remote workers using more energy than previously and, therefore, having higher bills [6]. The COVID-19 pandemic also intensified existing disparities in energy insecurity, with Black and Hispanic households being more likely to be unable to pay for their energy utilities and to face disconnection [3,6]. While many state and local governments introduced utility shutoff/disconnection moratoriums and protections during the pandemic, it was done in a patchwork manner that differed significantly across the United States [3,6]; many utility moratoriums have also since been lifted despite the continuation of the pandemic [3].

While people with disabilities were more vulnerable to energy insecurity prior to the COVID-19 pandemic, less is known about how the pandemic impacted their energy insecurity during the pandemic. For these reasons, the aim of this study was to explore the energy insecurity of people with disabilities during the pandemic. We had the following research questions:

1. How many people with disabilities were energy insecure during the pandemic?
2. How did the energy insecurity of people with disabilities compare to people without disabilities?
3. How did energy insecurity differ among people with disabilities themselves based on their sociodemographics?

To explore these questions, we analyzed United States Census Bureau *Household Pulse Survey* data from 52,890 people with disabilities and 391,532 people without disabilities.

2. Materials and Methods

2.1 Data

This exploratory cross-sectional study was a secondary data analysis of data from the United States Census Bureau's *Household Pulse Survey* [18]. To examine the impact of the pandemic in the country, the Census Bureau administered the online *Pulse* survey to randomly selected households in the United States. Between July 21, 2021 and January 10, 2022, a total of 518,728 people participated in the survey.

The Census Bureau used the following questions, which were developed by a United Nations Statistical Commission City Group [19,20], to measure disability:

1. Do you have difficulty seeing, even when wearing glasses?;
2. Do you have difficulty hearing, even when using a hearing aid?;
3. Do you have difficulty remembering or concentrating?; and,
4. Do you have difficulty walking or climbing stairs?

Answer options were: (0.) No – no difficulty; (1.) Yes – some difficulty; (2.) Yes – a lot of difficulty; and, (3.) cannot do at all. People who answer ‘a lot of difficulty’ or ‘cannot do at all’ have the applicable disability (yes [1]; no [0]) for each question [19]. (People who did not complete these questions were removed from the sample.) A total of 52,890 people had disabilities and 391,532 did not have the applicable disabilities (henceforth referred to as ‘people without disabilities’ for clarity), resulting in a final sample size of 444,422 people. Using SPSS complex samples, we applied the frequency-person weights supplied by the Census Bureau [18] to account for population demographics and nonresponses. When weighted, 14% of the sample were people with disabilities and 86% were people without disabilities. (This is similar to the American Community Survey which found 13% of noninstitutionalized people had disabilities in 2020 [21].)

2.2 Participants

Of the people with disabilities in the sample, 28.2% had cognitive disabilities, 25.1% had mobility disabilities, 15.5% had visual disabilities, 9.4% had hearing disabilities, and 21.8% had multiple disabilities (Table 1). About half (53.2%) of people with disabilities were between the ages of 18 and 54, compared to 59.3% of people without disabilities. Slightly more than half (56.6%) of people with disabilities were cisgender women and half (49.9%) of people without disabilities. Most people with (82.3%) and without disabilities (89.8%) were heterosexual. The majority of people with disabilities (76.4% and 83.2% respectively) and people without disabilities (78.0% and 84.3% respectively) were White and non-Hispanic. About half of people with disabilities (46.7%) had a high school degree or less education, meanwhile it was more common for people without disabilities to have some college or less (54.6%). Approximately half of people with disabilities (45.7%) were currently married compared to 58.7% of people without disabilities. Among people with disabilities, 30.1% had a household income of less than \$25,000, while only 12.8% of people without disabilities had a household income of less than \$25,000. Both people with and without disabilities most frequently lived in single-family detached homes (60.9% and 70.1% respectively) and owned homes with a mortgage or loan (37.7% and 46.3% respectively). The most common forms of health care insurance among people with disabilities were employer insurance (46.8%), Medicare (federal health insurance program for older adults over 65 and/or people with disabilities; 36.7%), and Medicaid (federal and state program for medical and long-term care expenses for low-income people; 30.1%). For people without disabilities, the most common forms of insurance were employer insurance (65.6%), Medicare (24.8%), and private insurance (21.7%). The average household size of was 3.4 people ($SE = 0.02$) for people with disabilities and 3.2 people ($SE = 0.01$) for people without

