# TVA HOME UPLIFT METRO AREAS
# FINAL REPORT ON NON-ENERGY IMPACTS

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## Acronyms and Abbreviations

| | |
|---|---|
| CAC | Knoxville-Knox County Community Action Committee |
| CARE | Center for Applied Research and Evaluation |
| CATI | Computer-Assisted Telephone Interview |
| CO | Carbon Monoxide |
| COPD | Chronic Obstructive Pulmonary Disease |
| COVID-19 | Coronavirus Disease 2019 |
| DOE | U.S. Department of Energy |
| DWaS | Data with a Soul |
| ECM | Energy Conservation Measure |
| EPB | Electric Power Board (of Chattanooga) |
| ETS | Environmental Tobacco Smoke |
| FPL | Federal Poverty Line |
| HVAC | Heating, Ventilation and Air Conditioning |
| IEQ | Indoor Environmental Quality |
| KUB | Knoxville Utility Board |
| LPC | Local Power Company |
| Metro Area | Metropolitan Area |
| MLGW | Memphis Light, Gas and Water |
| NEI | Non-Energy Impact |
| QoL | Quality of Life |
| SEEED | Socially Equal Energy Efficient Development |
| SDOH | Social Determinants of Health |
| TVA | Tennessee Valley Authority |
| UT | University of Tennessee |
| WAP | Weatherization Assistance Program |
| Wx | Weatherization |
| Yr | Year |

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# Executive Summary

This report contains results from the program evaluation conducted on the Tennessee Valley Authority's (TVA) Home Uplift weatherization pilot initiated in seven metro areas across the Tennessee Valley during 2018 and 2019. TVA created Home Uplift to address the significant energy efficiency and weatherization needs for low-income households within its service territory. Energy efficiency upgrades through Home Uplift weatherization typically include air sealing and insulation measures, replacement and maintenance of heating and air conditioning equipment, and the installation of new water heaters, windows, doors, refrigerators, lightbulbs and shower heads. General health and safety measures, as well as miscellaneous repairs, were also included. The evaluation findings contained in this report strongly suggest the TVA Home Uplift pilot produced a range of benefits for low-income qualifying households that include increased energy affordability and security, reduced financial hardships, dwelling quality improvements, and improved health and well-being of household members. Alongside these quantitative metrics, in-depth interviews with households emphasize the transformative impacts comprehensive weatherization has had on their quality of life. These shared experiences with Home Uplift help substantiate the aggregate survey findings and justify the monetization of select non-energy impacts (NEIs) for consideration of societal (e.g., public health) and household (e.g., improved sleep and productivity) benefits.

## Evaluation Objectives

It is widely accepted that low-income weatherization programs produce multiple household and societal benefits, also referred to as NEIs. These benefits can include improvements in health issues (e.g., thermal stress from reduced exposure to hot and cold temperatures) and utility affordability and security (e.g., reduced trade-offs between basic essentials, prevention of disconnections for non-payment). It is also understood that the NEIs of weatherization, as well as other types of energy efficiency programs, vary across geography, climate, occupancy, and housing types. The work completed through this evaluation aimed to expand upon the existing knowledge and evidence to better understand the impacts of weatherization on lower-income households across the Tennessee Valley. More specifically, the evaluators working on this project aimed to quantitatively and qualitatively measure the benefits of the Home Uplift pilot to better document current impacts and advance program outcomes moving forward. Additionally, a subset of practically significant and statistically defensible NEIs are monetized by pairing weatherization measures data and self-reported survey responses with publicly available cost information. This evaluation is the most comprehensive study ever conducted on the NEIs attributable to low-income weatherization in the Southeastern United States.

## Survey Outcomes

In partnership with the University of Tennessee, Knoxville's Center for Applied Research and Evaluation (UT CARE), the evaluation team exceeded its sample goal of surveying 625 Home Uplift households (i.e., treatment group) at baseline. A total of 701 Home Uplift households were surveyed across the seven pilot locations. During the first year of surveys, low-income, unweatherized households (i.e., control group) were also recruited from within the same metro areas as the treatment group households. A number of barriers interfered with achieving the

control group sample goal of 375 households. A total of 300 households were surveyed for the control group during the first year of the survey. For the treatment group, the second-year survey served to capture household responses, approximately 12 months after weatherization, to then be compared to the same survey questions administered pre-weatherization. It also served to capture the second-year responses within the unweatherized group to control for external factors impacting survey responses; not attributable to the weatherization interventions. Finally, additional modifications were made to the survey instrument after March 2020 in response to the COVID-19 pandemic to better understand and control for impacts of the pandemic.

## Key Findings

The TVA Home Uplift program produced meaningful improvements in a number of home energy, health and well-being, and dwelling quality outcomes. For example, hundreds of households across the Tennessee Valley that participated in Home Uplift no longer find it difficult to pay their energy bills and no longer worry about having heating or cooling when they need it. Households also reported being more energy secure after Home Uplift with fewer utility disconnect notices and disconnections.

*Characterization of Home Uplift Households:*

- An overwhelming majority of respondents (77 percent) who completed the evaluation survey – representative of households served through the Home Uplift pilot – identified as Black or African American homeowners.
- The average household size was 1.8 people and reported having lived in their homes an average of 23 years.
- The vast majority (97 percent) of Home Uplift households that were included in the health impacts analyses had healthcare coverage; 92 percent of unweatherized households in the control group also had healthcare coverage.
- Over 40 percent of survey respondents reported being retired. One quarter of survey respondents reported being unable to work a job; nearly half of those respondents that reported being unable to work stated that their health keeps them from working a job.
- The majority of households surveyed reported receiving either social security or Supplemental Security Income, about 60 and 20 percent respectively.
- Very few households reported receiving other government support or cash assistance, unemployment compensation or veteran's payments.

*Energy Security Findings:*

- After Home Uplift, use of secondary heating decreased across all types of equipment investigated, including: unvented propane or kerosene heaters, electric heaters, vented and unvented gas fireplaces, and wood-burning fireplaces and stoves.
- After taking into account decreases in the control group, a net statistically significant decline was found in the use of electric heaters (by 15 percent) after Home Uplift weatherization.
- A statistical difference was found in the percentage of households that reported using their oven to heat their home after Home Uplift; reducing exposure to this serious health and safety hazard for individuals and families across the Valley.

*General Health and Well-being Findings:*

- Weatherization recipients report being very satisfied with their life in general, their health, and present standard of living after Home Uplift at higher – and statistically significant – levels than before their homes were weatherized.
- On average, recipients of Home Uplift reported fewer days their sleep and physical or mental health was not good after weatherization.
- After Home Uplift, households reported a significant decrease in the amount of noise they could hear from the outside while indoors when the windows are closed. Households also reported significant reductions in noise interfering with sleep a great deal.
- The percentage of households who reported they didn't get prescription medications because they couldn't afford them decreased, significantly, by about 8 percent.
- Exposure to extreme temperatures inside homes during winter and summer months was significantly reduced after Home Uplift; 15 percent of households reported no longer being exposed to unsafe temperatures almost all or some of those months.
- After taking into account decreases in the control group, a net statistically significant decline was found in the exposure of both drafts and dust by over 20 percent in Home Uplift homes. Households also reported statistically significant decreases in observations of mold and standing water after Home Uplift.

## COVID-19 Pandemic Impacts on the Evaluation and Survey Findings

In March 2020, the evaluation survey was paused to ensure safety of the UT CARE survey administrators working on-site and to not overwhelm households impacted by the COVID-19 pandemic. When it was determined safe to resume the survey, a number of questions were added to better understand the impacts of the COVID-19 pandemic. Of those that completed the survey after March 2020, over 60 percent of employed individuals reported being essential workers; mostly in the healthcare, public health, and education sectors, with many others working in public utilities and social services. Importantly, for some analyses, controlling for whether the second survey took place before or after the COVID-19 pandemic lockdowns had a notable effect on the results. For example, the control group, in particular, was less likely to express concerns about paying their energy bills or being disconnected after the start of the pandemic, possibly due to the disconnection moratorium. These impacts are further explored in Section 4.

## Recommended Home Uplift Metro Area NEIs for Monetization

Both direct and indirect impacts that can be attributable to weatherization were assessed during the Home Uplift pilot NEI evaluation. The NEIs evaluated are grounded in theoretical reasoning and program findings – meaning it is logical to conclude that weatherization improvements lead to utility bill cost savings, reduced financial hardships, and better dwelling quality; which, in turn, produce subsequent health and well-being benefits. The selection of NEIs for monetization is based upon observations of practical and significant changes in survey outcomes between the pre- and post-weatherization time periods. These treatment group outcomes were then compared to control group outcomes, when deemed appropriate. Many NEIs are supported by additional outcomes (e.g., subjective experiences with thermal comfort, difficulty paying energy bill) drawn

from the survey that further signal change and justify inclusion in our valuation of benefits attributable to the Home Uplift pilot.

The eight health and well-being NEIs proposed for monetization include reduced:

- Likelihood of CO poisoning;
- Disconnections of electricity or natural gas;
- Likelihood of fire risk;
- Number of times households had to throw food away because their refrigerator was broken or because they lost power (i.e., food spoilage);
- Use of high-interest, short-term loans or pawn shops to assist with paying utility bills;
- Number of days the respondent did not feel they got enough sleep; thereby improving work and home productivity;
- Incidences where prescriptions were not filled or not taken as prescribed; and
- Healthcare encounters for thermal stress impacts resulting from exposure to hot and cold temperatures when inside homes.

Together, these benefits produce an estimated annual NEI value of $1,580 that can be claimed for every house weatherized through Home Uplift. This value includes the value of a statistical life (VSL) claimed for each predicted avoided death from exposure to extreme cold temperatures inside a home and from prevented deaths from reduced house fires. If the VSL is not included, the estimated annual NEI value for Home Uplift is $209.

A total Present Value for these NEIs with and without the VSL was also calculated. The NEI Present Value for all years the benefits of Home Uplift are likely to persist (10 years) is estimated to be $15,405. If the VSL is not included, the estimated Present Value for Home Uplift NEIs is estimated to be $2,039.

# 1. Introduction

It is widely accepted that low-income weatherization programs produce multiple household and societal benefits, also referred to as non-energy impacts (NEIs). These benefits can include improvements in health issues (e.g., thermal stress from reduced exposure to hot and cold temperatures) and utility affordability and security (e.g., reduced trade-offs between basic essentials, prevention of disconnections for non-payment). It is also understood that the NEIs of weatherization, as well as other types of energy efficiency programs, vary across geography, climate, occupancy, and housing types. The work completed through this evaluation aimed to expand upon the existing knowledge and evidence to better understand the impacts of weatherization on income-eligible households across the Valley. More specifically, the evaluators working on this project aimed to quantitatively and qualitatively measure the benefits of the Home Uplift pilot to better document current impacts and advance program outcomes on-going. Additionally, a subset of practically significant and statistically defensible NEIs will be monetized by pairing self-reported survey data with publicly available cost data. This is evaluation is by far the most comprehensive ever conducted on the NEIs attributable to low-income weatherization in the Southeastern United States.

Findings from this work will be used to meaningfully engage energy, housing, and health sectors using data resources and findings that illustrate the intersection of energy, housing and health for low-income populations across the TN Valley, the Southeast and the U.S. Outcomes will be shared with participating and non-participating local power companies (LPCs), community partners, philanthropies, and industries as partners and beneficiaries of this work. Outcomes from this evaluation serve to inform future work completed through Home Uplift to successfully fulfill TVA's mission to "make life better for the people of the Tennessee Valley."

## Background on the Home Uplift Pilot and Evaluation

The Home Uplift pilot was a low-income weatherization project funded by TVA and participating LPCs in its jurisdiction. Energy efficiency upgrades through Home Uplift weatherization typically include air sealing and insulation measures, heating and air conditioning equipment maintenance and replacement, heat pump water heater installation, window and door replacement, refrigerator upgrades, LED bulbs, and low-flow showerheads. The four major metro areas in TVA's region participated in the pilot: Knoxville, Nashville, Chattanooga, and Memphis, Tennessee. Other pilot locations included Huntsville, Alabama, 4 County Mississippi and the Western Kentucky Rural Electric Cooperative territory. Home Uplift's eligibility requirements and weatherization procedures were modeled after the U.S. Department of Energy's Weatherization Assistance Program (DOE WAP). The pilot focused on weatherizing single family, owner-occupied homes and a small number of mobile homes. A small number of homes weatherized in Huntsville are owned by its public housing program. As part of the pilot, TVA contracted with Three[3] to estimate the health, well-being and social determinants of health (SDOH) benefits attributable to the Home Uplift pilot. The evaluation reported on herein involved the design of a survey and data analysis plan to quantify the health and well-being benefits of households and to then monetize those NEIs observed to produce practical and significant benefits.

The evaluation design, project management, and data analyses have been directed by Three[3]. UT CARE administered the phone surveys just after homes received their energy audits but prior to weatherization and again one year later. Contact information for nearly all Home Uplift homes that received energy audits between 2018 and 2019 were uploaded to UT CARE through a secure file transfer protocol. The control sample for this evaluation was drawn from waiting lists, mailing lists, and lists of income eligible homes that received housing and energy assistance. Households that participated in the survey were provided a $20 incentive for the first round of survey completion and a $40 incentive to complete the second-year survey. Knoxville community-based organization, Socially Equal and Energy Efficient Development (SEEED), assisted with recruiting control group participants in Knoxville.

Finally, in 2019, Land Grant Films was contracted to complete a series of microdocumentaries to capture the lived experiences and impacts of Home Uplift weatherization by recipients. Households were identified through in-depth interviews that captured a number of different important themes; from dwelling quality impacts on quality of life to stressors associated with high energy burdens.

## Report Outline

Section 2 of this report contains the methodology underlying the evaluation of the health and households benefits attributable to the Home Uplift metro area pilot. Section 3 discusses findings from a series of in-depth interviews completed with a subset of survey respondents. Section 4 focuses on the survey outcomes and interpretation of findings. Section 5 describes the NEIs selected for monetization and the general approach. Values are presented as totals for each NEI selected, broken out as either household or societal benefits, with or without the inclusion of the value of statistical life (VSL). A total per household value is presented that combines all NEI values as a first-year benefit and at present value that considers the estimated number of years the NEI is likely to persist and be claimed post-weatherization. Concluding thoughts are found in Section 6.

# 2. Methodology

This section explains the quasi-experimental research design developed for this project and the objectives for different evaluation activities. A household survey was designed as the primary method for collecting self-reported information to measure NEIs attributable to Home Uplift weatherization. A semi-structured interview was also administered to select households that reported significant experiences with energy insecurity and other financial hardships, poor dwelling quality, and other important experiences before weatherization was completed. Data on weatherization measures were also collected for as many homes as possible to link survey outcomes to specific weatherization interventions.

## 2.1 Quasi-experimental Design and Analysis Plan

Three[3] employed a quasi-experimental research design that included surveying households that received Home Uplift weatherization (treatment group) and households of similar socioeconomic status that had yet to – and were not likely to – receive weatherization in the near future (control group). During its enrollment, TVA's Home Uplift providers requested households sign a waiver for their contact information to be shared with program evaluators conducting this survey research. Household information was then securely shared with UT CARE.

Control group households were recruited through several means depending on the Home Uplift site. For example, in some locations, staff working in Home Uplift operations would contact households on waiting lists that were not likely to receive weatherization in the next year. At other Home Uplift sites, local community organizations recruited interested control group households by going door-to-door. In the more difficult areas to recruit control group households, postcards were sent to publicly available addresses they had been eligible for the area's tax freeze programs. In another location, postcards were sent to addresses on previously compiled lists for households living in high energy burdened zip codes. Households interested in completing the survey would provide a verbal consent (if recruited by phone) to be contacted by UT CARE or could call UT CARE survey staff directly. Screening criteria were developed for UT CARE to use when contacting potential control group households. Prior to completing the survey, control group households were asked:

- If they or another adult have lived in the home for at least one year[1];
- If the household qualified for government services, such as energy assistance, disability, or other forms of public welfare benefits; and
- If their current home received weatherization services in the past ten years.

Having both a treatment and control group allows for quasi-experimental analyses; meaning the data are organized to perform differences-in-differences tests between the two groups to account for factors influencing outcomes other than the intervention (i.e., weatherization). Appropriate statistical tests were performed to measure changes from pre- to post-weatherization for a range of outcomes such as asthma, thermal stress, headaches, and other physical and mental health issues being studied. For example, paired analyses (analysis of the same person's survey data

[1] Treatment group households were also asked if they had lived in the home for at least one year.

from pre to post-intervention environments) were conducted for individuals with asthma in the treatment group using a paired sample t-test to determine changes in the number of health care encounters from pre- to post intervention. These types of analyses account for any reductions or increases in outcomes over that same time period observed in the control group. Other statistical tests, (e.g., mainly chi-square/McNemar tests) were performed for different types of variables and to test differences and changes in outcomes between and within research groups.

Power calculations aimed to provide a very high level of confidence in the research results and the capability to detect statistically significant changes in health and other outcomes from one year to the next. Table 1 displays the final sample frame for the Home Uplift NEI survey for each metro area site that participated in the pilot. The table also displays the breakout of total survey completions by each of these evaluation sites and by research group.

**Table 1: Home Uplift Metro Area NEI Evaluation Sample**

| Home Uplift Pilot NEI Evaluation Sample | | | |
|---|---|---|---|
| **Treatment Group** | | Pre-Weatherization/ Year 1 | Post-Weatherization/ Year 2 |
| | Sample Frame | 893 | 625 |
| | Projected Response Rate | 70% | 80% |
| | Sample Goal | 625 | 500 |
| | **Final Sample** | **701** | **572** |
| **Control Group** | | Round 2/Year 1 | Round 2/Year 2 |
| | Sample Frame | 750 | 375 |
| | Projected Response Rate | 50% | 80% |
| | Sample Goal | 375 | 300 |
| | **Final Sample** | **300** | **222** |

## 2.2 Survey Design

The survey instrument for the Home Uplift NEI evaluation for the metro areas was designed to capture the following information: household demographics, dwelling quality including thermal comfort and exposure to indoor environmental hazards; general health and well-being; health status, symptoms and healthcare encounters for select health concerns; access to healthcare; energy security, affordability, and trade-offs of basic essentials (Table 2). The majority of survey questions were drawn from pre-existing survey instruments used by the study team in other weatherization evaluation work. As a form of best practice, survey questions from government sponsored research and tracking mechanisms are used for comparability. Any new questions devised for the metro area NEI study were pretested by survey partners at UT CARE with low-income households.

Additional modifications were made to the survey after March 2020 in response to the COVID-19 pandemic. Questions related to COVID-19 were added to 1.) control for impacts of the pandemic on household members and 2.) to better understand how Home Uplift weatherization might have acted as a protective factor during the pandemic. The survey instrument took approximately 25-30 minutes to complete and was primarily administered as a computer-assisted

telephone interview (CATI) by UT CARE. It was also formatted as a paper survey for harder to reach populations that required an in-person or a mailed survey. For example, upon realizing that the population served through Home Uplift at the Huntsville Housing Authority required additional support in survey administration, staff from Three[3] and UT CARE – in coordination with Home Uplift providers and housing authority representatives – visited the site for residents to complete the survey in-person.

