

Linking Home Energy Insecurity to the Built Environment and Population Health in Memphis

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Specific Aims

Many low-income householders in the US are experiencing a phenomenon called “energy insecurity.”¹ Energy insecurity refers to the inability to adequately meet household energy needs, such as utility shut-off, refusal to deliver heating fuel, unheated or uncooled days due to inability to pay utility bills, and use of a cooking stove as a source of heat.² Energy-insecure householders, in particular, their young children, are most likely to suffer from food insecurity and poor health, hospitalizations, and developmental risks,³ and thus face the “heat or eat” dilemma. The concept of energy insecurity merits far more attention given its widespread prevalence and its ties to housing instability, food insecurity, and health as well as a growing interest in energy solutions within the policy realm. However, energy security has rarely been measured, and this data gap hinders further understanding of the associated environmental and health disparities. At the local scale, Memphis (and Shelby County) has long been challenged with high rates of poverty and unemployment, low rates of health insurance, poor housing conditions, and high rates of health disparities.⁴ Research is warranted to position energy insecurity as a major public health concern with potential to fuel scalable policy changes.

The overall goal of this proposed study is to collect home energy insecurity (HEI) data in Memphis and assess the linkage of HEI with the built environment and health. There are three specific aims:

Aim 1: Develop an online HEI survey tool and collect HEI data from 150 homes in Shelby County. We will develop a web-based, user friendly HEI survey questionnaire based on an existing survey website. We will then administer this HEI survey to 150 homes that are located in 50 census tracts and 38 zip codes in Shelby County, TN.

Aim 2: Determine the effects of area-based socioeconomic status (SES) and racial variables on HEI. We are studying these determinants in a region with a gradient of SES to best characterize drivers of HEI disparities and to directly inform targets for future mitigation at the household level.

Aim 3: Assess associations of HEI with population health. We will examine whether HEI is associated with zip code level health outcomes, including mortality, cancers, cardiovascular diseases, respiratory diseases, emergency room visits, and hospitalization.

A secondary objective of this study is to suggest interventions, programs, and policies to improve energy security, the built environment, and health status in Memphis. We also aim to develop lessons learned, best practices and other resources to support scale up of effective HEI assessment regionally and nationally. This project will involve multiple housing stakeholders including government agencies, residents, health researchers, engineers, community housing advocates, and property owners/managers. We will disseminate results in academic and housing trade outlets.

Background and Significance

Energy insecurity refers to the inability to adequately meet household energy needs and is marked by three dimensions- economic, structural and behavioral.¹ Low-income households experience the greatest economic burden as energy expenditures often exceed 10 percent of household income. Likewise, the structural deficiencies in older, outdated homes result in less comfort, inefficiencies and higher expenses to cool, warm and maintain homes. The behavioral aspects of energy insecurity reflect coping strategies such as vigilance over the thermostat, partial bill payments and the use of supplemental heating sources such as stoves and space heaters. A key barrier to adopting home energy efficiency and weatherization measures includes high up-front costs.⁵ Energy efficiency benchmarking in urban areas has indicated that the least-efficient residential buildings were located in neighborhoods with the highest asthma rates.⁶ Thus suggesting a link between energy and health that remains underexplored, particularly among vulnerable populations.⁷

Memphis and Shelby County have been challenged with issues of poverty, housing, and health disparity. Over 1/5 of county households have incomes below the Federal Poverty Level. Memphis has one of the highest percentages of substandard housing in the nation. According to the U. S. Census' American Housing Survey,⁸ Memphis and Shelby County have 50,000 households living in substandard housing units, which are concentrated in low-income and African American areas. Two deleterious health-outcomes traditionally

associated with poor housing and income levels – asthma and lead-based paint poisoning are significant problems among minority children in Memphis and Shelby County. Memphis was named as the nation’s top 3 “Asthma Capital” for five consecutive years (2011 to 2015).⁹ Shelby County has the highest rates of pediatric ED and inpatient admissions for asthma in TN: 2,018/100,000 for ED visits compared to the state average of 1,032/100,000; and for inpatient, 255/100,000 compared to the state rate of 135/100,000.¹⁰ The National Center for Healthy Housing (NCHH) ranked Memphis 40th out of 44 for housing conditions in its inner city.¹¹

The built environment, energy insecurity and health outcomes are rarely assessed concurrently. These information gaps warrant a systematic evaluation of the interaction of environmental exposure and energy security, and the resulting health effects. Indeed, the concept of energy insecurity ties to housing instability, environmental exposure, and economic status. Further evidence is needed to demonstrate the feasibility and impacts of energy efficiency interventions targeting exposure reduction and health and well-being improvement in socioeconomically disadvantaged households. This study will uniquely capture all aspects of low-income energy affordability and establish the first database of HEI in Memphis. The results are expected to provide a starting point for local-scale assessments; identify locations of concern for further investigations; prioritize and inform energy assistance programs; promote the public’s awareness of energy efficiency and security; and develop more effective housing interventions in Memphis. The methodologies and practice are also expected to be scalable to the regional and national levels.