Table 1
Demographics

Characteristic	% (weighted)		<i>p</i>
	People with disabilities	People without disabilities	
Disability			
None	0.0%	100.0%	
Hearing only	9.4%	0.0%	
Visual only	15.5%	0.0%	n/a
Cognitive only	28.2%	0.0%	
Mobility only	25.1%	0.0%	
Multiple disabilities	21.8%	0.0%	
Age			
18 to 24	7.9%	7.0%	
25 to 34	14.4%	17.4%	
35 to 44	14.3%	18.4%	
45 to 54	16.6%	16.5%	<0.001
55 to 64	19.6%	17.7%	
65 to 74	17.3%	16.6%	
75+	9.8%	6.5%	
Gender			
Cis male	38.6%	48.6%	
Cis female	56.6%	49.9%	
Transgender	1.5%	0.4%	<0.001
None of these	3.3%	1.1%	
Sexual orientation			
Heterosexual	82.3%	89.8%	
Gay or lesbian	4.0%	3.2%	
Bisexual	7.1%	4.0%	<0.001
Something else	3.7%	1.6%	
I don't know	2.9%	1.6%	
Race			
White, alone	76.4%	78.0%	
Black, alone	12.2%	11.1%	<0.001
Asian, alone	3.7%	6.1%	
Another race alone, or multiracial	7.8%	4.9%	
Ethnicity: Hispanic			
Yes	16.8%	15.7%	0.01
No	83.2%	84.3%	
Education			
Less than high school degree	11.8%	6.1%	
High school graduate/equivalent	34.9%	28.4%	
Some college	23.6%	20.1%	
Associate's degree	10.0%	9.8%	<0.001
Bachelor's degree	11.7%	19.2%	
Graduate degree	8.0%	16.3%	
Marital status			
Now married	45.7%	58.7%	
Widowed	7.3%	4.2%	
Divorced	16.8%	10.9%	<0.001
Separated	3.6%	1.8%	
Never married	26.7%	24.3%	
Household income (2020)			
Less than \$25,000	30.1%	12.8%	<0.001
\$25,000 - \$34,999	15.7%	10.5%	

\$35,000 - \$49,999	14.0%	12.0%	
\$50,000 - \$74,999	16.1%	17.6%	
\$75,000 - \$99,999	9.5%	13.7%	
\$100,000 - \$149,999	8.5%	16.7%	
\$150,000 - \$199,999	3.0%	7.8%	
\$200,000+	3.1%	8.9%	
Home setting			
Single-family, detached	60.9%	70.1%	
Single-family, attached	7.2%	7.6%	
Apartment building	21.8%	17.8%	<0.001
Mobile home	8.0%	4.2%	
Boat, RV, van, etc.	2.0%	0.4%	
Home payment status			
Owned free/clear	22.4%	26.1%	
Owned with mortgage/loan	37.7%	46.3%	<0.001
Rented	36.1%	26.2%	
Occupied without payment/rent	3.8%	1.4%	
Health care coverage/insurance			
Employer insurance			
Yes	46.8%	65.6%	<0.001
No	53.2%	34.4%	
Private insurance			
Yes	20.9%	21.7%	0.06
No	79.1%	78.3%	
Medicare			
Yes	36.7%	24.8%	<0.001
No	63.3%	75.2%	
Medicaid			
Yes	30.1%	13.7%	<0.001
No	69.9%	86.3%	
TRICARE or other military health care			
Yes	5.9%	4.4%	<0.001
No	94.1%	95.6%	
Veteran Affairs health care			
Yes	8.1%	4.6%	<0.001
No	91.9%	95.4%	
Indian health service			
Yes	1.8%	0.7%	<0.001
No	98.2%	99.3%	
Other			
Yes	6.4%	4.3%	<0.001
No	93.6%	95.7%	
Number of people in household (M (SE))	3.4 (0.02)	3.2 (0.01)	<0.001
Worked for pay in last week			
Yes	40.8%	61.1%	<0.001
No	59.2%	38.9%	
Household job loss			
Yes	25.2%	14.6%	<0.001
No	74.8%	85.4%	
Received Child Tax Credit			
Yes	19.3%	22.2%	<0.001
No	80.7%	77.8%	
Household SNAP beneficiary			
Yes	23.0%	10.4%	<0.001
No	77.0%	89.6%	

disabilities. Of people with disabilities, 40.8% worked for pay in the last week compared to 61.1% of people without disabilities, and 25.2% of people with disabilities experienced a job loss in their household in the last month compared to 14.6% of people without disabilities. Among people with disabilities, 19.3% received the Child Tax Credit (2021 pandemic tax credit of \$2,000-\$3,600 per child for families with incomes below \$150,000) compared to 22.2% of people without disabilities. Slightly less than one-quarter of people with disabilities (23.0%) lived in a household where someone received Supplemental Nutrition Assistance Program (SNAP) benefits (food purchase benefits for low-income people). Only 10.4% of people without disabilities lived in households that received SNAP.

Demographics of people with and without disabilities significantly differed based on: age; gender; sexual orientation; race; ethnicity; education; marital status; household income; home setting; home payment status; health care providers (except private insurance); household size; working for pay; household job loss; Child Tax Credit; and SNAP. Compared to the larger United States population, the sample was relatively evenly distributed, both for people with and without disabilities, related to race, ethnicity, education, and household SNAP benefits [21]. Compared to the population, people with and without disabilities in the sample were higher income, and people with disabilities were slightly younger [21].

2.3 Measures

The *Pulse* survey asked participants the following questions about energy insecurity:

- In the last 12 months, how many months did your household reduce or forego expenses for basic household necessities, such as medicine or food, in order to pay an energy bill?
- In the last 12 months, how many months did your household keep your home at a temperature that you felt was unsafe or unhealthy?

- In the last 12 months, how many times was your household unable to pay an energy bill or unable to pay the full bill amount?

The answer options for each of these three questions were: (1.) never; (2.) 1 or 2 months; (3.) some months; and, (4.) almost every month. Those people who answer ‘1 or 2 months,’ ‘some months,’ or ‘almost every month’ are considered to have reduced/forwent basic household necessities due to an energy bill, kept their home at unsafe/unhealth temperatures, and been unable to pay an energy bill respectively (yes [1], no [0]) [22].

