Home Energy Efficiency and Health: Connections for Vulnerable Populations

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INTRODUCTION AND BACKGROUND

Economic, environmental and societal forces contribute substantially to our health – as much as, studies show, or more than genetics, individual behavior and access to healthcare.[1] Examples of these **Social Determinants of Health** include quality of housing and schools, access to healthy foods, living-wage jobs, transportation mobility, environmental exposures to pollution and other hazards, availability of social support networks and community safety.[2]

Energy, too, is an important social determinant of health including its source, generation, transmission and delivery, mode of use, cost, and associated wastes and emissions. One of the most direct influences on individual and family health is the home environment, so changes that are made to make homes more energy efficient can have direct and indirect impacts on those living in the house. It could be direct, such as whether ventilation is adequate to prevent the buildup of indoor pollutants, or indirect, such as when households pay disproportionate amounts for energy bills which, in turn, may affect the availability of resources to support healthy living such as food, quality housing and healthcare (US DOE, 2018).

Rutgers scholars have been at the forefront of promoting **Health in All Policies (HiAP)** as a collaborative approach to reducing disparities and improving the health of all communities and people by incorporating health considerations into decision-making across sectors and policy areas.[3] In this report, as part of our continuing HiAP efforts in New Jersey, we present highlights related to home energy efficiency from a desktop Health Impact Assessment of New Jersey's Draft Energy Master Plan (EMP) that we prepared in August of 2019 that offered a "health lens" through which to view some of the potential impacts of implementing elements of the EMP.[4] The analysis focuses on health equity, or the concept of equitable access to conditions and resources that allows one to live the healthiest life possible. It pays strong attention to impacts on populations and communities that may already suffer disproportionate health, social, environmental, and economic inequities, which may be exacerbated by proposed home energy efficiency programs.

This brief report is not intended to be comprehensive or exhaustive in its presentation, but rather to summarize some of the recent scientific literature that connects energy efficiency to health, and to present a set of insights informed by these findings. We consider it a start rather than a finish. It scratches the surface of this topic and certainly points to vast opportunities to further explore the ways in which the goals, contents and implementation of policies and programs to improve energy efficiency can influence the health and well-being of New Jersey's most vulnerable residents.

Below we first include brief explanatory background and definitions related to cross-cutting themes that are important to this topic and this analysis.

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[1] http://www.countyhealthrankings.org/what-is-health

[2] https://www.cdc.gov/socialdeterminants/

[3] https://www.cdc.gov/policy/hiap/index.html

[4] Lowrie, K and L.A. Von Hagen. 2019. *The New Jersey Energy Master Plan: Opportunities to Integrate Health and Health Equity.*

Fuel Poverty: This term refers to the tradeoffs that can occur in a household between paying for heating or cooling and paying for other household essentials like food, rent or clothing. As Hernandez (2016) writes: "The "heat or eat" dilemma demonstrates the trade-offs that low-income householders make in order to meet the basic necessities of life whereby at-risk groups are forced to decide between food and energy, often sacrificing one for the other.

Fuel poverty is connected to energy inefficient buildings and poor quality housing that is expensive to heat, and disproportionately affects low-income households (Hernandez et al., 2014, 2016). It can be particularly dangerous for the elderly in times of extreme heat or cold, and can create food insecurity or hunger, which can negatively affect the early growth and development of young children (NEADA, 2011; Franke and Nadler, 2019). Because of necessary budget trade-offs, a lower-income family might not address other housing hazards like pests, water leaks and mold, creating unhealthy living environments.

The implications of any program or policy implemented from the Energy Master Plan on fuel poverty will determine whether the health outcomes associated with fuel poverty are more or less likely. If costs for residential heating, cooling and other household energy needs increase as a result of a new initiative, for example, those costs will account for a higher percentage of household budgets, creating more fuel poverty and creating health impacts disproportionately greater on poorer households. An energy efficiency program for fuel poor households, on the other hand, for example, can potentially positively impact wellbeing, quality of life, financial stress and comfort (Curl and Keans, 2017; Grey et al, 2017; Liddell and Guiney, 2015; Maidment et al, 2015).