Approaches

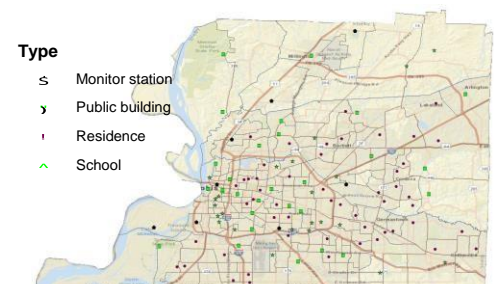
Specific Aim 1: Develop an online HEI survey tool and collect HEI data from 150 homes in Shelby County.

Study Area. This study will be conducted in Shelby County, TN. The county base Memphis is the largest city in TN, and the 20th largest city in America. Radiant from Memphis, the land-use type displays a clear industrialurban-suburban-rural gradient: Memphis is an industrial and urban center, Germantown, Bartlett, and Collierville are suburban, and the rest are mostly rural areas.

Participants. We will recruit 150 households in Shelby County. The households will be selected based on census tract and zip code. There are 221 census tracts and 38 zip codes in Shelby, and we will randomly select 50 census tracts and 3 households in each tract. We will also ensure that the selected census tracts and households cover all the zip codes. The households will be chosen to represent a variety of neighborhood settings, i.e., downtown, urban, suburban, and rural.

Recruitment. Before site recruitment commenced, the field protocols, recruitment flyer and the consent form designed will be submitted to the Institutional Review Board (IRB) of UM. The study team will utilize a number of ways to spread the study message for the recruitment. These included: (1) a webpage for the study; (2) distribute the recruitment flyer via group emails; (3) community and stakeholders’ meetings; (4) post study message on online social media, e.g., Facebook; (5) personal contacts via telephone and email; and (6) inperson meetings with owners/managers of targeted sites. The recruitment is part of the community involvement.

It should be noted that Dr. Jia has recently completed a county-wide community-scale air monitoring program, in which 112 sites located in 106 census tracts were recruited, as displayed in the figure. Dr. Jia has established wide connections with the Memphis City Department of Community and Housing Development, Shelby County Health Department, Memphis Healthy Homes Partnership, Sierra Club, and many other local organizations. His experience and connections will ensure the recruitment.



The Home energy insecurity (HEI) survey instrument. The HEI Scale is a validated survey developed by the federal Low-Income Home Energy Assistance Program (LIHEAP).¹² It covers a range of issues related to household energy including financial strain (economic burden), constraints on household necessities such as food, medical and household expenses (trade-offs), shut-offs threats and utility disconnections due to nonpayment of bills. We will supplement the HEI with additional questions about housing quality and common behavioral responses to energy inadequacies;¹³ The HEI Scale classifies a household into one of the five basic categories: Thriving, Capable, Stable, Vulnerable, and In-Crisis. The HEI Scale calculation involves three steps:

- (1) Data collection from energy assistance recipients.
- (2) Scaling the respondents, which involves using the collected data to determine which threshold is applicable to each individual respondent. and
- (3) Repeating the data collection and scaling process a second time to determine the movement (if any) of the participants on the HEI Scale.

Development of an online version of the HEI survey. Field tests of the survey have found that it is user-friendly; however, currently only paper-based survey is available. We will utilize SurveyMonkey (<https://www.surveymonkey.com/>), a free online survey software & questionnaire tool to create an online HEI survey questionnaire. This online questionnaire will be accessible from personal computers, tablets, and smartphones, and yield results immediately and graphically.

Administer the survey. The HEI Scale can be used in diverse circumstances while maintaining some uniformity of design and application. Each survey should take between 10 and 15 minutes to perform. Survey questions, however, may prompt conversations with the client, however. The “conversation making” aspects of the survey are considered to be a good impact of the survey.

Specific Aim 2: Determine the effects of area-based socioeconomic status (SES) and racial variables on HEI.

SES data. Census-tract level racial composition and SES data will be obtained from the Census 2015, Summary File 3.¹⁴ Examples of SES variables include percent of the population that is African American and median household income.

Geospatially weighted regression (GWR) analysis. We will explore how HEI can be predicted by tract-level SES variables using GWR analysis. We have successfully used GWR models to analyze environmental disparities in air toxics exposure in Memphis.¹⁵

Specific Aim 3: Assess associations of HEI with population health.

Health outcome data. We will obtain the latest health outcome data from Shelby County Health Department (SCHD). Dr. Jia has long been collaborating SCHD, and SCHD will provide zip-code level health outcome data.

Multivariable analysis. We will use multivariable regression models to assess whether HEI is a determinant of health outcomes. The models will also include covariates such as SES variables and environmental exposure variables.

Project Personnel

Dr. Chunrong Jia will be the principal investigator of this project. Dr. Jia’s research interests include environmental disparity, housing and built environment, and indoor air quality. He is currently a Harvard-JPB Environmental Health (EH) Fellow working with other 11 fellows to address EH issues in disadvantaged communities in the US. He is running several research projects funded by the US Environmental Protection Agency (EPA), Department of Housing and Urban Development (HUD), and JPB Foundation. Dr. Jia will develop the survey tools, collect and analyze data, and draft reports.

To-be-named research assistant (RA). This RA will assist in online survey development and field data collection.

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