



**National Weatherization Assistance  
Program Evaluation**

**Analysis Report**

**Non-Energy Benefits of WAP**

**Estimated with the Client Longitudinal Survey  
Final Report**

**January 2018**

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## Executive Summary

The National Weatherization Assistance Program (WAP) Evaluation included surveys with program participants before and after they received the program treatments. One of the key goals of the data collection effort was to estimate the impact of WAP on outcomes beyond energy usage, including health, safety, comfort, and affordability. ORNL published a report on these benefits and the valuation of these benefits using data from the Occupant Survey as well as secondary data. The methodology used in ORNL's analysis differed from the initial study plan and their results differed from those that APPRISE has published. This report describes the original analysis plans, how the ORNL analysis differs from those plans, and how the results of the APPRISE analysis differ from those reported by ORNL.

### *Study Design*

Pre- and Post-Treatment Occupant Surveys were included in the WAP evaluation to assess the program in ways that went beyond the available data from service delivery records. Data on energy affordability, housing conditions, comfort, safety, and health status indicators were collected before and after WAP service delivery for a treatment and a comparison group.

The Treatment Group received WAP services during Program Year 2011 or Program Year 2012, whereas the Comparison Group of households received services during Program Year 2010. The impact of weatherization on non-energy outcomes was estimated using a difference-in-differences approach. By estimating the differences in client status before and after WAP for the Treatment Group, and netting out a similar post-to-post difference for the Comparison Group, this evaluation design attempts to isolate the impact of WAP.

### *Study Limitations*

There are several limitations to the approach that should be acknowledged.

- **Specification of Comparison Group:** The typical quasi-experimental design in energy efficiency evaluations employs a later participant Comparison Group. This is an accepted approach because the Comparison Group is similar to the Treatment Group for the initial measurement, as both groups have not yet received weatherization, and the Comparison Group can provide a representation of what the Treatment Group's conditions would be one year later if the homes had not received WAP services.

However, the approach used in this study includes a Comparison Group of households who already received WAP services. As such, their quasi-pre measurement is more similar to the post measurement for the Treatment Group. One may argue that they have less room for exogenous factors to impact their measurements because they have already been impacted by WAP, and therefore this method may provide an underestimate of the potential impact of exogenous factors.

- **Longitudinal Survey Response Rate:** The longitudinal survey respondents are different from the WAP participants based on WAP statistics.
- **Omitted Variables:** The surveys did not collect data on household income or on Low-Income Home Energy Assistance Program (LIHEAP) receipt. These are important omitted variables because they can impact affordability and other non-energy variables measured in this analysis by as much or more than a few hundred dollars annual savings on the energy bill resulting from Weatherization.
- **Measurement Issues:** There are always measurement issues associated with self-reported data. One specific example in the WAP surveys was inconsistencies in the reporting on asthma. Over nine percent of the respondents provided a different response to the question “Have you ever had asthma?” in the Follow-Up Survey than in the Baseline Survey.

### ***Comparison of Analysis Procedures***

There were several differences in the analysis procedures that were used by APPRISE and by ORNL. This section summarizes how the studies differed.

1. **Longitudinal Framework:** The survey was designed to measure changes from pre- to post-weatherization for the Treatment Group and from post-weatherization to one year later for the Comparison Group. The conditions of the *same* participants are measured in the Pre- and Post-Treatment periods to measure the change for those participants, and the conditions of the earlier participants in the Comparison Group are measured one and two years following WAP completion to measure exogenous changes.

ORNL did not use a longitudinal sample. They included the 267 clients who only responded to the Baseline Survey and confirmed that they were weatherized, but did not complete the Follow-Up Survey because they refused, moved, were deceased, or could not be reached. ORNL did exclude the clients who were not weatherized or who were deferred for WAP and were not eligible for follow-up. Therefore, ORNL’s comparison is not a matched pre-post comparison analysis.

2. **Additional WAP Treatments:** A client satisfaction survey was completed three months following the Baseline Survey. Treatment Group respondents were contacted and interviewed if they had received weatherization services. Nine months after the Baseline Survey, Treatment Group respondents who had not yet received services at the time of the three-month follow-up were contacted and interviewed if they received weatherization services by that time. Clients had two opportunities to confirm that they received weatherization services, three and nine months following the Baseline Survey. ORNL included the 398 clients who completed the Pre- and Post-Treatment Surveys and who confirmed weatherization treatment at the three-month follow-up in their post analysis group. APPRISE included the additional 56 clients who did not confirm weatherization at the three-month follow-up, but confirmed weatherization at the nine-month follow-up.

3. Comparisons Reported: The other key difference between the studies is the comparisons that are reported. APPRISE reports the designed difference-in-differences net change.

- Net Change = (Pre-Treatment–Post-Treatment)–(Pre-Comparison–Post-Comparison)

The ORNL report presents the following differences and sometimes utilizes the average of these two measures as the impact.

- Gross Change = Pre-Treatment – Post-Treatment
- Additional Measure = Pre-Treatment – Pre-Comparison

While the difference between the WAP Pre-Treatment statistics and the Pre-Comparison Group statistics (Post-Treatment measurement) were used as an initial assessment of the program impact prior to implementation of the Follow-Up Survey, they should not be used in the context of a differences-in-differences analysis once the Post-Treatment survey results are available.

4. Statistical Significance: APPRISE only considers differences that are measured as statistically significant, at least at the 90 percent confidence level. ORNL includes differences that are not statistically significant when they value the non-energy benefits.
5. External Data: APPRISE only includes results that are statistically significant in the Occupant Survey analysis. When differences measured in the Occupant Survey are small, ORNL brings in secondary data to provide an alternate estimate of the impact of WAP on the non-energy benefit.

ORNL does not present their results in the differences-in-differences framework, but we translate their presentation to the differences-in-differences framework to allow for a direct comparison of APPRISE and ORNL results when possible. While there are some meaningful differences in the change in WAP indicators based on the differences-in-differences results and the groups included in the analyses, the larger differences result from the fact that APPRISE does not estimate a positive monetization for changes that are not measured as statistically significant in this study, while ORNL does include those changes; and that ORNL sometimes provides an alternate estimate of the WAP impact using secondary data when the differences measured in the Occupant Survey are small.

### ***Comparison of Program Impacts***

Many of the net changes measured in the ORNL and APPRISE studies are similar despite the differences in the Treatment and Comparison Group participants included in the analyses. However, some cannot be compared directly because APPRISE examines the percent with a particular response while ORNL examines the average rating. Additionally, in some cases, ORNL examines a subset of the respondent population.

### ***Comparison of Benefit Valuation***

For all but one benefit valued by ORNL, APPRISE did not find a statistically significant net change in the indicator. In such cases where the net change is not statistically significant, we assign the value of the indicator to \$0. It is important to note that there were many other statistically significant net changes in the indicators found in the APPRISE study that are not monetized in the ORNL report or in this report. We only compare the valuation for the measures that ORNL includes in their analysis.

