Energy insecurity and its ill health effects: A community perspective on the energy-health nexus in New York City

Diana Hernández[a],*, Eva Siegel[b]

[a] *Sociomedical Sciences, Columbia University, Mailman School of Public Health, 722 W 168th Street, New York, NY, 10032, USA*
[b] *Epidemiology, Columbia University, Mailman School of Public Health, 722 W 168th Street, New York, NY, 10032, USA*

ARTICLE INFO

ABSTRACT

This study examines the effects of a novel construct – *energy insecurity* – on adverse health in a community-based sample in New York City. Using a 2015 cross-sectional study of 2,494 households in Washington Heights, we described the socio-demographic characteristics of energy insecure households and examined the association between energy insecurity and health outcomes using logistic regression models. Twenty-seven percent of participants were energy insecure. Racial/ethnic minorities, households with children, long-term neighborhood residents, and those with poor housing conditions were more likely to be energy insecure; meanwhile, middle income households were not fully protect against energy insecurity. Energy insecurity was significantly associated with poor respiratory, mental health, and sleep outcomes; it was not associated with metabolic disorders, accidents, or neighborhood violence and cohesion. This study indicates that energy insecurity may explain some existing respiratory and mental health-related disparities in vulnerable populations. More research on energy insecurity is needed along with refinement of its measurement.

1. Introduction

Energy insecurity is an emerging concept that reflects hardships with the cost and quality of household energy; it is defined as "the inability to meet basic household energy needs" [1]. A recent operationalization of the concept demonstrates its three primary dimensions—physical, economic, and behavioral—while also describing associated adverse environmental, health, and social consequences [1]. The proposed "energy insecurity pathway to disease and disadvantage" describes energy insecurity as a mediator between structural conditions of disadvantage (i.e. neighborhood deprivation, limited social cohesion and substandard housing) and a) environmental exposures such as dampness, mold, and thermal discomfort in the home; b) poor health outcomes, such as respiratory diseases and mental illness; and c) social adversities including stigma, residential instability, and disruption of family routines. This conceptual pathway needs further empirical validation to better understand whether and how neighborhood dynamics, housing conditions, energy insecurity, and health outcomes are related.

Cook et al. [2] examined the association between energy insecurity and child health and well-being using a brief indicator of household energy insecurity administered in a clinical setting. The validated indicator measures four markers of energy insecurity: a) shut-off threat due to nonpayment, b) use of a cooking stove for heat, c) foregoing heat due to inability to pay the associated bills, and d) experiencing a disruption of services due to nonpayment. Between 2001 and 2006, this indicator was included in the Children's Sentinel Nutrition Assessment Program, which assessed 9,721 children who attended emergency rooms and primary care clinics in various cities throughout the United States, namely, Baltimore, Boston, Little Rock, Minneapolis and Philadelphia. The authors found that energy insecurity was associated with increased odds of hospitalization since birth, poor self-reported health, and developmental concerns among children, as well as increased odds of food insecurity after adjusting for household characteristics [2].

Building on these results, the present study is the first to use this validated indicator to examine energy insecurity's effects on health in a community-based sample of adults. By comparing health outcomes that would be expected (e.g., respiratory outcomes) and not expected (e.g., accidents) to be associated with energy insecurity, this study aims to explore the pathways through which energy insecurity is associated with poor health.

This study was conducted in the Washington Heights neighborhood of New York City, a neighborhood marked by social disadvantage [3,4]. Most Washington Heights residents are Hispanic (71%), nearly half (48%) are foreign born, and many (39%) have limited English language proficiency [5]. Twenty-seven percent of neighborhood residents live in

---

* Corresponding author.
  E-mail addresses: dh2494@cumc.columbia.edu (D. Hernández), els2205@cumc.columbia.edu (E. Siegel).

poverty, experience poorer health along several indices and many lack adequate access to healthcare [5]. The housing stock is comprised of relatively homogenous multifamily buildings with among the highest maintenance defects in the city [5]. Focusing on Washington Heights allowed us to examine residents living in comparable housing and neighborhood conditions to explore energy insecurity and its links to health in a relatively vulnerable population. Furthermore, our community-level focus offers a novel socio-spatial analytical context for a phenomenon – *energy insecurity* – that is widespread, though understudied in the United States. Recent estimates indicate that the national prevalence rate is as high as 33% such that 37 million U.S. households are energy insecure [6]. Furthermore, spatial disparities exist whereby disadvantaged communities are significantly more energy burdened by virtue of costs or inefficiencies [7–9]. To date, few studies have comprehensively analyzed the health effects of energy insecurity at the more granular level of neighborhoods within urban areas, particularly in the United States. The present study fills this gap.