**Table 2: Home Uplift Pilot NEI Survey Categories, Indicators, and Metrics and Weatherization Measures Information**

| Survey Categories | Indicators and Metrics | Number of Variables |
|---|---|---|
| Well-being | **General health and well-being**: sleep (1), physical and mental health (3), **Satisfaction**: life, health, standard of living (3) | 7 |
| Human Essentials | **Energy Security:** access to heating and cooling (4), reliance on energy assistance (5); **Food Security:** access to food (1), reliance on food assistance (1); **Healthcare**: coverage (3); **Adequate Housing**: temporarily moved out due to housing habitability issues (1) | 15 |
| Hardship | **Financial burden**: difficulty paying for energy (1), difficulty paying medical bills/medications (2), choosing between basic essentials (7), use of predatory loans (2); **Stressors**: worries about household members going hungry (1), not having heating or cooling or electricity (2); **Economic impacts**: missed days of work due to illness/injury (2), food waste from broken refrigerator/loss of power (1); **Educational impacts**: missed days of school (2) | 20 |
| Health Status | **General health:** poor health keeps from working at job or around the house (2); **Asthma:** prevalence and status (4), healthcare utilization (8), specific environmental triggers (7); **Thermal stress**: exposure to hot or cold temperatures (3), healthcare encounters (14); **Headaches**: headache and migraine incidence and severity (3), medication use and treatment (3); **Low-birth weight infants**: prevalence and monitoring (5); **COPD**: prevalence (2), healthcare utilization (3), medication use (1); **Arthritis** (year 2 survey only): prevalence (2), status (1) | 58 |
| Indoor Health and Safety Hazards | **Exposure**: CO (1), lead (2), environmental tobacco smoke (3), odors (1), noise (3); **Dwelling quality**: extreme temperatures (3), drafts (1), mold and standing water (2), dust (1), pests (2); **Safety hazards**: trips and falls (3), use of oven to heat home (1), fires (5), food poisoning (1), burns from scalding water (1) | 30 |
| COVID-19 (year 2 survey only) | **Diagnosis**: prevalence (2); **Well-being**: mental health (1); **Economic impacts**: employment status (2); **Financial burden**: use of predatory loans (1), **Utility security**: affordability and disconnections (1); **Food security**: access to nutritious food (2) | 9 |

| | | |
|---|---|---|
| Independent Variables | **Demographics and socioeconomics:** age (1), gender (1), race/ethnicity (3), education status (1), employment status (2), marital status (1), government assistance (other than food, utilities or healthcare) (1), disability status (1), veteran status (1), children in the home (1); household size (1), years lived in home (1), home ownership/renter status (1) **Housing characteristics**: broken heating/cooling equipment (2), cooking fuel type, wood burning stove (1), unvented combustion heating equipment (1), secondary heating equipment (1), heating system filters (2), thermostats (2), mechanical ventilation (1) **Behavior**: thermostat settings (2), window use (2); **Safety equipment**: CO monitor (2), smoke detectors (3); **Weatherization measures** (merged with survey data)**;** heating and cooling maintenance and replacements (8), air sealing, insulation, windows, and doors (8), water heating (3), refrigerators (1), lighting (1), other measures (6) | 62 |
| **Total Number of Questions in Final Survey Instrument** | | **201** |

## 2.3 In-depth Interviews with Select Households

Adhering to a mixed-methods evaluation approach, semi-structured interviews were designed to better understand household perceptions and lived experiences with energy insecurity, affordability issues, exposure to health and safety hazards, and chronic illness. In addition to survey variables that documented gender, race, ethnicity, and whether they owned or rented their homes, the following indicators were used to screen households for important baseline conditions and issues:

- General Health and Well-being: Survey respondents were asked the number of days during the past month that they experienced poor physical health, mental health, and the number of days poor health prevented them from doing their usual activities;
- Exposure to Extreme Temperatures: Households were asked whether their home was too hot, too cold, too drafty, or kept at unhealthy temperatures in the last 12 months;
- Health and Safety Concerns: Households were asked if they used secondary heating sources or if they used their cooking stove to heat their home the previous winter. They were also asked they had seen mold or standing water in the last 12 months; and
- Energy Affordability and Security: Survey administrators inquired whether households had difficulty paying their utility bills, relied on energy assistance, or had worried they would not have heating or cooling when they needed it during the last year.

Interviews were designed with the intention to meaningfully integrate respondents' own words into the research record and to better understand the impacts of weatherization. From these records, households that were interested in participating in a microdocumentary film project were able to share their experiences on camera through the direction of UT Land Grant Films.

## 2.4 Controlling for the Impacts of the COVID-19 Pandemic

Unexpectedly, the Coronavirus 2019 (COVID-19) caused many organizations to pause on-site operations in 2020. When UT, Knoxville closed its buildings in March 2020, UT CARE survey operators stopped the administration of the Home Uplift survey. When survey operations resumed in August 2020, a number of survey questions were added to control for the impacts of COVID-19 on survey responses and to better understand who the Home Uplift pilot was helping. Analyses were conducted on the survey data using the full sample and then comparing treatment and control group households stratified by whether they had been surveyed pre-pandemic or after the pandemic had fully impacted local economies and policies.

## 2.5 NEI Monetization Approach

A primary objective of the research conducted under this project is to quantify and monetize select health- and household-related NEIs attributable to TVA's Home Uplift pilot that operated in metro areas across the Valley. Along with publicly available healthcare utilization cost data, survey responses from recipients of the Home Uplift pilot were gathered to measure changes in reported health and household outcomes and events. Quantifiable outcomes deemed both practically and statistically significant were input into equations to monetize select NEIs. NEIs for the Home Uplift metro area pilot can then be assessed to determine if benefits of Home Uplift are accruing to sectors beyond the energy sector. More specifically, observed social and health benefits deemed significant can be used to engage with stakeholders in these sectors to establish collaborative processes that aim to improve the energy efficiency and habitability of housing across the Valley.

Prior to data collection, a set of NEIs were identified as benefits likely to accrue to either households or society as direct or indirect results of low-income weatherization. Survey questions were intentionally developed to ensure responses could be migrated as inputs for the monetization of NEIs attributable to Home Uplift. This subset of health related NEIs included: reduced COPD and asthma-related urgent care, emergency department, and hospital visits; reduced healthcare encounters related to residents being too cold or too hot inside their homes; reduced exposure to CO poisoning and fire risks; reduced missed days of work and school from illness or injury; reduced trips and falls; and improved adherence to prescription medication. Additional well-being or household NEIs included: reduced utility disconnections; reduced food insecurity and reliability on government food assistance; reduced food spoilage from broken refrigerators or lack of power; reduced use of predatory loans or pawn shops to assist with paying utility bills; and reduced number of days of poor sleep impactive work and home productivity. The final set of NEIs proposed herein are defensible based on their practical and statistical significance, and reasonableness; meaning there is existing evidence to suggest low-income weatherization programs produce the proposed benefit, or there is direct evidence to suggest that the comprehensive weatherization measures provide logical pathways to additional NEIs not previously researched or considered in other studies.

## 2.6 Evaluation Limitations

Due to the evaluation's quasi-experimental design, it was important to generate a representative sample of treatment homes and a comparable sample of control homes. Recruitment of control group homes was unique to each metro area site and dependent upon the availability of internal resources, extensive waiting lists for weatherization that could provide contact information for unweatherized homes (as described above). As a result, the control group diverged from the treatment group on several sample characteristics and baseline statistics (documented in Section 3). For example, more treatment group homes reported owning their own home than control group households (by about 40 percent). Treatment group respondents appear to be slightly older and are more likely to be retired than control group respondents. Finally, treatment group households appear to have struggled more with maintaining comfortable temperatures inside their homes and had more broken heating and cooling equipment at baseline (e.g., before weatherization). The average household size and number of households with children are higher in the control group, which also has higher rates of respondents that smoke cigarettes and households exposed to environmental tobacco smoke (ETS).

# 3. In-Depth Interview Findings

A small sample of Home Uplift households were identified and recruited (using the methodology described in Section 1.3) to complete in-depth interviews to better understand lived experiences with energy affordability and insecurity issues, exposure to indoor health and safety hazards, and psychosocial stressors related to housing and energy. The full semi-structured interviews (Appendix A) were conducted over the phone or in-person across the evaluation sites. Of those engaged, 36 individuals completed the full in-depth interview; six individuals completed a shorter version when evaluation staff were on location at the Huntsville Housing Authority in Alabama. Individuals who participated received a $50 gift card to a local grocery store.

A total of 27 individuals from participating households completed a post-weatherization interview where individuals were able to express their experiences with any observable impacts from the Home Uplift initiative. Interview responses were organized into overarching themes that aim to capture the most reported and impactful outcomes.

## 3.1 DWaS Outcomes

***Overall Well-being and Quality of Life***
Expressions of general well-being and quality of life (QoL) were observed across a number of interviews that reported an overall hardship and subsequent human suffering related to energy inefficient housing. Also captured are the potential life-changing benefits of weatherization programs like Home Uplift. This theme emphasizes the importance of formal and informal supports relied upon to help maintain energy security for many households living with unaffordable utilities, as well as reduced dependency on these supports and networks after weatherization.

*Highlighted Household Story*

> *One resident had an old, broken furnace, and she was using space heaters that "do not keep your house that warm." Her water heater had gone out at the same time as her heat, so it was "like a downhill trip for a while." She felt tired all the time, and noted that, "If you're mentally tired, it affects your whole body."*
>
> *Now that she has weatherization, however, "It feels luxurious! I feel like I'm rich." She also said, "[Home Uplift] changed my life; I don't have to be miserable now…It changes your outlook too; you don't feel so overwhelmed by your circumstances."*

***Energy Affordability Issues and 'Trade-Offs'***
This theme highlighted the extreme cases of energy insecurity and the trade-offs households are often forced to make between utility bills, food, medications and treatment, travel and socializing. It also emphasized psychosocial stress related to energy insecurity in the forms of disconnections and having to seek energy assistance while living on a fixed or low-income.

*Highlighted Household Story*

*One family said that, before Home Uplift, they were getting disconnected as much as every 3-4 months. The light bill averaged around $250-300 and got as high as $500 in winter. Saving money on the light bill would help them pay for prescriptions and gas for transportation to and from the doctor's office. They are on a fixed income and raising two grandkids currently with two already out of the house. They provide everything for the kids from school supplies to clothes to food and healthcare. Before receiving the new furnace from Home Uplift, they were worried about a fire from using space heaters all night.*

***Housing Indoor Environmental Quality and Health***

Households reported observations related to specific indoor environmental quality (IEQ) issues that correlate to health, such as mold and moisture exposures evidenced to impact respiratory health. Other health and safety issues captured under this theme include trip and fall hazards, pest infestations, and reduced dust.

*Highlighted Household Story*

*One resident noted trip and fall hazards in her home due to uneven floors and her bad back. She was concerned about rats and the potential for lead in the house's pipes and paint. The house had no vapor barrier, so it suffered from mold and moisture issues. She had a number of health issues, and her grandchildren were always sick, coughing, and in respiratory distress.*

***Benefits of Thermal Comfort***

The fourth theme covered a range of benefits associated with medical diagnoses impacted by exposure to extreme hot and cold indoor temperatures (e.g., arthritis), and other health and well-being indicators associated with thermal comfort, such as quality of sleep. Health and safety issues related to secondary heat sources were also captured under this theme.

*Highlighted Household Story*

*This resident, a veteran, had no central heat or air before Home Uplift and would use space heaters and window A/C units to regulate the temperature in his home. Sometimes he would drive an hour to his family's farmhouse just to be warm.*

*After Home Uplift, he said the house felt like home. "[The weatherization] is a blessing, especially this time of year [in winter]." Soon after the work was finished, he noticed the air felt fresher, which helped with his breathing problems. He had only praise for the program and said it was the first program that's followed through on what it said it would do—"and that means a lot down here."*

# 4. Survey Results

The TVA Home Uplift metro area survey findings are presented across a number of categories, metrics, and indicators drawn from the survey (as provided in Table 2) and weatherization measures provided by program administrators. This section aims to first characterize the household sample and housing stock to better understand who the Home Uplift pilot served and the conditions of their homes at baseline (pre-weatherization). This section then presents baseline statistics and any measurable changes detected in household reported issues related to energy insecurity and household energy usage behavior, financial hardships, general health and well-being, chronic health conditions, and exposures to health and safety hazards in the indoor environment.

## 4.1 Household Characterization

*Respondent Demographics*

Table 3 presents the characterization of the study sample for the treatment and control groups by site for each survey year. The overwhelming majority of primary survey respondents in both research groups identified as female and as Black or African American. More pre-weatherization respondents identified as White than the control group sample during the first year – by about 7 percent. The average age of the primary survey respondent was deemed to be statistically different between the treatment and the control group samples for both rounds of the survey; by four years. No respondent reported being Asian or Native Hawaiian/Other Pacific Islander in the first survey round. One individual reported being Asian and one individual reported being Native Hawaiian/Other Pacific Islander during the second round. Other than the difference in average age and difference in respondents identifying as White during the first round of the survey, no other statistical differences were found between the two groups on these demographics.

**Table 3: Household Characterization: Primary Respondent Demographics**

| Variable/Research Group[2] (n = Number of Respondents) | Treatment Pre-wx (n=701) | Treatment Post-wx (n=572) | Control Year 1 (n=300) | Control Year 2 (n=222) |
|---|---|---|---|---|
| Gender: Female | 81.2% | 82.9% | 84.0% | 86.5% |
| Age (mean) | 62 | 64 | 58*** | 60*** |
| Black or African American | 76.6% | 78.5% | 80.3% | 81.5% |
| White | 21.7% | 20.1% | 14.7%* | 16.7% |
| Hispanic or Latino Origin | 1.3% | 1.2% | 1.3% | 0.9% |
| American Indian/Alaska Native | 0.7% | 0.7% | 0.7% | 0.9% |
| Other Race | 0.9% | 0.2% | 2.3% | 0.5% |

[2] The two research groups are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a Pearson Chi-Square test or independent samples test (means) comparing treatment and control group samples for each Survey Round (1 and 2).

*Household Composition*

The Home Uplift pilot that operated in metro areas across the Tennessee Valley primarily served households that owned their own homes (Table 4). Households in this sample had an average household size of 1.8 people and lived in their homes an average of 23 years. Households in the control group were, on average, larger in size, lived in their home fewer years, and had much lower homeowner rates; at statistically significant levels.

**Table 4: Household Characterization: Household Size, Owner Status, Years Lived in Home**

| Variable/Research Group[3] (n = Number of Respondents) | Treatment Pre-Wx (n=701) | Treatment Post-Wx (n=570) | Control Year 1 (n=300) | Control Year 2 (n=222) |
|---|---|---|---|---|
| Average household size (mean) | 1.8 | 1.9 | 2.4*** | 2.4*** |
| Own home (not rent or other situation) | 85.0% | 85.0% | 58.5%*** | 58.5%*** |
| Number of years lived in home (mean) | 23 | 25 | 20 | 18*** |

Just over 26 percent of Home Uplift households in this sample reported that the primary wage earner of the household is employed full-time, and that 44 percent are currently retired (Table 5). Another quarter of households reported the primary wage earner is unable to work mostly because their health keeps them from working a job. About one third of Home Uplift households reported their highest level of education is a high school diploma or GED; a little less than a quarter reported having a college degree. The percentage of primary wage earners that are retired is the only statistical difference observed between the Home Uplift treatment group and the control group; with the control group having fewer retired individuals by about 7 percent. In addition, just over 5 percent of homes served through the Home Uplift program contained someone who served on active duty in the U.S. Armed Forces, Reserves or National Guard.

**Table 5: Household Characterization: Employment and Education Status**

| Variable/Research Group (n = Number of Respondents) | Treatment Pre-Wx (n=701) | Treatment Post-Wx (n=572) | Control Year 1 (n=300) | Control Year 2 (n=222) |
|---|---|---|---|---|
| Employed (primary wage earner) | 26.4% | 25.1% | 30.0% | 26.2% |
| Retired (primary wage earner) | 43.5% | 47.7% | 36.4%* | 37.8%* |
| Unable to work (primary wage earner) | 25.0% | 23.1% | 23.2% | 23.9% |
| Health keeps respondent from working a job | 52.7% | 48.3% | 48.5% | 50.2% |
| High school diploma/GED only | 33.7% | 33.2% | 35.7% | 31.5% |
| College degree(s) | 23.1% | 23.2% | 22.8% | 25.8% |

[3] The two research groups are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a Pearson Chi-Square test or independent samples test (means) comparing treatment and control group samples for each survey year (Year 1 and Year 2).

A new income question was added to the survey instrument prior to households being surveyed during the second year of the study. Income ranges (i.e., bands) were designed to calculate poverty status using federal poverty thresholds for 2019 (Table 6). Based on income estimates[4], approximately 43 percent of Home Uplift households were living below the federal poverty line (FPL) in the second year of the study. There was a statistically significant difference between the amount of weatherized participants (7 percent) and unweatherized participants (18 percent) who were living below 50 percent FPL; but not for 100 or 200 percent FPL.

**Table 6: Household Characterization: Poverty Status**

| Variable/Research Group[5] (n = Number of Respondents) | Treatment Pre-Wx | Treatment Post-Wx (n=572) | Control Year 1 | Control Year 2 (n=222) |
|---|---|---|---|---|
| Household living below 50% FPL | | 7.4% | | 17.8%*** |
| Household living below 100% FPL | | 43.2% | | 50.5% |
| Household living below 200% FPL[6] | | 90.5% | | 88.6% |

The majority of households that received Home Uplift services reported that at least one person living in the home receives either Social Security or Supplemental Security Income from the U.S. government (Table 7). A statistically significant difference was observed in the percentage of treatment households that received either of these benefits when compared to the control group. Small percentages of survey respondents in both research groups reported receiving welfare payments or cash assistance, Veteran's payments, or unemployment compensation, with the exception of control group households in the second year of the survey. A much higher rate of unemployment compensation is observed in both treatment and control group households when the sample is stratified by when the survey was completed. In the second-year survey, but prior to the COVID-19 pandemic[7], less than one percent of treatment and control group households reported that someone in the home received unemployment benefits, compared to 10 and 13 percent, respectively, during the pandemic.

[4] The mid-point of an income band and household size were used to calculate poverty status. Because of this, households on the lower end of an income band might still be living at or under 200% poverty thresholds but might appear to be living above the threshold in our tables. It appears as though 10 percent of Home Uplift households in this pilot were at the upper limits of the eligibility thresholds or moved above 200% FPL during the second year.

[5] The two research groups are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a Pearson Chi-Square test or independent samples test (means) comparing treatment and control group samples for each Survey Round (1 and 2).

[6] The mid-point of an income band and household size were used to calculate poverty status. Because of this, households on the lower end of an income band might still be living at or under 200% poverty thresholds but might appear to be living above the threshold in our tables. It appears as though just under 10 percent of Home Uplift households in this pilot were at the upper limits of the eligibility thresholds.

[7] For the purposes of this study, pre-COVID-19 surveys are considered those completed before UT CARE shut down its survey center in March 2020.