While ORNL estimates a total one-year value of \$1,439 from the non-energy benefits studied, APPRISE estimates a total one-year value of \$43 from those same non-energy benefits. The difference is mostly due to the fact that the only statistically significant net impact was on prescription affordability.

### ***Findings and Recommendations***

This study examined the methodologies used by ORNL and APPRISE to explain why the studies have different results. While there are many differences in the approaches used, the most significant differences in terms of valuing the non-energy benefits is that ORNL monetizes changes that are not statistically significant or uses secondary data when the differences measured in the Occupant Survey are small.

It is important to note that APPRISE found several statistically significant changes in net indicators in the WAP Occupant Survey that are not monetized by ORNL. These changes include affordability of energy bills, running out of a delivered fuel, presence of pests, mold and moisture, noise, draftiness, indoor winter and summer temperatures, unsafe or unhealthy indoor temperatures, affordability of medical care, days of poor physical health, and presence of home safety devices. Future research should provide a monetization for these benefits.

Additionally, more research of this kind is needed to assess these findings and to further estimate the impact of energy efficiency on non-energy impacts. Because such findings may be used in cost-effectiveness tests and impact the level of energy efficiency investments, it is critical to conduct additional studies that provide verification or refutation of these results.

Certain impacts are expected to be greater in specific populations, and additional study is needed for subpopulation groups. For example, elderly, disabled, and individuals with asthma are more likely to be impacted by reductions in mold and mildew and improvements in indoor air quality. Therefore, programs that focus on these households may have greater health impacts. Additionally, our research found that certain impacts were more pronounced in some climate zones, so differential impacts are expected when an individual state or utility territory is studied.

Non-energy benefits are real and they can be significant. While it can be challenging to estimate and monetize these benefits, it is important to do so. Furthermore, it is critical to present the results in a clear and transparent manner and to only claim benefits that have been measured.

## **I. Introduction**

The National Weatherization Assistance Program (WAP) Evaluation included surveys with program participants before and after they received the program treatments. One of the key goals of the data collection effort was to estimate the impact of WAP on outcomes beyond energy usage, including health, safety, comfort, and affordability. Oak Ridge National Laboratory (ORNL) published a report on these benefits and the valuation of these benefits using data from the Occupant Survey as well as secondary data. The methodology used in ORNL's analysis differed from the initial study plan and their results differed from an APPRISE publication. This report describes the original analysis plans, how the ORNL analysis differs from those plans, and how the results of the APPRISE analysis differ from those reported by ORNL.

### **A. *Weatherization Assistance Program***

The U.S. Department of Energy's (DOE) Weatherization Assistance Program was created by Congress in 1976 under Title IV of the Energy Conservation and Production Act. The purpose and scope of the Program as currently stated in the Code of Federal Regulations (CFR) 10CFR 440.1 is "to increase the energy efficiency of dwellings owned or occupied by low-income persons, reduce their total residential energy expenditures, and improve their health and safety, especially low-income persons who are particularly vulnerable such as the elderly, persons with disabilities, families with children, high residential energy users, and households with high energy burden." (Code of Federal Regulations, 2011)

### **B. *National Evaluation***

At the request of DOE, ORNL developed a comprehensive plan for a national evaluation of WAP. DOE furnished funding to ORNL for a national evaluation. The Scope of Work (SOW) for the evaluation included an Impact Assessment, a Process Assessment, Special Technical Studies, and a Synthesis Report. ORNL subcontracted evaluation research to APPRISE Incorporated and its partners the Energy Center of Wisconsin, Michael Blasnik and Associates, and Dalhoff Associates LLC.

### **C. *Purpose and Scope of this Report***

Following the conclusion of the APPRISE subcontract, ORNL independently authored a report in September 2014 entitled "Health and Household-Related Benefits Attributable to the Weatherization Assistance Program." This report analyzed Pre- and Post-Treatment Occupant Survey data to estimate the non-energy benefits of WAP and provided a monetization of those benefits. APPRISE authored a separate report in January 2018 that provided an independent analysis of the Baseline and Follow-Up Occupant survey data. The purpose of this report is to explain how the APPRISE analysis differs from the ORNL analysis and the impact on the results.

## II. Study Design

This section describes the research design and survey methodology used in the analysis of WAP non-energy benefits.

### A. *Survey Design and Implementation*

Pre- and Post-Treatment Occupant Surveys were included in the WAP evaluation to assess the program in ways that went beyond the available data from service delivery records. One important purpose of the Occupant Surveys was to provide estimates of non-energy benefits that resulted from the WAP treatments. Data on energy affordability, housing conditions, comfort, safety, and health status indicators were collected before and after WAP service delivery for a Treatment and a Comparison Group.

The Baseline Survey was conducted prior to the Treatment Group's home energy audit. While Treatment Group clients may have had some engagement with WAP during program application, these interviews represent the needs and conditions of the participants prior to WAP delivery. The Follow-Up Survey was conducted two years after the Baseline Survey at the same time of year as the Baseline Survey and assesses the same indicators to determine how client status and needs changed. [Note: The Follow-Up Survey was conducted 12 to 24 months after the treatment group clients received WAP services.] The Comparison Group was surveyed at the same time as the Treatment Group, but had already received service delivery at the time of the Baseline Survey. Therefore, the change for Comparison Group provides an assessment of how needs and conditions may have changed due to factors external to WAP. The Comparison Group assessment is a post-post treatment change measurement.

The Treatment Group received WAP services during Program Year 2011 or Program Year 2012, whereas the Comparison Group of households received services during Program Year 2010. The impact of weatherization on non-energy outcomes was estimated using a difference-in-differences approach. By estimating the differences in client status before and after WAP for the Treatment Group, and netting out a similar post-to-post difference for the Comparison Group, this evaluation design attempts to isolate the impact of WAP. One important pre-condition for this analysis is that the Treatment Group and Comparison Groups are similar enough so that the groups would have followed parallel trends in the absence of the program. Treatment and Comparison Group households were sampled from the same WAP agencies to maximize the probability of this similarity.

### B. *Analysis Framework*

The Baseline interviews were completed with 1,094 Treatment Group clients and 803 Comparison Group clients, for a total of 1,897. Of those 1,897 households, 139 households' treatment status could not be verified and were deemed ineligible and 15 households had moved. The remaining 1,743 respondents were contacted by phone. The Follow-up Survey was able to determine that 66 treatment households had not completed weatherization and only 454 of the treatment group clients received WAP services, continued to live in the weatherized housing unit, and could be contacted for follow-up interviews. Similarly, 430 of

the Comparison Group households who continued to live in their weatherized homes could be contacted. That group of 454 Treatment Group households and 430 Comparison Group households serves as the analysis population for the APPRISE analysis.

**Table II-1  
Attrition**

Population	Treatment Group*		Comparison Group	
	#	%	#	%
Baseline Survey Households	1,094	100%	803	100%
Treatment Status Determined	955	87%	803	100%
Complete	454	48%	430	54%
Incomplete	501	40%	373	46%
Final Follow-Up Sample	454		430	

The impact of weatherization on non-energy outcomes was estimated using a difference-in-differences approach.

