Effects of Home Uplift Weatherization on TennCare Utilization and Costs

Technical Report prepared for the Tennessee Valley Authority

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Acronyms and Abbreviations	
COPD	Chronic Obstructive Pulmonary Disease
COVID-19	Coronavirus Disease 2019
CPI	Consumer Price Index
DID	Difference-in-Differences
DOE	U.S. Department of Energy
FPL	Federal Poverty Line
HVAC	Heating, Ventilation and Air Conditioning
ICD-10-CM	International Classification of Diseases, Tenth Revision, Clinical Modification
IEQ	Indoor Environmental Quality
ITS	Interrupted Time Series
LPC	Local Power Company
Metro Area	Metropolitan Area
N or n	Number/Sample size
NEI	Non-Energy Impact
OLS	Ordinary Least Squares
p	p-value
QoL	Quality of Life
SDOH	Social Determinants of Health
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
UT	University of Tennessee
WAP	Weatherization Assistance Program
Wx	Weatherization
ZIP	Zero-Inflated Poisson

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Introduction

Health Benefits of Home Weatherization

Home weatherization programs seek to reduce home energy consumption and bills, improve dwelling quality, and protect occupants against extreme weather events. Comprehensive weatherization includes energy conservation measures such as home insulation, air sealing, and repairs and upgrades to Heating, Ventilation, and Air Conditioning (HVAC) systems. Many programs, such as the Tennessee Valley Authority's (TVA) Home Uplift Program, include health and safety measures alongside energy saving measures. In addition to lowering energy costs (Tonn et al., 2018), these programs can improve indoor temperatures (Ahrentzen et al., 2016; Alam et al., 2018; Poortinga et al., 2018), reduce infiltration of air pollution and environmental hazards (Doll et al., 2016; Francisco et al., 2017; Noris et al., 2013; Rose et al., 2015), and increase general comfort for residents (Haverinen-Shaughnessy et al., 2018; International Energy Agency, 2025, Rose et al., 2022). Combined, these improvements in the indoor environment and the reduced financial strain from lower utility bills may contribute to better health for residents (Rose, et al., 2022, Tonn et al., 2021).

The current study explores the potential health benefits that accrue to income-eligible households that received comprehensive weatherization services – at no cost – through Tennessee Valley Authority's Home Uplift initiative operating across Tennessee and the Tennessee Valley. The overarching goal of the research described in this report is to contribute to the foundation of evidence that describes the intersections between human health, energy efficiency, and healthy housing. Specifically, a study that examines Medicaid claims data pre- and post-weatherization will add to our knowledge about the health impacts of improving home energy efficiency. The study adds to the previous non-energy impact (NEI) evaluation completed by Three[3] (Rose et al., 2022).

Importantly, to conduct the study, a data sharing agreement was executed between Three[3] and the State of Tennessee's Division of TennCare for the secure transfer of identifiable Medicaid claims data for select (health) diagnostic codes. The data sharing agreement and research design was also governed by the Institutional Review Board of the University of TN, Knoxville.

Report Outline

The sections below detail the process and results of the TennCare Medicaid analysis for weatherization participants. Section 1 provides background information on and select findings from the previous Home Uplift NEI evaluation. Section 2 describes who participated in the study and the data collected about those participants. Section 3 describes the methods used to analyze the data, including comparing averages before and after weatherization and analyzing trends in Medicaid data over time. Section 4 presents the results of these analyses. Section 5 presents a discussion of the findings and concluding remarks.

Background on the Non-Energy Benefits of Home Uplift

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 Electric Power Association in 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). 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. This evaluation 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. A few of the key health-related findings from the Home Uplift pilot evaluation are highlighted on the next pages.

In partnership with the University of Tennessee, Knoxville's Center for Applied Research and Evaluation (UT CARE), a total of 701 Home Uplift households were surveyed across seven pilot locations between 2018 and 2021. During the first year of surveys, 300 low-income, unweatherized households (i.e., control group) were also surveyed from within the same metro areas as the treatment group households. For the treatment group, the second-year survey captured 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 any external factors impacting survey responses.

Select Findings from the Home Uplift Pilot NEI Evaluation

The TVA Home Uplift metro area survey findings described below include both baseline statistics (first year survey findings) and any measurable changes detected in household reported issues related to general health and well-being, chronic health conditions, and exposures to health and safety hazards in the indoor environment. Several of the findings on health and well-being supported the need for additional examination of the effects of weatherization on healthcare utilization and costs.

Exposure to Extreme Indoor Temperatures

According to survey responses, households that received Home Uplift experienced significant increases in access to working heating and cooling equipment (Table 1). Respectively, nearly 23 and 25 percent of households reported they were no longer able 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. These findings are important in linking Home Uplift impacts to health conditions associated with exposure to extreme (i.e., unhealthy) indoor temperatures.

Table 1. Broken Heating and Cooling Equipment

Variable/Research Group (n = Number of Respondents)	Treatment Baseline (n=701)	Treatment Pre-Wx (n=572)	Treatment Post-Wx (n=572)	Control Year 1[1] (n=222)	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%

Exposure to extreme temperatures inside homes was significantly reduced after Home Uplift (Table 2). For this set of analyses, only households that provided responses to both surveys are included in the table. Reported exposure to cold or very cold temperatures in winter was reduced by 40 percentage points and exposure to hot or very hot temperatures in summer was reduced by about 37 percentage points. Prior to Home Uplift, 22.4% of the treatment group reported regular exposure to unsafe temperatures in their homes, but this exposure dropped to just 7.7% after Home Uplift – a statistically significant 14.7 percentage point reduction. The control group also saw a statistically significant reduction in exposure to unsafe indoor temperatures, but the decrease was smaller at only 8.6 percentage points. Over 20 percent of households reported no longer being worried about not having electricity or cooling in summer or heating in winter. During the Home Uplift NEI evaluation, these and other variables were analyzed to determine influence of the COVID-19 pandemic on outcomes. However, whether the survey was completed pre- or during the pandemic did not appear to be a statistically significant predictor of this set of outcomes.

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

Table 2. Thermal Comfort

Variable/Research Group[2] (n = Number of Respondents)	Treatment Baseline (n=701)	Treatment Pre-Wx (n=570)	Treatment Post-Wx (n=570)	Control Year 1 (n=220)	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%**

Small but statistically significant reductions in the percent 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 3 and Table 4). Although similar improvements were observed in responses from the control group, these improvements tended to be smaller in magnitude and not statistically significant. Estimates were produced using data about individuals in the household rather than aggregated counts for the entire household. The number of health care encounters due to extreme cold exposure dropped for treatment group participants by 1.7 and 2.7 percentage points for emergency department visits and outpatient visits, respectively, following weatherization. Emergency department and outpatient/doctor's office visits for heat-related thermal stress declined by 0.9 and 1.2 percentage points, respectively, in the treatment group.

Table 3. Thermal Stress from Exposure to Cold Indoor Temperatures

Variable/Research Group[3] (n = Number of Respondents)	Treatment Baseline (n=1276)	Treatment Pre-Wx (n=911-917)	Treatment Post-Wx (n=911-917)	Control Year 1 (n=448-450)	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%

[2] 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).

[3] 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).

Table 4. Thermal Stress from Exposure to Hot Indoor Temperatures

Variable/Research Group (n = Number of Respondents)	Treatment Baseline (n=1276)	Treatment Pre-Wx (n=900-917)	Treatment Post-Wx (n=900-917)	Control Year 1 (n=448-449)	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%

Dwelling Quality and Exposures to Health Hazards

The Home Uplift NEI evaluation revealed that the program appears to produce meaningful improvements across a number of dwelling quality outcomes (Table 5). After taking into account decreases in the control group, a net statistical difference was found in the exposure of both drafts and dust by over 20 percentage points 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. This collection of exposures is important when considering home-based environmental triggers for respiratory health conditions such as asthma and COPD.

Table 5. Drafts, Dust, and Pest Exposures

Variable/Research Group[4] (n = Number of Respondents)	Treatment Baseline (n=701)	Treatment Pre-Wx (n=559-569)	Treatment Post-Wx (n=559-569)	Control Year 1 (n=212-222)	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%
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%***

[4] 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).

Energy Affordability and Trade-offs

The Home Uplift NEI evaluation explored several 'trade-off's' that many low-income households often make when deciding what bills to pay or what basic needs they need to purchase, such as prescriptions medications. Our survey findings suggest that 25% of pre-weatherized treatment households cut back on prescription refills or doses to pay for their utility bills, 17% of treatment households and 14% of control households faced this issue following weatherization. Following weatherization, the number of treatment households unable to afford prescriptions fell by 8% ($p < .001$), while the unweatherized control group did not see a statistically significant change.

Table 6. 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 you couldn't afford them (past 12 months)	29.0%	28.1% (n=569)	20.7%*** (n=569)	31.1% (n=219)	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% (n=568)	17.1%*** (n=568)	25.7% (n=218)	14.7% (n=218)

Chronic Respiratory Illnesses

The survey instrument for the Home Uplift pilot evaluation was also designed to determine prevalence of respiratory illness to help characterize the Home Uplift eligible population in the metro areas served through the pilot (Table 7). 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.

Asthma

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

Table 7. Asthma Prevalence

Variable/Research Group[5] (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)

COPD

Among survey respondents[6] in the Home Uplift sample, 15.6% reported being told by a health professional that they have COPD, emphysema, or chronic bronchitis (Table 8). Over 50 percent of respondents reported visiting a doctor for worsening symptoms and over 20 percent visited more urgent and emergency care settings. Office visits decreased by 9 percentage points and 15 percentage points in treatment and control groups, respectively. Significant reductions in urgent care, ED, and hospital visits are observed in the control group sample.

Table 8. COPD, Emphysema, and Chronic Bronchitis Prevalence and Healthcare Usage

Variable/Research Group[7] (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)

[5] 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).

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

[7] 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).

Arthritis

During a series of in-depth interviews with Home Uplift households (also described in the TVA NEI Evaluation Report (2022)), 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 9).

Table 9. Arthritis Prevalence and Symptoms

Variable/Research Group[8] (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)

[8] 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).

Medicaid Study: Data and Participants

Data Sources and Study Participants

Data for the current study were drawn from three sources: Medicaid data from the State of Tennessee Division of TennCare, survey data from evaluations of low-income weatherization programs, and data on the measures installed in homes undergoing low-income weatherization. Survey data and installed measures were collected during two prior research studies: a 2017-2020 evaluation of TVA's Home Uplift, which was still a pilot program at the time, and a follow-on study funded by the Tennessee Department of Environment and Conservation (TDEC) from 2021-2023 that placed temperature and humidity sensors in homes about to undergo weatherization through Home Uplift, now a fully launched program. Participants in the TDEC-funded study also completed a shorter survey with questions that partially overlapped the survey from the initial Home Uplift evaluation, allowing the team to combine results from both surveys.

Both weatherized (treatment) and non-weatherized (control) participants for the current study were recruited from the Home Uplift pilot evaluation and TDEC sensor study. Participants gave informed consent to request and acquire their linkable medical claims data from Tennessee's Medicaid office, known as TennCare. One limitation of this approach is that it does not capture any medical claims or costs billed to other forms of insurance, in the event that a participant has backup insurance or a different primary insurance. In 2021, an estimated 15.7% of the population had coverage through both Medicaid and a private insurer, and another 15.7% had coverage through both Medicaid and Medicare (Mykyta et al., 2023). A second limitation is that TennCare did not provide information on disenrollment, leaving ambiguity as to whether periods with no claims represent a time where participants are not utilizing healthcare or whether the participant became disenrolled from Medicaid temporarily or permanently. In 2024, a federal judge ruled that Tennessee had wrongfully terminated Medicaid coverage for thousands of Tennesseans beginning in 2019 (Pierson, 2024). The class action lawsuit, filed in 2020, requested the state re-enroll roughly 108,000 people who were likely wrongfully terminated from coverage (Kelman 2022).

Lastly, the timespan of the data covers the duration of the COVID-19 pandemic, and international health crisis. A national emergency and international travel ban was declared in the United States on March 13, 2020 (David J. Sencer CDC Museum). Testing data from Tennessee indicate that the last known major spike in cases ended in February 2022 (TN Department of Health, 2025), by which point 76% of the U.S. population had received at least one dose of a COVID-19 vaccine and 65% were fully vaccinated; in Tennessee, these rates were 61% and 54%, respectively (USAFacts). Using these timepoints, we can look at our participants in three groups: those weatherized before the start of the pandemic (n = 25), those

weatherized during the pandemic (n = 6), and those weatherized after the pandemic (n = 16). Additionally, there are a collective 709 months of pre-treatment data and 752 months of post-treatment data across all treatment group participants; Table 10 presents the breakout of how many months of data were before, during, or after the pandemic. The majority of pre-treatment data (70%) took place prior to the pandemic, whereas the post-treatment data were almost evenly split across the three time periods. Because more of the post-treatment data took place during and after the pandemic, we might expect higher medical costs and claims in the post-treatment period than would have otherwise been the case. However, the percent of data that took place during the pandemic was similar across time periods (22% vs. 28%).

Table 10. Percentage of Pre-Treatment and Post-Treatment Data Occurring Before, During, and After the COVID-19 Pandemic

	Pre-Treatment (Months of Data)	Post-Treatment (Months of Data)
Before COVID-19 Pandemic	496 (70%)	269 (36%)
During COVID-19 Pandemic	157 (22%)	214 (28%)
After COVID-19 Pandemic	56 (8%)	269 (36%)

Description of the Data

The data received from TennCare included key variables summarized in white in Table 11. Additionally, three variables calculated from the TennCare Data are described in grey rows at the bottom. Variables that were provided by TennCare but not used for the current analysis are not included in the table.