**Table 7: Household Characterization: Government Assistance**

| Variable/Research Group[8] (n = Number of Respondents) | Treatment Pre-Wx (n=701) | Treatment Post-Wx (n=572) | Control Year 1 (n=300) | Control Year 2 (n=222) |
|---|---|---|---|---|
| Someone in the home received income from: | | | | |
| Social Security | 60.6% | 70.5% | 50.7%** | 65.3% |
| Supplemental Security Income | 20.8% | 16.8% | 27.3%* | 22.1% |
| Welfare payments or cash assistance | 1.6% | 0.5% | 2.7% | 0.9% |
| Veteran's payments (VA benefits) | 0.9% | 1.9% | 2.0% | 3.2% |
| Unemployment compensation | 1.3% | 3.8% | 2.0% | 9.0%** |

*Healthcare Coverage*

The vast majority of main respondents in the treatment group reported having had healthcare coverage in the past 12 months during both survey years; pre and post-weatherization (Table 8). Although a slightly lower percentage of households in the control group had healthcare coverage – by about 5 percent at baseline – this difference between research groups was determined to be statistically significant during both years of the survey. A statistically significant difference was also observed between the research groups during the second year of the survey with nearly 5 percent fewer households in the control group having a health plan that covers at least some cost of prescription medications.

**Table 8: Household Characterization: Healthcare Coverage**

| Variable/Research Group (n = Number of Respondents) | Treatment Pre-Wx (n=701) | Treatment Post-Wx (n=572) | Control Year 1 (n=300) | Control Year 2 (n=222) |
|---|---|---|---|---|
| Main respondent has had healthcare coverage (past 12 months) | 93.4% | 97.0% | 88.0%** | 91.4%** |
| Health plan pays for at least some of the cost of prescriptions | 96.4% | 95.0% | 96.3% | 90.4%* |

## 4.2 Heating and Cooling Equipment

Starting in this section, for many survey variables, tests were performed within each research group to determine the statistical significance of observed changes from one year to the next; pre- and post-weatherization differences for the treatment group, and changes from year 1 to year 2 in the control group. When these tests are performed, only those households that supplied responses to both surveys are included in the analyses to allow for a better measurement of impact. The baseline statistic for the Home Uplift treatment group sample is also provided.

[8] The two research groups are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a Pearson Chi-Square test or independent samples test (means) comparing treatment and control group samples for each Survey Round (1 and 2).

After Home Uplift, an additional (~)15 percent of households reported having a thermostat that controls heating and/or cooling equipment inside their homes (Table 9). An additional 10 percent of households reported their heating system has an air filter (when it did not before). The difference between those that have a heating system filter between research groups during the second year of the survey is statistically significant.

**Table 9: Household Characterization: Thermostat and Heating Systems Filters**

| Variable/Research Group[9] (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=572) | Control Year 1 | Control Year 2 (n=222) |
|---|---|---|---|---|---|
| Home has thermostat that controls heating and/or cooling | 82.0% | 82.5% | 96.8%*** | 84.7% | 87.4% |
| Thermostat controls central heating only | 5.4% | 5.7% | 3.4% | 7.8% | 5.2% |
| Thermostat controls central cooling only | 1.2% | 1.5% | 0.7% | 1.0% | 0.5% |
| Thermostat controls central heating and cooling | 93.1% | 92.8% | 95.8% | 90.1% | 93.8% |
| Main heating system has an air filter | 83.3% | 83.1% | 93.8%*** | 81.9% | 81.4%*** |
| Air filter is a HEPA filter | 27.5% (n=418) | 26.8% | 33.4% (n=302) | 31.4% | 27.9% (n=86) |

*Broken Heating and Cooling Equipment*

Households that received Home Uplift experienced significant increases in access to working heating and cooling equipment (Table 10). Respectively, nearly 23 and 25 percent of households reported they were no longer unable to access their main heating and cooling equipment because it was broken. Statistically significant differences were found between the two research groups with far fewer control group households experiencing broken equipment during the first year, and an actual increase in broken heating and cooling equipment in the second year.

**Table 10: Broken Heating and Cooling Equipment**

| Variable/Research Group (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=572) | Control Year 1[10] | Control Year 2 (n=222) |
|---|---|---|---|---|---|
| Household unable to use main heating equipment because it was broken (in past 12 months) | 30.8% | 31.5% | 8.0%*** | 14.4%*** | 16.2% |
| Household unable to use central AC because it was broken (in past 12 months) | 35.5% | 35.1% | 10.5%*** | 21.6%*** | 19.4% |
| Household unable to use room AC because it was broken (in past 12 months) | 4.0% | 3.8% | 2.3% | 3.6% | 0.9% |

[9] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

[10] Control group responses at baseline and during year 2 were also compared to the treatment group. Statistically significant differences between the 2 research groups at baseline and for year 2 were observed using the Chi-square test.

*Use of Secondary Heating Equipment*

Use of secondary heating decreased across all types of equipment investigated: unvented propane or kerosene heaters, electric heaters, vented and unvented gas fireplaces, and wood-burning fireplaces and stoves (Table 11). After taking into account decreases in the control group, a net statistical difference was found in the use of electric heaters (by 15 percent) in the treatment sample. A statistical difference was also observed in the percentage of households that used their oven to heat their home between the pre and post-weatherization time periods. After considering reported changes in the control group sample, the difference was found to be 11 percent.

**Table 11: Use of Secondary Heating Equipment**

| Variable/Research Group[11] (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=572) | Control Year 1 | Control Year 2 (n=217-222) |
|---|---|---|---|---|---|
| In the past 12 months used… | | | | | |
| Electric heater | 48.9% | 52.4% | 28.3%*** | 47.7% | 41.9% |
| Unvented propane or kerosene heater | 4.0% | 3.8% | 1.0%** | 1.8% | 0.9% |
| Vented gas fireplace | 4.0% | 4.7% | 3.0% | 2.7% | 2.3% |
| Unvented natural gas fireplace | 2.7% | 2.8% | 1.0% | 3.2% | 1.8% |
| Wood-burning fireplace or stove | 6.0% | 6.3% | 2.4% | 1.8% | 2.3% |
| Oven to heat home frequently or all the time | 8.9% | 9.1% | 2.1%*** | 9.9% | 5.9%* |
| Oven to heat home (ever) | 35.1% | 35.6% | 13.7%*** | 33.2% | 23.5%** |

## 4.3 Indoor Temperature and Thermal Stress

Survey respondents were asked to estimate temperatures inside their homes during winter and summer months when someone is at home (Table 12). At baseline, treatment group respondents reported an average indoor temperature of 72 degrees Fahrenheit during both winter and summer months. Respondents in the control group reported keeping their homes at 73 and 71 degrees Fahrenheit in winter and summer, respectively. No observable differences were made from one year to the next. The full sample was used to produce these means.

[11] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

**Table 12: Indoor Temperatures**

| Variable/Research Group[12] (n = Number of Respondents) | Treatment Pre-Wx (n=701) | Treatment Post-Wx (n=572) | Control Year 1 (n=300) | Control Year 2 (n=222) |
|---|---|---|---|---|
| Temperature inside home during the winter (when someone is home) | 72.3 | 72.1 | 72.5 | 72.7 |
| Temperature inside home during the summer (when someone is home) | 71.9 | 71.8 | 71.4 | 71.3 |

Exposure to extreme temperatures inside homes was significantly reduced after Home Uplift (Table 13). For this set of analyses, only households that provided responses to both surveys are included in the table. This allows for better measurement of change from one year to the next by preventing differences between groups from skewing results. Reported exposure to cold or very cold temperatures in winter was reduced by 40 percent and exposure to hot or very hot temperatures in summer was reduced by about 37 percent. After Home Uplift, a significant 15 percent of households reported no longer being exposed to unsafe temperatures inside the home almost all or some months during the past year. Over 20 percent of households reported no longer being worried about not having electricity or cooling in summer or heating in winter. Improvements in thermal comfort and reductions in the percentage of households worried about not having electricity or cooling in summer or winter were also observed in the control group and at statistical levels, but not to the same degree as the treatment group. These variables were also analyzed to determine influence of the COVID-19 pandemic on outcomes; especially given the increase in access to utility bill relief and given that the majority of the control group sample completed the survey during the first year of the pandemic. However, whether the survey was completed pre- or during the pandemic did not appear to be a statistically significant predictor of these outcomes.

**Table 13: Thermal Comfort**

| Variable/Research Group[13] (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=570) | Control Year 1 | Control Year 2 (n=220) |
|---|---|---|---|---|---|
| Home is cold or very cold in winter | 57.1% | 57.7% | 17.5%*** | 35.9% | 30.5% |
| Home is hot or very hot in summer | 47.7% | 46.7% | 9.9%*** | 27.3% | 22.3% |
| Home is at an unsafe temperature almost all or some months | 22.4% | 22.4% | 7.7%*** | 17.7% | 9.1%** |
| Worried (during the summer) would not have electricity or cooling | 35.9% | 35.9% | 15.1%*** | 29.1% | 20.5%* |
| Worried (during the winter) would not have electricity or heating | 38.8% | 38.8% | 17.0%*** | 30.6% | 21.0%** |

[12] The full survey sample for each research group was used to produce these means.

[13] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

Small, but statistically significant, reductions in the percentages of individuals that visited healthcare settings for treatment of thermal stress from exposure to hot or cold temperatures inside their homes was observed after Home Uplift (Table 14 and Table 15). Although similar improvements were observed in responses from control group households, these improvements tended to be less and not deemed significant. Estimates were produced using all individual level data. Although not appearing to be practically significant, these low frequencies are often used as inputs for monetization of reduced thermal stress NEIs. Inputs from these tables are used for monetizing this benefit attributable to the Home Uplift pilot (Section 5).

**Table 14: Thermal Stress from Exposure to Cold Indoor Temperatures**

| Variable/Research Group[14] (n = Number of Respondents) | Treatment Baseline (n=1276) | Treatment Pre-Wx | Treatment Post-Wx (n=911-917) | Control Year 1 | Control Year 2 (n=448-450) |
|---|---|---|---|---|---|
| Individual in the household visited the following care setting because home was too cold (in the past 12 months) | | | | | |
| Went to Hospital | 0.6% | 0.8% | 0.1%* | 0.4% | 0.0% |
| Visited Emergency Department | 1.6% | 1.7% | 0.0%*** | 0.7% | 0.2% |
| Outpatient Clinic/Doctor's Office | 2.7% | 2.9% | 0.2%*** | 2.0% | 0.9% |
| Did any of the medical emergencies happen during a natural disaster or power outage? | 2.7% | 4.5% | 4.5% | 0.0% | 0/0% |

**Table 15: Thermal Stress from Exposure to Hot Indoor Temperatures**

| Variable/Research Group (n = Number of Respondents) | Treatment Baseline (n=1276) | Treatment Pre-Wx | Treatment Post-Wx (n=900-917) | Control Year 1 | Control Year 2 (n=448-449) |
|---|---|---|---|---|---|
| Individual in the household visited the following care setting because home was too hot (in the past 12 months) | | | | | |
| Went to Hospital | 0.2% | 0.2% | 0.1% | 0.4% | 0.0% |
| Visited Emergency Department | 0.9% | 1.0% | 0.1%* | 0.4% | 0.2% |
| Outpatient Clinic/Doctor's Office | 1.5% | 1.6% | 0.4%** | 1.3% | 0.7% |
| Did any of the medical emergencies happen during a natural disaster or power outage? | 3.7% | 0.0% | 0.0% | 0.0% | 0/0% |

[14] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

## 4.4 Energy Affordability and Security

A statistically significant reduction in the percentage of households that reported it was hard or very hard to pay energy bills was observed after Home Uplift, by a difference of about 18 percent. The number of households that reported relying on people they knew (to help pay bills) was also reduced significantly; by over 6 percent. Home Uplift households in the metro areas across the Valley consistently apply for and receive energy assistance (~ 37 percent), as evidenced in both years the survey was administered (Table 16). Control group households receive energy assistance at similar rates. The majority of households in both research groups primarily receive assistance for their energy bills in the winter months with the vast majority seeking assistance from local agencies; especially during the second year of the survey.

**Table 16: Energy Bill Assistance**

| Variable/Research Group[15] (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=568) | Control Year 1 | Control Year 2 (n=220) |
|---|---|---|---|---|---|
| Very hard or hard to pay energy bills | 69.1% | 67.6% | 51.2%*** | 62.0% | 54.8%* |
| Household received energy assistance in past year | 37.4% | 38.0% | 40.1% | 35.5% | 40.5% |
| **Received energy assistance in:** Winter | 72.3% | 72.7% | 75.5% (n=143) | 62.5%** | 75.0% (n=56) |
| Summer | 23.1% | 25.9% | 21.0% | 25.0% | 17.9% |
| Fall | 7.7% | 6.3% | 15.4%* | 8.9% | 19.6% |
| Spring | 8.5% | 8.4% | 7.0% | 19.6% | 7.1% |
| **Received energy assistance from:** Local agency | 78.1% | 77.6% | 90.9%*** (n=143) | 78.6% | 98.2%** (n=56) |
| Utility company | 2.7% | 1.4% | 2.1% | 3.6% | 0.0% |
| State agency | 1.9% | 2.8% | 2.1% | 7.1% | 0.0% |
| Family or friends | 1.5% | 0.0% | 0.0% | 1.8% | 1.8% |
| Church | 3.1% | 3.5% | 1.4% | 3.6% | 0.0% |
| People they knew helped pay energy bills almost every month or some months | 16.0% | 14.8% | 9.7%** | 14.5% | 11.4% |

In addition to seeking energy assistance from the sources listed above, households in both research groups reported use of short-term, high-interest loans and pawns shops to assist with paying their energy bills (Table 17). A decreased dependency on these loans and pawn shops was observed in the treatment group. Although not shown here, an increase in usage was observed in the control group sample surveyed pre-COVID-19 pandemic.

[15] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

**Table 17: Use of Short-Term, High-Interest Loans, and Pawn Shops for Energy Bills**

| Variable/Research Group[16] (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=572) | Control Year 1 | Control Year 2 (n=222) |
|---|---|---|---|---|---|
| Used high interest loan (e.g., payday, car-title loan, tax-refund anticipation) or pawn shop to assist with paying utility bill | 20.3% | 20.1% | 12.1%*** | 24.3% | 20.7% |

*Utility Disconnections*

Households reported being more energy secure after Home Uplift, with fewer utility disconnect notices and disconnections (Table 18). Home Uplift recipients reported statistically significant reductions in disconnection notices (by 8 percent) and disconnections (by 7 percent). Before Home Uplift, about 60 percent of households were unable to access their main source of heating and cooling. After weatherization, the percentage of households unable to access their main source of heat or cooling – as a result of a utility disconnection – decreased by about 10 percent and 20 percent, respectively. Control group households also reported receiving fewer disconnection notices and utility disconnections during the second year of the survey. This could be due, in part, to moratoriums on disconnections put in place during the COVID-19 pandemic (explored further below). Another important finding of this evaluation is that, at baseline, those households that reported being disconnected from their electricity or natural gas for non-payment were very often unable to use their main sources of heating or cooling when they needed to.

**Table 18: Energy Disconnections**

| Variable/Research Group[17] (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=565-570) | Control Year 1 | Control Year 2 (n=220) |
|---|---|---|---|---|---|
| Received a disconnect, shut-off, or non-delivery notice (almost every, some months) | 25.9% | 25.8% | 17.9%*** | 30.9% | 24.5% |
| Electricity or natural gas was disconnected because unable to pay energy bill | 10.6% | 9.8% | 3.3%*** | 12.3% | 7.7%* |
| While electricity or natural gas was disconnected, could not use main source of heat | 58.1% (n=74) | 61.5% | 61.5% (n=13) | 72.7% | 72.7% (n=11) |
| While electricity or natural gas was disconnected, could not use main source of cooling | 61.6% (n=73) | 75.0% | 50.0% (n=12) | 63.6% | 72.7% (n=11) |

[16] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

[17] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

Prevalence of energy disconnections was also considered by whether the second-year survey was completed during the first year of the COVID-19 pandemic (Table 19). Fewer disconnections were observed in the control group sample during COVID-19 than before. Because of the moratoriums on utility disconnections across the Valley, a new question was added to the survey asking about unpaid balances. Less than 30 percent of households that received Home Uplift had unpaid utility balances at the time the second-year survey was administered (between August 2020 and February 2021) compared to nearly 38 percent of unweatherized households in the control group.

**Table 19: Energy Disconnections During the COVID-19 Pandemic**

| Variable/Research Group[18] (n = Number of Respondents) | Treatment Group | | Control Group | |
|---|---|---|---|---|
| ***During the past 12 months…*** | Pre-Wx | Post-Wx | Year 1 | Year 2 |
| Received disconnect notice (almost every month or some months) (pre- COVID-19 pandemic) | 26.2% | 18.3%*** (n=367) | 38.8% | 38.8% (n=67) |
| Received disconnect notice (almost every month or some months) (during COVID-19 pandemic) | 25.3% | 17.2%* (n=198) | 27.5% | 18.3%* (n=152) |
| Electricity was disconnected (pre-COVID-19 pandemic) | 9.2% | 3.2%*** (n=371) | 18.2% | 12.1% (n=66) |
| Electricity was disconnected (during COVID-19 pandemic) | 11.1% | 3.5%*** (n=199) | 9.7% | 5.8% (n=154) |
| Have unpaid utilities balance (during COVID-19 pandemic) | | 29.2% | | 37.5% |

Small, but statistically significant, reductions in the percentage of households that did not pay their energy bill to pay for other utilities, or vice versa, was observed (Table 20). This is meaningful when compared to unweatherized households in the control group that reported an increase in not paying their energy bill in order to pay other utility bills. Households reported fewer instances of not paying their water, sewage, and secondary fuel bills in order to pay their energy bills but were more likely to not pay their telephone bill.

[18] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

**Table 20: Energy Bill and Other Utilities Trade-offs**

| Variable/Research Group[19] (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=571) | Control Year 1 | Control Year 2 (n=218) |
|---|---|---|---|---|---|
| ***During the past 12 months…*** | | | | | |
| Did not pay energy bills in order to pay other utility bills (every or every other month) | 4.7% | 4.7% | 3.0% | 6.0% | 6.0% |
| Did not pay other utility bills in order to pay energy bills (every or every other month) | 5.4% | 5.4% | 2.6%* | 8.7% | 6.4% |
| **Utilities not paid:** | (n=182) | | (n=54) | | (n=43) |
| Water | 24.7% | 29.6% | 18.5% | 18.6% | 7.0% |
| Sewage | 14.3% | 16.7% | 13.0% | 14.0% | 9.3% |
| Telephone | 64.3% | 68.5% | 77.8%* | 81.4% | 95.3% |
| Secondary energy fuel | 4.4% | 7.4% | 1.9% | 4.7% | 2.3% |

Although no statistically significant changes were observed in the percentage of households that did not pay energy bills in order to pay for food, or vice versa, both weatherized and unweatherized households reported improved food security during the second year of the study (Table 21). For both research groups, households reported being less likely to forego food in order to pay energy bills and were less worried about household members having nutritious food.