- Treatment Group: Clients who received weatherization services in Program Year 2011 or Program Year 2012 and responded to both the Baseline and Follow-Up Surveys.
- Comparison Group: Clients who received weatherization services in Program Year 2010 and responded to both surveys.
- Gross Program Impact: Treatment Group Change
- Net Program Impact: Treatment Group Change – Comparison Group Change

By estimating the differences in client status before and after WAP for the Treatment Group, and netting out a similar post-to-post difference for the Comparison Group, this evaluation design attempts to isolate the impact of WAP from changes exogenous to WAP that may have impacted the non-energy benefit indicators. This approach is often used in energy efficiency program evaluations where random assignment is not feasible or accepted by program managers.

The Quasi-Experimental Design is illustrated in Table II-2

**Table II-2**  
**Quasi-Experimental Analysis Design**

	<b>Pre</b>	<b>Post</b>	<b>Change</b>	<b>Measured</b>
Treatment	Before Audit	12-18 Months After Services	Pre-Post	Program Impact + Other Factors
Comparison	After Services	One Year Later	Post-Post	Other Factors
Treatment - Comparison			[Treatment Pre – Treatment Post] – [Comparison Post1 – Comparison Post2]	Program Impact

### **C. Study Limitations**

There are several limitations to the approach that should be acknowledged.

- **Specification of Comparison Group:** The typical quasi-experimental design in energy efficiency evaluations employs a later participant Comparison Group. This is an accepted approach because the Comparison Group is similar to the Treatment Group for the initial measurement, as both groups have not yet received weatherization, and the Comparison Group can provide a representation of what the Treatment Group's conditions would be one year later if they had not received WAP services.

However, the approach used in this study includes a Comparison Group of households who already received WAP services. As such, their quasi-pre measurement is more similar to the post-measurement for the Treatment Group. One may argue that they have less room for external factors to impact their measurements because they have already been impacted by WAP, and therefore provide an underestimate of the potential impact of exogenous factors.

Table II-3 compares the approach used in this analysis to the typical Comparison Group design.

**Table II-3**  
**Comparison Group Limitation**

	<b>Pre</b>	<b>Post</b>	<b>Change</b>
Treatment Group	1-12 Months Before Audit	1-12 Months After Services	Pre Treatment – Post Treatment
Typical Comparison	13-24 Months Before Audit	1-12 Months Before Audit	2 Years Pre Treatment – 1 Year Pre Treatment
Survey Comparison	After Services	One Year Later	1 Year Post Treatment – 2 Years Post Treatment

It was necessary to utilize this Comparison Group approach rather than the typical approach because a Pre- and Post-Treatment survey was needed for the Treatment Group and a more than one year pre- and then a one year later survey was needed for the Comparison Group (two pre-treatment surveys one year apart). To interview these clients more than one year prior to WAP services (and then have their one year Post-

Treatment survey still be prior to WAP delivery), one would need to have a long waiting list of clients who would not be served until one year after the Treatment Group. This type of waiting list may have been available in other time periods, but the WAP evaluation was implemented during the American Recovery and Re-investment Act (ARRA) period when WAP received a big influx of funding and waiting lists were typically eliminated.

- **Longitudinal Survey Response Rate:** The longitudinal survey respondents are different from the WAP participants based on WAP statistics. For example, Table II-4 shows that the very cold climate is overrepresented in the survey and the hot climate is underrepresented in the survey.

**Table II-4**  
**WAP Clients by Climate Zone**

Climate Zone	Survey Respondents		Program Year 2010 WAP Clients
	Treatment Group	Comparison Group	
Number of Households	454	430	331,865
Very Cold	25%	27%	18%
Cold	49%	41%	38%
Moderate	16%	21%	17%
Hot	10%	11%	27%
TOTAL	100%		100%

- **Omitted Variables:** The surveys did not collect data on household income or on Low-Income Home Energy Assistance Program (LIHEAP) receipt. These are important omitted variables because they can impact affordability and other non-energy variables measured in this analysis as much or more than a few hundred dollars annual savings on the energy bill resulting from Weatherization.

Research has shown that there are considerable short-term fluctuations in income for low-income households. A 2017 study based on data from the Survey of Income and Program Participation (SIPP) found that of those in the bottom quintile of the income distribution in 2009, 21 percent moved up one quintile and ten percent moved up two or more quintiles by 2012.<sup>1</sup> A recent Equifax report found that 80 percent of those with income below the federal poverty level had a change of more than ten percent in one quarter.<sup>2</sup> Additionally, income mobility may be more pronounced than it typically is

<sup>1</sup>Hisnanick, Giefer, and Williams, "Dynamics of Economic Well-Being: Fluctuations in the U.S. Income Distribution: 2009-2012." U.S. Census Bureau. July 2017. Household Economic Studies. <https://www.census.gov/content/dam/Census/library/publications/2017/demo/p70-142.pdf>

<sup>2</sup><https://www.theworknumber.com/gov/News/newsletters/May-2016/Study-Income-Fluctuation-in-Lower-Income-Individuals.asp>

during the period for this analysis because of the continuing recovery from the Great Recession of December 2007 to June 2009. WAP participants may be more likely to experience an increase in income following participation due to the economic recovery.

With respect to benefit receipt, many households are referred to WAP following application for LIHEAP. Therefore, WAP participants are more likely to receive LIHEAP in the Post-Treatment year than in the Pre-Treatment year. In Fiscal Year 2010, the average heating benefit nationwide was \$391, with a range from \$90 in Mississippi to \$2,612 in Alaska. This benefit would outweigh the average WAP energy bill saving of \$223 for single family homes.

Some of the non-energy benefits, especially affordability, that are attributed to WAP in this analysis may be due to LIHEAP receipt and to changes in income. These omitted variables may result in an upward bias in the analysis results. However, these concerns are mitigated by the use of the comparison group.

- **Measurement Issues:** Measurement issues can be important when analyzing self-reported data. One specific example in the WAP surveys was inconsistencies in the reporting on asthma.

Over nine percent of the respondents provided a different response to the question “Have you ever had asthma?” in the Follow-Up survey than in the Baseline survey. APPRISE attempted to contact all respondents with inconsistent answers to verify that the same respondent completed both surveys and to verify the correct responses. The results of these contacts were as follows and shows that there is considerable uncertainty with respect to the accuracy of this report.

- 34 percent of the changed responses were corrected during the follow-up interview.
- 18 percent were verified as never having asthma in the Baseline survey and having asthma in the Follow-Up survey.
- 19 percent reached a different respondent in the verification call and the response could not be verified.
- 28 percent could not be reached to verify the response.

### III. Comparison of Analysis Procedures

There were several differences in the analysis procedures that were used by APPRISE and by ORNL. This section summarizes how the studies differed.

Table III-1 compares the clients included by APPRISE and ORNL in the Pre- and Post-Treatment and Comparison Group samples. The differences are also described below.