2.4 Analyses

To explore our first research question about the energy insecurity of people with disabilities, we conducted complex samples descriptive statistics. To examine our second research question comparing the energy insecurity of people with and without disabilities (independent variable [IV]), we used complex samples binary logistic regressions with each of the three energy insecurity questions (dependent variables [DVs]), while controlling for all sociodemographics (covariates [CVs]). To explore our third research question about differences in energy insecurity among people with disabilities themselves, we utilized complex samples binary logistic regressions to examine differences in energy insecurity (DVs) based on people with disabilities’ sociodemographics (IVs). Confidence intervals (CIs) for all odds ratios (OR) were 95%.

3. Results

3.1 Energy Insecurity of People with and without Disabilities

During the pandemic, 50.8% of people with disabilities reported their households reduced or forwent basic household necessities in order to pay an energy bill, compared to 25.5% of people without disabilities (Table 2). Controlling for all sociodemographics, people with disabilities

were 2.30 times (CI [2.17, 2.42]) more likely than people without disabilities to report their households reduce/forgo basic household necessities to pay an energy bill.

Moreover, 36.1% of people with disabilities kept their home at an unsafe or unhealthy temperature during the pandemic, compared to 15.9% of people without disabilities. Controlling for all sociodemographics, people with disabilities were 2.14 times (CI [2.03, 2.26]) more likely to keep their home at an unsafe/unhealthy temperature than people without disabilities.

Among people with disabilities, 37.5% reported being unable to pay an energy bill during the last year of the pandemic, compared to 17.1% of people without disabilities. Controlling for all sociodemographics, people with disabilities were 1.97 times (CI [1.86, 2.10]) more likely to be unable to pay an energy bill than nondisabled people.

Table 2

Energy Insecurity During the Pandemic: Differences Between People with and without Disabilities

	%		Adjusted OR (CI; ref: nondisabled)	<i>p</i>
	People with disabilities	People without disabilities		
Reduced/forgo household necessities to pay energy bill				
Yes	50.8%	25.5%	2.30 [2.17, 2.42]	<0.001
No	49.2%	74.5%	ref	
Kept home at unsafe/unhealthy temperature				
Yes	36.1%	15.9%	2.14 [2.03, 2.26]	<0.001
No	63.9%	84.1%	ref	
Unable to pay energy bill				
Yes	37.5%	17.1%	1.97 [1.86, 2.10]	<0.001
No	62.5%	82.9%	ref	

Note. Odds ratio (OR) adjusted for: age; gender; sexual orientation; race; ethnicity; education; marital status; household income; home setting; home payment status; health care coverage; work for pay in last week; household job loss; SNAP; Child Tax Credit; and number of people in household.

3.2 Differences in the Energy Insecurity of People with Disabilities

In addition to disparities compared to people without disabilities, there were significant differences in energy insecurity among people with disabilities themselves based on their sociodemographics (Table 3).