**Table 21: Energy Bill and Food Trade-offs**

| Variable/Research Group (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=567) | Control Year 1 | Control Year 2 (n=219) |
|---|---|---|---|---|---|
| ***During the past 12 months…*** | | | | | |
| Did not purchase food in order to pay energy bills (every or every other month) | 9.9% | 10.4% | 7.4% | 10.5% | 7.3% |
| Did not pay energy bills in order to purchase food (every or every other month) | 3.2% | 3.2% | 1.9% | 4.6% | 3.2% |
| In past 4 weeks, a household member went an entire day and night without eating because there was not enough food | 8.0% | 7.2% | 6.0% | 10.9% | 7.7% |
| In past 4 weeks, worried household members would not have nutritious food | 20.3% | 20.0% | 15.8%* | 20.8% | 15.8% |
| In past 12 months, household received food stamps or WIC to help pay for food | 39.3% | 36.1% | 34.7% | 55.7% | 54.3% |

[19] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

For this evaluation, reduced food spoilage was newly explored as a potential NEI of low-income weatherization. The loss of food from a broken refrigerator or from a power disruption – occurring from a natural event or from a utility disconnection for non-payment – can be costly to a household. A statistically significant reduction in the number of times food had to be thrown away because the refrigerator was broken or lost power was observed in the treatment group (Table 22). The inputs from this table are used to monetize this NEI in Section 5.

**Table 22: Food Spoilage**

| Variable/Research Group[20] (n = Number of Respondents) | Treatment Baseline (n=697) | Treatment Pre-Wx | Treatment Post-Wx (n=569) | Control Year 1 | Control Year 2 (n=215) |
|---|---|---|---|---|---|
| Number of times had to throw food away because refrigerator was broken or lost power (last 12 months) | .51 | .50 | .30** | .27 | .22 |

## 4.5 IEQ, Health and Safety, and Habitability

This section provides information on a range of IEQ, health and safety, and habitability issues stemming from the home environment that can be mitigated by programs like Home Uplift.

*Carbon Monoxide (CO) and Fire Safety and Exposures*
Both Home Uplift and control group households reported having more CO monitors in the second year of the study (Table 23). Home Uplift households reported a statistically significant increase with 80 percent of households having a CO monitor, compared to 45 percent of unweatherized households. At baseline, more treatment group households reported using gas for cooking (31 percent) compared to control group households (18 percent). The use of exhaust fans that vents to the outdoors significantly increased in the treatment group post-weatherization.

**Table 23: Carbon Monoxide (CO) Safety Equipment and Exposures**

| Variable/Research Group (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx | Control Year 1 | Control Year 2 |
|---|---|---|---|---|---|
| Home has CO monitor | 52.3% | 44.5% | 79.7%*** (n=553) | 35.9% | 46.6% (n=206) |
| CO monitor is currently working | 92.8% | 93.3% | 97.5%* (n=285) | 98.2% | 98.2% (n=56) |
| Gas is used for cooking in the home | 30.7% | 28.7% | 28.0% (n=572) | 19.8% | 20.7% (n=222) |
| Exhaust fan that vents to the outside is used regularly while cooking | 52.8% | 53.0% | 62.1%*** (n=564) | 55.2% | 59.9% (n=212) |

[20] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

After Home Uplift weatherization, 99 percent of households reported having one or more working smoke detectors (Table 24). A statistically significant increase in the number of working smoke detectors was also observed in the treatment sample to a greater extent than in the control group. Households rarely reported fires starting from either secondary or primary heating sources. The average number of times the fire department was called to homes in either research group was extremely low. Not reported in this table, the need for medical attention because of a fire in the home or as a result of scalding water from the tap was rarely reported, if at all.

**Table 24: Fire Safety Equipment and Exposures**

| Variable/Research Group[21] (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=570) | Control Year 1 | Control Year 2 (n=221) |
|---|---|---|---|---|---|
| Home has one or more smoke detectors | 96.4% | 96.4% | 98.9%* | 93.7% | 95.9% |
| Number of working smoke detectors (mean) | 2.6 | 2.7 | 4.2*** (n=538) | 2.8 | 3.0** (n=195) |
| Did a fire start in your home as a result of secondary heat source (last 12 months) | 0.3% | 0.4% | 0.2% (n=566) | 0.5% | 0.9% (n=219) |
| Did a fire start in your home as a result of primary heating source (last 12 months) | 0.3% | 0.4% | 0.4% (n=566) | 0.0% | 0.9% (n=218) |
| Number of times fire department called to home (last 12 months) (mean) | .04 | 0.5 | 0.1 (n=571) | 0.0 | 0.7 (n=220) |

*Dwelling Quality and Exposures to Health Hazards*

The Home Uplift program appears to have produced meaningful improvements in a number of dwelling quality outcomes (Table 25). After taking into account decreases in the control group, a net statistical difference was found in the exposure of both drafts and dust in Home Uplift homes. Post-weatherization, over 20 percent of households reported they no longer found their homes too drafty; all or most of the time. Similarly, over 20 percent of households reported they no longer found their homes too dusty; all or most of the time after Home Uplift. Households in the treatment group also reported statistically significant decreases in observations of mold and standing water. Decreases in exposure to mold and standing water were also observed in unweatherized homes, and also at statistically significant levels.

[21] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

**Table 25: Drafts, Dust, and Pest Exposures**

| Variable/Research Group[22] (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=559-569) | Control Year 1 | Control Year 2 (n=212-222) |
|---|---|---|---|---|---|
| Home is too drafty (all or most of the time) | 37.9% | 39.6% | 11.5%*** | 24.9% | 18.4% |
| Home is too dusty (all or most of the time) | 38.4% | 38.6% | 16.3%*** | 29.7% | 25.5% |
| Home is extremely or very infested with cockroaches or other insects | 3.7% | 3.9% | 3.3% | 4.6% | 1.4% |
| Home is extremely or very infested with rats, mice, or other rodents | 1.9% | 2.1% | 1.4% | 2.3% | 0.5% |
| Seen mold in the home (in past 12 months) | 29.9% | 29.9% | 19.3%*** | 30.0% | 20.9%** |
| Seen standing water in the home (in past 12 months) | 10.7% | 11.1% | 6.7%** | 15.3% | 5.9%*** |

Households in the treatment group reported a significant decrease in the amount of noise they could hear from the outside while indoors when the windows are closed after Home Uplift (Table 26). Households also reported significant reductions in noise interfering with sleep at all and at either very great or great levels. Households reported fewer experiences smelling odors from the outdoors when inside the home. Reductions in both noise and odors were also observed in survey responses from unweatherized households, but not at significant levels, with the exception in the reduction of outdoor noise interfering with sleep.

**Table 26: Noise and Odors**

| Variable/Research Group (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx | Control Year 1 | Control Year 2 |
|---|---|---|---|---|---|
| Can hear a great deal of noise from outside while indoors when the windows are closed | 35.7% | 36.8% | 21.4%*** (n=571) | 28.4% | 25.2% (n-222) |
| Noise from outside interferes with sleep | 49.2% | 53.0% | 39.3%*** (n=440) | 49.4% | 36.7%** (n=166) |
| Noise from outside interferes with sleep a very great deal or a great deal | 13.3% | 15.9% | 10.2%** (n=440) | 15.1% | 9.6% (n=166) |
| Can smell a great deal or some odors from outside while indoors with the windows shut | 23.6% | 23.5% | 15.2%*** (n=566) | 22.1% | 17.1% (n=222) |

[22] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

*Smoking and Environmental Tobacco Smoke*

Analysis of the prevalence of smoking cigarettes and exposure to environmental tobacco smoke (ETS) was conducted with the full survey sample. Of those that answered the survey questions, about 16 percent of respondents in the Home Uplift group reported smoking cigarettes at least some days; compared to over 25 percent to the control group (Table 27). Only 70 percent of households in the control group reported that smoking is not allowed inside their homes. Exposure to ETS was less likely in treatment group households with just over 80 percent reporting smoking is not allowed inside. This variable was used when assessing environmental triggers in homes with people with asthma and other types of respiratory illness.

**Table 27: Exposure to Environmental Tobacco Smoke**

| Variable/Research Group[23] (n = Number of Respondents) | Treatment Post-Wx (n=701) | Treatment Post-Wx (n=572) | Control Year 1 (n=300) | Control Year 2 (n=222) |
|---|---|---|---|---|
| **Main respondent smokes:** Every day | 9.8% | 9.1% | 17.4% | 21.6% |
| Some days | 6.4% | 6.0% | 8.4% | 8.6% |
| Not at all | 83.7% | 84.9% | 74.2% | 69.8% |
| Smoking is not allowed inside the home | 81.2% | 82.3% | 70.1% | 70.3% |
| Smoking is allowed at some places or at sometimes inside the home | 5.3% | 3.5% | 12.1% | 10.8% |
| Smoking is permitted anywhere, anytime | 13.5% | 14.2% | 17.8% | 18.9% |
| **How often does someone smoke inside the home:** Daily | 11.2% | 11.2% | 16.3% | 18.9% |
| Weekly | 2.0% | 1.9% | 5.4% | 5.9% |
| Monthly | 1.7% | 0.9% | 0.7% | 2.3% |
| Less than monthly | 2.6% | 0.9% | 4.7% | 1.8% |

*Habitability*

Prior to Home Uplift weatherization, over 10 percent of households had to move out of their home within the past 12 months because their home did not have power, was too hot or too cold, had flooding, or a fire (Table 28). After weatherization, the percentage of households that had to move out of their home because it was too hot or too cold inside decreased by over half; from 7 percent to 3 percent. However, reductions in these occurrences was also observed in the unweatherized, control group during the second year of the survey. Responses were stratified by whether the survey was completed during the COVID-19 pandemic – which also provided access to additional relief funds and other resources. During the second year of the survey, Control group households surveyed pre-COVID-19 pandemic reported a slight increase in threats to habitability; treatment group households reported a decrease.

[23] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

**Table 28: Habitability**

| Variable/Research Group[24] (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=572) | Control Year 1 | Control Year 2 (n=222) |
|---|---|---|---|---|---|
| ***During the past 12 months…*** | | | | | |
| **Temporarily moved out of home because:** | | | | | |
| Did not have power | 4.6% | 4.7% | 3.1% | 3.2% | 3.6% |
| Home was too hot | 3.9% | 3.8% | 1.4%** | 4.5% | 1.4% |
| Home was too cold | 3.4% | 3.8% | 1.4%* | 3.2% | 0.5% |
| Flooding | 0.1% | 0.2% | 0.2% | 0.0% | 0.5% |
| Fire | 0.0% | 0.0% | 1.2% | 0.0% | 1.4% |
| None of the above | 89.0% | 89.0% | 93.0%** | 83.3% | 93.2%*** |

## 4.6 Health and Well-being

The population served by Home Uplift that participated in the evaluation survey reported the prevalence of several chronic illnesses and ailments, including arthritis (60 percent), asthma (17 percent), COPD and other respiratory illnesses (16 percent), and headaches (70 percent). As stated, it is well-established that improvements in energy efficiency and dwelling quality through weatherization can produce a positive feedback loop of improvements in chronic health outcomes, as well as in household financial security, well-being, and life satisfaction. This section explores the health and well-being impacts of Home Uplift using survey outcomes.

*General Physical Health, Mental Health, and Sleep*

On average, recipients of Home Uplift reported fewer days their sleep and physical or mental health was not good (Table 29). A statistically significant decrease in the number of days survey respondents felt they did not get enough sleep was observed after Home Uplift weatherization. A statistically significant decrease in the number of days respondents stated their physical or mental health was not good was also observed post-weatherization. The number of days poor physical or mental health days kept survey respondents from doing usual activities, such as self-care or recreation, also reduced statistically after weatherization. Many of these reductions were also observed in control group responses, but not to the same degree or at significant levels.

[24] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

**Table 29: General Physical Health, Mental Health, and Sleep**

| Variable/Research Group[25] (n = Number of Respondents) | Treatment Pre-Wx | Treatment Post-Wx (n=534) | Control Year 1 | Control Year 2 (n=213) |
|---|---|---|---|---|
| *During the past 30 days, for about how many days do you feel you did not get enough rest or sleep?* | 10.6 | 8.7*** | 10.7 | 9.1* |
| *Thinking about your physical health […] for about how many days during the past 30 days was your physical health not good?* | 8.6 | 6.6*** | 7.7 | 7.6 |
| *Thinking about your mental health […] for about how many days during the past 30 days was your mental health not good?* | 5.5 | 4.8 | 5.5 | 6.5 |
| *During the past 30 days, for how many days did poor physical or mental health keep you from doing your usual activities, such as self-care, work or recreation?* | 6.3 | 5.0** | 5.5 | 4.2* |
| *During the COVID-19 Pandemic, would you say your mental health has gotten worse?** | | 16.6% (n=199) | | 25.8% (n=155) |

*Prescription Medication Adherence*

The percentage of households who reported they did not get prescription medications because they could not afford them decreased, significantly, by about 8 percent (Table 30). At baseline, one quarter of Home Uplift households reported they had not filled a prescription or took less than the full dose in order to pay the utility bill. Not in this table, nearly 32 percent of households entering into Home Uplift reported experiencing difficulty paying medical bills. As a result of the prevalence of lack of medication adherence and households having to choose between medications and paying their energy bills, this NEI was deemed significant enough to include for monetization (Section 5).

**Table 30: Prescription Adherence**

| Variable/Research Group (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx | Control Year 1 | Control Year 2 |
|---|---|---|---|---|---|
| Household members needed prescription medicines but didn't get them because they couldn't afford them (past 12 months) | 29.0% | 28.1% | 20.7%*** (n=569) | 31.1% | 25.6% (n=219) |
| Did not fill a prescription or took less than the full dose in order to pay the utility bill (past 12 months) | 25.0% | 25.0% | 17.1%*** (n=568) | 25.7% | 14.7% (n=218) |

[25] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

*Chronic Respiratory Illnesses*

The survey instrument for the Home Uplift pilot evaluation was designed to determine prevalence of respiratory illness to help characterize the Home Uplift eligible population in the metro areas served through the pilot (Table 31, Table 35). The survey was also designed to measure self-reported morbidity and healthcare utilization to calculate changes over time; from pre- to post-weatherization for the treatment group, and from the first year to the second for the control group. Question panels were developed specific for 1.) asthma, and 2.) for a collective assessment of chronic obstructive pulmonary disease (COPD), emphysema, and chronic bronchitis. In addition, demographics and other characterizing information were analyzed for each of these subsamples.

**Asthma**

The prevalence of asthma in the Home Uplift metro area population, at baseline, is about 17 percent; with 14 percent of the subsample reporting they still have asthma. The control group sample reports a 19 percent lifetime asthma and 16 percent current asthma prevalence.

**Table 31: Asthma Prevalence**

| Variable/Research Group[26] (n = Number of Respondents) | Treatment Pre-Wx (n=1,293) | Treatment Post-Wx (n=1,058) | Control Year 1 (n=711) | Control Year 2 (n=521) |
|---|---|---|---|---|
| Lifetime Asthma: Main Respondents | 18.1% (n=127) | 17.0% (n=97) | 25.7% (n=77) | 30.2% (n=67) |
| Asthma Sub-sample – ALL household members with *lifetime asthma* | 17.2% (n=223) | 16.8% (n=178) | 18.7% (n=133) | 23.2% (n=121) |
| Current Asthma: Main Respondents | 13.3% (n=93) | 10.7% (n=97) | 21.3% (n=64) | 24.8% (n=55) |
| Asthma Sub-sample – ALL household members with *current asthma* | 13.5% (n=174) | 11.4% (n=121) | 16.0% (n=114) | 18.2% (n=96) |
| Adult | 71.3% (n=124) | 70.9% (n=78) | 74.3% (n=84) | 73.3% (n=66) |
| Children (< 18) | 28.2% (n=49) | 29.1% (n=32) | 25.7% (n=29) | 26.7% (n=24) |

Of those that reported having lifetime asthma, the asthma subsample was further defined by those that reported having symptoms less than 12 months ago (i.e., active asthma). Table 32 provides the demographics information for this subsample. Individuals providing asthma information for this evaluation tended to be female and Black or African American adults.

[26] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

**Table 32: Asthma Subsample Demographics**

| Variable/Research Group[27] (n = Number of Respondents) | Treatment Yr 1 (n=144) | Control Yr 1 (n=95) |
|---|---|---|
| Gender: Female | 68.4% | 66.7% |
| Age (mean) | 44 | 42 |
| Black or African American | 78.5% | 75.8% |
| White | 19.4% | 10.5% |
| Hispanic or Latin Origin | 1.4% | 3.4% |
| Other Race | 0.7% | 1.1% |
| Refused to answer about race/ethnicity | 2.1% | 11.6% |
| Under 18 years old | 20.0% | 26.4% |

The primary analysis aimed at determining Home Uplift weatherization on impacts on asthma indicators focused on those individuals with data for both years of the survey; to better measure changes from pre- to post-weatherization and to control for external factors potentially influencing changes in the control group sample (Table 33). Improvements in the number of asthma 'flare-ups' (i.e., exacerbations) and visits to the hospital for worsening symptoms of asthma were observed in both treatment and control groups. Individuals in the control group sample overwhelming reported improvements across all asthma indicators, with the exception of urgent care visits. No change in emergency department (ED) visits was observed in the treatment sample; compared to an observed decrease of about 5 percent in the control group.

**Table 33: Asthma Symptoms and Healthcare Usage**

| Variable/Research Group (n = Number of Respondents with active asthma) | Treatment Pre-wx | Treatment Post-Wx (n=72) | Control Year 1 | Control Year 1 (n=57) |
|---|---|---|---|---|
| Had asthma symptoms < 1 week ago | 37.2% | 44.4% | 46.4% | 56.1% |
| # of asthma 'flare-ups' in past 3 months | 5.5 | 4.0 | 7.8 | 4.1 |
| Stayed overnight in the hospital because of asthma (in past 12 months) | 5.8% | 2.0% | 5.3% | 0 |
| Number of times stayed overnight in hospital (mean) | .08 | .04 | .07 | .00 |
| Visited the ED because of asthma (in past 12 months) | 8.7% | 8.7% | 24.6% | 19.3% |
| Number of ED visits (mean) | .13 | .10 | .49 | .35 |
| Visited an urgent care center because of asthma (in past 12 months) | 3.0% | 10.4% | 12.3% | 15.8% |
| Number of urgent care center visits (mean) | .06 | .14 | .37 | .33 |

[27] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

Additional regression analyses were conducted to adjust for differences between the two samples (e.g., exposure to mold inside the home, ETS). A more detailed analysis of asthma outcomes will be reported separate from this report.

**COPD**

About 16 percent of survey respondents[28] in the Home Uplift sample reported being told by a health professional that they have COPD, emphysema, or chronic bronchitis; compared to 17 percent in the control group sample (Table 34). This table also provides responses to whether respondents had to see a doctor, or if they visited urgent care, the ED, or a hospital because of symptoms related to shortness of breath, bronchitis, or other COPD or emphysema flare-up. Additional analyses attempted to control for whether the respondent with this illness also reported smoking cigarettes. Over 50 percent of respondents reported visiting a doctor for worsening symptoms – whether they smoke cigarettes or not – and over 20 percent visited more urgent and emergency care settings. Office visits decreased by 9 percent and 15 percent in treatment and control groups, respectively. Meaningful reductions in urgent care, ED, and hospital visits are observed in the control group sample.