1. Longitudinal Framework: The survey was designed to measure changes from pre- to post-weatherization for the Treatment Group and from post-weatherization to one year later for the Comparison Group. The conditions of the *same* participants are measured in the Pre- and Post-Treatment periods to measure the change for those participants, and the conditions of the earlier participants in the Comparison Group are measured one and two years following WAP completion to measure exogenous changes.

ORNL did not exclude the 267 clients who confirmed that they were weatherized, but did not complete the Follow-Up Survey because they refused, moved, were deceased, or could not be reached. ORNL did exclude the clients who were not weatherized or who were deferred for WAP and were not eligible for follow-up. Therefore, ORNL's comparison is not a matched pre-post comparison analysis.

**Table III-1**  
**Sample Comparison**

APPRISE	Treatment Group		Comparison Group	
	Pre	Post	Pre	Post
	454	454	430	430
	Clients who received WAP in FY 2011, responded to the pre- and post-treatment surveys, and remained in the same home.		Clients who received WAP in FY 2010, responded to both surveys, and remained in the same home.	
ORNL	Treatment Group		Comparison Group	
	Pre	Post	Pre	Post
	665	398	803	430
	Clients who received WAP in FY 2011, responded to the pre-treatment survey, and confirmed WAP service delivery at the three-month follow-up.	Clients who received WAP in FY 2011, responded to the pre- and post-treatment surveys, and confirmed WAP service delivery at the three-month follow-up.	Clients who received WAP in FY 2010 and responded to the baseline survey.	Clients who received WAP in FY 2010, responded to the baseline and follow-up survey, and remained in the same home.

2. Additional WAP Treatments: A Client Satisfaction Survey was completed three months following the Baseline Survey. Treatment Group respondents were contacted and interviewed if they had received weatherization services. Nine months after the Baseline

Survey, Treatment Group respondents who had not yet received services at the time of the three-month follow-up were contacted and interviewed if they received weatherization services by that time. Clients had two opportunities to confirm that they received weatherization services, three and nine months following the Baseline Survey. ORNL included the 398 clients who completed the Pre- and Post-treatment surveys and who confirmed weatherization treatment at the three-month follow-up in their post analysis group. APPRISE included the additional 56 clients who did not confirm weatherization at the three-month follow-up, but confirmed weatherization at the nine-month follow-up.

3. Comparisons Reported: The other key difference between the studies is the comparisons that are reported. APPRISE reports the designed difference-in-differences net change.
  - Net Change = (Pre-Treatment–Post-Treatment) – (Pre-Comparison–Post-Comparison)

The ORNL report presents the following differences and sometime utilizes the average of these two measures as the impact.

- Gross Change = Pre-Treatment – Post-Treatment
- Additional Measure = Pre-Treatment – Pre-Comparison

While the difference between the WAP Pre-Treatment statistics and the Pre-Comparison Group statistics (post-treatment measurement) were used as an initial assessment of the program impact prior to implementation of the Follow-Up Survey, they should not be used in the context of a differences-in-differences analysis once the Post-Treatment survey results are available.

4. Statistical Significance: APPRISE only considers differences that are measured as statistically significant, at least at the 90 percent confidence level. ORNL includes differences that are not statistically significant when they value the non-energy benefits.
5. External Data: APPRISE only includes results that are statistically significant in the Occupant Survey analysis. When differences measured in the Occupant Survey are small, ORNL brings in secondary data to provide an alternate estimate of the impact of WAP on the non-energy benefit.

ORNL does not present their results in the differences-in-differences framework, but we translate their presentation to the differences-in-differences framework to allow for a direct comparison of results when possible. While there are some meaningful differences between the ORNL and APPRISE studies in the change in WAP indicators based on the differences-in-differences results and the groups included in the analyses, the larger differences result from the fact that APPRISE does not include changes that are not measured as statistically significant in this study, while ORNL does include those changes. Additionally, ORNL sometimes provides an alternate estimate of the WAP impact using secondary data when the differences measured in the Occupant Survey are small.

## IV. Comparison of Program Impacts

This section provides a comparison of the net changes estimated for the WAP participants in the APPRISE and ORNL studies based on analysis of the Occupant Baseline and Follow-Up Surveys.

### A. *Affordability Impacts*

This section compares some of the findings from the APPRISE and ORNL analyses with respect to the affordability impact. Table IV-1 displays information from the following survey question.

Question: “How hard is it to pay your energy bills?”

- 01 Very hard
- 02 Hard
- 03 Neither hard nor not hard
- 04 Not hard
- 05 Not hard at all
- 96 REFUSED
- 97 DON'T KNOW

The APPRISE analysis examines the percent of respondents who report that it was very hard or hard to pay their energy bills. The table shows a statistically significant net decline of 20 percentage points in this indicator. The ORNL analysis shows the average score on a scale of one to five. The table shows that net change in the average score was a decline of .51 points, indicating a reduction in the difficulty of paying energy bills, without a clear interpretation of the meaning of that reduction. Note that while ORNL does not present the results in the framework presented below, as a differences-in-differences analysis, we have translated the information displayed in their tables to this format for comparison of results. Additionally, while ORNL presents the statistical significance for comparisons of the Pre- and Post-Treatment group, the Pre-Treatment group and the Pre-Comparison group, and the Pre-Comparison group and the Post-Comparison group, they do not present the statistical significance of the net change.

**Table IV-1  
Difficulty Paying Energy Bills**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Observations	454	454		430	430		
Very hard or hard to pay energy bills	76%	49%	-26% ***	58%	52%	-6% **	-20% ***
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Observations	665	398		803	430		
How hard is it to pay your energy bills (1=very hard, 5=not at all hard)	2.18	2.88	-0.70***	2.61	2.80	-0.19	-0.51

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

Table IV-2 compares results from analysis of questions related to access to medical care. The table shows that the APPRISE analysis finds statistically significant net reductions in the percentage who could not afford to see a doctor of seven percentage points and who could not afford a prescription of ten percentage points. These results point to somewhat greater impacts than the ORNL analysis. However, it is important to note that the changes for the treatment group are very similar for the APPRISE and the ORNL studies.

**Table IV-2  
Access to Medical Care in the Past 12 Months**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Could not afford to see doctor	33%	23%	-10% ***	24%	21%	-3%	-7% **
Could not afford prescription	33%	21%	-10% ***	22%	21%	-1%	-10% ***
Had problems paying medical bills	40%	33%	-7% ***	33%	29%	-4% *	-3%
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Could not afford to see doctor	32%	24%	-8% ***	25%	21%	-4%	-4%
Could not afford prescription	33%	22%	-11% ***	24%	21%	-3%	-8%
Had problems paying medical bills	41%	32%	-9% ***	34%	29%	-5%	-4%

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

### B. Housing Unit Impacts

Table IV-3 compares results on mold and mildew. The table shows that the results for a mildew odor or musty smell are very similar, but the results for mold are somewhat different.