Table 3

Sociodemographic Differences in Energy Insecurity of People with Disabilities

Characteristic	Reduced/forwent basic needs to pay energy bill		Kept home at unsafe temperature		Unable to pay energy bill	
	OR [CI]	<i>p</i>	OR [CI]	<i>p</i>	OR [CI]	<i>p</i>
Disability (ref: hearing)						
Visual	1.43 [1.18, 1.75]	<0.001	1.60 [1.32, 1.94]	<0.001	1.58 [1.27, 1.95]	<0.001
Cognitive	1.42 [1.19, 1.70]	<0.001	1.46 [1.22, 1.75]	<0.001	1.30 [1.07, 1.58]	0.009
Mobility	1.11 [0.93, 1.33]	0.25	1.13 [0.95, 1.35]	0.17	1.11 [0.92, 1.36]	0.28
Multiple	2.23 [1.84, 2.70]	<0.001	2.41 [2.01, 2.88]	<0.001	2.02 [1.65, 2.47]	<0.001
Age (ref: 18 to 24)						
25 to 34	1.35 [1.07, 1.70]	0.012	0.82 [0.65, 1.04]	0.11	1.66 [1.29, 2.13]	<0.001
35 to 44	1.47 [1.13, 1.89]	0.003	0.98 [0.76, 1.26]	0.86	2.13 [1.63, 2.80]	<0.001
45 to 54	1.77 [1.37, 2.28]	<0.001	1.19 [0.92, 1.53]	0.18	2.13 [1.62, 2.80]	<0.001
55 to 64	1.36 [1.05, 1.76]	0.019	1.11 [0.86, 1.43]	0.44	1.60 [1.21, 2.11]	0.001
65 to 74	0.88 [0.66, 1.18]	0.40	0.89 [0.67, 1.19]	0.44	1.16 [0.84, 1.60]	0.36
75+	0.45 [0.31, 0.65]	<0.001	0.58 [0.41, 0.83]	0.003	0.53 [0.34, 0.80]	0.003
Gender (ref: cis male)						
Cis female	1.09 [0.98, 1.21]	0.10	0.89 [0.80, 0.99]	0.025	1.19 [1.06, 1.33]	0.002
Transgender	1.00 [0.66, 1.50]	0.99	1.40 [0.95, 2.05]	0.09	1.33 [0.88, 2.02]	0.18
None of these	1.02 [0.70, 1.49]	0.93	0.89 [0.63, 1.26]	0.52	1.37 [0.94, 1.98]	0.10
Sexual orientation (ref: heterosexual)						
Gay or lesbian	1.41 [1.15, 1.73]	0.001	1.26 [1.02, 1.56]	0.032	1.15 [0.92, 1.44]	0.21
Bisexual	1.17 [0.99, 1.39]	0.07	1.22 [1.03, 1.46]	0.023	1.03 [0.86, 1.24]	0.72
Something else	1.34 [1.00, 1.80]	0.046	1.27 [0.93, 1.73]	0.14	1.10 [0.83, 1.45]	0.52
I don't know	1.02 [0.71, 1.46]	0.94	1.37 [1.00, 1.88]	0.05	1.00 [0.68, 1.46]	0.99
Race (ref: White alone)						
Black, alone	1.34 [1.15, 1.57]	<0.001	0.97 [0.83, 1.13]	0.71	1.79 [1.52, 2.09]	<0.001
Asian, alone	1.17 [0.88, 1.54]	0.28	1.20 [0.89, 1.61]	0.23	0.62 [0.43, 0.89]	0.010
Another race alone, or multiracial	1.06 [0.86, 1.31]	0.56	1.09 [0.90, 1.31]	0.39	1.20 [0.97, 1.47]	0.09
Ethnicity: Hispanic (ref: not Hispanic)	1.34 [1.16, 1.55]	<0.001	1.17 [1.02, 1.35]	0.027	1.11 [0.95, 1.29]	0.20
Education (ref: graduate degree)						
Less than high school degree	1.28 [1.00, 1.63]	0.05	1.02 [0.81, 1.28]	0.86	1.51 [1.17, 1.95]	0.001
High school graduate/equivalent	1.19 [1.03, 1.36]	0.015	0.83 [0.73, 0.96]	0.011	1.18 [1.02, 1.37]	0.03
Some college	1.32 [1.16, 1.49]	<0.001	1.00 [0.88, 1.13]	0.94	1.30 [1.13, 1.48]	<0.001
Associate's degree	1.26 [1.09, 1.45]	0.001	1.03 [0.89, 1.18]	0.73	1.29 [1.11, 1.50]	<0.001
Bachelor's degree	0.99 [0.88, 1.13]	0.93	1.00 [0.88, 1.14]	0.98	1.01 [0.88, 1.16]	0.89
Marital status (ref: never married)						
Now married	1.22 [1.06, 1.42]	0.006	1.04 [0.91, 1.20]	0.55	1.17 [1.00, 1.36]	0.05
Widowed	1.29 [1.03, 1.63]	0.03	0.96 [0.76, 1.20]	0.69	1.13 [0.87, 1.47]	0.35
Divorced	1.24 [1.06, 1.45]	0.007	1.08 [0.93, 1.26]	0.30	1.21 [1.03, 1.41]	0.020
Separated	1.26 [0.97, 1.62]	0.08	1.04 [0.82, 1.31]	0.77	1.31 [1.00, 1.70]	0.046
Household income (ref: \$200,000+)						
Less than \$25,000	6.85 [4.92, 9.53]	<0.001	3.44 [2.50, 4.73]	<0.001	5.96 [4.12, 8.62]	<0.001
\$25,000 - \$34,999	7.60 [5.51, 10.48]	<0.001	2.92 [2.13, 4.00]	<0.001	5.82 [4.05, 8.37]	<0.001
\$35,000 - \$49,999	6.05 [4.41, 8.28]	<0.001	2.63 [1.93, 3.56]	<0.001	4.71 [3.30, 6.74]	<0.001
\$50,000 - \$74,999	4.50 [3.31, 6.11]	<0.001	2.04 [1.51, 2.76]	<0.001	3.61 [2.54, 5.15]	<0.001
\$75,000 - \$99,999	2.85 [2.08, 3.89]	<0.001	1.64 [1.21, 2.23]	0.002	2.22 [1.54, 3.19]	<0.001
\$100,000 - \$149,999	1.82 [1.33, 2.49]	<0.001	1.21 [0.89, 1.65]	0.23	1.54 [1.07, 2.22]	0.020
\$150,000 - \$199,999	1.40 [0.88, 2.24]	0.15	1.16 [0.75, 1.81]	0.51	1.36 [0.74, 2.51]	0.32
Home setting (ref: Single-family, detached)						
Single-family, attached	0.99 [0.84, 1.18]	0.93	1.04 [0.87, 1.24]	0.66	1.00 [0.84, 1.20]	0.98
Apartment building	0.85 [0.74, 0.98]	0.027	0.75 [0.66, 0.87]	<0.001	0.75 [0.65, 0.87]	<0.001