**Table 34: COPD, Emphysema, and Chronic Bronchitis Prevalence and Healthcare Usage**

| Variable/Research Group[29] (n = Number of Respondents) | Treatment P1 (n=701) | Treatment P2 (n=572) | Control P1 (n=300) | Control P2 (n=222) |
|---|---|---|---|---|
| Ever been told by health professional that they have COPD, emphysema, or chronic bronchitis | 15.6% | 13.0% | 17.3% | 17.2% |
| Had to see doctor in past 12 months for symptoms related to shortness of breath, bronchitis, or other COPD or emphysema flare-ups | 54.2% (n=120) | 43.2% (n=74) | 65.2% (n=46) | 50.0% (n=38) |
| Visited urgent care, ED, or hospital because of COPD, emphysema, or chronic bronchitis (in past 12 months) | 21.7% (n=120) | 13.7% (n=73) | 28.3% (n=46) | 5.3% (n=38) |

[28] The survey question asking about COPD, emphysema and chronic bronchitis was asked only for the main respondent of the survey and not about all individuals in the household.

[29] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

**Table 35: COPD, Emphysema, and Chronic Bronchitis Subsample Demographics**

| Variable/Research Group[30] (n = Number of Respondents) | Treatment Yr 1 (n=120) | Control Yr 1 (n=38) |
|---|---|---|
| Gender: Female | 80.8% | 84.8% |
| Age (mean) | 63 | 58 |
| Hispanic or Latin Origin | 0.8% | 0.0% |
| Black or African American | 56.7% | 82.6% |
| White | 41.7% | 13.0% |
| Employed for wages | 14.3% | 17.4% |
| Health keeps from working a job | 72.3% | 75.0% |
| Smokes (every day or some days) | 30.8% | 43.5% |
| Smoking is allowed inside the home | 25.8% | 45.7% |

Based on our survey findings, Home Uplift impacts on respiratory health, such as asthma and COPD, are inconclusive. Despite notable reductions in exposures to environmental asthma triggers, including mold and dust, it is not clear whether asthma improved or worsened after Home Uplift due to the inconsistencies in indicators. For example, the percentage of individuals with asthma that reported symptoms "within the last week" increased (within both treatment and control groups), but the average number of asthma flare-ups (i.e., exacerbations) decreased for both groups. Across both adult and child age groups, individuals with asthma visited hospital and emergency care settings less often for worsening asthma symptoms (in both treatment and control groups) but visited the urgent care more often. It also appears as though individuals with active asthma in the control group at baseline had higher frequencies of symptoms and healthcare encounters than the treatment group; perhaps living with more uncontrolled asthma and thus providing more opportunity for improvements during the second year of the study, through such things as improved access to healthcare and asthma treatment plans.

It is also notable that the Home Uplift pilot defers homes with extreme amounts of mold. It is possible that the reductions in exposure to mold in the control group were at more extreme levels than the treatment group, thereby having a greater impact on the respiratory health outcomes for individuals in those homes.

*Headaches*

The evaluation team analyzed the reported incidence of household members experiencing chronic headaches (Table 36). Approximately 30 percent of respondents in the Home Uplift sample reported suffering from headaches. Over 70 percent of those that suffered from headaches in the treatment group at baseline reported they had headaches that were either new, more frequent, or more severe in the three months prior to being surveyed. Although improvements were observed from one year to the next in the treatment group, similar

[30] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

improvements were also observed in the control group, making it difficult to attribute changes to the weatherization.

**Table 36: Headaches**

| Variable/Research Group (n = Number of Respondents) (main respondents that suffer from headaches only) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=130) | Control Year 1 | Control Year 2 (n=49) |
|---|---|---|---|---|---|
| Had headaches that are either new or more frequent or severe than the ones you have had before (in past 3 months) | 71.2% | 76.2% | 70.0% | 83.7% | 77.6% |

*Missed Days of Work and School*

Changes in the number of missed days of work and school were analyzed using the full sample of individuals that were either employed during the time of the survey or in school (Table 37). No statistically significant changes were observed in either subsample, especially when compared to control group outcomes. However, in some analyses of missed days of work, controlling for whether the second survey took place before or after the COVID-19 pandemic lockdowns had a notable effect on the results.

**Table 37: Missed Days of Work and School**

| Variable/Research Group[31] (n = Number of Respondents) | Treatment Pre-Wx (n=180) | Treatment Post-Wx (n=141) | Control Year 1 (n=82) | Control Year 2 (n=58) |
|---|---|---|---|---|
| Number of days primary wage earner missed because of their own illness or injury (past 12 months) | 6.4 | 4.4 | 5.9 | 3.9 |
| Number of days primary wage earner missed because of another household member's illness or injury (past 12 months) | 3.3 | 1.8 | 2.4 | 1.1 |
| Number of days of missed pre-school by child who missed the most amount of school (past 12 months) | 7.6 (n=24) | 7.2 (n=25) | 3.7 (n=19) | 3.1 (n=9) |
| Number of days of missed school by child in grade school who missed the most amount of school (past 12 months) | 4.6 (n=140) | 3.5 (n=101) | 6.3 (n=72) | 2.6** (n=64) |

*Trips and Falls*

The incidence of household members experiencing trips or falls while inside their home was analyzed (Table 38). Neither the incidence rate at baseline or the change in incidence in the second year proved significant within and between research groups.

[31] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

**Table 38: Trips and Falls**

| Variable/Research Group (n = Number of Respondents) | Treatment Baseline (n=701) | Treatment Pre-Wx | Treatment Post-Wx (n=564) | Control Year 1 | Control Year 2 (n=218) |
|---|---|---|---|---|---|
| Someone in home suffered a trip or fall inside the home that required medical attention | 5.7% | 6.0% | 4.6% | 6.4% | 4.6% |

*Arthritis*

During the in-depth interviews with households (discussed in Section 3), several households described the impacts of the home environment, in particular thermal discomfort, on arthritis symptoms. As a result, a panel of arthritis prevalence and symptoms questions were included in the second-year survey to help characterize the Home Uplift population and determine how best to measure the potential health benefits of weatherization in the future. According to the survey findings, approximately 60 percent of survey respondents reported being diagnosed with some form of arthritis and experience symptoms often (Table 39).

**Table 39: Arthritis Prevalence and Symptoms**

| Variable/Research Group[32] (n = Number of Respondents) | Treatment Year 2 | Control Year 2 |
|---|---|---|
| Have you ever been told by a doctor or other health professional that you have arthritis? | 60.3% | 54.8% |
| **Type of Arthritis:** | | |
| Osteoarthritis | 32.5% | 38.8% |
| Rheumatoid | 30.8% | 25.9% |
| Fibromyalgia | 6.7% | 4.7% |
| Lupus | 0.0% | 2.4% |
| Chronic Regional Pain Syndrome | 1.7% | 0.0% |
| Other form of Arthritis | 5.8% | 4.7% |
| How long has it been since you last had any symptoms of arthritis? (Less than one day) | 66.9% (n=118) | 68.2% (n=85) |

*Life Satisfaction*

Weatherization recipients report being very satisfied with their life in general, their health, and present standard of living after Home Uplift at higher – and statistically significant – levels than before their homes were weatherized (Table 40). Survey respondents in the unweatherized group reported a decrease in feeling very satisfied in these areas. These life satisfaction outcomes suggest improvements in quality of life (QoL) post-weatherization.

[32] The differences within each research group are found to be statistically different at either: * p< .05, ** p< .01, or *** p< .001 in a McNemar test or paired samples t-test (means) comparing responses within each treatment and control group sample for each survey round (year 1 and year 2).

**Table 40: Life Satisfaction**

| Variable/Research Group (n = Number of Respondents) | Treatment Pre-Wx | Treatment Post-Wx (n=563-569) | Control Year 1 | Control Year 2 (n=217-218) |
|---|---|---|---|---|
| ***Satisfied with…*** | | | | |
| **Your life in general:** Very satisfied | 59.8% | 66.6%** | 50.7% | 50.2% |
| **Your health:** Very satisfied | 35.3% | 47.4%*** | 33.2% | 27.7% |
| **Your present standard of living:** Very satisfied | 43.3% | 55.4%*** | 39.0% | 35.8% |

## 4.7 COVID-19 Considerations and Impacts

The COVID-19 pandemic is evidenced to have impacted job and financial security for households across the Tennessee Valley. New survey questions were added to better understand who was receiving Home Uplift services and their lived experiences with economic hardships during the COVID-19 pandemic. Of those individuals in Home Uplift households that reported being employed full-time during the second year survey, 60 percent could be classified as essential workers (Tables 41 through 42). The majority of essential workers reported being a professional or otherwise working in healthcare or public health, and education providers. Only 27 percent of households reported that the employment status of individuals had not changed due to the COVID-19 virus.

**Table 41: Economic Impacts from the COVID-19 Pandemic**

| Variable/Research Group IF Employed and Answered COVID-19 Questions | **Treatment (n=53)** | **Control (n=36)** |
|---|---|---|
| Essential Workers | 60% | 69% |
| Lost job/source of income | 5% | 11% |
| Temporarily Laid off | 29% | 26% |
| Wages or pay reduced | 11% | 3% |
| Work hours reduced | 21% | 16% |
| Able to work from home | 23% | 13% |
| Employment status not changed due to the virus | 27% | 29% |

**Table 42: Economic Impacts from the COVID-19 Pandemic on Essential Workers**

| Variable/Research Group<br>IF Employed as an Essential Worker | Treatment (n=32) | Control (n=25) |
|---|---|---|
| Healthcare or Public Health Professional | 16% | 12% |
| Works in Healthcare or Public Health | 16% | 8% |
| Education Provider | 16% | 28% |
| Works in Public Utilities Sector | 13% | - |
| Social Services Provider | 13% | 4% |
| Essential Sales Worker (e.g., grocery store) | 6% | 12% |
| Law Enforcement | 6% | - |
| Childcare Worker | 6% | 4% |
| Food Processing | 3% | 4% |
| Janitorial | 3% | 4% |
| Agricultural, Fisheries or Forestry Worker | 3% | - |

*COVID-19 Impacts on Survey Outcomes*

The research team conducted analyses to determine the influence of the COVID-19 pandemic's impacts on select variable outcomes. For example, due to moratoriums on utility disconnections, the tests used to calculate a net difference between outcomes in the treatment group and outcomes in the control group likely produced a more conservative NEI than it would have in the absence of control group households having increased access to pandemic relief in the forms of energy assistance and reduced threat of utility disconnections for nonpayment. These impacts will be further isolated in a targeted paper on this issue. For the purposes of this evaluation, although it appears as though the COVID-19 pandemic influenced some survey outcomes, no statistically significant impacts were observed. Also considered was the impact that a reduced sample size would have on the statistical power and reliability of outcomes within each research group if the groups were stratified. It was thus determined that the full samples for each group would be used in analyses that aim to measure the difference in responses from one year to the next and not to further stratify the sample by COVID-19 time periods for this report.

## 4.8 Weatherization Measures

Home Uplift weatherization measures were provided for over 600 households that participated in the evaluation survey (Tables 43 through 46). The majority of Home Uplift households in this sample received air sealing (60 percent) and attic insulation (63 percent), as well as some form of heat pump or furnace installation (63 percent). The majority of homes also received duct sealing and repair, insulation or replacement (70 percent). Other major weatherization measures included air conditioning, window, and door installations. Water heating (e.g., electric, gas, and heat pump water heaters), refrigeration and lighting measures were also part of the weatherization work scope. Finally, many Home Uplift households received repair work and moisture management.

**Table 43: Air Sealing, Insulation, Windows and Doors**

| Weatherization Measures Installed | Treatment Households (n=611) |
|---|---|
| Air Sealing | 59.6% |
| Attic Insulation | 62.5% |
| Belly Insulation | 0.2% |
| Wall Insulation | 3.4% |
| Double Paned Window Replacement | 14.6% |
| Single Paned Window Replacement | 6.4% |
| Storm Windows Added to Single Paned Windows | 0.5% |
| Exterior Door Replacement | 16.4% |

**Table 44: Heating and Cooling Systems**

| Weatherization Measures Installed | Treatment Households (n=611) |
|---|---|
| Heat Pump Replacement (Ducted) | 28.3% |
| Heat Pump Replacement (Non-Ducted) | 15.4% |
| Dual Fuel Heat Pump | 4.1% |
| Furnace | 14.9% |
| Mini-Split | 1.6% |
| Central Air Conditioning Installation | 15.4% |
| Tune-up | 9.8% |
| Duct Sealing and Repair, Insulate or Replace | 66.9% |

**Table 45: Water Heating, Refrigeration, and Lighting**

| Weatherization Measures Installed | Treatment Households (n=611) |
|---|---|
| Electric Water Heater | 2.9% |
| Gas Water Heater | 6.7% |
| Heat Pump Water Heater | 6.9% |
| Refrigerator | 4.7% |
| Lighting | 19.6% |

**Table 46: Other Measures**

| Weatherization Measures Installed | Treatment Households (n=611) |
|---|---|
| Electrical Repairs | 6.2% |
| Structural Repairs | 10.1% |
| Mechanical Repairs | 47.1% |
| Plumbing Repairs | 15.4% |
| Miscellaneous Repairs | 62.8% |
| Moisture Management | 16.4% |

# 5. Select NEIs for Monetization

Home Uplift NEIs identified in Section 4 were assessed for monetization. The selection of NEIs for monetization is based upon observations of practical and significant changes in survey outcomes between the pre- and post-weatherization time periods. Treatment group outcomes were then compared to control group outcomes, when deemed appropriate, and a difference in differences (DID) calculation was performed[33]. The NEIs selected are supported by additional outcomes (e.g., subjective experiences with thermal comfort, difficulty paying energy bill) drawn from the survey that further signal change and justify inclusion in our valuation of benefits attributable to the Home Uplift pilot.

The eight Home Uplift health and well-being NEIs proposed for monetization include reduced:

- Likelihood of CO poisoning;
- Disconnections of electricity or natural gas;
- Likelihood of fire risk;
- Food spoilage – measured by the number of times households had to throw food away because their refrigerator was broken or because they lost power;
- Use of high-interest, short-term loans or pawn shops to assist with paying utility bills;
- Incidences where prescriptions were not filled or not taken as prescribed;
- Number of days the respondent did not feel they got enough sleep; thereby improving work and home productivity; and
- Healthcare encounters for thermal stress impacts resulting from exposure to hot and cold temperatures when inside homes.

Table 47 and Table 48 summarize each of the NEIs selected for inclusion and the point estimates calculated using the aforementioned approaches. Individual equations used for the valuation of each NEI are contained in the Appendix of this report. Together, these benefits produce an estimated annual (i.e., first year) NEI value of $1,579.80 that can be claimed for every house weatherized through Home Uplift. This estimate includes the value of avoided death, also known as the 'value of a statistical life' (VSL)[34] claimed for each predicted avoided death from exposure to extreme cold temperatures inside a home and from prevented deaths from reduced house fires and CO poisoning.[35] Table 47 provides the total annual value for these NEIs with and without the VSL included. If the VSL is not included, the estimated annual NEI value for Home Uplift is $208.88.

[33] The monetization of reduced home fires was calculated using a different approach that considered the typical weatherization measures installed evidenced to lower fire risk.
[34] VSL is a measure used to compare regulatory costs to benefits. See OMB Circular A-4 for more discussion on VSL or visit U.S. EPA's website: https://www.epa.gov/environmental-economics/mortality-risk-valuation#whatisvsl
[35] The study team adopted the VSL value recommended by the U.S. Department of Transportation (DOT) ($9.6 million), which is similar to the VSL value used by the U.S. Environmental Protection Agency (EPA). https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20a%20Statistical%20Life%20Guidance.pdf

Table 48 provides the Present Value for each of these NEIs with and without the VSL included. Together, these benefits produce a total NEI value for all years the benefits of Home Uplift are likely to persist (10 years). The total Present Value for monetized Home Uplift NEIs is $15,404.71. If the VSL is not included, the estimated Present Value for Home Uplift NEIs is $2,038.84.

**Table 47: Estimated Annual Total NEI Values**

| Estimated Annual NEI Values | Per HH w/ VSL[1] | Per HH w/o VSL | Societal | Total | Total w/o VSL |
|---|---|---|---|---|---|
| CO Poisoning | $3.58 | $0.01 | $0.02 | $3.60 | $0.03 |
| Disconnections | $1.34 | $1.34 | $0.00 | $1.34 | $1.34 |
| Fire Risk Reduced | $69.81 | $4.79 | $9.14* | $78.95 | $13.71 |
| Food Spoilage | $12.33 | $12.33 | $0.00 | $12.33 | $12.33 |
| Predatory Loans | $19.80 | $19.80 | $0.00 | $19.80 | $19.80 |
| Productivity (Home) | $15.42 | $15.42 | $0.00 | $15.42 | $15.42 |
| Productivity (Work) | $0.00 | $0.00 | $5.39 | $5.39 | $5.39 |
| Prescription Adherence | $0.00 | $0.00 | $19.22 | $19.22 | $19.22 |
| Thermal Stress (Heat) | $2.44 | $2.44 | $12.08 | $14.52 | $14.52 |
| Thermal Stress (Cold) | $1,312.77 | $10.66 | $96.46 | $1,409.23 | $107.12 |
| **Annual Total NEI per Home** | **$1,437.49** | **$66.79** | **$142.31** | **$1,579.80** | **$208.88** |

* Includes societal cost for avoided firefighter deaths ($0.22); Total societal benefit without avoided firefighter deaths ($8.92).

**Table 48: Estimated Present Value (10 years) of Total NEI Values**

| NEI Values in PV | PV Per HH[1] w/ VSL | PV Per HH w/o VSL | Societal PV | Total PV | Total PV w/o VSL |
|---|---|---|---|---|---|
| CO Poisoning | $17.65 | $0.03 | $0.11 | $17.76 | $0.14 |
| Disconnections | $13.05 | $13.05 | $0.00 | $13.05 | $13.05 |
| Fire Risk Reduced | $681.51 | $46.75 | $89.21* | $770.72 | $133.85 |
| Food Spoilage | $120.32 | $120.32 | $0.00 | $120.32 | $120.32 |
| Predatory Loans | $193.25 | $193.25 | $0.00 | $193.25 | $193.25 |
| Productivity (Home) | $150.51 | $150.51 | $0.00 | $150.51 | $150.51 |
| Productivity (Work) | $0.00 | $0.00 | $52.62 | $52.62 | $52.62 |
| Prescription Adherence | $0.00 | $0.00 | $187.60 | $187.60 | $187.60 |
| Thermal Stress (Heat) | $23.80 | $23.80 | $117.92 | $141.72 | $141.72 |
| Thermal Stress (Cold) | $12,815.50 | $104.11 | $941.67 | $13,757.17 | $1,045.78 |
| **PV Total NEI per Home** | **$14,015.59** | **$651.82** | **$1,389.13** | **$15,404.72** | **$2,038.84** |

*Includes additional societal cost for avoided firefighter deaths ($2.12). Total societal benefit without avoided firefighter deaths ($87.10).

## 5.1 Reduced CO Poisoning

CO is a colorless and odorless gas that is produced by the combustion of fossil fuels. In homes, CO can be produced by the combustion of fossil fuels for space heating, water heating, and cooking. CO that is not vented to the outdoors and builds up in homes can cause fatigues and nausea from low concentrations to severe poisoning and death from high concentrations. Combustion safety is a priority for weatherization programs. Combustion appliances are tested for leaks and the venting of CO to outdoors is examined. Safety problems are immediately addressed. Weatherization programs often install CO monitors to provide an extra layer of safety.