**Table IV-3  
Mold and Mildew**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Mildew odor or musty smell	29%	21%	-8%***	15%	16%	1%	-10%***
Mold	24%	19%	-5%**	17%	17%	-1%	-4%
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Mildew odor or musty smell	30%	21%	-9%***	16%	16%	0%	-9%
Mold	28%	19%	-9%***	19%	17%	-2%	-7%

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

Table IV-4 compares results with respect to insect or rodent infestation. The specific analyses conducted by APPRISE and ORNL are different. While APPRISE examines the change in the percent who report that the home is extremely or very infested and the percent that report the home is somewhat infested, ORNL examines the average rating. Both studies find statistically significant impacts in these indicators.

**Table IV-4  
Insect or Rodent Infestation**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Extremely/very infested with cockroaches, spiders, other insects	5%	2%	-3%**	2%	2%	0%	-3%**
Somewhat infested with cockroaches, spiders, other insects	19%	12%	-7%***	13%	15%	3%	-10%***
Extremely/very infested with rats or mice	2%	0%	-2%***	0%	1%	0%	-2%***
Somewhat infested with rats or mice	8%	6%	-2%	6%	6%	0%	-2%

ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
How infested is home with cockroaches, other insects, spiders (1=all the time, 4=never)	2.86	3.60	0.74***	3.50	3.60	0.10	0.64
How infested is home with mice (1=extremely infested, 5=not infested at all)	4.61	4.73	0.12**	4.37	4.32	0.05	0.07

### C. Occupant Comfort Impacts

This section compares results on occupant comfort. Table IV-5 shows that both APPRISE and ORNL find significant impacts on noise in the home when the windows are shut. However, APPRISE examines the percent of households who reported a great deal of noise and ORNL examines the average value of the rating.

**Table IV-5  
Levels of Noise with Windows Shut**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
A great deal of noise	28%	17%	-12%***	12%	12%	0%	-12%***
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Noise (1=great deal, 4=none at all)	2.07	2.37	0.30***	2.47	2.42	-0.05	0.35

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

Table IV-6 compares results with respect to draftiness. The table shows a reduction in draftiness was found in both studies. However, again a direct comparison cannot be made.

**Table IV-6  
Frequency of Draftiness**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Drafty all the time	12%	2%	-10%***	4%	3%	-1%	-9%***
Drafty most of the time	17%	4%	-12%***	4%	2%	-2%**	-10%***
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
How often home too drafty (1=all the time, 4=never)	2.86	3.60	0.74***	3.50	3.60	0.10	0.64

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

Table IV-7 compares the frequency of unsafe or unhealthy indoor temperatures. Both studies find an improvement in this indicator.

**Table IV-7**  
**Unsafe or Unhealthy Indoor Temperature**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Almost every month	3%	1%	-2% **	1%	1%	0%	-2%
Some months	8%	3%	-4% ***	3%	4%	1%	-6% ***
1-2 months	7%	2%	-5% ***	4%	4%	0%	-5% ***
Never	81%	93%	12% ***	91%	91%	0%	12% ***
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
How often home kept at unsafe or unhealthy temperature (1=almost every month, 4=never)	3.69	3.91	.22***	3.83	3.85	.02	.20

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

#### **D. Health Status Impacts**

This section compares results with respect to impacts on health status. Neither study finds a statistically significant net impact on the need for medical attention due to the home being too cold or too hot.

**Table IV-8**  
**Medical Attention Needed due to Home Temperature**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Needed medical attention because the home was too cold in the past year	3%	1%	-2% *	2%	1%	-1%	-1%
Needed medical attention because the home was too hot in the past year	2%	2%	-1%	1%	1%	0%	0%
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Needed medical attention because the home was too cold in the past year	3%	2%	-2%	2%	1%	-1%	0%
Needed medical attention because the home was too hot in the past year	2%	2%	-1% **	1%	1%	0%	-1%

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

Table IV-9 shows no significant impact on headaches in either study.

**Table IV-9  
Health Symptoms**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Headaches that are either new or more frequent or severe than ones you have had before in the past 3 months	17%	15%	-3%	13%	14%	0%	-3%
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Headaches that are either new or more frequent or severe than ones you have had before in the past 3 months	20%	16%	-4%	16%	14%	-2%	-2%

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

Table IV-10 shows that neither the APPRISE nor the ORNL studies found statistically significant net impacts on the prevalence of several medical issues.

**Table IV-10  
Prevalence of Medical Issues Verified by Doctor in the Past 12 Months**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Three or more ear infections per year	7%	7%	0%	6%	6%	0%	0%
Allergies	28%	31%	3%	21%	28%	7%***	-4%
The flu	21%	18%	-3%	16%	16%	-1%	-2%
Persistent cold symptoms more than 14 days	20%	14%	-6%***	17%	14%	-4%	-3%
Sinusitis	37%	33%	-4%*	34%	34%	0%	-4%
Bronchitis	24%	22%	-2%	22%	19%	-3%	1%
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Three or more ear infections per year	8%	7%	-1%	8%	6%	-2%	1%
Allergies	28%	31%	3%	24%	28%	4%	-1%
The flu	22%	18%	-4%	18%	16%	-2%	-2%
Persistent cold symptoms more than 14 days	21%	12%***	-9%	19%	14%	-5%	-4%
Sinusitis	37%	34%	-3%	35%	34%	-1%	-2%
Bronchitis	23%	22%	-1%	23%	19%	-4%	3%

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

Respondents were asked whether they were ever told by a doctor or health professional that they had asthma and if they answered affirmatively, they were asked whether they still had asthma. ORNL’s “Whole Asthma Sample” includes all respondents who reported that they still have asthma in either survey. The “Paired Sample” includes those who answered that they still had asthma in either survey and responded to both surveys. APPRISE examined the hospital visits for the full sample of respondents to both surveys, the same sample included in all other analysis tables.

Table IV-11 compares the APPRISE results for the full sample to the two ORNL samples. The table shows that while the ORNL estimates were greater than the APPRISE estimates, ORNL only found a statistically significant change for the Treatment Group “Whole Asthma Sample” with respect to emergency room visits. They do not report if the net change is statistically significant.

**Table IV-11**  
**Hospital Visits for Asthma in the Past 12 Months**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Overnight stay	3%	2%	-1%	1%	1%	0%	0%
Emergency visit	2%	2%	0%	3%	2%	0%	1%
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Overnight Stay – Whole Asthma Sample	14%	11%	-3%	7%	6%	-2%	-1%
Overnight Stay – Paired Sample	17%	11%	-6%	6%	6%	0%	-6%
Emergency Visit – Whole Asthma Sample	16%	4%	-12% **	19%	16%	-3%	-9%
Emergency Visit – Paired Sample	11%	4%	-6%	19%	17%	-2%	-4%

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

## V. Comparison of Benefit Valuation

This section compares the APPRISE and the ORNL benefit valuations. For all but one benefit valued by ORNL, APPRISE did not find a statistically significant net change in the indicator. In such cases, where the net change is not statistically significant, we assign the value of the indicator to \$0. It is important to note that there were many other statistically significant net changes found in the APPRISE study, but we only compare the valuation for the measures that ORNL includes in their analysis.