Table 11. Summary of Key Variables Received from TennCare and Calculated Variables

Variable Name	Variable Description
DATE_OF_BIRTH	Date of birth (used to calculate age)
SERVICE_DATE_OF_CLAIM	Date services were rendered and claim was made
TYPE_OF_CLAIM	High-level description of care setting. Includes four values: Inpatient, Outpatient, Professional or Pharmacy
BILLING_PROVIDER_ID	ID for medical group, office or hospital
BILLING_PROVIDER_NAME	Name for medical group, office or hospital
DIAG_1_CODE	ICD-10 code for the primary diagnosis
DIAG_1_DESC	Written description of the primary diagnosis
DIAG_1_CATEGORY	Category for the primary diagnosis
DIAG_1_CATEGORY_CODE	ID code assigned to the category for the primary diagnosis
DIAG_1_SUBCATEGORY	Subcategory for the primary diagnosis (if applicable)
DIAG_2_CODE	ICD-10 code for the secondary diagnosis
DIAG_2_DESC	Written description of the secondary diagnosis
DIAG_2_CATEGORY	Category for the secondary diagnosis
DIAG_2_CATEGORY_CODE	ID code assigned to the category for the secondary diagnosis
DIAG_2_SUBCATEGORY	Subcategory for the secondary diagnosis (if applicable)
DIAG_3_CODE	ICD-10 code for the tertiary diagnosis
DIAG_3_DESC	Written description of the tertiary diagnosis
DIAG_3_CATEGORY	Category for the tertiary diagnosis
DIAG_3_CATEGORY_CODE	ID code assigned to the category for the tertiary diagnosis
DIAG_3_SUBCATEGORY	Subcategory for the tertiary diagnosis (if applicable)
DIAG_4_CODE	ICD-10 code for the quaternary diagnosis
DIAG_4_DESC	Written description of the quaternary diagnosis
DIAG_4_CATEGORY	Category for the quaternary diagnosis
DIAG_4_CATEGORY_CODE	ID code assigned to the category for the quaternary diagnosis
DIAG_4_SUBCATEGORY	Subcategory for the quaternary diagnosis (if applicable)
PAID_UNITS	Number of units paid for, if applicable (e.g. number of doses in a pharmacy prescription)
PAID_AMOUNT	High-level amount paid by Medicaid for the claim
PAID_DTL_AMOUNT	Additional detail on amounts paid by Medicaid
RX_PAID_AMOUNT	Amount paid by Medicaid for prescriptions
IMPUTED_PAID_AMOUNT	CALCULATED: Harmonized variable representing total cost for a medical encounter
INFL_IMPUTED_PAID_AMOUNT	CALCULATED: IMPUTED_PAID_AMOUNT adjusted for inflation to the year 2024
Number_of_Claims	CALCULATED: Number of individual claims/line items included in the medical encounter

Data Preparation

The TennCare Medicaid claims data underwent five major steps to prepare for analysis:

1. **Cost data from three columns were harmonized into one variable** (IMPUTED_PAID_AMOUNT). The raw Medicaid data contained three variables with costs data: PAID_AMOUNT, PAID_DTL_AMOUNT, and RX_PAID_AMOUNT (for prescription medications). The first two variables had identical values for the majority of claims; in these cases, the value listed was imputed as the total amount paid for services. Where only PAID_AMOUNT or PAID_DTL_AMOUNT was filled in, that value was used as the cost of services. For pharmacy claims, IMPUTED_PAID_AMOUNT was populated from RX_PAID_AMOUNT. This created a unified variable for all medical costs.
2. **Cost data were adjusted for inflation.** Using the Consumer Price Index (CPI), the team adjusted all medical costs to 2024 U.S. dollars.
3. **Individual claims were grouped by medical encounter.** A single visit to the doctor's office can result in claims for multiple individual procedures. Often, only the primary claim/procedure would have an associated cost, and the remaining claims from the same visit would have no price listed. Therefore, all claims that took place at the same location, on the same day, with the same diagnostic codes, and for the same type of service (i.e. professional, pharmacy, outpatient or inpatient) were summarized into a single "encounter" and assigned one paid amount and a variable to indicate how many claims were included in each encounter.
4. **Diagnostic codes were assigned to categories.** Medical claims include information about the health condition or symptoms being treated during a medical visit. The ICD-10-CM system (International Classification of Diseases, Tenth Revision, Clinical Modification) assigns a unique number to each condition or symptom and organizes them into groups, such as "Diseases of the respiratory system" (National Center for Health Statistics, 2024). These larger groups subdivide into more granular categories like "Acute upper respiratory infections" and "Influenza and pneumonia". Using this system, the team applied category labels to each encounter in order to allow for analyzing, for example, all claims related to asthma.
5. **Additional variables for analysis were calculated.** For analysis, participants' age was calculated in two ways: one variable represented age at time of encounter, and one variable represented age at treatment. Age at treatment was used for pre-post analyses to designate a group of "near-elderly" participants who were age 55 or higher when they received weatherization work.

Methodology

Pre-Post Comparisons

For the initial analysis, data were restricted to the period 12 months prior to weatherization and 12 months after weatherization; however, data from the month immediately following weatherization were removed to provide a buffer period for two reasons: 1) most health effects would not manifest immediately after weatherization occurs; and 2) the process of weatherization may introduce additional dust and outdoor pollen tracked in as workers go in and out of the house, but these impacts would be temporary. A 12-month period was chosen to capture all seasons only once and control for any seasonal variation in health. The same approach was used for control group homes with the exception that, since these homes did not receive weatherization during the study period, data were instead restricted to 12 months prior to their survey completion and 12 months after survey completion to ensure the data fell within a comparable timeline to the weatherized participants; this also helps to control for any influence the survey itself may have on behavior, though any effects from taking the survey would be expected to be minimal.

The pre-post analysis examined both medical costs and the number of medical claims reported for each participant. For each outcome, the data were analyzed for each group separately (weatherized vs. non-weatherized) and also as a comparison across groups. To compare costs and claims before to after weatherization (or survey completion for the control group), the team used a Wilcoxon rank sum test, also known as a Mann-Whitney U which, unlike many statistical tests, does not assume that the data are normally distributed (bell-shaped); this fits our data better because they follow a non-normal distribution. Next, the change in the weatherized group was compared against the change in the control group using a difference-in-differences (DID) model; the pre-treatment data were subtracted from the post-treatment data for each group, and the resulting differences were compared again using the Wilcoxon rank sum test. DID models allow us to control for changes in health due to external factors rather than weatherization itself. If both the weatherized and non-weatherized homes saw equal improvements in health, then the change likely was not attributable to weatherization; if, however, the weatherized households saw a greater improvement than the control group, then it would provide evidence that weatherization caused the health benefits.

Time Series Analysis

The above analysis was limited to a 24-month window for each person to make the pre and post data as comparable as possible and limit the impacts of time and seasonality. However, the full Medicaid data covered nearly eight years in total. To make use of the full data, the team also used an adapted version of the Interrupted Time Series (ITS) method. This model focuses on trends over time, and how the trend in medical costs and claims changes following

weatherization. By focusing on trends, we get a "bigger picture". This model is less influenced by individual rare events (e.g. an expensive hospital stay) but looks at the pattern overall.
In order to perform the time series analysis, the team separately added up all medical costs and claims for each month and for each person. For months where a participant had no claims or costs, a zero was added to the data. However, because TennCare did not provide enrollment or disenrollment dates, a gap of 12 months or more was assumed to mean the person was no longer on Medicaid during that time. In these cases, we did not add zeroes into the data but left those months blank; (number of claims) and (medical costs) below display the resulting data. Each partially transparent dot represents one participant in a given month. Darker areas mean multiple dots overlap where multiple people had the same cost or number of claims.

Figure 1. Number of Medicaid (TennCare) Medical Claims per Person, per Month

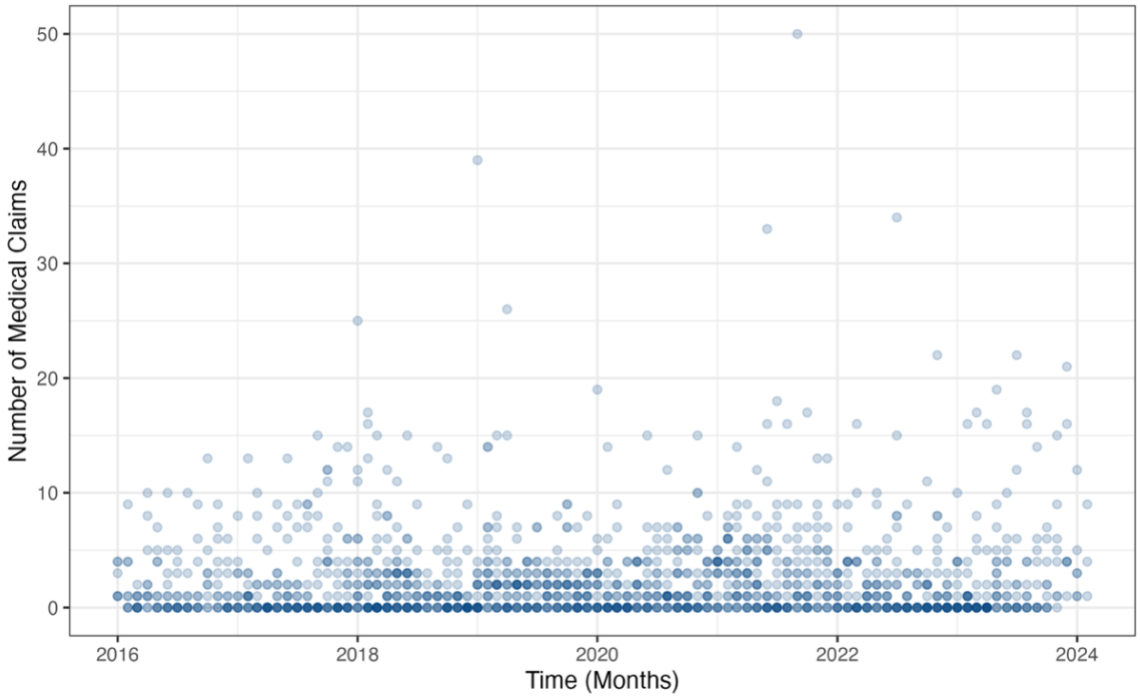
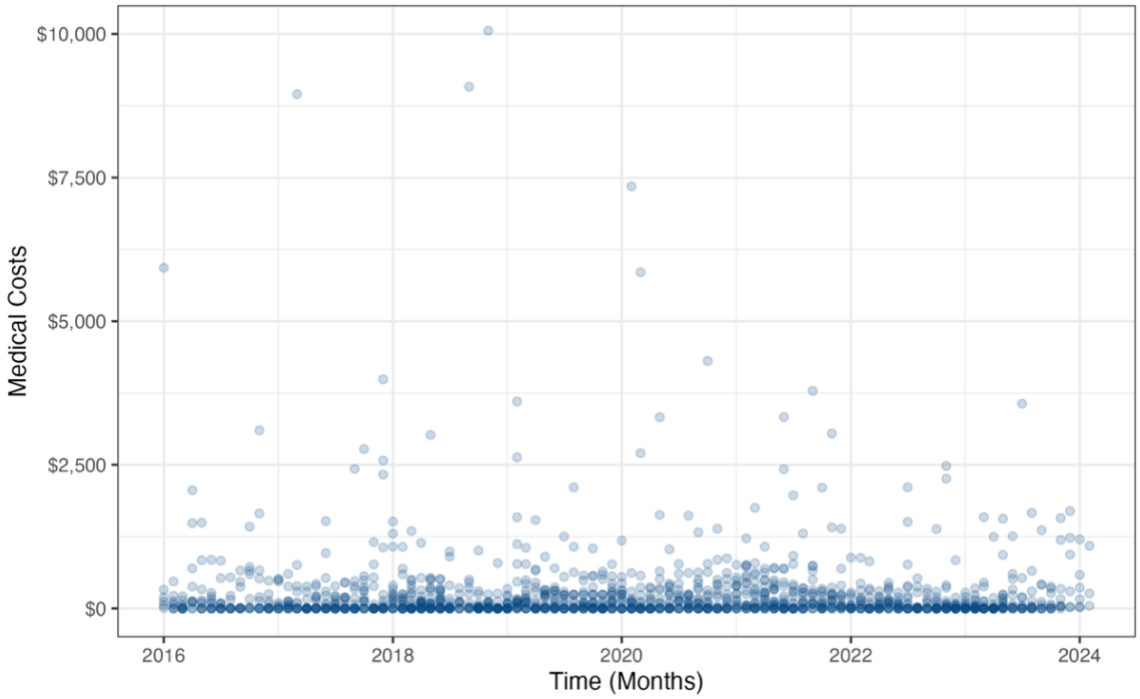


Figure 2. Medicaid (TennCare) Medical Costs Paid per Person, per Month



Note: One data point ($63,377 in January 2019) is not shown to preserve a reasonable scale for the plot.

The current analysis differs from a traditional Interrupted Time Series model in that the "interruption" (weatherization) did not happen at the same time for all participants. Weatherization dates for the participants ranged from July 2018 to September 2022, so the graphs above cannot be cleanly divided into "pre" and "post" periods. Instead, we converted the time variable from dates (shown above) to the number of months before or after treatment. For example, if a participant received weatherization in March 2020, an excerpt of their data would look like the example in Table 12. The numbering in "Time from Treatment" is unique to each person in the study.

Table 12. Example of Dates Converted to Time from Treatment (Weatherization)

Date (Months)	Time from Treatment (Months)
12-2019	-3
01-2020	-2
02-2020	-1
03-2020	0 (Treatment)
04-2020	1
05-2020	2

Using the Time from Treatment variable and data on the two outcomes (medical costs and number of claims), we can then estimate trends in each outcome both before and after weatherization across participants, even though each household had a different weatherization date. The simplified equation below represents the model's set up, where an outcome is regressed on (~) three variables:

1) **Period** – A binary variable indicating whether a month falls before (0) or after (1) weatherization.
2) **Time from Treatment** – A count variable indicating how many months have passed since weatherization (or how many months prior to weatherization); see.
3) **Period * Time from Treatment** – An "interaction term" where Period is multiplied by Time from Treatment; this allows the slope of the trendline to change from pre- to post-weatherization.

$$Number\ of\ Claims \sim Period + Time\ from\ Treatment + Period * Time\ from\ Treatment$$

While Ordinary Least Squares (OLS) is perhaps the most common regression method, the team instead used a Zero-Inflated Poisson (ZIP) regression. Analysts often choose ZIP regression for data with an outsized number of zeroes. In our case, the large number of zeroes results from imputing a zero in any month where a person has no claims/costs. More specifically, a ZIP regression is appropriate when zeroes might represent two different underlying realities. In the Medicaid data, a person might have zero costs/claims because they simply didn't go to the doctor or fill a prescription that month, but a person might also have zero costs/claims if they were disenrolled from Medicaid or used secondary insurance (some participants may have private insurance coverage in addition to Medicaid). Because a zero could represent either **having** Medicaid and not using it *or* **temporarily not having** Medicaid/using a different insurance, we determine the data follow a "zero-inflated" distribution. ZIP regression attempts to distinguish between the two sources of zeroes to more accurately estimate the impacts of our three variables on the outcome of interest.