The approach to estimating this CO NEI is based on the installation of CO monitors. Secondary literature was used to assess the reduction in CO poisonings that can be attributable to the installation of CO monitors. This literature was also used to estimate the number of emergency department visits, hospitalizations, and deaths from residential CO poisoning events. Estimates for the costs of ED visits and hospitalizations were taken from costs estimates published by the National Institutes of Health. To place an estimate on the value of lives saved, guidance from the U.S. Environmental Protection Agency and the U.S. Department of Transportation was used. The number of CO monitors installed in Home Uplift homes was drawn from the household survey described in the main body of this report. These results were adjusted to take into account average household sizes for homes entering this weatherization program. A complete description of the methods used to estimate the CO NEI can be found in the ORNL evaluation report this approach is based on.[36]

For the Reduced CO Poisoning NEI, we recommend an annual per unit NEI value of $3.60 that includes both the household and societal benefits and the avoided death benefit. The monetization approach and inputs used for estimating the suggested Reduced CO Poisoning NEI are presented in Tables 49 and 50, respectively. Table 51 provides the set of values for the Reduced CO Poisoning NEI.

[36] Tonn, B., Rose, E., Hawkins, B., and Conlon, B. 2014. "Health and Household-Related Benefits Attributable to the Weatherization Assistance Program," ORNL/TM-2014/345, Oak Ridge National Laboratory, Oak Ridge, TN, September. Section 4.2.2

**Table 49: Monetization Approach – Reduced CO Poisoning**

| Monetization Approach |
|---|
| **Key Variables** |
| • ED = prevented # of ED visits per home<br>• H = prevented # of hospitalizations per home<br>• D = prevented # of deaths per home<br>• cm = change in the % of homes with CO monitors<br>• ed$ = estimated cost of ED visit<br>• h$ = estimated cost of hospitalization<br>• VSL = value of avoided death |
| **Equation 1.** *Annual Household Benefit (per weatherized unit)* |
| • *= (ED*cm*ed$ + H*cm*h$) * 0.03 + (D*cm*VSL)*<br>• *NEI = ((.0000335 * .245 * $618) + (.00000678 * .245 * $13,932)) * 0.03 + (.00000152 * .245 * $9,600,000)* |
| **Equation 2.** *Annual Societal Benefit (per weatherized unit)* |
| • *= (ED*cm*ed$ + H*cm*h$) * 0.97*<br>• *NEI = ((.0000335 * .245 * $618) + (.00000678 * .245 * $13,932)) * 0.97* |

**Table 50: Sources/Inputs – Reduced CO Poisoning**

| Inputs/Sources | |
|---|---|
| **Household Survey** | • Change in the % of homes with CO monitors (24.5%) |
| **Literature: Peer Reviewed and Other** | • Tonn et al. (2014)<br>  ○ % of out-of-pocket costs covered by households = 3%<br>  ○ % of insurance costs covered by society = 97%<br>  ○ Prevented ED and hospital visits, and prevented deaths per weatherized unit: Tonn et al. (2014)<br>• Estimated cost of ED visit[1]<br>• Estimated cost of hospitalization[2] |

[1] https://www.ncbi.nlm.nih.gov/pubmed/28888530
[2] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4733068/

**Table 51: Estimated Impact of Reduced CO Poisoning**

| CO Poisoning NEI | | | | |
|---|---|---|---|---|
| **Beneficiary** | **Annual Per Unit Benefit** | **Annual Per Unit Benefit W/O Avoided Death Benefit** | **PV Per Unit Benefit Over 10 Years** | **PV Per Unit Benefit W/O Avoided Death Benefit** |
| **Households** | $3.58 | $0.01 | $17.65 | $0.03 |
| **Society** | $0.02 | $0.02 | $0.11 | $0.11 |
| **Total** | $3.60 | $0.03 | $17.76 | $0.14 |

For the Reduced CO Poisoning NEI, we recommend an annual NEI value of $3.60 that includes both the household and societal benefits, $3.58 and $0.02, respectively, with the avoided death benefit.

## 5.2 Reduced Disconnections

Home Uplift recipients reported statistically significant reductions in disconnection notices and disconnections. Control group households also reported receiving fewer utility disconnections during the second year of the survey, but not at the same rate as treatment group households. Consistent with the reductions in utility disconnections is the decrease in households reporting it is no longer hard or very hard to pay energy bills. Although the prevalence of energy disconnections was also considered by whether the second-year survey was completed during the first year of the COVID-19 pandemic when utility disconnection moratoriums were established across the Valley, it was determined the disconnection percentages for the entire survey period would be used to ensure statistical power and reliability of data.

The monetization approach and inputs used for estimating the Reduced Disconnections NEI are presented in Tables 52 and 53, respectively. Table 54 provides the set of values for the Reduced Disconnections NEI.

**Table 52: Monetization Approach – Disconnections**

| **Monetization Approach** |
|---|
| **Key Variables** |
| • C = average cost of disconnection ($)<br>• D = average cost of late fees ($)<br>• E = change in % of HHs that have been disconnected in the past 12 months |
| **Equation 1.** *Annual Household Benefit (per weatherized unit)* |
| • *= (C + D) * E*<br>• *NEI = ($63.49 +$6.87) * .019* |

**Table 53: Sources/Inputs – Disconnections**

| **Inputs/Sources** | |
|---|---|
| Household Survey | • Change in the % of HHs that have been disconnected in the past 12 months |
| Literature: Peer Reviewed and Other | • Huntsville Utilities (2013). Customer Service Fees.[1]<br>• Memphis Light, Gas, and Water (2017). Electric, Gas and Water Schedule of Charges.[2]<br>• Nashville Electric Service (2021). Cut-off and Reconnect.[3]<br>• EPB (2021). What Are the Reconnection Fees?[4]<br>• Warren RECC (n.d.). Services Charges. [5]<br>• Huntsville Utilities (2016). Customer Care Manual. [6]<br>• Knoxville Utilities Board (2018). Gas Division Service Procedures.[7]<br>• Energy Information Administration (2019). 2019 Average Monthly Bill – Residential. [8]<br>• EPB (2021). What Happens If I'm Late Paying My Monthly Payment? [9]<br>• Warren RECC (2017). TVA Schedule of Rules and Regulations.[10] |

[1] https://www.hsvutil.org/ac/wp-content/uploads/2013/09/Customer-Service-Fees-PDF-version-updated-6.16.16.pdf
[2] https://www.mlgw.com/images/content/files/pdf/ScheduleofCharges.pdf
[3] https://www.nespower.com/pay-my-bill/
[4] https://epb.com/support/faq/loQRq9M0VasOgXMV7VmDToyxol0MJwCjOYopvbNdu3OjAJQl56FLllo3r39m/
[5] http://www.wrecc.com/service-charges/
[6] https://www.hsvutil.org/ac/wp-content/uploads/2017/06/Customer-Care-Manual-FINAL-6-22-17.pdf
[7] https://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf

[8] https://www.kub.org/uploads/Gas_Division_Service_Procedures_.pdf
[9] https://epb.com/support/faq/pMe6g6bmxlC0bnN4ngPvTRaM3lbBeXTXk3DeQ5J9tAVd6A6zYMUkYBZanNyP/
[10] http://www.wrecc.com/wp-content/uploads/2018/04/Rules-and-Regulations-TVA-February-23-2017.pdf

**Table 54: Estimated Impact of Reduced Disconnections**

| Beneficiary | Annual Per Unit Benefit | PV Per Unit Benefit Over 10 Years |
|---|---|---|
| **Households** | $1.34 | $13.05 |
| **Society** | $0 | $0 |
| **Total** | $1.34 | $13.05 |

For the Reduced Disconnections NEI, we recommend an annual NEI value of $1.34 that includes only a household benefit.

## 5.3 Reduced Fire Risk

There are numerous weatherization measures and associated activities that can reduce fire risks in low-income homes. These include replacing and/or repairing dangerous heating, cooling, and water heating systems, and making electrical repairs. Other weatherization measures can suppress fires, such as insulation and air sealing. To estimate a Reduced Fire Risk NEI for Home Uplift the methods and secondary data were adapted from the national WAP evaluation.

For the WAP evaluation, the National Fire Incident Reporting System (NFIRS) was used to identify all causes of home fires in the United States and home conditions that can suppress the spread of home fires. A subset of fire ignition causes, and suppression factors were drawn from NFIRS that were rated to be most impacted by typical comprehensive weatherization programs. The causes and suppression factors were mapped to over a dozen typical weatherization measures. Data from NFIRS were drawn to estimate probabilities of fire risks attributable to the ignition causes and suppression factors. Other databases and publications were used to estimate reductions in both occupant and firefighter injuries and deaths due to the reduction in home fires.

It should be noted that the main monetization input produced through the WAP evaluation was adjusted for the Home Uplift evaluation, referred to as the ‘coefficient of reduced fire risk”. Adjustments were necessary to capture the differences in types of measures installed between the two programs, and the rate at which the measures were installed. Home Uplift measures were first mapped to the WAP measures, if possible. Only Home Uplift measures that were included in the list of “ignitors” or “suppressors”, as categorized through the WAP evaluation, were considered. Any inputs associated with WAP measures that were not installed through Home Uplift were zeroed out. For those measures that could be directly mapped the following calculations were made:

1- Adjustment Factor: For each “mappable” measure installed (MI) the % difference between the rate of measure installation in WAP and the rate of measure installation in Home Uplift was calculated.

*Adjustment Factor = (WAP % MI - Home Uplift % MI) / WAP % MI.*

2- Risk Reduction rate by Home Uplift measure: The newly calculated adjustment factors were used to adjust the Risk Reduction rate for each "mappable" WAP measure to calculate a Risk Reduction rate for the Home Uplift measures.

*Risk Reduction rate (Home Uplift measure) =*
*Risk Reduction rate (WAP measure) * Adjustment Factor*

3- Coefficient of reduced risk (reduced probability of fire) in SF home, attributable to Home Uplift: The Risk Reduction rates (for all Home Uplift measures) were totaled to calculate a coefficient of reduced fire risk. This coefficient was used as the main adjusted input into the Reduced Fire Risk NEI for the HU evaluation.

*Coefficient of reduced risk = Total of RR rates / 100*

The monetization approach and additional inputs used for estimating the Reduced Fire Risk NEI are presented in Table 55 and Table 56, respectively. Table 57 presents the estimated annual household and societal benefits of the Reduced Fire Risk NEIs. The estimated NEI values are presented both with and without the avoided death benefit included.

**Table 55: Monetization Approach – Reduced Fire Risk**

| **Monetization Approach** |
|---|
| **Key Variables** |
| • B = Coefficient of reduced fire risk in SF home, attributable to Home Uplift<br>• C = estimated # occupant deaths per home fire<br>• D = estimated # occupant injuries per home fire<br>• E = estimated household cost $ of occupant injuries per home fire<br>• F = estimated societal cost $ of occupant injuries per home fire<br>• G = estimated # firefighter deaths per home fire<br>• H = estimated # firefighter injuries per home fire<br>• I = estimated societal cost $ of firefighter injuries<br>• J = estimated household cost for property loss per home fire<br>• K = estimated societal costs for property loss per home fire<br>• L = value of avoided death |
| **Equation 1.** *Annual Societal Benefit (per home)* |
| • *= B *((G *L) + (H * I) + (D * F) + K)*<br>• *Societal NEI = .0004515 * ((.00005 * $9,600,000) + (.1 * $7,585) + (.0349 * $6,362) + $18,778)* |
| **Equation 2.** *Annual Household Benefit (per weatherized unit)* |
| • *= B *((C *L) + (D * E) + J)*<br>• *Household NEI =. 0004515 *((.015 * $9,600,000) + (.0349 * $1,223) + $10,563)* |
| **Equation 3.** *Total NEI* |
| • *Total NEI = Societal NEI + Household NEI*<br>• *Total NEI = $9.14 + $69.81 = $78.95* |

**Table 56: Sources/Inputs – Reduced Fire Risk**

| Inputs/Sources | |
|---|---|
| Literature: Peer Reviewed and Other | • Estimated # occupant deaths (.015), and injuries (.0349), per home fire[1]<br>• Reduced probability of fire in SF home, attributable to weatherization measures installed through Home Uplift[2]<br>• Estimated household cost $ for occupant injuries ($1,223), and societal costs for occupant injuries ($6,362) per home fire[3]<br>• Estimated # firefighter deaths per home fire[3]<br>• Estimated # firefighter injuries per home fire[3]<br>• Estimated societal cost $ of firefighter injuries[3]<br>• Estimated household cost for property loss per home fire[1]<br>• Estimated household cost for property loss per home fire[1] |
| Open-Source Databases | • Bureau of Economic Analysis: Regional Price Parity to adjust national cost estimates to TN price levels<br>• Bureau of Labor Statistics: Consumer Price Index to price-adjust medical costs from 2008 to 2020 |

[1] *Home Structure Fires, National Fire Protection Association, 2017*
[2] The reduced probability of SF home fires, attributable to Home Uplift weatherization, was derived from adjusting the reduced probability of home fires calculated through the national WAP evaluation's health and household NEI study (Tonn et. al. 2014).
[3]The rate of measures installed through Home Uplift were used to make appropriate adjustments.

**Table 57: Estimated Impact of Reduced Fire Risk**

| Fire Risk NEI | | | | |
|---|---|---|---|---|
| **Beneficiary** | **Annual Per Unit Benefit** | **Annual Per Unit Benefit W/O Avoided Death Benefit** | **PV Per Unit Benefit Over 10 Years** | **PV Per Unit Benefit W/O Avoided Death Benefit** |
| **Households** | $69.81 | $4.79 | $681.51 | $46.75 |
| **Society** | $9.14 | $8.92 | $89.21 | $87.10 |
| **Total** | $78.95 | $13.71 | $770.72 | $133.85 |

For the Reduced Fire Risk NEI, we recommend an annual NEI value of $78.95 that includes both the household and societal benefits, $69.81 and $9.14, respectively, with the avoided death benefit.

## 5.4 Reduced Food Spoilage

Reduced food spoilage was newly explored as a potential NEI of low-income weatherization and. Survey respondents were asked about the number of times they had to throw food away because the refrigerator was broken, or they had lost power (for any reason) in the last 12 months. A statistically significant reduction in the number of times survey respondents reported having to throw food away because the refrigerator was broken or lost power was observed in the treatment group (Table 22). The result from a DID calculation between the treatment and control groups was used as the primary input for monetizing the Reduced Food Spoilage NEI.

A study that looked at power outage-related expenses estimated that, per household, an average of $160 was spent on replacing food from a power outage lasting at least 12 hours.[37] The team hypothesized that the eligible Home Uplift population would incur lower costs from food spoilage due to being income constrained and having greater access to government assistance than the general population. We subjectively chose a conservative modifier of 50% – given that power outages can occur from external, environmental events – resulting in an estimated average of $80 spent on replacing food after each incident. We then adjusted the $80 cost estimate for inflation from 2011 costs to 2019 costs.

The monetization approach and inputs used for estimating the Reduced Food Spoilage NEI are presented in Table 58. Table 59 provides the set of values for the Reduced Food Spoilage NEI.

**Table 58: Monetization Approach – Food Spoilage**

| **Monetization Approach** |
|---|
| **Key Variables** |
| • D = Change in # of times had to throw food away (mean)<br>• C$ = Average cost of food replacement per incident of Food Spoilage |
| **Equation 1.** *Total Household NEI value* |
| • *= D * C$*<br>• *NEI = 0.15 * $82.17* |

**Table 59: Estimated Impact of Reduced Food Spoilage**

| **Food Spoilage NEI** | | |
|---|---|---|
| **Beneficiary** | **Annual Per Unit Benefit** | **PV Per Unit Benefit Over 10 Years** |
| **Households** | $12.33 | $120.32 |
| **Society** | $0 | $0 |
| **Total** | $12.33 | $120.32 |

For the Reduced Food Spoilage NEI, we recommend an annual NEI value of $12.33 that includes only a household benefit.

## 5.5 Reduced Predatory Loans

We hypothesized that weatherized households could experience monetary savings attributable to reduced need for taking out short-term, high-interest, or “predatory", loans due to improved financial situations (e.g., from reduced energy costs or decreased medical expenses).

The survey asked households whether they had used four specific types of predatory loans: payday loans, car title loans, pawn shops, and tax refund advances. Using a DID approach, we calculated the net change in percentage of households that used each loan type from pre- to post-

[37] https://www.aagenpro.com/often-overlooked-costs-extended-power-outage/

weatherization for the Treatment group compared to the Control group. Using legitimate sources, we estimated the amount of interest and fees a household would likely pay before the loan was repaid; in the case of tax refund anticipation loans, we found an existing estimate of the average associated fees. After applying the percentage of the population served by Home Uplift that used these types of loans pre- to post weatherization (which included the DID analysis between the treatment and control groups), the cost savings for the Treatment group was estimated by subtracting the total costs of these loan types for the post-weatherization time period from the pre-weatherization time period. From there, a per unit cost was estimated by dividing that cost savings across the total household sample.

The monetization approach and inputs used for estimating the Reduced Predatory Loans NEI are presented in Tables 60 and 61, respectively. Table 62 provides the set of values for the Reduced Predatory Loans NEI.