Table V-1 displays the gross and net changes in carbon monoxide (CO) detectors and CO poisoning. We found a large, statistically significant increase of 40 percentage points in the percent of respondents who had a working CO detector. However, no change was found in CO poisoning, a very rare occurrence.

**Table V-1**  
**WAP Impact on CO Poisoning**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Has working carbon monoxide monitors	44%	80%	36%***	76%	73%	-4%*	40%***
Poisoned by breathing in carbon monoxide, and therefore went to see a medical professional in the past 12 months	0%	0%	0%	0%	1%	0%	0%

ORNL did not include the estimates of these impacts from the WAP Occupant Survey in their report. They note that only five out of 2,291 households answered yes to the question as to whether they had been poisoned by CO. Therefore, both the APPRISE and the ORNL research find no evidence of WAP impacts on CO poisoning in the study. However, ORNL makes use of secondary data to estimate the incidence of CO poisoning based on CDC counts of low-income CO-related hospital visits relative to the population below 200 percent of poverty with combustion appliances. These incidences were then multiplied by the WAP population with combustion appliances. Additionally, ORNL uses data from a study comparing symptoms of CO poisoning and hospitalization among those with and without CO detectors to estimate the number of ER visits, hospitalizations, and deaths prevented. They use hospital costs and a \$7.5 million EPA Value of a Statistical Life to estimate the monetary benefits shown in Table V-2.

**Table V-2**  
**ORNL Monetization of Benefits Attributable to Reducing CO Poisoning**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Five Years	PV Per Unit Benefit Over Five Years
Households	\$12,815	\$0.16	\$65,642	\$0.78
Society	\$2,512,461	\$31.27	\$12,869,520	\$152.67
Total	\$2,525,276	\$31.43	\$12,935,162	\$153.45

Table V-3 presents the results from the APPRISE analysis of the change in smoke detectors and home fires. While we find a statistically significant net increase in the presence of working smoke detectors, there is no indication that there was a reduction in fires.

**Table V-3**  
**WAP Impact on Home Fires**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Has working smoke detectors	90%	97%	7%***	97%	96%	-1%	8%***
Fire department called to put out fire	1%	0%	-1%**	1%	0%	-1%**	0%
Fire from an alternative heating source	1%	1%	0%	1%	1%	0%	0%
Needed medical attention due to fire	0%	0%	0%	0%	0%	0%	0%

ORNL does not include the estimates of these impacts from the WAP survey in their report, except in a footnote. The footnote presents the following information, showing no measured impact from WAP on fires.

**Table V-4**  
**WAP Impact on Home Fires**

ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Fire department called to put out fire	1%	0%	-1%	1%	0%	-1%	0%
Fire from an alternative heating source	1%	1%	0%	1%	1%	0%	0%
Needed medical attention due to fire	0%	0%	0%	0%	0%	0%	0%

Therefore, both the APPRISE and the ORNL research find no evidence of WAP impacts on home fires in the study. However, ORNL makes use of secondary data to estimate the impact of WAP on fires. They use national fire data, categorize incidents based on whether they are preventable by weatherization, estimate frequency among low-income households and then WAP participants, and apply estimates to all WAP participants to estimate the number of fires prevented by WAP. They then monetize the benefits by estimating the cost of injuries and deaths due to these fires. ORNL's resulting monetary benefits shown in Table V-5.

**Table V-5**  
**ORNL Monetization of Benefits Attributable to Home Fires**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Five Years	PV Per Unit Benefit Over Five Years
Households	\$505,363	\$6	\$5,025,946	\$63
Society	\$6,205,939	\$77	\$61,719,426	\$768
Total	\$6,711,302	\$84	\$66,745,373	\$831

Table V-6 displays the studies' results with respect to WAP impact on medical attention needed because the home was too hot or too cold. APPRISE's net changes shown in Table V-6 were not statistically significant, and ORNL's measurements are approximately the same.

**Table V-6**  
**Medical Attention Needed due to Home Temperature**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Needed medical attention because the home was too cold in the past year	3%	1%	-2% *	2%	1%	-1%	-1%
Needed medical attention because the home was too hot in the past year	2%	2%	-1%	1%	1%	0%	0%
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Needed medical attention because the home was too cold in the past year	3%	2%	-2%	2%	1%	-1%	0% <sup>1</sup>
Needed medical attention because the home was too hot in the past year	2%	2%	-1% **	1%	1%	0%	-1% <sup>2</sup>

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

<sup>1</sup>Unrounded value is -0.5%.

<sup>2</sup>Unrounded value is -0.8%

Instead of using the net change in the table above, ORNL uses the following equation to develop estimates of 1.4 percent and 1.1 percent reductions in cold- and heat-related illnesses.

$$[(\text{Pre-treatment} - \text{Post-treatment}) + (\text{Pre-treatment-Comparison Group Pre})]/2$$

ORNL then monetized these changes based on costs of medical services and calculated the values shown in Tables V-7 and V-8.

**Table V-7**  
**ORNL Monetization of Benefits Attributable to Cold-Related Illnesses and Deaths**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Ten Years	PV Per Unit Benefit Over Ten Years
Households	\$153,855	\$1.91	\$1,530,119	\$19.04
Society	\$31,446,005	\$391.35	\$312,737,416	\$3,892.09
Total	\$31,599,860	\$393.26	\$314,267,535	\$3,911.14

**Table V-8**  
**ORNL Monetization of Benefits Attributable to Heat-Related Illnesses and Deaths**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Ten Years	PV Per Unit Benefit Over Ten Years
Households	\$122,236	\$1.52	\$1,215,668	\$15.13
Society	\$6,904,985	\$85.93	\$68,671,586	\$854.63
Total	\$7,027,221	\$87.45	\$69,887,254	\$869.76

Respondents were asked whether they were ever told by a doctor or health professional that they had asthma and if they answered affirmatively, they were asked whether they still had asthma. ORNL’s “Whole Asthma Sample” includes all respondents who reported that they still have asthma in either survey. ORNL uses the difference for this sample for the Treatment Group, a reduction of three percentage points in overnight hospital stays (not statistically significant) and a reduction of 12 percentage points in emergency room visits.

**Table V-9**  
**Hospital Visits for Asthma in the Past 12 Months**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Overnight stay	3%	2%	-1%	1%	1%	0%	0%
Emergency visit	2%	2%	0%	3%	2%	0%	1%
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Overnight Stay – Whole Asthma Sample	14%	11%	-3%	7%	6%	-2%	-1%
Emergency Visit – Whole Asthma Sample	16%	4%	-12% **	19%	16%	-3%	-9%

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

ORNL uses the Treatment Group results, applies these results to the WAP population, and monetizes the results using average hospital costs. Their results are shown in Table V-10.