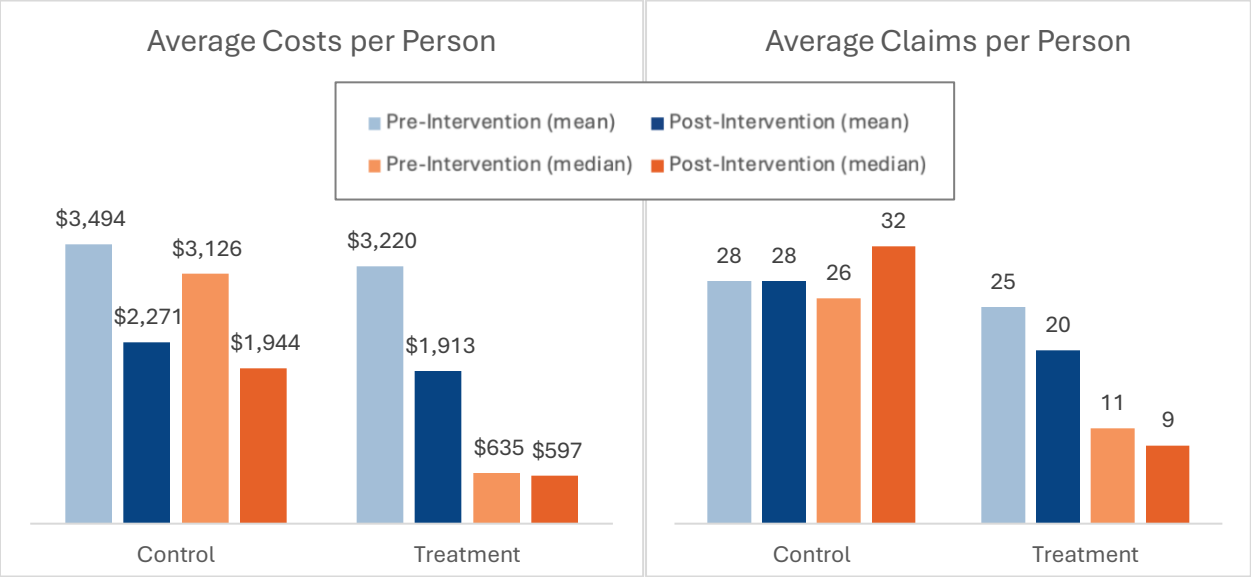
Results

The results below examine the costs paid by Medicaid and the number of claims billed to Medicaid across participants as well as for specific subgroups of interest. Changes in costs and claims are presented by weatherization status, measure type, ability to pay utility bills, age, setting of care, and health condition.

Pre-Post Analysis

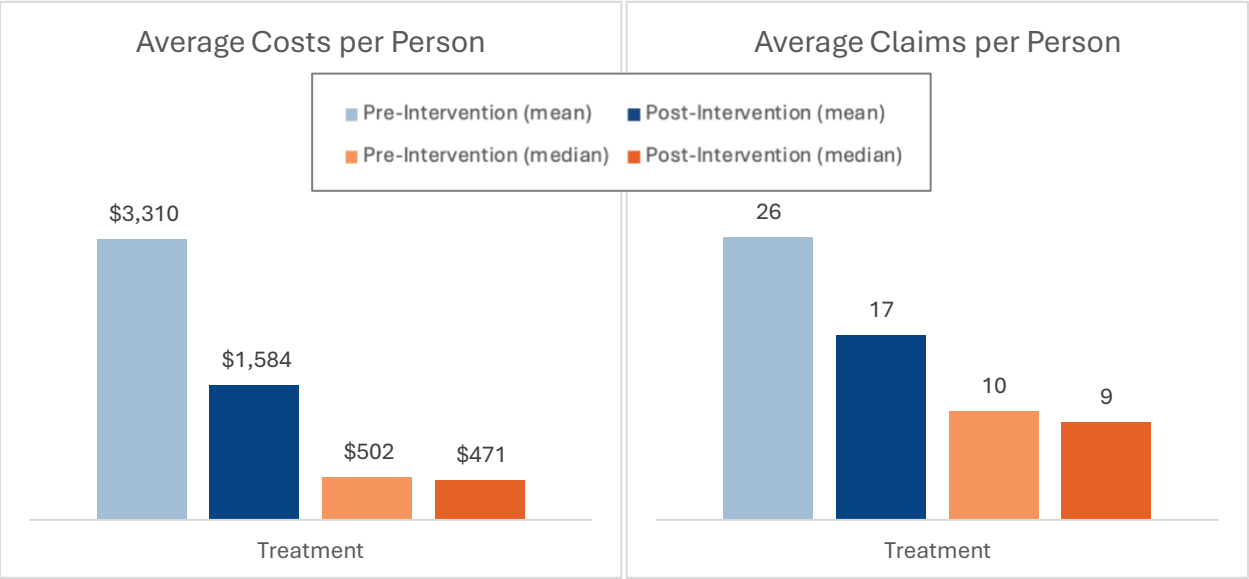
Total medical costs decreased in both the treatment and control groups (sample sizes: N = 50 and N = 9, respectively) when looking at both average and the median costs. The decrease was not statistically significant for either group, or when comparing across groups. Conversely, the average number of medical claims for the control group stayed constant and the median increased, whereas the weatherized homes saw a reduction in the number of claims reported (though again, neither was statistically significant).

Figure 3. Total Medicaid Costs (left) and Claims (right) per Person, Pre- and Post-Treatment



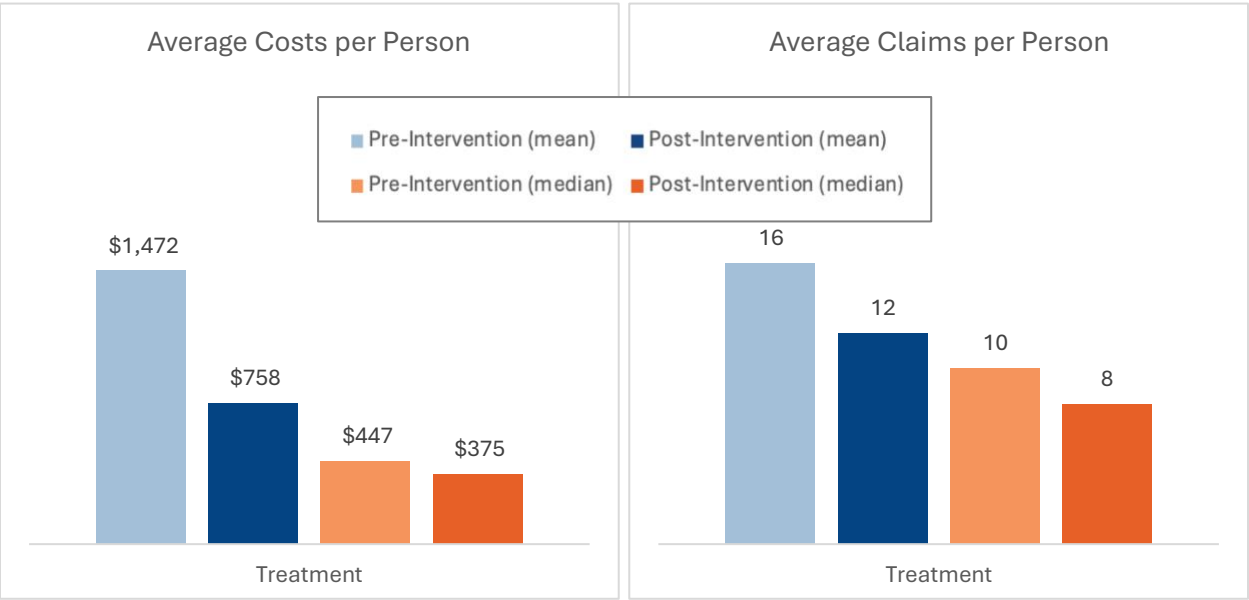
In addition to overall results, the team examined the set of homes that received at least one major weatherization measure, defined as new heating or cooling equipment, insulation, air sealing, or ductwork repair or replacement; 45 of the 50 treatment homes met this criterion. Impacts to costs and number of claims were similar to the previous analysis, with reductions across the board; however, this time the reduction in medical claims was marginally significant at p = .07.

Figure 4. Medicaid Costs and Claims for Households that Received Major Weatherization Measures



The team additionally assessed impacts for households who reported they found it "Hard or Very Hard" to pay their utility bills during the initial, pre-weatherization survey (N = 13). The same pattern of reductions in costs and claims held, with no statistically significant results.

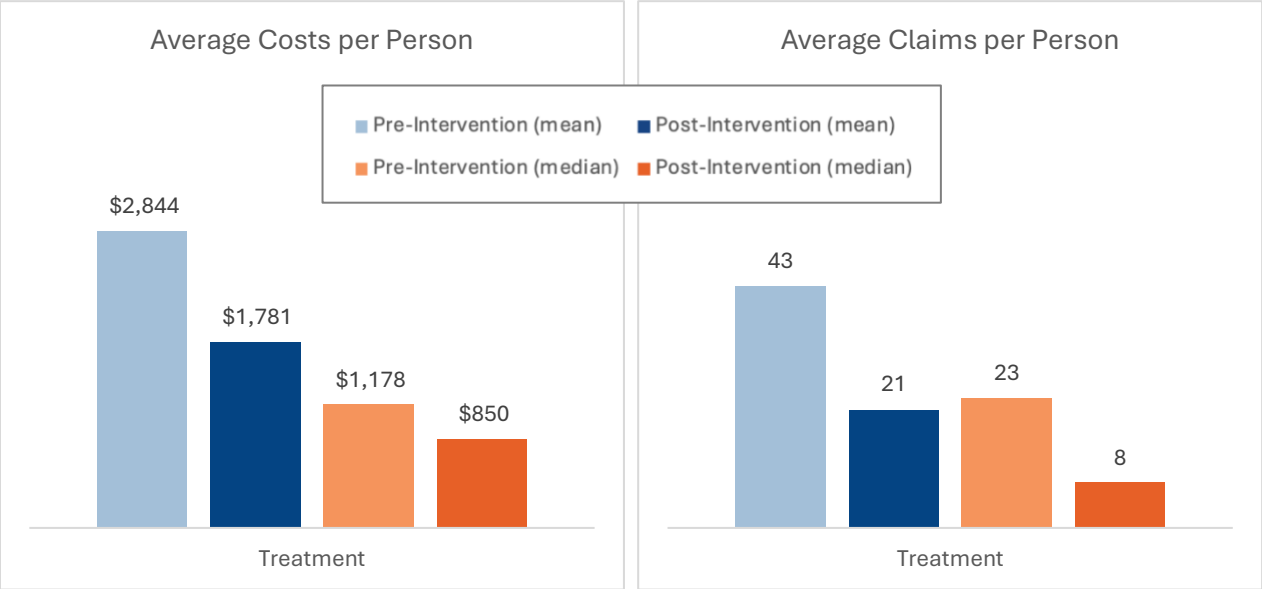
Figure 5. Medicaid Costs and Claims for Homes that Reported it was "Hard" or "Very Hard" to Pay Utility Bills prior to Weatherization



The team also examined results for participants who were age 55 or older at time of treatment (N = 11), as previous research indicates this to be a particularly vulnerable population.

Beginning around age 55, people may experience the health and physical impacts of aging and find it more difficult to work at paid jobs, but the majority of the social safety net has not yet activated for them (e.g. Medicare begins at age 65). This leaves the group of "near-elderly" at risk of financial and health burdens. Notably, this group saw a drastic and statistically significant reduction (p = .01) in the average number of medical claims per person, from 43 claims before weatherization to 21 after.

Figure 6. Medicaid Costs and Claims for Weatherization Recipients Age 55 and Over



Next, costs and claims were analyzed by setting of care to distinguish more severe events like hospitalizations and emergency department visits from more routine care at professional and pharmacy settings. Medical costs for professional services or office visits decreased across both groups (Control N = 9, Treatment N = 50). The number of medical claims for professional or office settings increased for the control group but decreased for the treatment group; neither the pre-post nor DID test statistics were statistically significant.

Similar patterns were seen for pharmacy costs and claims (Figure 8; Control N = 4, Treatment N = 20). Interestingly, average costs increased for the treatment group but median costs still went down, indicating perhaps there was an unusually expensive prescription medication in the post-weatherization period that had an outsize influence on the mean. Sample sizes were relatively smaller, leading to greater variation in general, and results were not statistically significant.

For outpatient or emergency department visits, increases were seen across three out of four cost categories (Control N = 7, Treatment N = 21) yet claims remained nearly constant in the control group and fell in the weatherized group. No results were statistically significant.

Only two study participants had inpatient claims, and they were both in the treatment group and occurred in the pre-weatherization period, which does not allow for comparisons. Mean and median costs were $30,650, and the mean and median number of claims was 19.