Table 3

Sociodemographic Differences in Energy Insecurity of People with Disabilities

Characteristic	Reduced/forwent basic needs to pay energy bill		Kept home at unsafe temperature		Unable to pay energy bill	
	OR [CI]	<i>p</i>	OR [CI]	<i>p</i>	OR [CI]	<i>p</i>
Mobile home	1.29 [1.06, 1.57]	0.012	1.23 [1.03, 1.46]	0.025	1.36 [1.11, 1.66]	0.003
Boat, RV, van, etc.	0.77 [0.50, 1.20]	0.25	1.13 [0.75, 1.71]	0.57	0.93 [0.59, 1.47]	0.76
Home payment status (ref: Owned free/clear)						
Owned with mortgage/loan	1.13 [1.00, 1.28]	0.05	1.13 [0.99, 1.28]	0.06	1.13 [0.98, 1.30]	0.08
Rented	1.27 [1.09, 1.48]	0.002	1.41 [1.21, 1.65]	<0.001	1.73 [1.48, 2.03]	<0.001
Occupied without payment/rent	0.98 [0.73, 1.32]	0.91	1.50 [1.15, 1.95]	0.002	1.97 [1.47, 2.64]	<0.001
Health insurance						
Employer insurance (ref: no)	0.89 [0.80, 0.99]	0.03	0.97 [0.87, 1.07]	0.51	0.97 [0.87, 1.09]	0.64
Private insurance (ref: no)	1.01 [0.89, 1.13]	0.92	0.97 [0.86, 1.09]	0.60	0.87 [0.77, 1.00]	0.045
Medicare (ref: no)	0.92 [0.80, 1.06]	0.25	1.00 [0.87, 1.14]	0.95	0.85 [0.74, 0.98]	0.031
Medicaid (ref: no)	1.08 [0.94, 1.23]	0.27	0.93 [0.82, 1.05]	0.23	1.21 [1.06, 1.38]	0.004
TRICARE or other military health care (ref: no)	0.93 [0.73, 1.19]	0.58	1.14 [0.90, 1.44]	0.27	0.86 [0.65, 1.13]	0.27
Veteran Affairs health care (ref: no)	0.98 [0.81, 1.19]	0.84	0.96 [0.78, 1.18]	0.71	1.11 [0.89, 1.38]	0.36
Indian health service (ref: no)	1.20 [0.72, 1.98]	0.48	1.11 [0.72, 1.72]	0.63	1.30 [0.79, 2.14]	0.30
Other (ref: no)	1.16 [0.93, 1.45]	0.19	1.07 [0.85, 1.36]	0.55	1.06 [0.81, 1.40]	0.66
Worked for pay in last week (ref: no)	1.13 [1.01, 1.26]	0.04	0.96 [0.86, 1.07]	0.47	1.02 [0.91, 1.15]	0.75
Household job loss (ref: no)	2.50 [2.22, 2.82]	<0.001	2.07 [1.86, 2.31]	<0.001	2.45 [2.18, 2.75]	<0.001
Child Tax Credit (ref: no)	1.15 [1.00, 1.32]	0.58	0.70 [0.61, 0.81]	<0.001	1.09 [0.95, 1.26]	0.22
SNAP household (ref: no)	1.20 [1.03, 1.39]	0.019	1.09 [0.95, 1.25]	0.21	1.30 [1.12, 1.51]	<0.001
Number of people in household	1.06 [1.02, 1.10]	0.002	1.06 [1.03, 1.10]	<0.001	1.12 [1.08, 1.16]	<0.001

3.2.1 Reducing/forgoing Basic Needs to Pay an Energy Bill

In terms of reducing/forgoing basic needs to pay an energy bill, controlling for all other variables, compared to people with hearing disabilities, people with visual disabilities were 1.43 times (CI [1.18, 1.75]) more likely to reduce/forgo basic needs to pay an energy bill, people with cognitive disabilities 1.42 times (CI [1.19, 1.70]) more likely, and people with multiple disabilities 2.23 times (CI [1.84, 2.70]) more likely. Compared to 18–24-year-old people with disabilities, 25–64-year-old people with disabilities were significantly more likely to reduce/forgo basic needs to pay an energy bill (ORs range from 1.35–1.77), and 75+ year-old people with disabilities significantly less likely (OR [CI] = 0.45 [0.31, 0.65]). Compared to heterosexual people with disabilities, gay and lesbian people with disabilities were 1.41 times

(CI [1.15, 1.73] more likely to reduce/forgo basic needs to pay an energy bill and people with disabilities who said their sexual orientation was ‘something else’ were 1.34 times (CI [1.00, 1.80]) more likely. Black people with disabilities were 1.34 times (CI [1.15, 1.57]) more likely to reduce/forgo basic needs to pay an energy bill than White people with disabilities. Hispanic people with disabilities were 1.34 times (CI [1.16, 1.55]) more likely to reduce/forgo basic needs to pay an energy bill than non-Hispanic people with disabilities. Compared to people with disabilities with graduate degree, people with high school degrees (OR [CI] = 1.19 [1.03, 1.36]), some college (OR [CI] = 1.32 [1.16, 1.49]), and associate’s degrees (OR [CI] = 1.26 [1.09, 1.45]) were all more likely to reduce/forgo basic needs to pay an energy bill. Compared to people with disabilities who have never been married, currently married (OR [CI] = 1.22 [1.06, 1.42]), widowed (OR [CI] = 1.29 [1.03, 1.63]), and divorced (OR [CI] = 1.24 [1.06, 1.45]) people with disabilities were more likely to reduce/forgo basic needs to pay an energy bill. People with disabilities with household incomes of less than \$150,000 were more likely (ORs ranged from 1.82-7.60) to reduce/forgo basic needs to pay an energy bill than people with disabilities with a household income of \$200,000+. Compared to people with disabilities who lived in single-family detached homes, people with disabilities who lived in apartment buildings were 1.18 times (OR [CI] = 0.85 [0.74, 0.98]) less likely to reduce/forgo basic needs to pay an energy bill and people who lived in mobile homes 1.29 times (CI [1.06, 1.57] more likely to reduce/forgo basic needs to pay an energy bill. Renters with disabilities were 1.27 times (CI [1.09, 1.48]) more likely to reduce/forgo basic needs to pay an energy bill than people with disabilities who owned their homes free and clear. People with disabilities with employer insurance were 1.12 times (CI [0.80, 0.99]) less likely to reduce/forgo basic needs to pay an energy bill than people with disabilities with other forms of health insurance. People with disabilities who worked for pay