A related term, "**energy insecurity,"** is defined as "an inability to adequately meet basic household energy needs." Energy insecurity is an important contributor to chronic stress in low-income households (Hernandez, 2016; Curl and Kearns, 2017).

Energy Justice: An emerging concept related to energy planning is "energy justice," a framework that focuses on how costs and benefits of an energy system are distributed throughout society (distributive justice), and on representative decision-making (Sovacool 2016; Sovacool, 2019). Jenkins et al (2018) define it normatively as a "world where all individuals, across all areas, have safe, affordable and sustainable energy that is, essentially, socially just."

Other scholars have referred to the "three A's" of energy systems: availability, accessibility and affordability. Availability indicates the technical availability of a particular form of energy; accessibility is the opportunity to access it and its associated services; and affordability is the capacity of all populations to afford the energy services (Johansson and Goldemberg, 2002; Reddy, 1985).

Health Equity: Health equity is "the principle underlying a commitment to reduce—and, ultimately, eliminate—disparities in health and in its determinants, including social determinants. Pursuing health equity means striving for the highest possible standard of health for all people and giving special attention to the needs of those at greatest risk of poor health, based on social conditions." By focusing on both health disparities as well as the social, physical and economic determinants of health, efforts to advance health equity include policies, programs and strategies to address underlying factors like

structural racism that unjustly and unfairly preclude people from access to the systems and conditions that support health and well-being. (Braveman, 2014).

LITERATURE REVIEW: PROJECTED HEALTH IMPACTS

The report that follows is a modified section from the larger New Jersey EMP study mentioned in the introduction. That study featured a modified version of a methodology developed for a new initiative piloted at Johns Hopkins University with support from the Health Impact Project[5] called "Health Notes."[6] An expedited review of research identified studies that seek to explain how energy efficiency measures could affect the social determinants of health, with a particular emphasis on health equity.

Research Question

How will ***energy efficiency programs*** impact health outcomes, with a particular emphasis on populations that are most vulnerable to potential impacts?

Conceptual Model: Health Pathways

The conceptual model is a depiction of the pathway from the implementation of an activity to its ultimate effects on human health. The model's first column describes the "**Program Components**." The next column lists "**Direct Impacts**" that can be expected as a result of implementation of the component. These are the changes in society, the economy or the environment that are reasonably expected to happen as a result of plan implementation. The next column "**Intermediate Impacts**" are the changes to social determinants of health that are hypothesized to occur – either positively or negatively (the direction of the changes are based on the finding of the literature review). Thus they are written as "changes" and not as "increases" or "decreases." The key objective of the literature review is to understand the linkages between the direct impacts of plan components and intermediate impacts. Finally, the "**Health Outcomes**" column displays the ways that those determinants listed in the prior column affect human health as ultimate physical or mental health outcomes. Many of these linkages are well-established in literature.

[5] A collaboration of the Robert Wood Johnson and the Pew Charitable Trusts (www.healthimpactproject.org).
[6] Policy Tools to Address the Social Determinants of Health. Keshia M. Pollack Porter. June 5, 2018. Available at: https://www.jhsph.edu/research/centers-and-institutes/health-services-outcomes-research/_images/Materials/Policy%20Tools%20to%20Address%20the%20Social%20Determinants%20of%20Health.pdf

Conceptual Model – Home Energy Efficiency and Health

Program Component	Direct Impacts/Changes	Primary Intermediate Impacts	Health Outcomes
MAXIMIZE ENERGY EFFICIENCY IN HOMES OF LOW-INCOME, MINORITY, AGING OR DISABLED HOUSEHOLDS	Change in energy efficiency in homes of low-income families	Change in housing quality and safety Change in indoor air quality Change in housing affordability Change in utility costs Change in disposable income	Change in income-related health outcomes, such as chronic disease and mental health Change in health outcomes associated with healthy home temperature Change in health outcomes associated with indoor air quality