Figure 7. Medicaid Costs and Claims per Person for Professional Services (Office Visits)

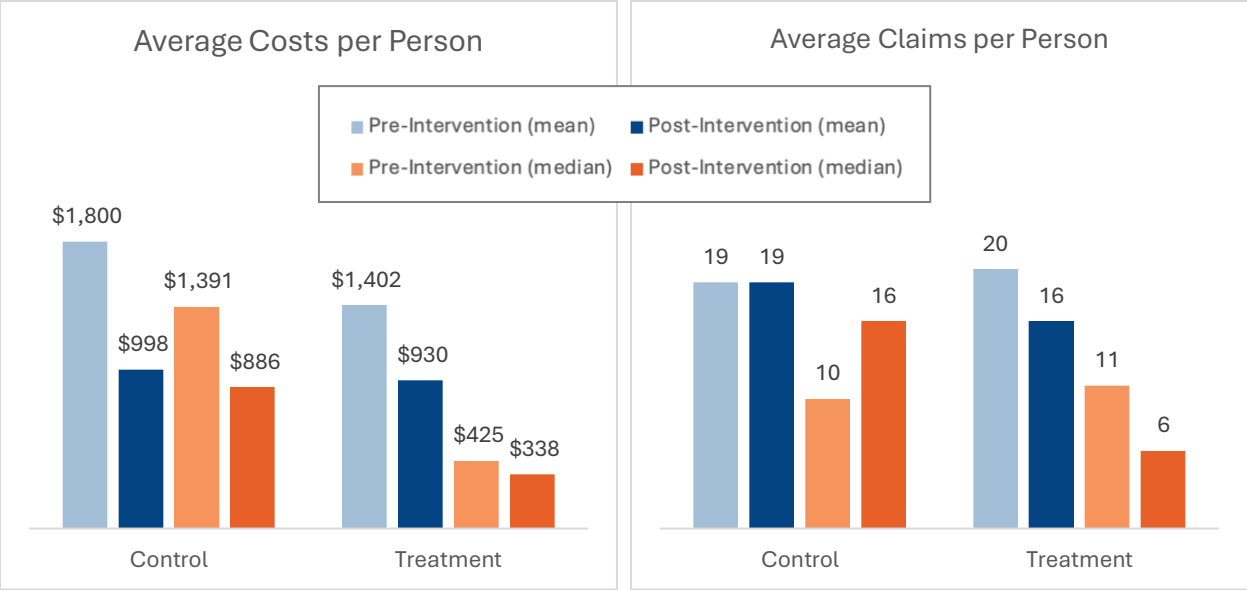


Figure 8. Medicaid Costs and Claims per Person for Pharmacy-Related Medical Care

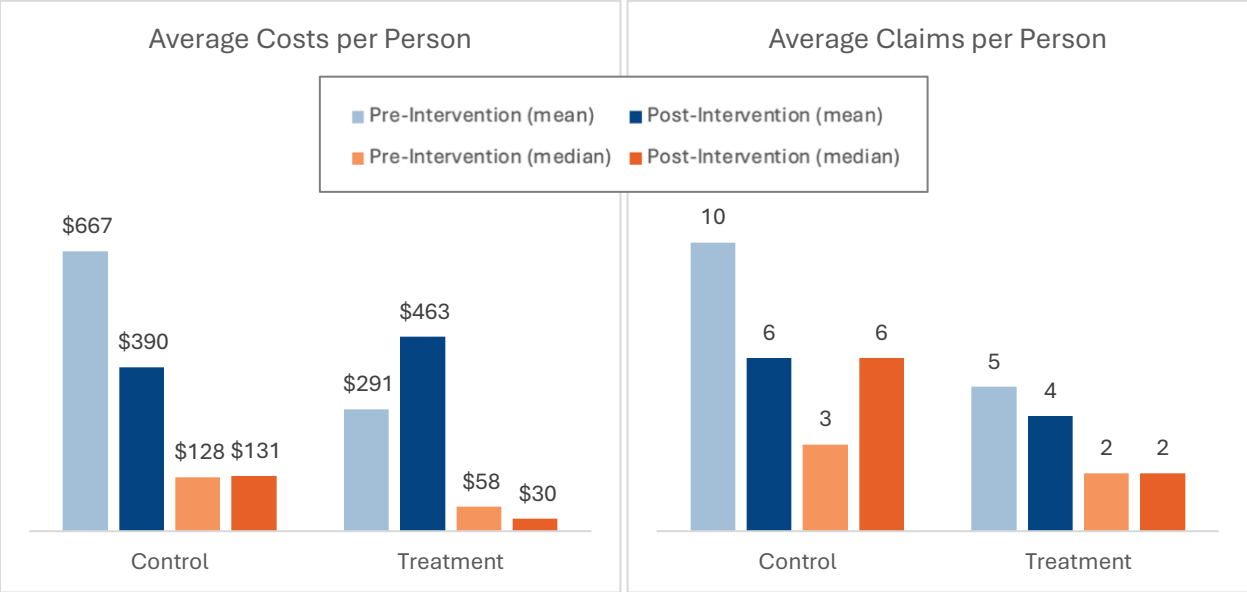
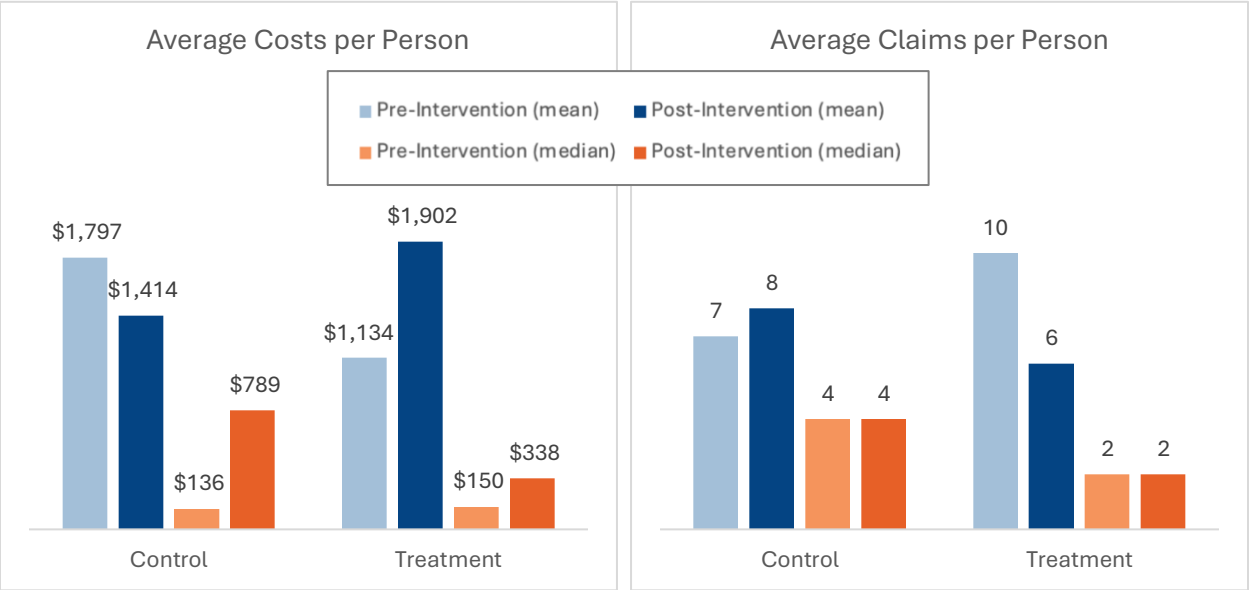


Figure 9. Medicaid Costs and Claims per Person for Outpatient (Emergency Department) Medical Care



Next, we looked at just the treatment group to examine the average number of claims and average medical costs for different groups of related health conditions. While the results were not statistically significant, mean (average) costs decreased by 10% or more in ten categories and increased by 10% or more in five categories. The average number of claims decreased in four categories, increased in seven categories, and changed by less than 0.5 in four categories (i.e. no meaningful change). Routine care such as annual wellness exams increased in both costs and claims, which can indicate that participants are more able to invest in preventative care.

Figure 10. Average (Mean) Costs by Health Condition per Person with the Condition, Treatment Group Only

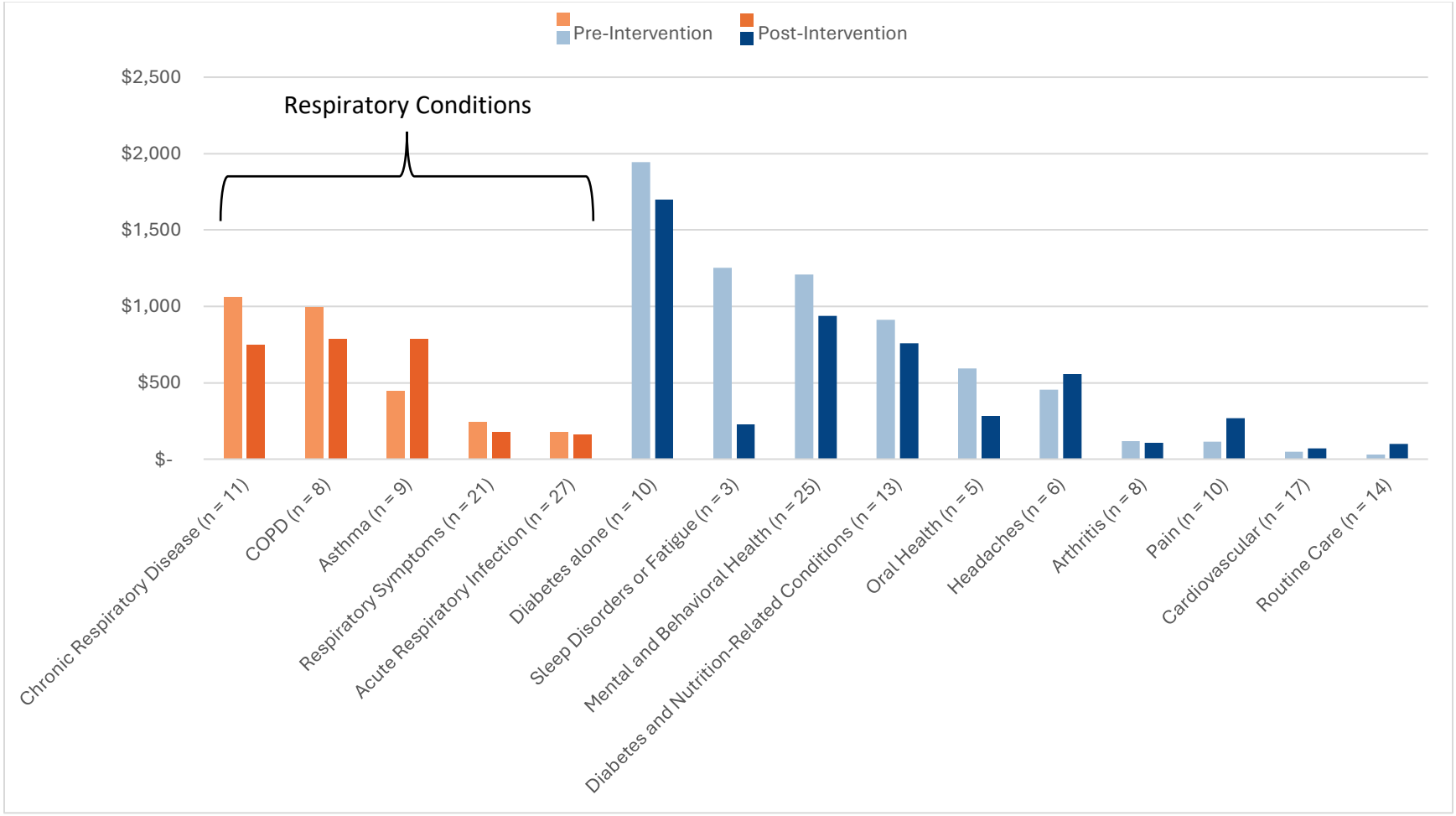
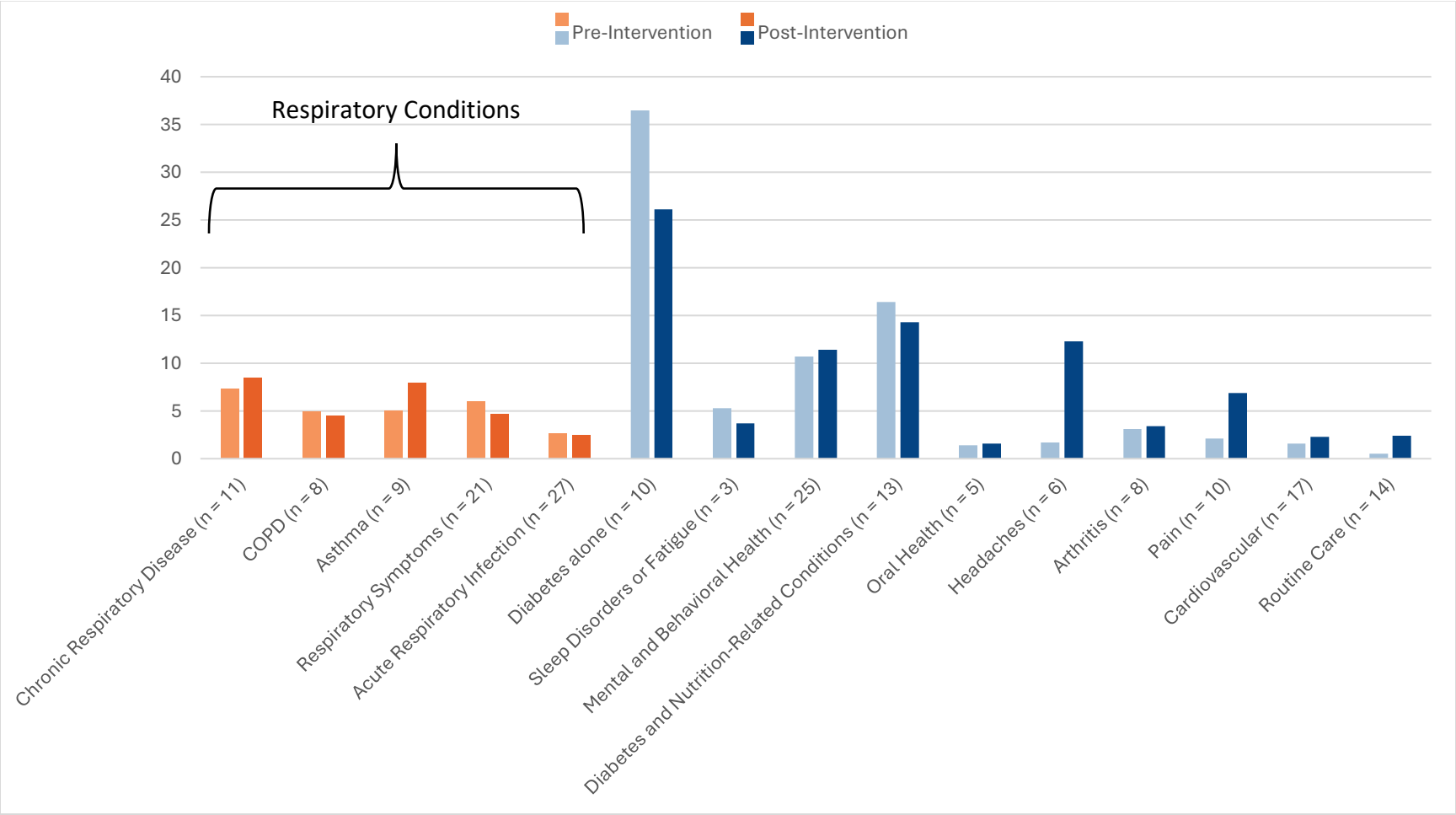


Figure 11. Average (Mean) Number of Claims by Health Condition per Person with the Condition, Treatment Group Only