**Table V-10**  
**ORNL Monetization of Benefits Attributable to Reduction in Asthma Symptoms**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Ten Years	PV Per Unit Benefit Over Ten Years
Households	\$1,269,965.20	\$15.75	\$12,630,082.45	\$156.66
Society	\$15,133,735.38	\$186.25	\$150,508,316.98	\$1,852.28
Total	\$16,403,700.58	\$202.00	\$163,138,399.42	\$2,008.93

Table V-11 compares APPRISE and ORNL results with respect to days of not enough sleep in the past 30 days. It is not clear why the post-treatment estimates differ to such a large extent. While APPRISE does not find a change in the percent with sleep problems, ORNL finds a large change.

**Table V-11**  
**Days of Enough Sleep in the past 30 days**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Not Enough Sleep							
1-15 days	36%	34%	-2%	39%	39%	0%	-2%
16-29 days	10%	9%	<-1%	8%	7%	-1%	0%
All 30 days	20%	21%	1%	16%	16%	<-1%	2%
Percent with sleep/rest Problems (sum of above)	66%	64%	-2%	63%	62%	-1%	-1%
Number of days did not get enough rest or sleep last month	11.1	11.1	0	10.0	9.4	-0.5	0.6
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Percent with sleep/rest problems	66%	29%	-37%***	60%	33%	-27%***	-10%
Number of days did not get enough rest or sleep last month	11.7	6.6	-5.1***	9.7	5.0	-4.7***	-0.4

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

Instead of using the net change of ten percent shown in the table above, ORNL uses the following equation to develop an estimate of a 21.4 percentage reduction in respondents reporting no sleep problems.

$$[(\text{Pre-treatment} - \text{Post-treatment}) + (\text{Pre-treatment-Comparison Group Pre})]/2$$

ORNL monetizes the impact on work productivity using data on lost productivity for employees with sleep problems from an independent study and the percent of respondents who are employed full time.

**Table V-12A**  
**ORNL Monetization of Benefits Attributable to Increased Work Productivity**  
**(Improved Sleep)**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Ten Years	PV Per Unit Benefit Over Ten Years
Total (society)	\$14,650,178	\$182.33	\$145,699,236	\$1,813

ORNL monetizes the impact on housework productivity using data on lost productivity for employees with sleep problems from an independent study, hourly wages for housework, and average number of hours spent on housework.

**Table V-12B**  
**ORNL Monetization of Benefits Attributable to Increased Housework Productivity**  
**(Improved Sleep)**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Ten Years	PV Per Unit Benefit Over Ten Years
Total (households)	\$10,740,521	\$133.67	\$106,816,837	\$1,329

Table V-13 displays changes in the number of missed days by the primary wage earner due to illness or injury. The table shows significant differences between the APPRISE and ORNL estimates but the cause of the differences is not clear. However, neither study finds statistically significant changes.

**Table V-13**  
**Work Days Missed by Primary Wage Earner Due to Illness or Injury**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Own Illness/Injury	1.59	1.87	0.27	1.73	2.28	0.55	-0.28
Other HH Member Illness/Injury	0.34	0.28	-0.06	0.37	0.53	0.16	-0.21
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Own Illness/Injury	5.85	6.01	0.16	5.93	8.42	2.49	-2.33
Other HH Member Illness/Injury	1.82	1.03	-0.79	1.33	2.43	-1.10	0.31

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

Instead of using the net change in the table above, ORNL uses the following equation to develop an estimate of .52 fewer missed days of work.

$$[(\text{Pre-treatment} - \text{Post-treatment}) + (\text{Pre-treatment-Comparison Group Pre})]/2$$

Based on that reduction, the percent of WAP households with an employed primary wage earner, the average hourly wage based on an independent study, and eight hours of work per day, ORNL computes the following benefits.

**Table V-14**  
**ORNL Monetization of Benefits Attributable to Fewer Missed Days at Work**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Ten Years	PV Per Unit Benefit Over Ten Years
Households	\$1,301,972	\$16.20	\$12,948,405	\$161.15
Society	\$325,493	\$4.05	\$3,237,101	\$40.29
Total	\$1,627,466	\$20.25	\$16,185,507	\$201.43

Table V-15 displays the analysis of the use of short-term high-interest loans. The table shows no statistically significant net changes in the use of these loans in either analysis.

**Table V-15**  
**Short-Term High-Interest Loans**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Payday Loan	4%	4%	<1%	3%	3%	-1%	1%
Tax Refund Anticipation Loan	5%	4%	-1%	3%	2%	-1%	1%
Car Title Loan	1%	1%	<-1%	1%	2%	<1%	<-1%
Pawn Shop	7%	5%	-2%*	4%	3%	<-1%	-2%
Other Short-Term, High Interest Loan	2%	2%	0%	2%	2%	<1%	<-1%
Any of the Above	15%	13%	-2%	9%	9%	<-1%	-2%
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Payday Loan	5%	4%	-1%	4%	3%	-1%	0%
Tax Refund Anticipation Loan	6%	4%	-2%	4%	2%	-2%	0%
Car Title Loan	2%	1%	-1%	2%	2%	0%	-1%
Pawn Shop	8%	4%	-4%**	5%	3%	-2%	-2%
Other Short-Term, High Interest Loan	3%	3%	0%	2%	2%	0%	0%

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

ORNL estimates the change using the average method described above and derive a total reduction (of all types of these loans) of nine percentage points. They estimate the value of the

benefit based on the average loan amount and average interest amounts from an external source to develop the monetized estimates shown in Table V-16.

**Table V-16**  
**ORNL Monetization of Benefits Attributable to Fewer Missed Days at Work**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Ten Years	PV Per Unit Benefit Over Ten Years
Total (households)	\$572,000	\$7.12	\$5,700,000	\$70.77

Table IV-17 displays the change in ability to afford prescriptions. Both studies find a statistically significant impact on this measure. The net change measured by APPRISE is a ten percentage point reduction in the percent who could not afford their prescription.

**Table V-17**  
**Ability to Afford Prescriptions**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Could not afford prescription	33%	21%	-10%***	22%	21%	-1%	-10%***
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Could not afford prescription	33%	22%	-11%***	24%	21%	-3%	-8%

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

APPRISE estimates the monetized benefit as follows.

- Spending in the U.S. for prescription drugs was \$234.1 billion in 2008<sup>3</sup> and there were 116.78 households in the U.S. in 2008, resulting in an average cost of \$2,005 per household.
- The WAP survey found that 75 percent of participants had health insurance coverage.
- The Kaiser study found that individuals with health insurance paid 24 percent of their prescription costs.<sup>4</sup>
- A Mayo Clinic study found that only 50 percent of the population takes their prescriptions as prescribed.<sup>5</sup>

<sup>3</sup> Kaiser Family Foundation. Prescription Drug Trends. May 2010.  
<https://kaiserfamilyfoundation.files.wordpress.com/2013/01/3057-08.pdf>

<sup>4</sup> Ibid.