Methodology: Literature Review Process

Based on the model and research question, a set of search terms was developed. We searched for studies that examined the connection between the direct and indirect impacts and the health determinants. (e.g. Energy Efficiency and Indoor Air Quality, etc.). Searches were conducted using platforms available through the Rutgers Library system including EBSCO and PubMed. Individual sector-specific journals were also searched (*Energy Policy*, *Energy Journal*). The team attempted to find systematic reviews or meta-analyses, whenever possible. We only included studies conducted in the past five years, unless we determined it to be key research through reference review, and we also focused only on studies published in English, and those that closely related to the research questions

As a supplementary search, we also consulted key pieces of grey literature (nonsystematic research, U.S. agency and nongovernmental organization reports and publications), and also some Health Impact Assessment (HIA) reports from the national database (available at www.healthimpactproject.org).

It is important to note that although we attempted to find key pieces of literature, we were limited in time and thus had to make choices that may have resulted in missing some important pieces of literature, such as using only two main search engines for generation of results. We also did not, for example, look comprehensively at the reference lists of included papers to find additional key literature.

Literature Review Summary Findings

We first list some of the major findings in answer to the research question, followed by a narrative summary of key literature identified:

How will ***energy efficiency programs*** impact health outcomes, with a particular emphasis on populations that are most vulnerable to potential impacts?

- If properly implemented alongside ventilation, energy efficiency retrofits in housing can improve health by reducing exposure to cold/heat and outdoor air pollutants.
- Weatherizing without maintaining proper ventilation can negatively affect indoor air quality through trapping of toxic chemicals and lead to build up of moisture and mold. Groups at high risk of these adverse health effects include the elderly (especially those living on their own),

individuals with pre-existing illnesses, people living in overcrowded accommodation, and the socioeconomically deprived.

- Energy efficiency programs in low-income communities can improve well-being and mental health, as the home is perceived as more of a safe haven, particularly for households who suffer disproportionately from housing-based hazards.
- Energy efficiency retrofits can accomplish a co-benefit of addressing other health and safety hazards in homes.
- Energy efficiency improvements should save money for lower-income households, but can also result in increased cost to homeowners if rents or other costs/rates increase, negating the savings that could have been created from reduced energy usage.

Energy-efficiency measures aimed at retrofits of existing housing include sealing the building envelope, increasing thermal insulation, and changing windows. A number of studies have found that investments in warmth and energy efficiency improve housing conditions, reduce fuel costs, and increase comfort and a sense of pride in one's home, which then lead to direct and indirect improvements in general health, respiratory health and mental health (Curl and Kearns, 2017; Hernandez, 2016; Grey et al, 2017; Chen and Chen, 2019; Free et al, 2010; Berry and Davidson, 2015).

Homes that are not energy efficient can be drafty and cold. The literature shows that these conditions and low indoor temperatures are commonly associated with a wide range of negative health consequences, including an increased risk of strokes, heart attacks and respiratory illnesses, as well as with common mental disorders (Grey et al, 2017; Hernandez, 2016). Groups at high risk of these adverse health effects include the elderly (especially those living on their own), individuals with pre-existing illnesses, people living in overcrowded accommodation, and the socioeconomically deprived (Vardoulakis et al, 2015). Renters are at a significant disadvantage when landlords have little incentive to improve older, less efficient building systems and appliances particularly when the onus of payment falls on the tenants (Hernandez, 2016

A review of studies on energy efficiency and their impact on health found that recipients on low incomes saw greater improvements in health following energy efficiency interventions, supporting the inclusion of energy efficiency measures in strategies to tackle social issues like fuel poverty and health inequity. People with low incomes or, particularly, poor health are starting from a lower baseline of health, and also tend to spend more time in their homes. For both of these reasons, it is likely that they will benefit more from any improvement to the indoor environment (Maidment et al, 2014). A possible concern related to fuel poverty, though, is that even if energy use is reduced, either utility rates or rent can go up, adding pressure to household budgets and negating potential gains from reduced energy usage (Copiello, 2015).