within the last week were 1.13 times (CI [1.01, 1.26]) more likely to reduce/forgo basic needs to pay an energy bill than people with disabilities who did not work for pay. People with disabilities who experienced a household job loss within the last month were 2.05 times (CI [2.22, 2.82]) more likely to reduce/forgo basic needs to pay an energy bill than people with disabilities who did not experience a household job loss. People with disabilities who lived in households that received SNAP were 1.20 times (CI [1.03, 1.39]) more likely to reduce/forgo basic needs to pay an energy bill than people with disabilities in households without SNAP. People with disabilities who lived in larger households were more likely to reduce/forgo basic needs to pay an energy bill (OR [CI] = 1.06 [1.02, 1.10]).

3.2.2 Keeping Homes at Unsafe Temperatures

In terms of keeping homes at unsafe and unhealth temperatures, controlling for all other variables, compared to people with hearing disabilities, people with visual disabilities (OR [CI] = 1.60 [1.32, 1.94]), cognitive disabilities (OR [CI] = 1.46 [1.22, 1.75]), and multiple disabilities (OR [CI] = 2.41 [2.01, 2.88]) were more likely to keep their homes at unsafe temperatures (Table 3). People with disabilities 75 years-old and older were 1.72 times (OR [CI] = 0.58 [0.41, 0.83]) less likely to keep their homes at unsafe temperatures than 18–24-year-old people with disabilities. Cisgender women with disabilities were 1.12 times (OR [CI] = 0.89 [0.80, 0.99]) less likely than cisgender men with disabilities to keep their homes at unsafe temperatures. Compared to heterosexual people with disabilities, gay and lesbian (OR [CI] = 1.26 [1.02, 1.56]), and bisexual (OR [CI] = 1.22 [1.03, 1.46]) people with disabilities were more likely to keep their homes at unsafe temperatures. Hispanic people with disabilities were 1.17 times (CI [1.02, 1.35]) more likely to keep their homes at unsafe temperatures than non-Hispanic people with disabilities. People with disabilities with high school degrees were 1.20 times less (OR [CI] =

0.83 [0.73, 0.96]) likely to keep their homes at unsafe temperatures than people with disabilities with graduate degrees. People with household incomes of less than \$100,000 were more likely (ORs ranged from 1.64-3.44) to keep their homes at unsafe temperatures than people with disabilities with household incomes of \$200,000 and higher. Compared to people with disabilities who lived in detached single-family homes, those who lived in apartment buildings were 1.33 times (OR [CI] = 0.75 [0.66, 0.87]) less likely to keep their homes at unsafe temperatures and people with disabilities who lived in mobile homes 1.23 times (CI [1.03, 1.46]) more likely to keep their homes at unsafe temperatures. Compared to people with disabilities who owned their homes free and clear, people with disabilities who rented (OR [CI] = 1.41 [1.21, 1.65]) and occupied without payment (OR [CI] = 1.50 [1.15, 1.95]) were more likely to keep their homes at unsafe temperatures. People with disabilities who experienced a household job loss within the last month were 2.07 times (CI [1.86, 2.31]) more likely to keep their homes at unsafe temperatures than people with disabilities who did not experience a household job loss. People with disabilities who lived in households that received the Child Tax Credit were 1.43 times (OR [CI] = 0.70 [0.61, 0.81]) less likely to keep their homes at unsafe temperatures than people with disabilities in households that did not receive the Child Tax Credit. People with disabilities who lived in larger households were more likely to keep their homes at unsafe temperatures (OR [CI] = 1.06 [1.03, 1.10]).

3.2.3 Inability to Pay an Energy Bill

In terms of inability to pay an energy bill, controlling for all other variables, compared to people with hearing disabilities, people with visual disabilities (OR [CI] = 1.58 [1.27, 1.95]), cognitive disabilities (OR [CI] = 1.30 [1.07, 1.58]), and multiple disabilities (OR [CI] = 2.02 [1.65, 2.47]) were more likely to be unable to pay an energy bill (Table 3). Compared to 18–24-year-old

people with disabilities, 25-64-year-old people with disabilities were more likely (ORs ranged from 1.60-2.13) to be unable to pay an energy bill and 75+ year old people with disabilities less likely to be unable to pay an energy bill (OR [CI] = 0.53 [0.34, 0.80]). Cisgender women with disabilities were 1.19 times (CI [1.06, 1.33]) more likely to be to be unable to pay an energy bill than cisgender men with disabilities. Compared to White people with disabilities, Black people with disabilities were 1.79 times (CI [1.52, 2.09]) more likely to be unable to pay an energy bill and Asian people with disabilities 1.61 times (CI [0.43, 0.89]) less likely to be unable to pay an energy bill. People with disabilities with less than a Bachelor's degree were more likely (ORs ranged from 1.18-1.51) to be unable to pay an energy bill than people with disabilities with a graduate degree. Compared to people with disabilities who were never married, those who were divorced (OR [CI] = 1.21 [1.03, 1.41]) and separated (OR [CI] = 1.31 [1.00, 1.70]) were more likely to be unable to pay an energy bill. People with disabilities with household incomes of less than \$150,000 were more likely (ORs ranged from 1.54-5.96) to be unable to pay an energy bill than people with disabilities with household incomes of \$200,000+. Compared to people with disabilities who lived in detached single-family homes, those who lived in apartment buildings were 1.33 times (OR [CI] = 0.75 [0.65, 0.87]) less likely to be unable to pay an energy bill and people with disabilities who lived in mobile homes 1.36 times (CI [1.11, 1.66]) more likely to be unable to pay an energy bill. Compared to people with disabilities who owned their homes free and clear, people with disabilities who rented (OR [CI] = 1.73 [1.48, 2.03]) and occupied without payment (OR [CI] = 1.97 [1.47, 2.64]) were more likely to be unable to pay an energy bill. People with disabilities with private insurance were 1.15 times (OR [CI] = 0.87 [0.77, 1.00]) less likely to be unable to pay an energy bill than people with disabilities with other forms of health insurance. People with disabilities who were Medicare beneficiaries were 1.18 times (OR [CI] =