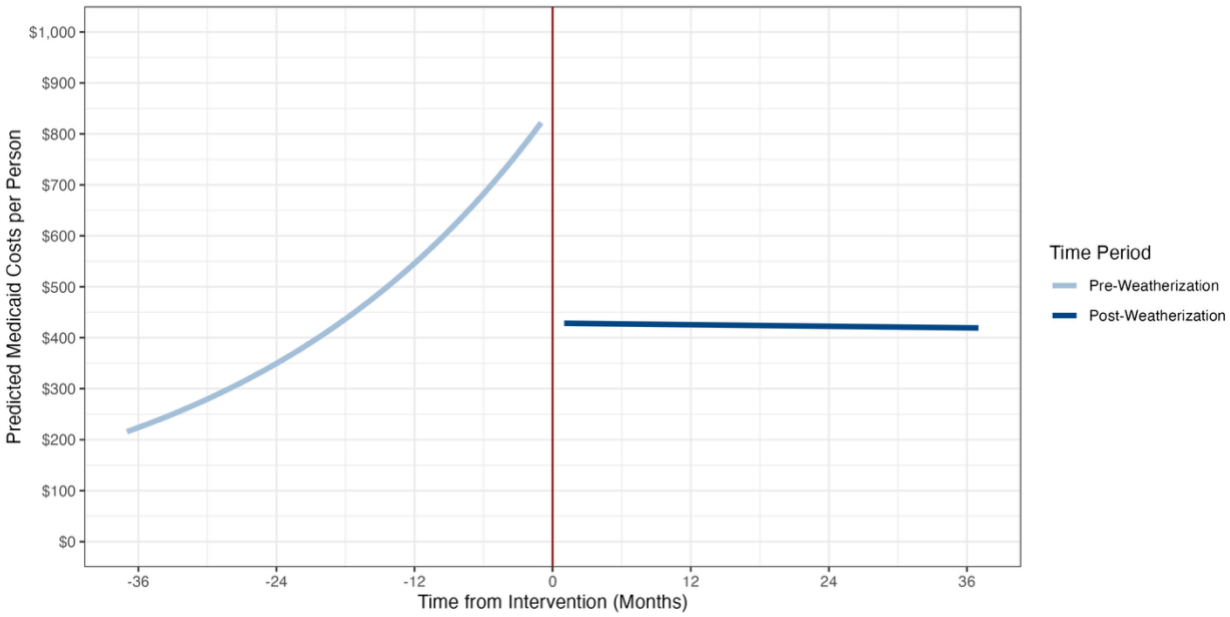


Time Series Analysis

As noted in the Methodology section, trends in costs and claims were assessed using a zero-inflated Poisson (ZIP) regression, which consists of two models operating simultaneously: a *count* model and a *zero-inflation* model. The zero-inflation model predicts how often a zero was due to either a person being disenrolled from Medicaid at the time or their medical expenses were billed to an insurance provider other than Medicaid; these are "extra" (inflated) zeroes in the data. The count model predicts how many dollars were spent by Medicaid or how many claims were billed to Medicaid for the average participant in a given month. For our purposes, the focus of the time series analysis is the count model – we are interested in changes in Medicaid costs for people enrolled in and using Medicaid.

In the time series analysis, Medicaid costs increased by 4% on average each month prior to weatherization. Immediately following weatherization, costs decreased by 50% and then leveled out with only a .06% decrease month-over-month. All model coefficients were statistically significant at the $p < .001$ level; notably, the pre-treatment data point of $63,377 in January 2019 (two months before the home received weatherization) exerted a large influence on the model.

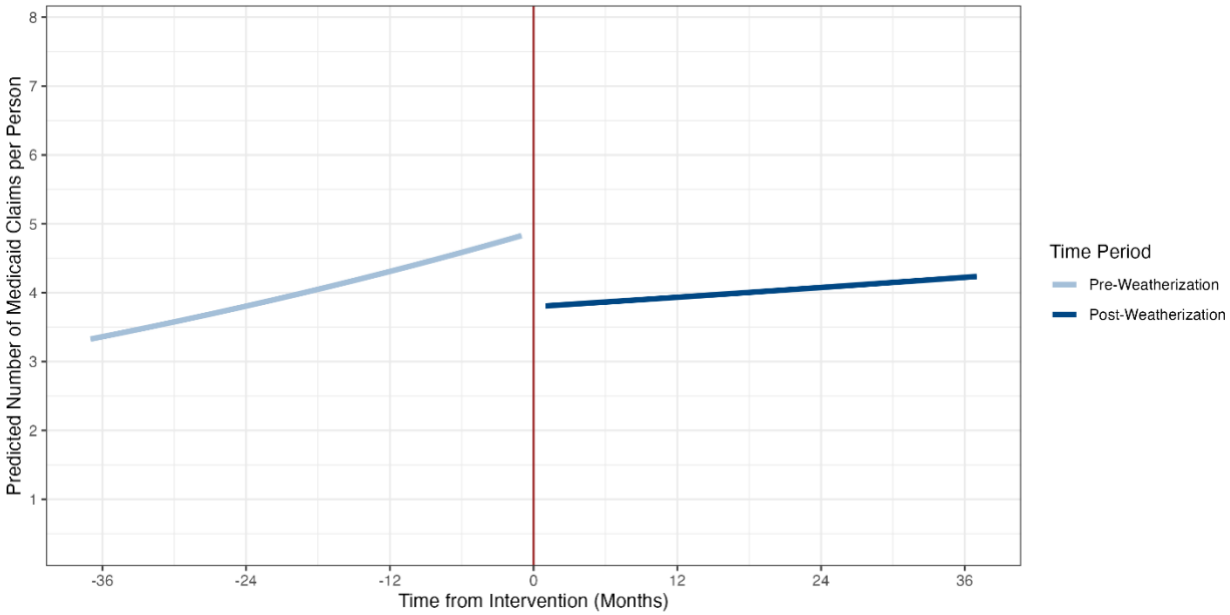
Figure 12. Predicted Trend in Medicaid Costs Before and After Home Uplift Weatherization



Note: The 50% decrease in costs predicted by the model represents the impact attributable solely to weatherization. When also accounting for the rising trend in costs over time, the decrease from one month before weatherization to one month after weatherization was 48% or $394.

The predicted number of Medicaid claims also decreased following weatherization. **Claims initially rose by 1% month-over-month prior to weatherization but then dropped by 22% immediately following weatherization (p < . 001).** In the post-weatherization period, claims continued to increase over time but not as steeply, rising by only 0.3% month-over-month; the change in slope was marginally significant at p = .06.

Figure 13. Predicted Trend in Medicaid Claims Before and After Home Uplift Weatherization



Note: The 22% decrease in claims predicted by the model represents the impact attributable solely to weatherization. When also accounting for the rising trend in claims over time, the decrease from one month before weatherization to one month after weatherization was 21% or 1.02 claims.

Discussion and Conclusion

Following on a long history of evidence that home weatherization can improve health outcomes, the current analysis of TennCare Medicaid data adds support that weatherization likely improves general health and well-being.

When looking at total costs and claims across all participants, we found that both costs and claims consistently decreased for those receiving weatherization. For homes that didn't receive weatherization, their costs decreased, but the average number of claims per person stayed the same, and the median number of claims actually increased. Notably, TennCare funding per enrollee has steadily increased from 1994 to 2024; decreases in costs per person for study participants are not likely tied to changes in funding or payment levels (Spears, 2017; Mouchette & Spears, 2025; Wadhwani, 2024).

Changes in overall costs and claims for the treatment and control groups were driven largely by similar trends in costs and claims for professional services, which represent the majority of the claims (71.3%). Both costs and the number of claims consistently decreased for the treatment group, while costs decreased to a lesser degree in the control group and claims stayed level or even increased, depending on the measure used (mean vs. median, respectively). Professional services include a wide array of procedures, such as annual wellness exams, primary care visits for illness, dental care, physical therapy, office-based mental and behavioral health, diagnostic testing, and more.

By contrast, results for both pharmacy and outpatient claims were mixed. The treatment group saw higher average pharmacy costs following Home Uplift but slightly lower median costs, with the number of claims staying steady. The increase in average costs appears driven largely by a single case where a resident experienced an inpatient hospital stay for diabetes-related complications prior to weatherization and afterwards required more expensive diabetes medications during the post-weatherization period. On the whole, pharmacy care appears stable from before to after weatherization. Conversely, pharmacy care for the control group had mixed results, possibly due to the small sample size (N = 4). There was no outlier in the pre-treatment data that would clearly explain the difference in outcomes between the mean and median costs and claims.

Costs for outpatient care were largely below $2,000 per encounter, but a number of outlying encounters above $5,000 in both the treatment and control groups (range $5,520-$24,642) may have exerted an uneven influence on the means; median estimates indicate that while costs rose modestly for the treatment group, a much larger increase was seen in the control group. The median number of claims remained even in both groups. However, the pre-weatherization period for the treatment group was characterized by multiple intensive encounters with total claims ranging from 29 to 54 claims per encounter; by contrast, in the post-weatherization period, only one outpatient encounter had more than 30 claims.

Reductions in the number of Medicaid claims were statistically significant for two groups of participants: those who received major measures (HVAC, air sealing, or insulation) as part of their weatherization package, and near-elderly weatherization recipients age 55 and over. **Participants receiving major measures saw their average Medicaid costs drop by $1,726 (52%) and average claims reduced by nine per person (35%).** Changes in median costs and claims were more modest at $31 and one claim, respectively. While the group receiving major measures represented the majority of the treatment group (45 out of 50 participants, or 90%), the fact that results for this subgroup were statistically significant but results for the treatment group as a whole were not may point to the importance of these measures in driving health and well-being improvements when included within the complete weatherization package.

Drastic improvements were reported among the near-elderly (age 55+) with a $1,063 (37%) reduction in average costs and a reduction of 22 claims per person (51%) on average (decrease in median: $328; 15 claims). These represent important health benefits for a group beginning to experience the health issues of aging but traditionally not yet eligible for Medicare or Social Security benefits. Beginning at age 55, average healthcare spending for men in particular tends to jump noticeably compared to earlier in life, while average healthcare costs for women rise more steadily across all age groups (McGough et al., 2024). The potential for weatherization to delay or even temporarily reverse this trend at a critical period in life should not be overlooked.

While not statistically significant, the analysis also found consistent reductions in both mean and median costs and claims for those who reported it was "hard" or "very hard" to pay their utility bills in the pre-weatherization survey. The energy savings from weatherization are expected to have stronger benefits for those struggling most to pay their utility bills. Lower energy costs may allow these households to keep their home at a safer temperature or pay for needed medications.

When broken out by health condition, costs and claims were mixed but leaned toward improvements. While the results may be limited by smaller sample sizes, average costs decreased for ten health categories and increased for five. One of the categories that rose slightly in costs was routine care, which can be a sign of improving preventive care. The average number of claims increased for seven categories, decreased for four categories, and remained roughly the same in four categories.

Time series analysis results provided further evidence that weatherization may not only have a short-term impact on reducing costs and claims but may also help to stabilize costs and claims in the long run. While the high level of variability in the cost data encourages caution in interpreting the results, the number of claims experienced by each participant had less variance and may provide a more reliable picture of weatherization's positive impacts. Further, it is encouraging that both the costs and number of claims showed similar trends of immediate reductions following weatherization and then a flattening of costs and claims in the long-run. Future work may involve exploring models that are more robust to outliers to improve confidence in the cost modelling.

Key Takeaways from TVA's Home Uplift Weatherization Pilot

The preponderance of evidence indicates that weatherization can **reduce both TennCare medical costs and the number of claims** incurred by enrollees.

Weatherization has the potential to have positive effects on a wide array of health issues, with initial evidence of benefits for diabetes, sleep disorders and fatigue, COPD, and general respiratory symptoms.

Weatherization has the potential to **decrease more rare but extremely costly medical encounters.**

With regard to program design, **incorporating major weatherization measures** and **prioritizing older adults** can have a stronger and more measurable impact on reducing Medicaid claims.

Households that reported **difficulty paying their utility bills prior to weatherization** were also observed to have greater reductions in Medicaid costs and claims than the general Home Uplift sample.

Appendix A. Requested ICD-10-CM Codes

Diagnostic Codes Requested from TennCare

The following pages summarize the health conditions and specific ICD-10-CM diagnostic codes the team used to request claims data from TennCare. Ultimately, the TennCare office provided claims beyond the request below. However, the tables present the rationale for each code requested and how it is theorized to relate to weatherization. Additionally, the codes are categorized into two tiers – High and Moderate Confidence – based on the amount of available evidence that the given health conditions may be impacted by weatherization.

Tier 1 Disease/Illness/Incident: **HIGH** confidence diagnosis is linked to housing and home energy as evidenced in the literature and evaluations	**ICD-10 Description**	**ICD-10-CM Codes**	**Justification**
Respiratory and Rhinitis			
Allergic rhinitis	Vasomotor and allergic rhinitis (stuffy nose caused by dust, allergens)	J30.0-J30.9	Home-based environmental allergens and outdoor generated environmental allergens can be mitigated by weatherization
Arthritis	Infectious arthropathies, Autoinflammatory syndromes, Inflammatory polyarthropathies, Osteoarthritis	M00.011-M19.93	Reduced exposure to extreme indoor temperatures evidenced by weatherization
Asthma	Asthma	J45.20-J45.998	outdoor generated environmental allergens can be mitigated by weatherization
Bronchitis	Bronchitis, not specified	J40	outdoor generated environmental allergens can be mitigated by weatherization
	Acute bronchitis	J20.0-J20.9	outdoor generated environmental allergens can be mitigated by weatherization
	Chronic bronchitis	J41.0-J42	outdoor generated environmental allergens can be mitigated by weatherization
COPD	Other chronic obstructive pulmonary disease	J44.0, J44.1, J44.9	outdoor generated environmental allergens can be mitigated by weatherization
Emphysema	Emphysema	J43.0-J43.9	outdoor generated environmental allergens can be mitigated by weatherization
Headaches			
Headaches	Headache	R51	environmental quality and noise can be reduced after weatherization
	Other Headache Syndromes	G44.001-G44.89	environmental quality and noise can be reduced after weatherization