Another benefit of energy efficiency programs, studies have found, is an increase in general well-being, and self-reported improved respiratory health and fewer missed work days after energy retrofits, regardless of actual indoor environmental quality improvements, suggesting a subjective component (Grey et al, 2016; Haverinen-Shaughnessy, 2018).

Energy efficiency measures, however, can come with unintended consequences. Insulating a building and sealing its envelope, especially in combination with energy-efficiency measures to reduce the air flow rates, could lead to unhealthy indoor environments. In general, thicker thermal insulation might lead to built up moisture and increase the risk of mold growth (Wierzbicka et al, 2018; Mundt-Peterson, 2015). Chronic exposure to damp in dwellings is associated with important health risks and mainly respiratory problems as asthma and allergies (Kolokotska, 2015). Air-tightening with inadequate

ventilation in buildings allows accumulation of pollutants indoors (e.g. gas, smoke, radon, chemicals in building materials and consumer products such as formaldehyde and VOC's), highlighting the need to consider indoor pollution in assessments of exposure and possible health effects after energy efficiency retrofits (Hamilton et al, 2015; Morawska et al, 2017; US EPA; Vasiliyev et a., 2016; Milner et al, 2014; Vardoulakis et al, 2015).

To reduce indoor air quality problems and potentially improve health, careful selection of indoor building materials and ensuring sufficient ventilation are important for achieving the expected health benefits from retrofits and for green building designs. (Coombs et al, 2016; Hamiliton et al, 2015). However, refurbished or newly built sealed homes with optimized ventilation may still lead to lower ventilation rates than intended due to occupant interventions, for example, closing windows to reduce noise. Effective communication strategies focusing on awareness and perception of risk may help address indoor air quality issues. This must be supported by improved household energy efficiency with the provision of more effective heating and ventilation strategies, specifically to help alleviate those suffering from fuel poverty (Sharpe et al, 2015; Mari-Dell'Olmo et al, 2017). US EPA stresses that residents need to have fresh air ventilation systems, radon testing, and training on identifying and isolating other pollutants in homes that could build up to unsafe levels.

INCORPORATING HEALTH AND HEALTH EQUITY INTO HOME ENERGY EFFICIENCY PROGRAMS

This section outlines potential opportunities for enhancing positive health impacts and mitigating negative health impacts during the development and implementation of home energy efficiency programs

Key Overall Opportunities:

- **Promote Energy Efficiency** – Given its limited scope, this study looked only at efficiency retrofits on existing housing. However, in general, improving energy efficiency generally in all sectors of society (business, industry, government) is expected to be a big win for health particularly for low-income residents. Health benefits come in the form of reduced emissions from power plants, improved condition and safety of residences, reduced expenditures on energy, as well positive impacts from contributions to local economies. While New Jersey was ranked 18th nationally in the American Council for an Energy Efficient-Economy's annual ranking of state energy efficiency programs for 2018, it was also identified as most improved for the same year. Continuing to expand on the state's improvements would appear to offer opportunities for health as well (Berg et al, 2018).
- **Monitor and Evaluate Health Impacts** – Implementation of a new efficiency program presents an excellent opportunity to institute a process of evaluation of health impacts. This could involve identification of expected impacts through an HIA or checklist (see below), collection of relevant baseline data for affected populations, and tracking of changes through time. This would contribute to general knowledge about health impacts of energy programs, and also help energy agencies to better understand co-benefits and costs, and modify implementation to either enhance those co-benefits or reduce costs and negative impacts.
- **Consider Health Impact Assessment (HIA**) - As implementation begins, lead agencies can look toward Health Impact Assessments as a way to bring health to the table as part of the decision-

making process in several ways: engaging health professionals in the discussion, using available tools/literature/science to project the magnitude and distribution of direct and indirect health outcomes. HIA is a nationally recognized, evidence-based approach that is designed to consider potential health outcomes during the decision-making process so modifications can be made to promote positive health outcomes and mitigate negative ones. By design, HIA has a strong focus on engaging the populations most affected by a decision, including populations and communities that are under resourced and traditionally under represented.