<sup>5</sup> Brown and Bussell. Medication Adherence: WHO Cares? Mayo Clinic Proceedings. April 2011.  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3068890/>

- We estimate the average cost per household as 25 percent times the full prescription amount plus 75 percent of the 24 percent of costs that insured individuals pay. Therefore, we estimate the average prescription cost as follows.
- Average Prescription Cost =  $(\$2005 \times .25) + (\$2005 \times .75 \times .24) = \$862$
- Benefit =  $(\% \text{ afford prescriptions}) \times (\text{Prescription } \$) \times (\% \text{ take prescriptions as prescribed})$   
 $= 10\% \times \$862 \times 50\% = \$43$

Taking the present discounted value of that benefit over 15 years with a five percent discount rate, we estimate a lifetime value of \$446.

ORNL computes a value of ten percent for the reduction in household who cannot afford prescriptions using the averaging methodology described above. Based on this value, an estimate of the cost of patients not taking their prescription medications, an estimate of the number who should be taking medications, and the prescription compliance rate, they monetize the benefit as shown in the table below.

**Table V-18**  
**ORNL Monetization of Benefits Attributable to Prescription Affordability**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Ten Years	PV Per Unit Benefit Over Ten Years
Total (society)	\$15,587,079	\$193.98	\$155,016,925	\$1,929.22

Table V-19 displays changes in the ability to afford food. APPRISE analyzed the data for all respondent households and ORNL analyzed the data for households containing females of childbearing age. Neither analyses find a significant difference in the measure.

**Table V-19**  
**Ability to Afford Food**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Household could not pay energy bills at least every few months to pay for food.	23%	17%	-5%**	13%	11%	-1%	-4%
Household could not buy food at least every few months to pay for energy bills	13%	10%	-4%**	8%	8%	-1%	-3%
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Household with female of child-bearing age traded off energy bills for food.	53%	44%	-9%	31%	21%	-10%	1%

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

ORNL notes that the treatment and comparison group differences are not statistically significant but estimates a reduction of 15.5 percent using their averaging approach. Based on this reduction, the expected number of births, and the percent of births expected to be low birth weight, they estimate the monetized benefits shown in Table V-20.

**Table V-20**  
**ORNL Monetization of Benefits Attributable to Food Affordability**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Ten Years	PV Per Unit Benefit Over Ten Years
Total (society)	\$1,600,298	\$19.92	\$15,915,321	\$198.07

Table V-21 displays the change in Food Stamps and WIC assistance. There is a difference between the APPRISE and the ORNL estimates shown in the table.

**Table V-21**  
**Food Stamps and WIC Assistance**

APPRISE Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Received Food Stamps or WIC	54%	49%	-5% **	52%	50%	-2%	-3%
ORNL Study	Treatment Group			Comparison Group			Net Change
	Pre	Post	Change	Pre	Post	Change	
Received Food Stamps or WIC	56%	50%	-6% **	50%	50%	0%	-6%

Statistical significance at the \*\*\*99 percent, \*\*95 percent, and \*90 percent levels.

ORNL estimates the difference as six percentage points using their averaging approach. Based on this change and the average annual food assistance subsidy, they monetize the benefit as shown in Table V-22.

**Table V-22**  
**ORNL Monetization of Benefits Attributable to Reduced Food Assistance**

ORNL Study Beneficiary	First Year Program Benefit	First Year Per Unit Benefit	PV Program Benefit Over Ten Years	PV Per Unit Benefit Over Ten Years
Total (society)	\$6,723,000	\$84	\$66,862,000	\$832

Table V-23 provides a comparison of the impact estimates and the monetization for all of the benefits monetized in the ORNL report. While ORNL estimates a total one-year value of \$1,439, APPRISE estimates a total one-year value of \$43 because the only significant net impact was the prescription affordability.

**Table V-23**  
**APPRISE and ORNL Monetization of WAP Benefits**

Benefit	Reduction Estimate		Per Unit Monetization Estimate			
			First Year		Lifetime	
	APPRISE	ORNL	APPRISE	ORNL	APPRISE	ORNL
CO Poisoning	0%	No Report	\$0	\$31.43	\$0	\$153.45
Home Fires	0%	0%	\$0	\$84	\$0	\$831.00
Cold-Related Illness/Death	1%	1%	\$0	\$393.26	\$0	\$3,911.14
Heat-Related Illness/Death	0%	1%	\$0	\$87.45	\$0	\$869.76
Asthma Emergency Dept. Visits	1%	12%	\$0	\$202.00	\$0	\$2008.93
Sleep Problems/Work Productivity	1%	21%	\$0	\$182.33	\$0	\$1,813
Sleep Problems/Housework Productivity	1%	21%	\$0	\$133.67	\$0	\$1,329
Missed Days of Work	.49	.52	\$0	\$20.25	\$0	\$201.43
Short-Term Loans	2%	9%	\$0	\$7.12	\$0	\$70.77
Prescriptions Affordability	10%***	10%	\$43	\$193.98	\$446	\$1,929.22
Food Affordability	4%	16%	\$0	\$19.92	\$0	\$198.07
Food Assistance	3%	6%	\$0	\$84	\$0	\$832
<b>Total Benefit</b>			<b>\$43</b>	<b>\$1,439</b>	<b>\$446</b>	<b>\$14,148</b>

Statistical significance at the \*\*\*99 percent.

## VI. Findings and Recommendations

This study examined the methodologies used by ORNL and APPRISE to explain why the studies find different results. While there are many differences in the approaches used, the most significant differences in terms of valuing the non-energy benefits is that ORNL monetizes changes that are not statistically significant or uses secondary data when the differences measured in the Occupant Survey are small. APPRISE does not assign a value to these benefits that are not measured as statistically significant in the Occupant Surveys.

It is important to note that APPRISE found several statistically significant changes in net indicators in the WAP Occupant Survey that are not monetized by ORNL. These changes include affordability of energy bills, running out of a delivered fuel, presence of pests, mold and moisture, noise, draftiness, indoor winter and summer temperatures, unsafe or unhealthy indoor temperatures, affordability of medical care, days of poor physical health, and presence of home safety devices. Future research should provide a monetization for these benefits.

Additionally, more research of this kind is needed to assess these findings and to further estimate the impact of energy efficiency on non-energy impacts. Because such findings may be used in cost-effectiveness tests and impact the level of energy efficiency investments, it is critical to conduct additional studies that provide verification or refutation of these results.

Certain impacts are expected to be greater in specific populations, and additional study is needed for subpopulation groups. For example, elderly, disabled, and individuals with asthma are more likely to be impacted by reductions in mold and mildew and improvements in indoor air quality. Therefore, programs that focus on these households may have greater health impacts. Additionally, our research found that certain impacts were more pronounced in some climate zones, so differential impacts are expected when an individual state or utility territory is studied.

Non-energy benefits are real and they can be significant. While it can be challenging to estimate and monetize these benefits, it is important to do so. Furthermore, it is critical to present the results in a clear and transparent manner and to only claim benefits that have been measured.