Migraines	Migraine	G43.001-G43.919	environmental quality and noise can be reduced after weatherization
Mental Health			
Mental health	Anxiety, dissociative, stress-related, somatoform and other nonpsychotic mental disorders	F40-F48	Reduced cost burdens, food insecurities and worry about home safety and housing conditions after weatherization
Thermal Stress			
Thermal stress, exposure to heat	Exposure to excessive natural heat	X30.XXXA, X30.XXXD, X30.XXXS	Reduced exposure to extreme indoor temperatures evidenced by weatherization
	Effects of heat and light	T67.011A-T67.9XXS	Reduced exposure to extreme indoor temperatures evidenced by weatherization
Thermal stress, exposure to cold	Exposure to excessive natural cold	X31.XXXA, X31.XXXD, X31.XXXS	Reduced exposure to extreme indoor temperatures evidenced by weatherization
	Hypothermia	T68.XXA, T68.XXXD, T68.XXXS	Reduced exposure to extreme indoor temperatures evidenced by weatherization
	Other Effects of Reduced Temperature	T69.011A-T69.9XXS	Reduced exposure to extreme indoor temperatures evidenced by weatherization
	Superficial frostbite	T33.011A-T33.99XS	Reduced exposure to extreme indoor temperatures evidenced by weatherization
	Frostbite with tissue necrosis	T34.011A-T34.99XS	Reduced exposure to extreme indoor temperatures evidenced by weatherization
Other Health Issues			
Low birth weight Infants	Disorders of newborn related to short gestation and low birth weight, not elsewhere classified	P07.00-P07.39	Reduced exposure to extreme indoor temperatures evidenced by weatherization and reduced food insecurity
Injuries and Poisoning			

Burns	Burns and corrosions of external body surface, specified by site	T20-T25	Installation of smoke alarms, reduced need for secondary heating equipment, replacement of faulty heating equipment during weatherization
	Burns and corrosions confined to eye and internal organs	T26-T28	secondary heating equipment, replacement of faulty heating equipment during weatherization
	Burns and corrosions of multiple and unspecified body regions	T30-T32	Installation of smoke alarms, reduced need for secondary heating equipment, replacement of faulty heating equipment during weatherization
Carbon monoxide poisoning	Toxic effect of carbon monoxide	T58.01XA-T58.94XS	weatherization and safety assessment of combustion equipment
Contact with excessive heat	Contact with hot household appliances	X15	secondary heating equipment, replacement of faulty heating equipment during weatherization
	Contact with hot heating appliances, radiators and pipes	X16	Installation of smoke alarms, reduced need for secondary heating equipment, replacement of faulty heating equipment during weatherization
	Contact with hot engines, machinery and tools	X17	secondary heating equipment, replacement of faulty heating equipment during weatherization
	Contact with other hot metals	X18	secondary heating equipment, replacement of faulty heating equipment during weatherization
	Contact with other heat and hot substances	X19	secondary heating equipment, replacement of faulty heating equipment during weatherization
Food poisoning	Other bacterial foodborne intoxications, not elsewhere classified	A05.0-A05.9	
Trips and falls	Slipping, tripping, stumbling and falls	W00.0XXA-W19.XXXS	Installation of new energy efficienct refrigerator and fall preventions, such as grab bars, hand rails; improved physical health can also reduced
Scalding from tap Water	Contact with hot tap-water	X11.0XXA-X11.8XXS	new hot water equipment is often completed during weatherization

Tier 2: Disease/Illness/Incident: **MODERATE** confidence diagnosis cnn be linked to housing and home energy as evidenced in the literature and evaluations	**ICD-10 Description**	**ICD-10-CM Codes**	**Justification**
Cardiovascular disease	Ischemic heart diseases	I20.0-I25.9	housing issues impact CVD outcomes, including thermal stress, poor nutrition, poor sleep,
	Pulmonary heart disease and diseases of pulmonary circulation	I26.01-I28.9	housing issues impact CVD outcomes, including thermal stress, poor nutrition, poor sleep, anxiety, etc.
	Other forms of heart disease	I30.0-I52	housing issues impact CVD outcomes, including thermal stress, poor nutrition, poor sleep,
Diabetes	Diabetes mellitus	E08.00-E13.9	diabetes outcomes, including poor nutrition and high cholesterol and lack of physical activity
Ear infections	Otitis externa	H60.00-H60.93	such as colds, flus or allergies that can be reduced by weatherization
	Nonsuppurative otitis media	H65.00-H65.93	such as colds, flus or allergies that can be reduced by weatherization
	Suppurative and unspecified otitis media	H66.001-H66.93	such as colds, flus or allergies that can be reduced by weatherization
	Otitis media in diseases classified elsewhere	H67.1-H67.9	such as colds, flus or allergies that can be reduced by weatherization
	Eustachian salpingitis	H68.001-H68.029	such as colds, flus or allergies that can be reduced by weatherization
	Mastoiditis and related conditions	H70.001-H70.93	such as colds, flus or allergies that can be reduced by weatherization
Flu	Influenza	J09.X1-J11.89	diagnosis related to respiratory issues
High cholesterol	Pure hypercholesterolemia, unspecified	E78.00	Poor nutrition from food insecurity can impact cholesterol
	Familial hypercholesterolemia	E78.01	cholesterol
	Mixed hyperlipidemia	E78.2	cholesterol

	Other hyperlipidemia	E78.4	cholesterol
	Hyperlipidemia, unspecified	E78.5	cholesterol
Lead poisoning	Abnormal lead level in blood	R78.71	when inside the home and in some instances will test for lead before conducting work
Oral Health	Diseases of oral cavity	K00-K08.9	that otherwise lead people to choose between paying for utilities and health care
Sinus infections	Acute sinusitis	J01.00-J01.91	illnesses, such as allergic rhinitis which can be reduced after weatherization
	Chronic sinusitis	J32.0-J32.9	illnesses, such as allergic rhinitis which can be reduced after weatherization
SDOH: Codes Z55-65: Persons with potential health hazards related to socioeconomic and psychosocial circumstances	**ICD-10 Description**	**ICD-10-CM Codes**	**Justification**
Problems related to housing and economic circumstances (Z59)	Inadequate housing; Lack of heating, Restriction of space, Technical defects in home preventing adequate care, Unsatisfactory surroundings	Z59.1	Weatherization results in improved housing conditions and aims to reduce home energy costs which can provide financial relief
	Lack of adequate food and drinking water	Z59.4	conditions and aims to reduce home energy costs which can provide financial relief
	Extreme Poverty	Z59.5	conditions and aims to reduce home energy costs which can provide financial relief
	Low income	Z59.6	conditions and aims to reduce home energy costs which can provide financial relief
	Other problems related to housing and economic circumstances	Z59.8	Weatherization results in improved housing conditions and aims to reduce home energy costs which can provide financial relief
	Problem related to housing and economic circumstances, unspecified	Z59.9	Weatherization results in improved housing conditions and aims to reduce home energy costs which can provide financial relief

Problems related to other psychosocial circumstances (Z65)	Problem related to unspecified psychosocial circumstances	Z65.9	Weatherization results in improved housing conditions and aims to reduce home energy costs which can provide financial relief

Appendix B. Health Categories

Grouping ICD-10-CM Codes into Health Categories

ICD-10-CM diagnostic codes are granular and designed for medical providers to bill insurers or payors at a detailed level. However, the codes are organized in hierarchy of higher-level categories which informed the categories used for analysis. The table below lists each ICD-10-CM code that was listed in the received TennCare data; a description of what diagnosis the code represents; and whether or not the diagnostic code was included in the original request to TennCare. For ICD-10-CM codes that were deemed as potentially impacted by weatherization, either with high confidence, moderate confidence, or as an exploratory hypothesis, the following are also included: a high-level category of related diagnoses; a code assigned to the category for analysis; a more granular subcategory of related diagnoses; and a code assigned to the subcategory.

ICD-10-CM	ICD-10-CM CODE DESCRIPTION	HEALTH CATEGORY	CATEGORY CODE	HEALTH SUBCATEGORY	SUBCATEGORY CODE
J40	BRONCHITIS NOT SPEC AS ACUTE/CHRON	Chronic_Respiratory_Disease	1	Bronchitis, not specified	1.2.1
J432	CENTRILOBULAR EMPHYSEMA	Chronic_Respiratory_Disease	1	Emphysema	1.2.3
J439	EMPHYSEMA UNSPECIFIED	Chronic_Respiratory_Disease	1	Emphysema	1.2.3
J441	COPD WITH ACUTE EXACERBATION	Chronic_Respiratory_Disease	1	Other chronic obstructive pulmonary disease	1.2.4
J449	COPD UNSPECIFIED	Chronic_Respiratory_Disease	1	Other chronic obstructive pulmonary disease	1.2.4
J4520	MILD INTERMIT ASTHMA UNCOMPLICATED	Chronic_Respiratory_Disease	1	Asthma	1.1
J4521	MILD INTERMIT ASTHMA W/AC EXACERBAT	Chronic_Respiratory_Disease	1	Asthma	1.1
J4530	MILD PERSIST ASTHMA UNCOMPLICATED	Chronic_Respiratory_Disease	1	Asthma	1.1
J4531	MILD PERSIST ASTHMA W/AC EXACERBAT	Chronic_Respiratory_Disease	1	Asthma	1.1
J4540	MOD PERSISTENT ASTHMA UNCOMPLICATED	Chronic_Respiratory_Disease	1	Asthma	1.1
J45901	UNSPECIFIED ASTHMA WITH (ACUTE) EXACERBATION	Chronic_Respiratory_Disease	1	Asthma	1.1
J45909	UNSPECIFIED ASTHMA UNCOMPLICATED	Chronic_Respiratory_Disease	1	Asthma	1.1
J301	ALLERGIC RHINITIS DUE TO POLLEN	Respiratory_Symptoms	2	Allergic rhinitis	2.1
J302	OTHER SEASONAL ALLERGIC RHINITIS	Respiratory_Symptoms	2	Allergic rhinitis	2.1
J305	ALLERGIC RHINITIS DUE TO FOOD	Respiratory_Symptoms	2	Allergic rhinitis	2.1
J3081	ALLERG RHINIT D/T ANIMAL HAIR DANDR	Respiratory_Symptoms	2	Allergic rhinitis	2.1
J3089	OTHER ALLERGIC RHINITIS	Respiratory_Symptoms	2	Allergic rhinitis	2.1
J309	ALLERGIC RHINITIS UNSPECIFIED	Respiratory_Symptoms	2	Allergic rhinitis	2.1
J310	CHRONIC RHINITIS	Respiratory_Symptoms	2	Chronic rhinitis	2.2
J9600	AC RESP FAIL UNS HYPOX/HYPERCAPNIA	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
J9601	ACUTE RESPIRATORY FAIL W/HYPOXIA	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
J9610	CHR RESP FAIL UNS HYPOX/HYPERCAPNIA	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
J9611	CHRONIC RESPIRATORY FAIL W/HYPOXIA	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R05	COUGH	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R051	ACUTE COUGH	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R059	COUGH, UNSPECIFIED	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R0600	DYSPNEA UNSPECIFIED	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R0602	SHORTNESS OF BREATH	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R0609	OTHER FORMS OF DYSPNEA	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R062	WHEEZING	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R0681	APNEA NOT ELSEWHERE CLASSIFIED	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R0683	SNORING	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R0902	HYPOXEMIA	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R091	PLEURISY	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R0981	NASAL CONGESTION	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R0982	POSTNASAL DRIP	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
R0989	OTHER SPECIFIED SYMPTOMS AND SIGNS INVOLVING THE CIRCULATORY AND RESPIRATORY SYSTEMS	Respiratory_Symptoms	2	Other respiratory symptoms	2.3
M00062	STAPHYLOCOCCAL ARTHRITIS LEFT KNEE	Arthritis	3	Arthritis, Other	3.3
M069	RHEUMATOID ARTHRITIS UNSPECIFIED	Arthritis	3	Rheumatoid Arthritis	3.2
M0800	UNSPECIFIED JUVENILE RA UNS SITE	Arthritis	3	Arthritis, Other	3.3
M150	PRIMARY GENERALIZED OSTEOARTHRITIS	Arthritis	3	Osteoarthritis	3.1
M159	POLYOSTEOARTHRITIS UNSPECIFIED	Arthritis	3	Osteoarthritis	3.1
M170	BILATERAL PRIM OSTEOARTHRITIS KNEE	Arthritis	3	Osteoarthritis	3.1
M1711	UNI PRIM OSTEOARTHRITIS RT KNEE	Arthritis	3	Osteoarthritis	3.1
M1712	UNI PRIM OSTEOARTHRITIS LT KNEE	Arthritis	3	Osteoarthritis	3.1
M179	OSTEOARTHRITIS OF KNEE UNSPECIFIED	Arthritis	3	Osteoarthritis	3.1
M1812	UNILATERAL PRIMARY OSTEOARTHRITIS OF FIRST CARPOMETACARPAL JOINT, LEFT HAND	Arthritis	3	Osteoarthritis	3.1
M19011	PRIMARY OSTEOARTHRITIS RT SHOULDER	Arthritis	3	Osteoarthritis	3.1
M19012	PRIMARY OSTEOARTHRITIS LT SHOULDER	Arthritis	3	Osteoarthritis	3.1
M19022	PRIMARY OSTEOARTHRITIS LEFT ELBOW	Arthritis	3	Osteoarthritis	3.1
M19031	PRIMARY OSTEOARTHRITIS RIGHT WRIST	Arthritis	3	Osteoarthritis	3.1
M19042	PRIMARY OSTEOARTHRITIS LEFT HAND	Arthritis	3	Osteoarthritis	3.1
M1990	UNSPECIFIED OSTEOARTHRITIS UNS SITE	Arthritis	3	Osteoarthritis	3.1
G43009	MIGRAINE W/O AURA NOT INTRCT W/O SE	Headaches	4	Migraines	4.2
G43119	MIGRAINE W/AURA INTRCTW/O STAT EPI	Headaches	4	Migraines	4.2
G43719	CHR MIGRAINE W/O AURA INTRCT W/O SM	Headaches	4	Migraines	4.2
G43809	OTH MIGRAINE NOT INTRACTABLE W/O SM	Headaches	4	Migraines	4.2
G44099	OTHER TAC NOT INTRACTABLE	Headaches	4	Headaches	4.1
G44209	TENSION-TYP HEADACHE UNS NOT INTRCT	Headaches	4	Headaches	4.1
G44221	CHRON TENSION-TYPE HEADACHE INTRACT	Headaches	4	Headaches	4.1
G44319	AC POST-TRAUMA HEADACHE NOT INTRACT	Headaches	4	Headaches	4.1
G4482	HEADACHE ASSOC W/SEXUAL ACTIVITY	Headaches	4	Headaches	4.1