- **Use Health Checklist** - If there is not sufficient time or resources to conduct a full or rapid HIA study prior to implementing elements of programs, phases of future planning, design and implementation could be reviewed for health impacts by use of a health and health equity checklist in consultation with the public health sector. Below for consideration are questions that could serve as a model template. Examples are available nationally that could serve as a foundation for efforts in New Jersey.

Health and Health Equity Checklist for Evaluation of Energy Projects

Checklists are practical tools to assist with evaluating the impacts of implementation of plans, policies, projects and programs. The following set of questions related to potential health impacts of energy efficiency programs is not an exhaustive list, rather it is provided as a starting point for consideration. A more exhaustive checklist could be developed through a rigorous process including a cross-sector collaboration of health, economic, energy and environmental organizations with input from community-based organizations that represent environmental justice communities.

Health and Health Equity Checklist for Energy Efficiency Programs: Model

1. Is there explicit language connecting the project to human health outcomes or health equity considerations?
2. How is the project including public health experts in the decision-making process?
3. How is the project engaging local stakeholders and how often? Does the public engagement reflect the diversity of the community and reduce barriers to participation (e.g. provide food, childcare, transit-access, translation)?
4. What are the socioeconomic characteristics of the affected community? Will the project be located in a community that already suffers from a disproportionate environmental burden?
6. How will the project affect utility costs and other household expenses? How will this affect low-income populations?
7. What types of and how many jobs will be provided (e.g. temporary or permanent; high-skill or low-skill, benefits available)? Where will hires come from?
8. What are the sources, levels and types of program-related air pollution – both outdoor and indoor? How will air emissions be monitored? What populations will be most affected by the exposure?
9. How will the current background noise level change with the addition of this program?

Specific Opportunities to Integrate Health and Health Equity into Energy Efficiency Programs:

- Housing energy efficiency interventions that promote warmth, adequate cooling and energy savings and that include adequate ventilation systems are a significant opportunity to positively influence health outcomes, and addresses health equity if prioritized for populations living in sub-standard quality housing.
- Literature suggests that it is important for energy efficiency programs implemented in buildings occupied by vulnerable households to include education of households about maintenance of ventilation systems, cooking habits and other factors affecting the health of the indoor living environment.
- To protect against the threat of utility disconnection and increasing fuel poverty, rebates or financial assistance can protect low-income households from rent increases resulting from efficiency upgrades.
- If possible, there is an opportunity to track health impacts and learn more about maximizing the benefits of energy efficiency upgrades by monitoring homes that are weatherized with regard to the health of the indoor environment, including indoor air temperature, indoor relative humidity and indoor CO2 concentrations, and resident health outcomes.
- Energy efficiency programs provide an opportunity to also perform priority health/safety repairs at the same time as energy upgrades, addressing inequities by giving priority to repairs that improve both health/safety and energy efficiency in substandard housing.
- Agencies and organizations implementing weatherization or energy efficiency upgrades in homes and schools can assure attention to optimal installation and functioning of the system by following the US EPA's comprehensive IAQ guidelines. (See https://www.epa.gov/indoor-air-quality-iaq/energy-weatherization-and-indoor-air-quality).

Concluding Comments:

We hope this study and its related insights will assist decision-makers in considering how to maximize benefits to health and health equity in moving forward with energy efficiency programs in New Jersey. Our team of Rutgers University researchers stands ready to help in continuing study and application of these opportunities. The state's public health leaders actively support the concept of Health in All Policies in New Jersey, including in the energy sector, opening up opportunities for building cross-sector partnerships to advance efforts to more systematically consider health and health equity outcomes of energy policy and planning in New Jersey.

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