2. Methodology

2.1. Washington Heights Community Survey

The Washington Heights Community Survey was a cross-sectional study conducted in 2015 by the Columbia University Mailman School of Public Health and the Global Research Analytics for Population Health Team at the behest of New York-Presbyterian Hospital [10]. This project leveraged a mandated Community Health Needs Assessment conducted every three years by the hospital to better understand the health status, needs and healthcare utilization patterns of the hospital's surrounding community. Residents and stakeholders identified housing issues as a primary concern in the community and understanding the prevalence and correlates of energy insecurity in Washington Heights was of particular interest to Dr. Hernández, a co-investigator on the project and the lead author of the present study.

2.2. Data collection

The 45-minute survey, conducted by a contracted opinion survey research firm- ABt SRBI, included questions on socio-demographic characteristics, healthcare access, health risk behaviors, and current health status and medical conditions. Address-based samples with and without matching phone numbers were employed. Information about the survey was mailed to those without matching phone numbers. Data collection also included a cell phone random digit dial (RDD) sample of active numbers within the two zip codes (10032 and 10033) in Washington Heights. Trained interviewers conducted the survey by phone in English or Spanish, with an American Association for Public Opinion Research response rate of 16.8%, a limitation partially overcome by weighting as discussed below. Using the next/most recent birthday sampling procedure, survey respondents were chosen based on the household adult with the next and most recent birthday. All participants provided informed consent and received a $25 incentive check by mail.

2.3. Sample

A final sample of 2,494 interviews was included in the analysis. Unmatched address-based samples resulted in 1,099 interviews, matched samples resulted in 1,042 interviews, and the cell RDD sample resulted in 370 interviews. Sample weights were developed prior to data analysis to account for differential probabilities of selection of address-based sample households with and without matching phone numbers and RDD cell phones as well as the distribution of adult demographic characteristics of Washington Heights found in the American Community Survey in 2009–2010 [11]. These weights also served to correct for possible bias associated with the low response rate.

2.4. Independent variables and outcome measures

2.4.1. Energy insecurity

The validated brief indicator of household energy insecurity was administered to study participants to determine whether households had sufficient and continuous access to adequate household energy as a basic need [1,2]. The 4-question indicator variable asked if during the past 12 months a household: 1) received a shut-off notice; 2) used a cooking stove for heat; 3) went without heat due to inability to pay; 4) experienced an interruption in utility service due to non-payment. Based on responses to these questions, households were categorized as energy secure (no to all), moderately energy insecure (yes to a shut-off threat), or extremely insecure (yes to foregoing heat, using a stove for heat, or experiencing a shut-off).

2.4.2. Socio-demographic factors

All survey respondents self-reported race, household income level, educational attainment, and other socio-demographic variables, such as the presence and age of children or elderly householders. Healthcare coverage related to age and income level was measured through participation in Medicare and Medicaid, respectively. Food-related aid was measured by participation in the Supplemental Nutrition Assistance Program (SNAP) and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Food hardship (a proxy for food insecurity) was captured by an affirmative response to: *"ever hungry but didn't eat because you couldn't afford enough food in the past year."*

2.4.3. Housing and neighborhood

Residential stability, measured as years lived in the neighborhood, was categorized empirically according to documented demographic shifts in neighborhood composition to reflect population changes. Poor housing conditions were based on observations of at least two of the following conditions in the last 30 days: cockroaches, mold and/or mice. Neighborhood cohesion was measured as agreement with: *"this is a close-knit or unified neighborhood;"* neighborhood violence was measured by a positive response to: *"anyone used violence, (i.e. mugging, fight, or sexual assault), against you or any household member anywhere in your neighborhood in the past year."*

2.4.4. Health

Self-reported lifetime diagnoses (by a medical provider) of asthma, diabetes, hypertension, or depressive disorder were dichotomous variables, as were recent (in the past 12 months) asthma attack, pneumonia, or accidental fall. Non-binary health outcomes were categorized empirically and then tested through sensitivity analyses. Poor quality sleep was dichotomized into those that reported *"trouble falling or staying asleep, or sleeping too much"* for at least several days during the past two weeks versus no sleep disturbance at all. Self-reported overall health was dichotomized into those that reported excellent, very good, or good health versus those that reported fair or poor health.

2.5. Analytical approach

Our analysis had two aims: first, to describe the characteristics of energy insecure households in Washington Heights and second, to examine the association between energy insecurity and health outcomes. We hypothesized a priori that respiratory and mental health outcomes would be associated with energy security and that metabolic disorders and accidents would not be associated with energy insecurity. Chi-square tests were conducted on categorical demographic variables; linear regression models were used to describe continuous demographic variables. Logistic regression models were used to examine binary health outcomes. Directed acyclic graphs (DAGs) were created to evaluate potential confounders. DAGs are graphical representations that aid in the identification of variables that could bias estimates; variables identified as confounders – in this case, race and income –