0.85 [0.74, 0.98]) less likely to be unable to pay an energy bill than people with disabilities with other forms of health insurance. People with disabilities who were Medicaid beneficiaries were 1.21 times (CI [1.06, 1.38]) more likely to be unable to pay an energy bill than people with disabilities with other forms of health insurance. People with disabilities who experienced a household job loss within the last month were 2.45 times (CI [2.18, 2.75]) more likely to be unable to pay an energy bill than people with disabilities who did not experience a household job loss. People with disabilities who lived in households that received SNAP were 1.30 times (CI [1.12, 1.51]) more likely to be unable to pay an energy bill than people with disabilities in households without SNAP. People with disabilities who lived in larger households were more likely to be unable to pay an energy bill (OR [CI] = 1.12 [1.08, 1.16]).

4. Discussion

During the COVID-19 pandemic, approximately 2 out of every 5 people with disabilities (38%) were unable to pay an energy bill. As a result of energy expenses, 51% of people with disabilities reduced or forwent basic household necessities, such as medicine or food, in order to pay an energy bill, putting them further at risk for other forms of insecurity, such as food and housing insecurity. Moreover, 36% of people with disabilities kept their homes at unsafe or unhealthy temperatures, thereby increasing risks to their physical and mental health. In fact, our findings suggest people with disabilities were significantly more likely to be energy insecure during the pandemic than people without disabilities, even when sociodemographics, including household income, were controlled.

Household income and job loss played a role in if people with disabilities were energy insecure, with lower income people with disabilities being more likely to forgo basic needs, keep their homes at unsafe temperatures, and be unable to pay an energy bill. While energy insecurity

was related to income, there were many other factors that also increased the likelihood of people with disabilities being energy insecure during the pandemic. For example, people with disabilities with less education were more likely to be energy insecure. Prior to the pandemic, people with less than a college education were more likely to be energy insecure [1,7]; during the pandemic, people with disabilities with less education may have had more trouble finding deferral or other assistance programs, thus leading them to be energy insecure. This finding may also be related to the relationship between education and income.

People who experience multiple marginalization people, including gay, lesbian, bisexual, and queer people with disabilities, Black and Hispanic people with disabilities, and cisgender women with disabilities, were more likely to be unable to pay energy bills, go without basic needs to pay energy bills, and/or keep their homes at unsafe temperatures than people with disabilities from social majority groups. As such, it is especially important that programs designed to reduce energy insecurity pay particular attention to the needs of people who experience multiple marginalization; furthermore, it is crucial for research and data collection efforts to consider intersectionality when tracking and studying the impacts of energy insecurity, including disconnections [1,3].

People with disabilities who lived in households that received SNAP benefits were more likely to be unable to pay an energy bill during the pandemic, as well as were more likely to go without basic needs in order to pay an energy bill. While states can include calculation of heating and cooling costs into SNAP eligibility requirements, if, and, how, they do so differs wildly across the United States [23]. In 2019, a proposed rule was introduced by the Food and Nutrition Service [23] to standardize how utility costs, including heating and cooling, were factored into SNAP eligibility requirements; however, the Food and Nutrition Service noted doing so would

“have an adverse or disproportionate impact on protected groups. Households with an elderly or disabled individual will be disproportionately affected... because these households do not face the cap on excess shelter costs and therefore would experience a greater [SNAP] benefit increase or decrease” [23, n.p.].

In terms of home setting, people with disabilities who lived in apartment buildings were less likely to be energy insecure than those in detached single-family homes, which is likely due to the fact that apartments use less energy than single-family homes and/or because rent for apartment buildings may include energy utilities [13]. Conversely, people with disabilities who lived in mobile homes were significantly more likely to be energy insecure. As previous research suggests mobile homes do not differ in energy consumption [24], and people who live in mobile homes do not face more financial hardship than those in single-family homes [25], additional research is needed to explore this finding, including if there is an interaction between disability, home type, and ownership status that impacts energy insecurity.

In addition to home type, there was a relationship between energy insecurity and housing ownership status. People with disabilities who rented their homes or occupied their homes without payment/rent were significantly more likely to be energy insecure during the pandemic than those people with disabilities who owned their homes free and clear. Research indicates that rental units are more likely to lack weatherization and energy efficiency measures because utilities fall on renters, not the property owners [2,13,16]. This, as well as the fact that many renters were more at risk for eviction during the COVID-19 pandemic [26] – while housing moratoriums may have been in place, not all landlord accepted federal rental aid and some preferred to evict tenants instead, and lifted housing moratoriums put additional burden on

renters to make up payments [26-28] – may be why renters with disabilities were more likely to be energy insecure in this study.