**Table 60: Monetization Approach – Predatory Loans**

| **Monetization Approach** |
|---|
| **Key Variables** |
| • PDL = average cost of interest/fees for payday loan for 5 months (average length of loan)<br>• CTL = average cost of interest/fees for car title loan for 9 months (average length of loan)<br>• PS = average cost of interest/fees for pawn shop loan twice/year (average # of times)<br>• TRAL = average cost of fees for tax refund anticipation loan (average fees amount)<br>• $p\%_i$ = change in % of HHs needing to use loan type i, where i includes PDL, CTL, PS, and TRAL<br>  ○ DID in % change was calculated between the Treatment and Control group responses prior to calculation |
| **Equation 1.** *Annual Household Benefit (per weatherized unit)* |
| • $= (p\%_{PDL} * PDL)+(p\%_{CTL} * CTL) + (p\%_{PS} * PS) + (p\%_{TRAL} * TRAL)$<br>• $NEI = (0*\$490) + ( .01*\$1,693) + ( .04*\$63) + ( .01 * \$35)$ |

**Table 61: Sources/Inputs – Predatory Loans**

| Inputs/Sources | |
|---|---|
| Household Survey | • Change in the % of HHs taking out a given loan type (a) |
| Literature: Peer Reviewed and Other | • Federal Deposit Insurance Corporation (2015). National Survey of Unbanked and Underbanked Households.[1]<br>• N. Bhutta, J. Goldin, T. Homono (2015). Consumer Borrowing After Payday Loan Bans.<br>• The Pew Charitable Trusts (2015). Auto Title Loans: Market practices and borrowers' experiences.[2]<br>• National Consumer Law Center and Consumer Federation of America (2006). Another Year of Losses: High-Priced Refund Anticipation Loans Continue To Take a Chunk Out Of Americans' Tax Refunds: The NCLC/CFA 2006 Refund Anticipation Loan Report.[3]<br>• National Consumer Law Center and Consumer Federation of America (2021). 2021 Tax Season: Higher Costs for Vulnerable Taxpayers During the COVID Economic Crisis.[4]<br>• R. B. Avery (2011). Payday Loans versus Pawnshops: The Effects of Loan Fee Limits on HH Use. [5]<br>• OppLoans (2017). "Tennessee". [6]<br>• Center for Responsible Lending (2013). Car-Title Lending.[7]<br>• Center for Responsible Lending (2013). Driven to Disaster: Car-Title Lending and its Impact on Consumers. [8]<br>• National Pawnbrokers Association (n.d.). What is a Pawn Transaction? [9]<br>• National Pawnbrokers Association (2014). Pawn Industry Statistics. [10]<br>• Pawn Shops Today (n.d.). Who Is the Customer? [11] |

[1] https://www.fdic.gov/householdsurvey/2015/2015report.pdf
[2] http://www.pewtrusts.org/~/media/assets/2015/03/autotitleloansreport.pdf
[3] https://consumerfed.org/pdfs/2006_RAL_report.pdf
[4] https://www.nclc.org/images/pdf/taxes/Rpt_2021_Tax_Time.pdf
[5] https://www.frbsf.org/community-development/files/2-avery-paper.pdf
[6] https://www.opploans.com/wp-content/uploads/2017/08/State-Page-Table_TN.docx.pdf
[7] https://www.responsiblelending.org/other-consumer-loans/car-title-loans/research-analysis/CRL-Car-Title-Report-FINAL.pdf
[8] http://www.responsiblelending.org/state-of-lending/reports/7-Car-Title-Loans.pdf
[9] https://www.nationalpawnbrokers.org/assets/2020/09/MediaFactsAboutPawn-3.pdf
[10] https://nationalpawnbrokers.org/assets/2018/02/FAQ_2018.pdf
11 https://www.pawnshopstoday.com/the-customer/

**Table 62: Estimated Impact of Reduced Need to Use Predatory Loans**

| Predatory Loans NEI | | |
|---|---|---|
| **Beneficiary** | **Annual Per Unit Benefit** | **PV Per Unit Benefit Over 10 Years** |
| **Households** | $19.80 | $193.25 |
| **Society** | $0 | $0 |
| **Total** | $19.80 | $193.25 |

For the Reduced Predatory Loan NEI, we recommend an annual NEI value of $19.80 that includes only a household benefit.

## 5.6 Improved Prescription Medication Adherence

It is possible that the direct household income benefits attributable to weatherization may allow some households to afford prescription medicines after weatherization, subsequently decreasing medical expenses. An important benefit to society for complying with physician directed prescriptions is a substantial reduction in hospitalization rates.

We used responses to a resident survey question asking whether anyone in the household had needed to forego prescription medications due to monetary constraints. We combined the results from this question with secondary literature on the societal and medical costs of prescription non-adherence, which leads to poorer health outcomes. Using these two, we estimated the savings from improved medication adherence following weatherization.

The monetization approach and inputs used for estimating the Prescription Adherence NEI are presented in Tables 63 and 64, respectively. Table 65 provides the set of values for the Prescription Adherence NEI.

**Table 63: Monetization Approach – Prescription Adherence**

| **Monetization Approach** |
|---|
| **Key Variables** |
| • e = Annual cost to national economy due to lack of prescription medication adherence<br>• p = U.S. population<br>• i = % of population taking prescriptions<br>• n = % of population non-prescription adherent<br>• d = Change in the percentage of HHs better able to afford prescriptions (%)<br>• a = Adjustment factor, some HHs still will not adhere to prescriptions (%) |
| **Equation 1.** *Annual Societal Benefit (per weatherized unit)* |
| • *= (e / (p * i * n)) * d * a*<br>• *NEI = ($250,000,000,000 / (327,000,000 * .7 * .5)) * .019 * .5* |

**Table 64: Sources/Inputs – Prescription Adherence**

| Inputs/Sources | |
|---|---|
| Household Survey | • Change in the percentage of HHs better able to afford prescriptions: -1.9% |
| Literature: Peer Reviewed and Other | • Annual cost to society for an individual being non-prescription adherent ($2,023):[1]<br>• % of population taking prescriptions: 70%<br>• % of population non-prescription adherent: 50%<br>• Cost to economy of prescription non-adherence ($250B)[2]<br>Cutler R. L., *et al (2018).* Economic impact of medication non-adherence by disease groups: a systematic review. *BmJ Open*; 8: e016982. doi: 10.1136/bmjopen-2017-016982.<br>• Adjustment factor: 0.5<br>Liberman et al (2011). Are caregivers adherent to their own medications? Journal of the American Pharmacists Association, Volume 51, Issue 4, 492–498. https://doi.org/10.1331/JAPhA.2011.10006 |
| Open-Source Databases | • U.S. population December 2019: 328,239,523[3]<br>http://census.gov |

[1] http://annals.org/aim/fullarticle/1357338/interventions-improve-adherence-self-administered-medications-chronic-diseases-united-states
[2] https://www.nejm.org/doi/pdf/10.1056/NEJMp1307084
[3] http://census.gov

**Table 65: Estimated Impact of Increased Prescription Adherence**

| Prescription Adherence NEI | | |
|---|---|---|
| **Beneficiary** | **Annual Per Unit Benefit** | **PV Per Unit Benefit Over 10 Years** |
| **Households** | $0 | $0 |
| **Society** | $19.22 | $187.60 |
| **Total** | $19.22 | $187.60 |

For the Prescription Adherence NEI, we recommend an annual NEI value of $19.22 that includes only a societal benefit.

## 5.7 Home and Work Productivity

Existing literature indicates that lack of sleep can negatively impact productivity not only at the workplace but at home. Households in the treatment group reported significant reductions in noise interfering with sleep at all and at either very great or great levels (Table 26). Respondents were also asked: "*During the past 30 days, for about how many days have you felt you did not get enough rest or sleep*?" Survey findings indicate a reduction of 1.9 days (mean) in reports of "poor" sleep from respondents that are weatherization recipients, at a statistically significant level (Table 29).

The percent change in mean number of days that the main respondents got better sleep and rest (1.2%) determined both NEI values related to changes in productivity levels (i.e., Work Productivity and Home Productivity). Through these inputs, annual household savings attributable to annual increases in workplace productivity and non-market home production (i.e., housework) due to better sleep and rest was calculated. The only difference between the home and work productivity monetization approach was employment status. Respondents that confirmed that their household's primary wage earner was employed or self-employed were included in the Work Productivity NEI analysis. All respondents were included in the Home productivity NEI analysis.

Table 66 through Table 68 present the monetization approach and inputs used to calculate the Home Productivity NEI and the estimated value, while Table 69 through Table 71 are dedicated to the Work Productivity NEI.

**Table 66: Monetization Approach – Home Productivity**

| **Monetization Approach** |
|---|
| **Key Variables** |
| • p = Annual productivity increases attributable to better sleep and rest ($)<br>• a = Average annual salary U.S. worker ($)<br>• i = Productivity increase in housework (= p/a)<br>• d = Percent change in mean # of days main respondents get better sleep and rest<br>• w = Value of an hour of non-market HH production (housework)<br>• h = Hours per week housework |
| **Equation 1.** *Annual Household Benefit for Increased Home Productivity (per Wx unit)* |
| • = i * d * w * h * 52 (weeks)<br>• *NEI = .05 * .012 * $22.76 * 21.5 * 52* |

**Table 67: Sources/Inputs – Home Productivity**

| **Inputs/Sources** | |
|---|---|
| Household Survey | • % change in # of days main respondents get better sleep and rest: 1.2% |
| Literature: Peer Reviewed and Other | • Annual productivity increase attributable to better sleep and rest[1]: $1,702<br>• Value for an hour of non-market HH production (housework)[2]: $22.76 |
| Open-source Databases | • Average # of hours per week spent on housework[3]: 21.5 hours/week<br>• Average annual salary U.S. worker[4]: $33,706 |

[1] https://www.rand.org/pubs/research_reports/RR1791.html
[2] https://www.forbes.com/sites/jennagoudreau/2011/05/02/why-stay-at-home-moms-should-earn-a-115000-salary/#5bb109f275f4
https://www.bea.gov/household-production/
[3] http://www.bls.gov/opub/mlr/2009/07/art3full.pdf
[4] https://fred.stlouisfed.org/series/MEPAINUSA646N

**Table 68: Estimated Impact of Increased Home Productivity**

| Home Productivity NEI | | |
|---|---|---|
| **Beneficiary** | **Annual Per Unit Benefit** | **PV Per Unit Benefit Over 10 Years** |
| **Households** | $15.42 | $150.51 |
| **Society** | $0 | $0 |
| **Total** | $15.42 | $150.51 |

For the Home Productivity NEI, we recommend an annual NEI value of $15.42 that includes only a household benefit.

**Table 69: Monetization Approach – Work Productivity**

| **Monetization Approach** |
|---|
| **Key Variables** |
| • p = Annual increase in employee productivity attributable to better sleep and rest ($)<br>• d = % change in # of days main respondents get better sleep and rest<br>• s = % of main respondents employed |
| **Equation 1.** *Annual Societal Benefit for Increased Work Productivity (per Wx unit)* |
| • = p * d * s<br>• *NEI = $1,702 * .012 * .264* |

**Table 70: Sources/Inputs – Work Productivity**

| **Inputs/Sources** | |
|---|---|
| Household Survey | • % change in # of days main respondents get better sleep and rest: 1.2%<br>• % of main respondents employed: 26.4% |
| Literature: Peer Reviewed and Other | • Annual increase ($) in employee production, attributable to better sleep and rest[1]: $1,702 |

[1] https://www.rand.org/pubs/research_reports/RR1791.html

**Table 71: Estimated Impact of Increased Work Productivity**

| Work Productivity NEI | | |
|---|---|---|
| **Beneficiary** | **Annual Per Unit Benefit** | **PV Per Unit Benefit Over 10 Years** |
| **Households** | $0 | $0 |
| **Society** | $5.39 | $52.62 |
| **Total** | $5.39 | $52.62 |

For the Work Productivity NEI, we recommend an annual NEI value of $5.39 that includes a societal benefit, only.

## 5.8 Thermal Stress

Survey findings and inputs gleaned from secondary literature[38] were used to determine annual household and societal savings attributable to reduced thermal stress. The monetized value was based on changes in incidences of medical encounters and avoided deaths due to exposure to extreme temperatures in the home. The study team analyzed and monetized cold stress and heat stress separately.

Respondents were asked, "*During the past 12 months, how many times [because home was too cold or too hot] did anyone in the household have to go to…* [*a doctor, the ED, or be hospitalized*]?" The percentages of individuals that visited healthcare settings for treatment of thermal stress decreased, these changes were found to be at statistically significant levels (Table 14 and Table 15). Overall, fewer incidences of medical encounters across all care settings were reported after Home Uplift for both cold and heat stress. There were no changes in the number of hospitalizations for heat stress.

Changes in the number of avoided medical encounters were used as the main input for monetization. Table 72 and Table 73 present these estimates of change, along with the monetization approach, and cost multipliers. Cost multipliers were calculated using medical expenditures specific to each care setting for treatment of thermal stress. Expenditures were broken out by 'payer' to attribute the savings to either the household (reduced out-of-pocket expenses) or to society (reduced private and public insurance costs). [39,40,41]

[38] The team retrieved costs for treatment for cold- and heat-related illnesses associated with thermal stress from online databases provided by the Department of Health and Human Services (DHHS). These databases are sponsored by the Agency for Healthcare Research and Quality (AHRQ), based on the 2015 MEPS and a collection of databases sponsored by AHRQ and referred to as the HCUP. Data related to incidence rates of treatment type and number of deaths following hospitalizations was mined from both the MEPS and HCUP databases using the International Classification of Diseases diagnostic codes, associated with "Effects of reduced temperature" (ICD-9-CM 991.0-991.9) and "Effects of heat and light" (ICD-9-CM 992.0-992.9) as the queries. Several medical conditions are associated with exposure to extreme temperatures, with hypo- and hyperthermia being the most extreme, and less prevalent.

[39] Center for Financing, Access, and Cost Trends, AHRQ, MEPS, 2017.

[40] Reference Table: Median expenditures per person with expense by source of payment and insurance coverage, United States, 2017. https://meps.ahrq.gov/mepstrends/hc_use/

[41] Expenditures by payer and percent of expenditures for treatment of thermal stress, by payer: Medical Expenditure Panel Survey (MEPS) – 2015.

**Table 72: Monetization Approach and Inputs – Thermal Stress - Cold**

| | Variable | Emergency Dept. (ED) Visits | Doctor Visits | Hospital-izations | Avoided Deaths |
|---|---|---|---|---|---|
| **[A]** | **Estimate of change (difference in differences)** | **-0.016** | **-0.012** | **-.003** | **Uses Hospitalizations (-.003)** |
| **[B]** | Household benefit Cost multiplier (per person) | $24.40 | $177.32 | $1,135.49 | $241,130.30 |
| **[C] = [B] * 1.8** | Household benefit Cost multiplier (per household) | $43.92 | $319.18 | $2,043.88 | $434,034.54 |
| **[D]** | Societal benefit Cost multiplier (per person) | $202.26 | $731.63 | $13,857.98 | $0.00 |
| **[E] = [D] * 1.8** | Societal benefit Cost multiplier (per household) | $364.06 | $1,316.93 | $24,944.36 | $0.00 |
| **[F] = [A] * [C]** | **Total Household NEI Value** | **$0.70** | **$3.83** | **$6.13** | **$1,302.10** |
| **[G] = [A] * [E]** | **Total Societal NEI Value** | **$5.83** | **$15.80** | **$74.83** | **$0.00** |

Notes/sources:

**1.8 = Benefits accrue across all members of the household. The mean number of occupants per Home Uplift household is 1.8 persons.**

**[B], [D] = Cost multipliers are presented here to simplify the table. Cost multipliers capture costs by payer, percent of OOP costs based on type on insurance, and percent of annual treatment costs by payer and by care setting type.**

**[F], [G] = Due to rounding, calculations might not provide exact values. The team reports up to three decimal points, but the calculations used to derive the incidence rates use unrounded values.**

**Table 73: Monetization Approach and Inputs – Thermal Stress – Heat**

| | Metric / Measure | Emergency Dept. (ED) Visits | Doctor Visits | Hospital-izations | Avoided Deaths |
|---|---|---|---|---|---|
| **[A] =** | **Estimate of change (difference in differences)** | **-0.006** | **-0.007** | **0.0** | **Uses Hospitalizations (0.0)** |
| **[B] =** | Household benefit Cost multiplier (per person) | $28.55 | $169.04 | NA | NA |
| **[C] = [B] * 1.8** | Household benefit Cost multiplier (per household) | $51.38 | $304.27 | NA | NA |
| **[D] =** | Societal benefit Cost multiplier (per person) | $232.57 | $759.35 | NA | NA |
| **[E] = [D] * 1.8** | Societal benefit Cost multiplier (per household) | $418.62 | $1,366.83 | NA | NA |
| **[A] * [C]** | **Total Household NEI Value** | **$0.31** | **$2.13** | **$0.00** | **$0.00** |
| **[A] * [E]** | **Total Societal NEI Value** | **$2.51** | **$9.57** | **$0.00** | **$0.00** |

Notes/sources:
**1.8 = Benefits accrue across all members of the household. The mean number of occupants per Home Uplift household is 1.8 persons.**
**[B], [D] = Cost multipliers are presented here to simplify the table. Cost multipliers capture costs by payer, percent of OOP costs based on type on insurance, and percent of annual treatment costs by payer and by care setting type.**
[F], [G] = Due to rounding, calculations might not provide exact values. The team reports up to three decimal points, but the calculations used to derive the incidence rates use unrounded values.

The study team calculated the value of avoided deaths by multiplying the change in incidence rate of hospitalizations reported through the survey by the rate of hospitalizations (due to thermal stress) that result in death (secondary data), multiplied by the VSL. Table 74 shows these values and provides the inputs used to calculate them and the total value of the avoided death benefit, for cold stress only. Since the incidence of hospitalizations from heat stress did not change after Home Uplift, the avoided death benefit for heat stress is zero.

**Table 74: Estimating Avoided Deaths from Extreme Thermal Stress**

| Inputs | Cold-related | Heat-related |
|---|---|---|
| [A] = Change in number of respondents reporting at least one hospitalization for thermal stress | .003 | 0 |
| [B] = Percent of hospitalizations from thermal stress resulting in death (national rate) | 2.51% | 1.28% |
| [C] = [A * B] = Rate of reduction in deaths from thermal stress due to weatherization | 0.008% | 0.0% |
| VSL | $9.6M | $9.6M |
| **[C] * VSL * 1.8 = Household avoided death NEB$, *per household*, per year *(mean # of persons in home = 1.8)*[1]** | **$1,302** | **$0** |

[1] Due to rounding, calculations might not provide exact values. The team reports up to three decimal points, but the calculations used to derive the incidence rates use unrounded values.

Table 75 and Table 76 present the estimated annual household and societal benefits of the cold stress and heat stress NEIs, respectively. The estimated NEI values are presented both with and without the avoided death benefit included.

**Table 75: Estimated Annual Impact of Reduced Thermal Stress (Cold)**

| Thermal Stress (Cold) NEI | | | | |
|---|---|---|---|---|
| **Beneficiary** | **Annual Per Unit Benefit** | **Annual Per Unit Benefit W/O Avoided Death Benefit** | **PV Per Unit Benefit Over 10 Years** | **PV Per Unit Benefit W/O Avoided Death Benefit** |
| **Households** | $1,312.77 | $10.66 | $12,815.50 | $104.11 |
| **Society** | $96.46 | $96.46 | $941.67 | $941.67 |
| **Total** | $1,409.23 | $107.12 | $13,757.17 | $1,045.78 |

For the Thermal Stress - Cold NEI, we recommend an annual NEI value of $1,409.23 that includes both the household and societal benefits, $1,312.77 and $96.46, respectively, with the avoided death benefit.

**Table 76: Estimated Annual Impact of Reduced Thermal Stress (Heat)**

| Thermal Stress (Heat) NEI | | | | |
|---|---|---|---|---|
| **Beneficiary** | **Annual Per Unit Benefit** | **Annual Per Unit Benefit W/O Avoided Death Benefit** | **PV Per Unit Benefit Over 10 Years** | **PV Per Unit Benefit W/O Avoided Death Benefit** |
| **Households** | $2.44 | $2.44 | $23.80 | $23.80 |
| **Society** | $12.08 | $12.08 | $117.92 | $117.92 |
| **Total** | $14.52 | $14.52 | $141.72 | $141.72 |

For the Thermal Stress - Heat NEI, we recommend an annual NEI value of $14.52 that includes both the household and societal benefits, $2.44 and $12.08, respectively. For the Thermal Stress – Heat NEI, no avoided death benefit was observed.

# 6. Conclusion

The TVA Home Uplift program produced meaningful improvements in home energy security, health and well-being, and dwelling quality outcomes. Households expressed the importance of thermal comfort inside their homes and the relief that comes from affordable energy bills and fewer utility disconnections. Many Home Uplift recipients are now better able to afford prescription medications and no longer have to make the difficult choice between paying for their utilities or paying for other basic essentials. Household members report fewer days of poor sleep and physical health. They are less exposed to extreme temperatures, drafts, dust, noise, and mold. The installation of health and safety measures, like CO and smoke detectors, reduces the risk of poisoning and house fires. Health and safety are also improved with fewer households using secondary heating equipment or ovens to heat their homes. Overall, the Home Uplift pilot improved the quality of life for households living across the Tennessee Valley.