G4489	OTHER HEADACHE SYNDROME	Headaches	4	Headaches	4.1
R51	HEADACHE	Headaches	4	Headaches	4.1
R519	HEADACHE UNSPECIFIED	Headaches	4	Headaches	4.1
F1011	ALCOHOL ABUSE IN REMISSION	Mental_Behavioral_Health	5	Substance abuse	5.2
F1120	OPIOID DEPENDENCE UNCOMPLICATED	Mental_Behavioral_Health	5	Substance abuse	5.2
F1290	CANNABIS USE UNS UNCOMPLICATED	Mental_Behavioral_Health	5	Substance abuse	5.2
F1410	COCAINE ABUSE UNCOMPLICATED	Mental_Behavioral_Health	5	Substance abuse	5.2
F17200	NICOTINE DEPEND UNS UNCOMPLICATED	Mental_Behavioral_Health	5	Substance abuse	5.2
F17210	NICOTINE DEPEND CIGARETTES UNCOMP	Mental_Behavioral_Health	5	Substance abuse	5.2
F17218	NICOTINE DEPEND CIG W/OTH INDUC D/O	Mental_Behavioral_Health	5	Substance abuse	5.2
F3130	BIPOLAR CURR DEPRESSED MILD/MOD UNS	Mental_Behavioral_Health	5	Mood disorders	5.3
F3160	BIPOLAR CURRNT EPISODE MIXED UNS	Mental_Behavioral_Health	5	Mood disorders	5.3
F3189	OTHER BIPOLAR DISORDER	Mental_Behavioral_Health	5	Mood disorders	5.3
F319	BIPOLAR DISORDER UNSPECIFIED	Mental_Behavioral_Health	5	Mood disorders	5.3
F3289	OTHER SPECIFIED DEPRESSIVE EPISODES	Mental_Behavioral_Health	5	Mood disorders	5.3
F329	MAJ DEPRESS D/O SINGLE EPIS UNS	Mental_Behavioral_Health	5	Mood disorders	5.3
F330	MAJ DEPRESS D/O RECURRENT MILD	Mental_Behavioral_Health	5	Mood disorders	5.3
F331	MAJ DEPRESS D/O RECURRENT MOD	Mental_Behavioral_Health	5	Mood disorders	5.3
F332	MAJ DEPRESS RECURR SEV W/O PSYCH	Mental_Behavioral_Health	5	Mood disorders	5.3
F3341	MAJ DEPRESS D/O RECURR PART REMISS	Mental_Behavioral_Health	5	Mood disorders	5.3
F339	MAJOR DEPRESSIVE D/O RECURRENT UNS	Mental_Behavioral_Health	5	Mood disorders	5.3
F341	DYSTHYMIC DISORDER	Mental_Behavioral_Health	5	Mood disorders	5.3
F3481	DISRUPTIVE MOOD DYSREGULATION D/O	Mental_Behavioral_Health	5	Mood disorders	5.3
F39	UNSPECIFIED MOOD AFFECTIVE DISORDER	Mental_Behavioral_Health	5	Mood disorders	5.3
F410	PANIC DISORDER	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F411	GENERALIZED ANXIETY DISORDER	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F418	OTHER SPECIFIED ANXIETY DISORDERS	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F419	ANXIETY DISORDER UNSPECIFIED	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F422	MIXED OBSESSIONAL THOUGHTS AND ACTS	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F429	OBSESSIVE-COMPULSIVE D/O UNSPEC	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F430	ACUTE STRESS REACTION	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F4310	POST-TRAUMATIC STRESS DISORDER UNS	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F4312	POST-TRAUMATIC STRESS D/O CHRONIC	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F4320	ADJUSTMENT DISORDER UNSPECIFIED	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F4321	ADJUST D/O WITH DEPRESSED MOOD	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F4322	ADJUSTMENT DISORDER WITH ANXIETY	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F4323	ADJUST D/O MIXED ANX & DEPRESS MOOD	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F4324	ADJUST D/O W/DISTURBANCE CONDUCT	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F4325	ADJUST D/O W/MIXED DISTURB EMOTIONS	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F438	OTHER REACTIONS TO SEVERE STRESS	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F439	REACTION TO SEVERE STRESS UNS	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F446	CONVERSION D/O W/SENSORY SX/DEFICIT	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F458	OTHER SOMATOFORM DISORDERS	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F459	SOMATOFORM DISORDER UNSPECIFIED	Mental_Behavioral_Health	5	Stress and anxiety	5.1
F900	ADHD INATTENTIVE TYPE	Mental_Behavioral_Health	5	Childhood behavioral and emotional disorders	5.4
F902	ADHD COMBINED TYPE	Mental_Behavioral_Health	5	Childhood behavioral and emotional disorders	5.4
F909	ADHD UNSPECIFIED TYPE	Mental_Behavioral_Health	5	Childhood behavioral and emotional disorders	5.4
F913	OPPOSITIONAL DEFIANT DISORDER	Mental_Behavioral_Health	5	Childhood behavioral and emotional disorders	5.4
F919	CONDUCT DISORDER UNSPECIFIED	Mental_Behavioral_Health	5	Childhood behavioral and emotional disorders	5.4
F930	CONDUCT DISORDER, UNSPECIFIED, SEPARATION ANXIETY DISORDER OF CHILDHOOD	Mental_Behavioral_Health	5	Childhood behavioral and emotional disorders	5.4
F949	CHILDHOOD D/O SOCIAL FUNCTION UNS	Mental_Behavioral_Health	5	Childhood behavioral and emotional disorders	5.4
F988	OTH BEHAVR EMOTIONAL D/O CHILD ADOL	Mental_Behavioral_Health	5	Childhood behavioral and emotional disorders	5.4
T2122XA	BURN SECOND DEG ABD WALL INIT ENC	Injuries_Poisoning	6	Burns	6.1
W010XXA	FALL SAME LVL SLIP NO STRK OBJ INIT	Injuries_Poisoning	6	Trips and falls	6.5
W01190A	FALL SAME LEVL SLIP STRIK FURN INIT	Injuries_Poisoning	6	Trips and falls	6.5
W03XXXA	OTH FALL SAME LEVL COLL PERSON INIT	Injuries_Poisoning	6	Trips and falls	6.5
W06XXXA	FALL FROM BED INITIAL ENCOUNTER	Injuries_Poisoning	6	Trips and falls	6.5
W1809XA	STRIK AGNST OTH OBJ SBSQT FALL INIT	Injuries_Poisoning	6	Trips and falls	6.5
W1830XA	FALL SAME LEVEL UNSPECIFIED INITIAL	Injuries_Poisoning	6	Trips and falls	6.5
W1840XA	SLIP TRIP STUMBL NO FALL UNS INIT	Injuries_Poisoning	6	Trips and falls	6.5
W19XXXA	UNSPECIFIED FALL INITIAL ENCOUNTER	Injuries_Poisoning	6	Trips and falls	6.5
W19XXXD	UNSPECIFIED FALL SUBSEQUENT ENC	Injuries_Poisoning	6	Trips and falls	6.5

P0716	OTH LOW BIRTH WT NB 1500-1749 GRAMS	OBGYN	7	Low birth weight Infants	7.1
P0730	PRETERM NEWBORN UNS WEEKS GESTATION	OBGYN	7	Low birth weight Infants	7.1
H6001	ABSCESS OF RIGHT EXTERNAL EAR	Acute_Respiratory_Infection	8	Ear infections	8.7
H60513	AC ACTINIC OTITIS EXTERNA BILATERAL	Acute_Respiratory_Infection	8	Ear infections	8.7
H65199	OTH AC NONSUPPURATIVE OM UNS EAR	Acute_Respiratory_Infection	8	Ear infections	8.7
H6591	UNS NONSUPPURATIVE OM RT EAR	Acute_Respiratory_Infection	8	Ear infections	8.7
H66001	AC SUPPRTV OM W/O RUPT EAR DRUM RT	Acute_Respiratory_Infection	8	Ear infections	8.7
H66002	AC SUPPRTV OM W/O RUPT EAR DRUM LT	Acute_Respiratory_Infection	8	Ear infections	8.7
H66003	AC SUPPRTV OM W/O RUPT EAR DRUM BIL	Acute_Respiratory_Infection	8	Ear infections	8.7
H66004	AC SUPP OM W/O RUP EAR DRM RECUR RT	Acute_Respiratory_Infection	8	Ear infections	8.7
H66006	AC SUPP OM W/O RUP EAR DRM RECUR BI	Acute_Respiratory_Infection	8	Ear infections	8.7
H6642	SUPPURATIV OTITIS MEDIA UNS LT EAR	Acute_Respiratory_Infection	8	Ear infections	8.7
H6690	OTITIS MEDIA, UNSPECIFIED, INFECTION OF THE MIDDLE EAR	Acute_Respiratory_Infection	8	Ear infections	8.7
H6691	OTITIS MEDIA UNSPECIFIED RIGHT EAR	Acute_Respiratory_Infection	8	Ear infections	8.7
H6692	OTITIS MEDIA UNSPECIFIED LEFT EAR	Acute_Respiratory_Infection	8	Ear infections	8.7
H6693	OTITIS MEDIA UNSPECIFIED BILATERAL	Acute_Respiratory_Infection	8	Ear infections	8.7
J00	ACUTE NASOPHARYNGITIS COMMON COLD	Acute_Respiratory_Infection	8	Other acute respiratory infection	8.6
J0100	ACUTE MAXILLARY SINUSITIS UNS	Acute_Respiratory_Infection	8	Acute sinusitis	8.5.1
J0120	ACUTE ETHMOIDAL SINUSITIS UNS	Acute_Respiratory_Infection	8	Acute sinusitis	8.5.1
J0140	ACUTE PANSINUSITIS UNSPECIFIED	Acute_Respiratory_Infection	8	Acute sinusitis	8.5.1
J0180	OTHER ACUTE SINUSITIS	Acute_Respiratory_Infection	8	Acute sinusitis	8.5.1
J0190	ACUTE SINUSITIS UNSPECIFIED	Acute_Respiratory_Infection	8	Acute sinusitis	8.5.1
J020	STREPTOCOCCAL PHARYNGITIS	Acute_Respiratory_Infection	8	Other acute respiratory infection	8.6
J028	AC PHARYNGIT D/T OTH SPEC ORGANISMS	Acute_Respiratory_Infection	8	Other acute respiratory infection	8.6
J029	ACUTE PHARYNGITIS UNSPECIFIED	Acute_Respiratory_Infection	8	Other acute respiratory infection	8.6
J050	ACUTE OBSTRUCTIVE LARYNGITIS CROUP	Acute_Respiratory_Infection	8	Other acute respiratory infection	8.6
J069	ACUTE UP RESPIRATORY INFECTION UNS	Acute_Respiratory_Infection	8	Other acute respiratory infection	8.6
J09X9	FLU D/T ID NOVEL FLU VIRUS W/OTH	Acute_Respiratory_Infection	8	Flu	8.1
J1000	FLU D/T OTH ID FLU VIR UNS TYPE PN	Acute_Respiratory_Infection	8	Flu	8.1
J101	FLU D/T OTH ID FLU VIR OTH RSP MANF	Acute_Respiratory_Infection	8	Flu	8.1
J1089	FLU D/T OTH ID FLU VIRUS OTH MANIF	Acute_Respiratory_Infection	8	Flu	8.1
J1100	FLU D/T UNIDENTIFIED FLU VIR UNS PN	Acute_Respiratory_Infection	8	Flu	8.1
J111	FLU D/T UNIDENT FLU VIR RESP MANIF	Acute_Respiratory_Infection	8	Flu	8.1
J181	LOBAR PNEUMONIA UNS ORGANISM	Acute_Respiratory_Infection	8	Pneumonia	8.2
J200	ACUTE BRONCHITIS D/T MYCOPLASMA PN	Acute_Respiratory_Infection	8	Acute bronchitis	8.3
J208	ACUTE BRONCHITIS D/T SPEC ORGANISMS	Acute_Respiratory_Infection	8	Acute bronchitis	8.3
J209	ACUTE BRONCHITIS UNSPECIFIED	Acute_Respiratory_Infection	8	Acute bronchitis	8.3
J22	UNS ACUTE LOWER RESP INFECTION	Acute_Respiratory_Infection	8	Other acute respiratory infection	8.6
J320	CHRONIC MAXILLARY SINUSITIS	Acute_Respiratory_Infection	8	Chronic sinusitis	8.5.2
J321	CHRONIC FRONTAL SINUSITIS	Acute_Respiratory_Infection	8	Chronic sinusitis	8.5.2
J324	CHRONIC PANSINUSITIS	Acute_Respiratory_Infection	8	Chronic sinusitis	8.5.2
J328	OTHER CHRONIC SINUSITIS	Acute_Respiratory_Infection	8	Chronic sinusitis	8.5.2
J329	CHRONIC SINUSITIS UNSPECIFIED	Acute_Respiratory_Infection	8	Chronic sinusitis	8.5.2
U071	COVID-19	Acute_Respiratory_Infection	8	COVID-19	8.4
E7800	PURE HYPERCHOLESTEROLEMIA UNSPEC	Cardiovascular	9	High cholesterol	9.1
E782	MIXED HYPERLIPIDEMIA	Cardiovascular	9	High cholesterol	9.1
E785	HYPERLIPIDEMIA UNSPECIFIED	Cardiovascular	9	High cholesterol	9.1
I214	NON-ST ELEVATION MYOCARDIAL INFARCT	Cardiovascular	9	Ischemic heart diseases	9.2.1
I2699	OTH PULM EMBO W/O AC COR PULMONALE	Cardiovascular	9	Pulmonary heart disease and diseases of pulmonary circulation	9.2.2
I2720	PULMONARY HYPERTENSION UNSPECIFIED	Cardiovascular	9	Pulmonary heart disease and diseases of pulmonary circulation	9.2.2
I371	NONRHEUMATIC PULMONARY VALVE INSUFF	Cardiovascular	9	Other forms of heart disease	9.2.3
I428	OTHER CARDIOMYOPATHIES	Cardiovascular	9	Other forms of heart disease	9.2.3
I447	LT BUNDLE-BRANCH BLOCK UNSPECIFIED	Cardiovascular	9	Other forms of heart disease	9.2.3
I450	RIGHT FASCICULAR BLOCK	Cardiovascular	9	Other forms of heart disease	9.2.3
I4510	UNSPECIFIED RT BUNDLE-BRANCH BLOCK	Cardiovascular	9	Other forms of heart disease	9.2.3
I454	NONSPECIFIC INTRAVENTRICULAR BLOCK, CARDIOVASCULAR	Cardiovascular	9	Other forms of heart disease	9.2.3