4.1 Implications for Policy and Practice

Given a considerable proportion of people with disabilities were energy insecure during the COVID-19 pandemic, including at greater rates than people without disabilities, as the pandemic continues, and in wake of recovery from the pandemic, strategies and programs must be implemented to reduce energy insecurity. To reduce energy insecurity, utility disconnection moratoriums should continue [3,4,6,8]. Given moratoriums do not stop debt accrual, moratorium programs should also include strengthened disconnection policies, bill assistance, payment plans, and debt forgiveness [2-4,6,8,10]. As research indicates water shutoff moratoriums lowered COVID-19 infections and mortality rates, extending utility moratoriums may also have the added benefit of helping reduce COVID-19 [29].

Expanding people with disabilities' access to quality, affordable housing can also help reduce energy insecurity [2,10]. There is already a shortage of affordable, accessible housing to meet the needs of people with disabilities in the United States [30,31]. As a result, people with disabilities are more likely to live in poorer quality housing with inadequate conditions, settings that are likely also less energy efficient [31,32]. In addition to expanding quality, affordable, and accessible housing, expanding weatherization assistance programs and implementing programs to help assist people with disabilities with energy efficiency upgrades, such as more efficient appliances, would help reduce energy insecurity as well as help alleviate poverty [2,8-10,13].

In addition, as people with disabilities are more likely to be poor, financially insecure, and lack assets than nondisabled people [33-36], implementing poverty reduction strategies for people with disabilities would also help reduce energy insecurity [37]. For example, COVID-19

stimulus programs, including the Child Tax Credit, helped reduced material hardship and financial instability in the United States [38-40]. Given people with disabilities in our study who received the Child Tax Credit were significantly less likely to keep their homes at unsafe temperatures, it suggests future stimulus programs would help reduce energy insecurity.

Renters with disabilities were especially vulnerable to energy insecurity in this study. Many landlords do not prioritize energy efficiency upgrades because while they endure the expenses, the savings are generally received by the tenants [41,42]. For small landlords in particular, high investment costs and low capital can be barriers to improving energy efficiency [43]. Given small landlords were impacted by COVID-19 to a greater degree than larger landlords, as well as the fact that lost revenue during the pandemic resulted in many delaying household improvements, additional investment and loan opportunities would help small landlords improve energy efficiencies [42,44,45]. For example, the Whole-Home Repairs Act was recently introduced in the Pennsylvania state Senate to offer forgivable loans to small landlords so that they can improve the energy efficiency of their rental units, among other home improvements, such as disability accessibility [46]. Supporting small landlords with energy efficiency initiatives, including energy audits and weatherization, will not only help reduce energy consumption, but would also benefit renters with disabilities who face energy insecurity.

Finally, it is also important to note that during this same time period of the pandemic in our study when people with disabilities were energy insecure, with 37% of people with disabilities which keeping their homes at unsafe or unhealth temperatures, there were a number of natural disasters and instances of extreme weather in the United States, including Texas winter storm Uri [47], the Pacific Northwest heat wave [48], and a series of “unprecedented” fires in California [49, n.p.], among others, which would have further increased people with disabilities’

need for electricity for heating/cooling, hindered air quality, and resulted in power outages. While extreme weather impacts the health and quality of life of everyone [50], for people with disabilities, the co-occurrence of energy insecurity and natural disasters can be especially dangerous and deadly [9,17,37]. Given extreme weather is expected to become more common in the future [17,50,51], and people with disabilities are more likely to face energy insecurity, disaster planning initiatives must recognize the needs of people with disabilities, including their increased risk for energy insecurity even prior to these disasters [9]. When disasters strike, attempts should be made to minimize the loss of power for people with disabilities; when doing so is unavoidable, contingency plans and alternative solutions, such as accessible cooling centers, locations where people can freely power medical devices, and alarms which alert emergency services to do welfare checks, need to be in place.

4.2 Limitations

When interpreting this study's findings, a number of limitations should be noted. People volunteered to participate, so there is a chance of self-selection bias. Although population weights were used, the sample was higher income, and slightly younger than in the general population, which has particular implications for energy insecurity [21]. This was a secondary data analysis; as a result, we did not have the ability to ask follow-up questions or add additional variables, such as about people's energy expenses prior to the pandemic. In addition, while the Census Bureau's questions about disability are used in censuses around the world, they may not capture all kinds of disabilities. As such, the comparison group referred to as 'people without disabilities' may also include some people who have disabilities that were not captured by the Census Bureau's questions. It is also not clear if or how the Census Bureau made the survey accessible for people with disabilities. The Census Bureau also administered the survey online,

which would require people have access to the internet, which could have implications specifically related to energy insecurity.

4.3 Conclusion

People with disabilities were significantly more likely to be energy insecure prior to the COVID-19 pandemic [3,7,16]. According to our study, during the COVID-19 pandemic, more than one-third of people with disabilities were unable to pay an energy bill, more than one-third kept their homes at unsafe temperatures, and half forwent basic household necessities to pay an energy bill. Energy insecurity can hinder the health and quality of life of people with disabilities [1-3,7,8,10]. Energy justice demands everyone, including people with disabilities, have access to safe, affordable, and sustainable energy [1,2], during the COVID-19 pandemic and beyond.

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