Both direct and indirect impacts attributable to Home Uplift weatherization were assessed during the Home Uplift pilot NEI evaluation. Many NEIs are supported by additional outcomes described above (e.g., subjective experiences with thermal comfort, difficulty paying energy bill) that provide substantiating evidence that Home Uplift weatherization provides both household and societal benefits and that those benefits can be monetized. Together, these benefits produce an estimated first-year, annual NEI value of $1,580 (per household) that includes the likely prevention of deaths. An NEI Present Value is estimated to be $15,405. The monetization of NEIs provides further justification that weatherization programs, like Home Uplift, produce societal benefits in sectors beyond the energy sector.

# Appendix A:
# Data With a Soul Testimonials

**Table 77: DWaS Overall Well-being and QoL Theme Responses**

| Overall Well-being and Quality of Life |
|---|
| **Knoxville, TN** |
| Before weatherization, paying bills was "hectic". She places a high value on having a place to call home for herself and her children. She has new pride in her home which she refers to as "peace haven" and "little cottage"; she invites people to visit now. |
| She worries about the future and being able to age in place inside her family home. |
| She highlighted the importance of family for informal support. |
| He expressed psychosocial stress related to a number of issues related to the plumbing, leaking roof, and subsequently being dropped by his homeowner's insurance. One bathroom couldn't be used, and the other had water issues from a failing gutter. He said that the bills are a source of stress for him. He has a mortgage to worry about and is worried about finding insurance for the home. He did not specify how the stress manifests itself or whether he has a way of managing the stress. |
| **Chattanooga, TN** |
| The heat didn't work on her old unit, only the A/C, so she used space heaters, "which do not keep your house that warm." Weatherization installed eight windows and a heating system, new ductwork, smoke and CO detectors, and some air sealing for the attic. All the rooms are at the same temperature now. "Makes my life not so miserable." She would spend time in only one or two rooms. Her water heater had gone out at the same time as her heat, so it was "like a downhill trip for a while." "My life really changed when I got better appliances." Windows were really old; a pane had fallen out of one. The new windows have been really wonderful. "Changed my life; I don't have to be miserable now." EPB is coming out again to do air leak test. "It changes your outlook too; you don't feel so overwhelmed by your circumstances." Was tired all the time<br>"If you're mentally tired it affects your whole body."<br>Now that she has weatherization: "It feels luxurious! I feel like I'm rich." |
| The stress of living there impacts her quality of life, which she believes will improve after weatherization. Last winter, her daughter would miss up to three days at a time. If the house got too cold, she would have her daughter go in one of the interior rooms to do homework so it would stay warmer. Traffic has increased significantly, causing more noise and dust. The noise in particular makes her anxious. Worried about a fire from the space heaters and getting sick from the cold. Also, the traffic and noise. She said that weatherization will relieve a lot of stress, especially related to the temperature. |
| Hoping weatherization will improve her quality of life. She lives on disability for a ruptured aorta. |

| Huntsville, AL |
| --- |
| Motivated to improve her quality of life through advanced education and positive attitude. She reported a sense of social cohesion in HA neighborhood in stating that people look out for each other. |
| Noise sometimes interferes with sleep. Can hear traffic and gun shots. |
| **Memphis, TN** |
| Would do more with her children if had lower energy bills. |
| Retired fixed income living with grandchildren. Worries about her bills and the state of the home. |
| Fixed income, difficult to pay bills. |
| Noted good neighborhood with people who have lived there for years. |
| Three break-in attempts. Loves her home. Believes weatherization will change her life for the better. |
| Retired and on fixed income. Pride in home after living in apartments for so long. Her family determined if was worth the extra cost and financial stress to own a home. |
| **4-County, MS** |
| Daily stress. Mostly about bills. Weatherization has given her some comfort. Worries about life itself. |
| **Nashville, TN** |
| With weatherization savings she would put a little money aside to visit friends. Poor mental health. Chemo and cancer left her broke. Anxious about remembering if she turned the thermostat up or down after she leaves the house. Highly values her home which she calls her sanctuary. |
| Stresses before every winter. Stresses about heat and air. |
| She doesn't have worries besides paying light bill in winter and summer. |

**Table 78: DWaS Affordability and Trade-Offs Theme Responses**

| Affordability and Trade-Offs |
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| **Knoxville, TN** |
| Even with working two jobs, she would not purchase food or would eat unhealthy foods to pay other bills; she prioritized the mortgage. |

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| Utility bills can get up to $400 in the winter and $120 in summer. Her family helps with bills, and she eats inexpensive food. When her children were younger, she fell behind on her mortgage and had to choose which bills to pay. Between getting laid off and getting approved for disability, she had to put off routine and preventative healthcare. |
| She had high energy bills in winter and would sometimes allow a balance to develop over the winter that she would pay in summer when the bill is more manageable. She had cut back on other bills: no cable, low-cost phones, sleeps in warmer rooms, saves on gas money by limited driving. Her electricity was cut off last winter and she had to wear winter coats inside. Her furnace broke in February, so they had to use space heaters. Both residents are diabetic, but high bills mean they sometimes cannot afford healthy food. |
| She sometimes wouldn't pay car insurance if she has to make choices between bills. Leaks in her ducts meant her bills were higher in winter, as much as $300+. Her family helps with food and payments. |
| His most recent bill (which was a fairly mild December) was $391. He attributes the high cost [of his energy bill] to the space heaters they continually use in order to keep warm. They limit themselves to the living room, which is where they spend most of the day, even to sleep. The other rooms, including the bathroom, get "ice cold." They would sometimes turn on the oven to heat the kitchen so that they can cook more comfortably. He noted that he keeps a close eye on it and has not worried about fires. In the summer, the bills are around $200. He said the "air works okay." They have to make tradeoffs across the board, especially now with his dropped insurance. They had to pay out of pocket for doctor's visits. His mother helped pay for the bills. |
| **Chattanooga, TN** |
| Reduced energy bill by about half; high housing and utility cost burden before: "when you have that and limited income, you have nothing left"; on food stamps, Medicaid, etc. |
| Summer bill is usually lower than winter. Highest winter bill was around $200, and it was still freezing, which she noted was very disappointing. She would bring a heater into a room and close the door, and the temperature would still only get to 57. The house would be around 42 degrees on average. "It's disappointing when you have to pay out a big electric bill and you're still cold." She pays all of her bills first and goes from there on how she can spend her money, like what food she can get. She can't always buy the stuff she wants to have. "Owing money is very stressful," so she tries to avoid it when possible. A couple months during the winter the bills have been $180, but she expects with the weatherization they will come down. |

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| The bills get up to $400 in the winter. He is on disability now, but it took a three-year legal battle during which he had no income because his doctors would not clear him for work. He was dependent on family during that time. He has to work side jobs to pay the bills, doing custom gunsmithing work and anything else he is able to do. Beyond side jobs, he is on a fixed income of $1300/mo. During the time between having to quit work and getting disability, he looked into COBRA insurance and said it would have cost $1400/mo. He tried to apply for Medicaid for at least six months; the online application was down and referred him to his local office; the local office said he had to go online. He now finally has Medicare. He does not take certain medications he is prescribed because he cannot afford them; one he mentioned one would cost around $415 a month. He said that Medicare will not cover them. He would still like to see his utilities come down. For some reason the new unit has not reduced his electrical consumption yet, but EPB is working on figuring out what they can do to bring down his bills. (He suspects the single pane windows contribute) |
| Yes, very difficult. They get disconnected as much as every 3-4 months. The light bill averages around $250-300 and gets as high as $500 in winter. After weatherization they are hoping for a bill around $170. They are told the bill should drop around $100 with windows and sealing. Saving money on the light bill would help them pay for prescriptions and even just transportation to and from the doctor's office. They are on a fixed income and raising two grandkids currently (two more already out of the house), and they receive no form of support from either their children (the grandkids' parents) or the in-laws, so they have to provide everything for the kids from school supplies to clothes to food and healthcare. Worried about a fire from the space heaters and the utility bills. |
| The light bills get high in the winter because of the space heaters. Her cousin blew some insulation in the roof/attic two years ago, which brought the bills down from $400 to about $300 on average. She always manages to get the utilities paid, but sometimes she needs help from her church or cousin. She also gets about $90 a month for food stamps. |
| **Huntsville, AL** |
| Moved into the HA as it was more affordable while she is in school. Uses school money to help pay her bills, but still difficult to pay. Seeks energy assistance to help. |
| Rent is cheaper and can't find better. Different kind of trade-off/compromise |
| Due to nutritional and medication needs she cannot afford to engage in trade-offs that others experience. She relies on energy assistance to manage her expenses. |
| **Memphis, TN** |
| Used to get disconnect notice nearly every month and was reliant upon family help to pay utility bills when they got too high. She would pay minimum amount owed to keep the utilities on and would pay more if she had extra. Retired and on fixed income. Almost lost house due to nonpayment. Now pays 70% of income to mortgage. Uses food banks regularly. |
| If had lower utility bills would buy more food and do more things with her kids. |

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| Drafty house and very high energy bills in winter. $500-600 per month in winter. "Robs Peter to pay Paul". Uses LIHEAP and church assistance to pay bills. Sometimes she will not get her medications so she can pay her utilities. Utilities close to being disconnected every month. She receives SS check, but utility bill is sometimes higher than her check. Costs for medications are nearly $200/month. |
| Stopped buying snack foods and quit smoking. |
| Will allow herself to fall behind on bills in winter and catch up during summer. Will sometimes cut back on groceries because she prefers to be warm. Loves good food but will buy less important things like spices when she can't afford it. |
| Bills can get high in winter and summer. (Close to $400 the month before the survey). She will buy fewer groceries. Has a credit card for medical expenses for her aging dog. |
| Utility bills can range from $170 to over $350 on a fixed income of $1000/mo. Could afford repairs on the home when she was working. When managing bills will put off vehicle maintenance and city/state taxes. Savings were reduced during breast cancer and reconstructive surgeries. |
| **4-County, MS** |
| Will often have to choose between utilities, medication, and food. |
| Whole lot of trade-offs to pay energy bills such as cleaning and household supplies and kitchen needs. |
| **Nashville, TN** |
| Buys cheap food, does not go out to eat or out with friends, does not travel to save money. Spends most of her SS, savings, and retirement on medical costs. |
| She will sometimes not buy food to pay the utility bill. She will also not buy medicine in order to pay utility bill. |
| Light bill is really high. Will always pay utility bills, but not always cable and cell phone. Will also cut back on groceries. "All depends on how the light bill is." |

**Table 79: DWaS Housing IEQ and Health Theme Responses**

| **Housing IEQ and Health** |
|---|
| **Knoxville, TN** |
| Mold Improved when AC was fixed. |
| Extensive mold in basement (which originally led to weatherization deferral). Her granddaughter who used to spend time in the home developed asthma. As she ages, her home environment could be improved to prevent trips and falls. |

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| There were some holes in the floors, but no one had tripped. |
| There was mold in the bathroom and no working exhaust fan. She has respiratory problems, including coughing, wheezing, and stuffy head. |
| If they were less burdened by high energy bills, some of that money could be put toward the work that needs to be done on his Achilles tendon. Neither of them has chronic respiratory issues, but he did say that before they had the roof replaced and water damage fixed, they were “sneezing and wheezing” from the mold. |
| **Chattanooga, TN** |
| This home received a major remodel with both weatherization and home rehabilitation work including carpet removal and new floors. This should improve respiratory health for kids with asthma in the home and for her own respiratory distress (asthma). |
| She and her daughter took turns being sick for two straight months last winter with general respiratory issues: sore throat and sinus complaints. There wasn’t much the doctor could do other than keep recommending cold medicine. She was sick three times before Christmas, twice with bronchitis. This year they have been doing better so far, which she attributes to keeping the house warmer and slightly warmer weather. She also has degenerative joint disease and anxiety. |
| **Huntsville, AL** |
| Respondent reports undiagnosed respiratory distress and headaches. She observes mold and pest infestations (cockroaches and moths). She has no insurance. Uses natural remedies. She reported that "people are sick out here". |
| Mold observed in the home which exacerbates her symptoms. Her sons also have allergies. |
| **Memphis, TN** |
| Some mold and moisture issues in the home. Bad/painful arthritis. |
| Some mold and moisture issues in the home. |
| Trip and fall hazards from uneven floors and bad back. Concerned about the rats and about potential lead in pipes in paint. There is no vapor barrier. House has mold and moisture issues. She has number of health issues. Grandchildren are always sick, coughing, respiratory distress. |
| Improvements in dust after home improvement last year. Mold and moisture issues. |
| Has COPD. Works hard to keep dust levels manageable. |
| Leaky windows let rain inside if not plugged up. Falls a lot from her arthritis. |

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| Some moisture issues. Some new headaches, but not sure why. MRI will determine if cancer is back. |
| **4-County, MS** |
| Home was dusty before new AC. Now air feels fresh. Lung cancer survivor. Not good to have respiratory issues. |
| **Nashville, TN** |
| Breast cancer and other medical issues. Wheelchair bound until October. |
| Mold and moisture damage due to leaky roof. Years ago. Pulled out damaged insulation. Bronchitis and allergies all year long. Respiratory problems were worse with the mold. Grandson also has chronic respiratory problems, asthma. |
| Some mold and moisture issues. |

**Table 80: DWaS Benefits of Thermal Comfort Theme Responses**

| Benefits of Thermal Comfort |
|---|
| **Knoxville, TN** |
| With no working AC (which she could not afford to fix), the home was often "unbearable", especially in the kitchen. |
| She was using alternative heating sources, including a kerosene heater. It got very cold in winter and hot in summer. She has Complex Regional Pain Syndrome where extreme cold makes her very uncomfortable. |
| Heat can exacerbate one of the family member's COPD, so he needs AC. |
| Her windows were drafty and doors really old. She used a propane heater but not if kids were around so that they wouldn't get burned. |
| **Chattanooga, TN** |
| Importance of thermal comfort for health. Respondent has Pulmonary arterial hypertension and cannot get too hot or too cold. But would use fans instead of AC to lower energy costs. Now with new HVAC she can maintain comfort |

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| Windows were very drafty. A contractor friend told her she was losing a lot of heat out of them. She also didn't have return vents, so more air was going under house than in house. Got an all-new duct system. She would wear two bathrobes at a time and suffered a great deal of stress from the cold; "Stress can make you sick, too," she noted. "I was tired all the time," and she described a mental fatigue that made her physically tired as well. "January and February were nightmares." But with the new heater and windows, she said, "I don't have to dread winter this year…I've got a new song and dance." |
| There was no central heat or air until weatherization just recently installed a unit. He has already noticed the air feeling fresher, which helps with his breathing problems. Temperature is more even. He would use space heaters in the winter and window A/C units in summer. In winter, the temperature would be highly uneven between rooms due to insulation in interior walls (the house used to be smaller and has been built onto). According to him, when you got out of the shower, you would have to walk through one room that would be 25 degrees, and another might be 75. The window units in the summer built up condensation that would pool on the floor and has stained the carpet. He would have to turn them off on the hottest days because it would get too wet. Pooling water from window units that caused damage to wood and flooring/carpet. Turned off A/C units on the hottest days. Hasn't been able to replace carpet yet. Sometimes he would drive the hour to his family's farmhouse just to be warm. This house feels like home. Having the temperature more comfortable has made it even better. "[The weatherization] is a blessing, especially this time of year." He had only praise for the program and said it was the first program that's done what it said it would do, "and that means a lot down here." |
| The furnace broke down 4-5 years ago and they have been using multiple space heaters since. They would check each night before bed that the kids hadn't placed anything too close to the heaters and then check again throughout the night, constantly worrying. Sometimes they would put up plastic to block off rooms they couldn't heat. He has a condition called Peripheral Artery Disease, or a narrowing of the arteries leading to the hands and feet in his case. PAD is usually caused by atherosclerosis. The lack of blood is causing nerve damage, and he already lost one finger to gangrene. The skin also starts to burn and itch if exposed to cold temperatures. He has already had one surgery to try to increase blood flow. |
| "The house keeps us sick because we're cold all the time." The house was built in the 40s. There is no central heat or air. There used to be a gas stove, but she started getting headaches when she moved into the house and was told the gas stove was not properly vented, so she had it removed. However, no one was able to remove the piece of pipe going into the wall, so for years she had an open hole where the pipe was letting the hot air out of her living room until someone pointed out that she could at least plug it up with towels. Yes, the home is warmed with space heaters in nearly every room. This year she has been keeping them on longer/warmer to try and prevent respiratory issues this winter. She said, "I'm surprised I haven't gone up in smoke," worried about a fire from the heaters. |
| Difficult to maintain thermal comfort in both summer and winter seasons. Limited to certain rooms in the home. Heating sources are not always working or safe. Home is drafty and not well insulated. She is a renter. Her landlord says the home is "winterized". |

| Huntsville, AL |
| --- |
| Respondent has lupus. It is important to not get too hot or too cold as this could result in medical complications. Despite trying to stay cool, she still felt too hot during the summer inside her home. She also has fibromyalgia and arthritis which also flares with exposure to extreme temperatures |
| **Memphis, TN** |
| Cracks in floors and drafty doors. Home is cold in winter |
| Drafty, uninsulated home, unfinished floor, very old doors and windows with cracks around the edges. Used potentially unsafe heating sources when HVAC went out. |
| Drafty house and very high energy bills in winter. $500-600 per month in winter. Also holes where rats have chewed. Uses secondary heaters and bundles up. Cold aggravates her arthritis. |
| Will sleep in more livable rooms during hot summers or cold winters. Does not appear to impact arthritis. |
| Uses secondary heat sources including unvented gas heaters. Cold exacerbates her arthritis. Will try to bundle up and will take pain killers from a pain clinic. |
| Uses space heaters, but they might be faulty so turns them off after 15 minutes, so they don't start a fire. In the winter "it can be murder" for her arthritis. Both she and her son use inhalers all summer when it gets hot. Carpet is old. She started to pull up and replace with laminate in some rooms, but she cannot afford all rooms. |
| Home is drafty from original windows. Has replaced some. Weatherization will do more. |
| **4-County, MS** |
| She has heart problems (heart attack earlier in the year). Heat makes problems worse and could lead to heatstroke. She is able to maintain healthy temp inside home but at a cost. Used space heaters. Heat was going under trailer. |
| Power used to go out a lot. Furnace was insufficient and home would be cold/very cold. |
| **Nashville, TN** |
| Goes the distance for air sealing and filling cracks in the home to reduce drafts and attempts to be as energy efficient as possible. Still "freezes to death" in the winter. Very important that she finds comfort in her home. |

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| Uses heaters and fans as central heat and air is out. She and her grandson will stay with other people in winter when it is too cold. She will sometimes not buy food to pay the utility bill. Not convenient to stay with her daughter who is 45 minutes away and wastes gas money, but the home is too cold to stay inside. |
| Drafts come in through doors and windows. Puts up plastic sheeting. She has bronchitis and allergies. Upper respiratory issues worse in winter. She coughs and can’t stop. Sometimes goes to ER for breathing treatments. Also uses over the counter medications. Also, when it's cold she can't sleep. |