I4581	LONG QT SYNDROME, A HEART SIGNALING DISORDER THAT CAN CAUSE FAST, CHAOTIC HEARTBEATS (ARRHYTHMIAS)	Cardiovascular	9	Other forms of heart disease	9.2.3
I459	CONDUCTION DISORDER UNSPECIFIED	Cardiovascular	9	Other forms of heart disease	9.2.3
I471	SUPRAVENTRICULAR TACHYCARDIA	Cardiovascular	9	Other forms of heart disease	9.2.3
I4891	UNSPECIFIED ATRIAL FIBRILLATIONUNSPECIFIED ATRIAL FIBRILLATION	Cardiovascular	9	Other forms of heart disease	9.2.3
I493	VENTRICULR PREMATURE DEPOLARIZATION	Cardiovascular	9	Other forms of heart disease	9.2.3
I499	CARDIAC ARRHYTHMIA UNSPECIFIED	Cardiovascular	9	Other forms of heart disease	9.2.3
I509	HEART FAILURE UNSPECIFIED	Cardiovascular	9	Other forms of heart disease	9.2.3
I517	CARDIOMEGALY	Cardiovascular	9	Other forms of heart disease	9.2.3
I519	HEART DISEASE UNSPECIFIED	Cardiovascular	9	Other forms of heart disease	9.2.3
Z0000	ENC GEN ADULT EXAM W/O ABNORM FIND	Routine_Care	10	General Exams	10.1
Z0001	ENC GEN ADULT EXAM W/ABNORMAL FIND	Routine_Care	10	General Exams	10.1
Z00121	ENC RTN CHLD HLTH EXAM W/ABNRM FIND	Routine_Care	10	General Exams	10.1
Z00129	ENC RTN CHLD HLTH EX W/O ABNRM FIND	Routine_Care	10	General Exams	10.1
Z01810	ENCOUNTER PREPROCEDURAL CV EXAM	Routine_Care	10	General Exams	10.1
Z01812	ENCCOUNTER PREPROCEDURAL LAB EXAM	Routine_Care	10	General Exams	10.1
Z01818	ENCOUNTER OTHER PREPROCEDURAL EXAM	Routine_Care	10	General Exams	10.1
Z1152	ENCOUNT FOR SCREENING FOR COVID-19	Routine_Care	10	Screenings for Disease or Cancer	10.2
Z1211	ENC SCREEN MALIG NEOPLASM COLON	Routine_Care	10	Screenings for Disease or Cancer	10.2
Z122	ENC SCREEN MALIG NEOPLASM RESP ORGN	Routine_Care	10	Screenings for Disease or Cancer	10.2
Z1231	ENC SCR MAMMO MALIG NEOPLASM BREAST	Routine_Care	10	Screenings for Disease or Cancer	10.2
Z125	ENC SCREEN MALIG NEOPLASM PROSTATE	Routine_Care	10	Screenings for Disease or Cancer	10.2
Z131	ENCOUNTER FOR SCREENING FOR DM	Routine_Care	10	Screenings for Disease or Cancer	10.2
Z13220	ENC SCREENING FOR LIPOID DISORDERS	Routine_Care	10	Screenings for Disease or Cancer	10.2
Z1330	ENC SCRN EXM MNTL HLTH BEHV D/O UNS	Routine_Care	10	Screenings for Disease or Cancer	10.2
Z1331	ENCNTER FOR SCREENING DEPRESSION	Routine_Care	10	Screenings for Disease or Cancer	10.2
Z136	ENC FOR SCREENING FOR CV DISORDERS	Routine_Care	10	Screenings for Disease or Cancer	10.2
Z20822	CONTACT W/AND (SUSP) EXPOS COVID-19	Routine_Care	10	Immunization or Other Preventative Treatment	10.3
Z20828	CONTCT EXPS OTH VIRL COMMUNICABL DZ	Routine_Care	10	Immunization or Other Preventative Treatment	10.3
Z23	ENCOUNTER FOR IMMUNIZATION	Routine_Care	10	Immunization or Other Preventative Treatment	10.3
G4700	INSOMNIA UNSPECIFIED	Sleep_Fatigue	11	Sleep Disorders	11.1
G4710	HYPERSOMNIA UNSPECIFIED	Sleep_Fatigue	11	Sleep Disorders	11.1
G4730	SLEEP APNEA UNSPECIFIED	Sleep_Fatigue	11	Sleep Disorders	11.1
G4733	OBSTRUCTIVE SLEEP APNEA	Sleep_Fatigue	11	Sleep Disorders	11.1
G4761	PERIODIC LIMB MOVEMENT DISORDER	Sleep_Fatigue	11	Sleep Disorders	11.1
G479	SLEEP DISORDER UNSPECIFIED	Sleep_Fatigue	11	Sleep Disorders	11.1
R5383	OTHER FATIGUE	Sleep_Fatigue	11	Fatigue	11.2
D500	IRON DEFIC ANEMIA SEC BLD LOSS CHRN	Diabetes_and_Nutrition	12	Nutritional deficiency	12.3
D509	IRON DEFICIENCY ANEMIA UNSPECIFIED	Diabetes_and_Nutrition	12	Nutritional deficiency	12.3
E089	DIABETES MELLITUS DUE TO UNDERLYING CONDITION	Diabetes_and_Nutrition	12	Diabetes	12.1
E1110	TYPE 2 DM KETOACIDOSIS W/O COMA	Diabetes_and_Nutrition	12	Diabetes	12.1
E1121	TYPE 2 DM W/DIABETIC NEPHROPATHY	Diabetes_and_Nutrition	12	Diabetes	12.1
E1122	TYPE 2 DM W/DIABETIC CKD	Diabetes_and_Nutrition	12	Diabetes	12.1
E1140	TYPE 2 DM W/DIABETIC NEUROPATHY UNS	Diabetes_and_Nutrition	12	Diabetes	12.1
E1159	TYP 2 DM W/CIRC COMPLICATIONS	Diabetes_and_Nutrition	12	Diabetes	12.1
E11621	TYPE 2 DM W/FOOT ULCER	Diabetes_and_Nutrition	12	Diabetes	12.1
E11628	TYP 2 DM W/OTHER SKIN COMPLICATIONS	Diabetes_and_Nutrition	12	Diabetes	12.1
E1165	TYPE 2 DM W/HYPERGLYCEMIA	Diabetes_and_Nutrition	12	Diabetes	12.1
E1169	TYPE 2 DM W/OTHER SPEC COMPLICATION	Diabetes_and_Nutrition	12	Diabetes	12.1
E118	TYPE 2 DM W/UNS COMPLICATIONS	Diabetes_and_Nutrition	12	Diabetes	12.1
E119	TYPE 2 DM WITHOUT COMPLICATIONS	Diabetes_and_Nutrition	12	Diabetes	12.1
E1343	OTHER SPEC DM HYPEROSMOLAR COMA	Diabetes_and_Nutrition	12	Diabetes	12.1
E139	OTHER SPEC DM W/O COMPLICATIONS	Diabetes_and_Nutrition	12	Diabetes	12.1
E538	DEFICIENCY SPEC B GROUP VITAMINS	Diabetes_and_Nutrition	12	Nutritional deficiency	12.3

E559	VITAMIN D DEFICIENCY UNSPECIFIED	Diabetes_and_Nutrition	12	Nutritional deficiency	12.3
E8342	HYPOMAGNESEMIA	Diabetes_and_Nutrition	12	Nutritional deficiency	12.3
E860	DEHYDRATION	Diabetes_and_Nutrition	12	Dehydration	12.2
E871	HYPO-OSMOLALITY AND HYPONATREMIA	Diabetes_and_Nutrition	12	Dehydration	12.2
E876	HYPOKALEMIA	Diabetes_and_Nutrition	12	Dehydration	12.2
E878	OTHER D/O ELECTROLYTE & FL BAL NEC	Diabetes_and_Nutrition	12	Dehydration	12.2
R631	POLYDIPSIA	Diabetes_and_Nutrition	12	Nutritional deficiency	12.3
R633	FEEDING DIFFICULTIES	Diabetes_and_Nutrition	12	Nutritional deficiency	12.3
R634	ABNORMAL WEIGHT LOSS	Diabetes_and_Nutrition	12	Nutritional deficiency	12.3
R635	ABNORMAL WEIGHT GAIN	Diabetes_and_Nutrition	12	Nutritional deficiency	12.3
G8911	ACUTE PAIN DUE TO TRAUMA	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
G8918	OTHER ACUTE POSTPROCEDURAL PAIN	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
G8929	OTHER CHRONIC PAIN	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
G894	CHRONIC PAIN SYNDROME	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
M5410	RADICULOPATHY SITE UNSPECIFIED	Pain	13	Pain in specified body parts	13.1
M5412	RADICULOPATHY CERVICAL REGION	Pain	13	Pain in specified body parts	13.1
M5417	RADICULOPATHY LUMBOSACRAL REGION	Pain	13	Pain in specified body parts	13.1
M542	CERVICALGIA	Pain	13	Pain in specified body parts	13.1
M5440	LUMBAGO WITH SCIATICA UNS SIDE	Pain	13	Pain in specified body parts	13.1
M5441	LUMBAGO WITH SCIATICA RIGHT SIDE	Pain	13	Pain in specified body parts	13.1
M5442	LUMBAGO WITH SCIATICA LEFT SIDE	Pain	13	Pain in specified body parts	13.1
M545	LOW BACK PAIN	Pain	13	Pain in specified body parts	13.1
M5450	LOW BACK PAIN, UNSPECIFIED	Pain	13	Pain in specified body parts	13.1
M546	PAIN IN THORACIC SPINE	Pain	13	Pain in specified body parts	13.1
M549	DORSALGIA UNSPECIFIED	Pain	13	Pain in specified body parts	13.1
M7060	TROCHANTERIC BURSITIS UNS HIP	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
M75112	INCMPL ROT CUFF TEAR/RUPT LT SHLDR	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
M7522	BICIPITAL TENDINITIS LEFT SHOULDER	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
M7581	OTHER SHOULDER LESIONS RT SHOULDER	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
M7910	MYALGIA UNSPECIFIED SITE	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
M79601	PAIN IN RIGHT ARM	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
M79602	PAIN IN LEFT ARM	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
M79605	PAIN IN LEFT LEG	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
M79642	PAIN IN LEFT HAND	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
M79645	PAIN IN LEFT FINGERS	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
M797	FIBROMYALGIA	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
R070	PAIN IN THROAT	Pain	13	Pain in specified body parts	13.1
R072	PRECORDIAL PAIN	Pain	13	Pain in specified body parts	13.1
R0789	OTHER CHEST PAIN	Pain	13	Pain in specified body parts	13.1
R079	CHEST PAIN UNSPECIFIED	Pain	13	Pain in specified body parts	13.1

R300	DYSURIA	Pain	13	Pain in specified body parts	13.1
R52	PAIN UNSPECIFIED	Pain	13	Pain, not elsewhere specified; Other soft tissue disorders	13.2
R6884	JAW PAIN	Pain	13	Pain in specified body parts	13.1
Z9114	PT OTH NONCOMPLIANCE W/ MED REGIMEN	SDOH	14	Medication adherence	14.1
Z9119	PT NONCOMPLIANCE OTH MED TX&REGIMEN	SDOH	14	Medication adherence	14.1
K011	IMPACTED TEETH	Oral_Health	15	Other oral health concerns	15.3
K0252	DENT CARIES PIT FISS SURF PEN DENTN	Oral_Health	15	Cavities	15.1
K029	DENTAL CARIES, TOOTH DECAY OR DENTAL CAVITIES	Oral_Health	15	Cavities	15.1
K036	DEPOSITS ACCRETIONS ON TEETH	Oral_Health	15	Other oral health concerns	15.3
K047	PERIAPICAL ABSCESS WITHOUT SINUS	Oral_Health	15	Other oral health concerns	15.3
K0510	CHRONIC GINGIVITIS PLAQUE INDUCED	Oral_Health	15	Gingivitis	15.2
K0889	OTH SPEC DISORDERS TEETH SUPP STRCT	Oral_Health	15	Other oral health concerns	15.3
K210	GERD WITH ESOPHAGITIS	Gastrointestinal	16	Gastrointestinal	16.1
K2100	GASTR-ESOPH RFLX DS ESPHGTS W/O BLD	Gastrointestinal	16	Gastrointestinal	16.1
K219	GASTRO-ESOPHAGEAL REFLUX DISEASE WITHOUT ESOPHAGITIS	Gastrointestinal	16	Gastrointestinal	16.1
K222	ESOPHAGEAL OBSTRUCTION	Gastrointestinal	16	Gastrointestinal	16.1
K2900	ACUTE GASTRITIS WITHOUT BLEEDING	Gastrointestinal	16	Gastrointestinal	16.1
K2970	GASTRITIS UNS WITHOUT BLEEDING	Gastrointestinal	16	Gastrointestinal	16.1
K2990	GASTRODUODENITIS UNS W/O BLEEDING	Gastrointestinal	16	Gastrointestinal	16.1
K3184	GASTROPARESIS	Gastrointestinal	16	Gastrointestinal	16.1
R1010	UPPER ABDOMINAL PAIN, UNSPECIFIED	Gastrointestinal	16	Gastrointestinal	16.1
R1011	RIGHT UPPER QUADRANT PAIN	Gastrointestinal	16	Gastrointestinal	16.1
R1012	LEFT UPPER QUADRANT PAIN	Gastrointestinal	16	Gastrointestinal	16.1
R1013	EPIGASTRIC PAIN	Gastrointestinal	16	Gastrointestinal	16.1
R1031	RIGHT LOWER QUADRANT PAIN	Gastrointestinal	16	Gastrointestinal	16.1
R1084	GENERALIZED ABDOMINAL PAIN	Gastrointestinal	16	Gastrointestinal	16.1
R109	UNSPECIFIED ABDOMINAL PAIN	Gastrointestinal	16	Gastrointestinal	16.1
R110	NAUSEA	Gastrointestinal	16	Gastrointestinal	16.1
R1110	VOMITING UNSPECIFIED	Gastrointestinal	16	Gastrointestinal	16.1
R112	NAUSEA WITH VOMITING UNSPECIFIED	Gastrointestinal	16	Gastrointestinal	16.1
R1310	DYSPHAGIA UNSPECIFIED	Gastrointestinal	16	Gastrointestinal	16.1
R1311	DYSPHAGIA ORAL PHASE	Gastrointestinal	16	Gastrointestinal	16.1
R1312	DYSPHAGIA OROPHARYNGEAL PHASE	Gastrointestinal	16	Gastrointestinal	16.1
R1314	DYSPHAGIA PHARYNGOESOPHAGEAL PHASE	Gastrointestinal	16	Gastrointestinal	16.1
R142	ERUCTATION	Gastrointestinal	16	Gastrointestinal	16.1
R197	DIARRHEA UNSPECIFIED	Gastrointestinal	16	Gastrointestinal	16.1

Appendix C. References

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