

INTEGRATED HEALTHY HOMES ASSESSMENT AND INTERVENTION FOR CHILDREN IN MEMPHIS

In Shelby County, Tennessee, 22% of households have incomes below the Federal Poverty Level (FPL) including 1/3 of all children. Moreover, Memphis has one of the highest percentages of substandard housing in the nation. According to the U. S. Census' American Housing Survey,¹⁶ Memphis and Shelby County have 50,000 households living in substandard housing units; 16.9 percent of all owner-occupied housing units and 26.4 percent of all rental units have severe to moderate problems, including moisture and mold, rats and mice, roaches and other asthma triggers. Substandard housing is concentrated in low-income ZIP Codes in Memphis, where the majority of residents are African American. 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).⁸ 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 135/100,000.⁹ In 2013, Shelby County Health Department (SCHD) identified 332 children with blood levels ≥ 5 $\mu\text{g}/\text{dL}$. The majority of the affected children were African American. The National Center for Healthy Housing (NCHH) ranked Memphis 40th out of 44 for housing conditions in its inner city.¹⁰ Widespread asthma and lead related issues in conjunction with very poor housing conditions in Memphis and Shelby County underscores the need for comprehensive healthy homes research within this metropolitan area.

Key Research Gap and Importance of Study Focus Area. Integrated intervention programs for both asthma triggers and lead poisoning have seldom been implemented despite the co-existence of these two pediatric health issues. Substandard housing conditions are often related to allergic asthma and lead poisoning. Population-based environmental and clinical studies have shown asthma and lead poisoning often occur together, especially in urban, low-income minority children because of their increased vulnerability to both illnesses through environmental exposures.¹⁻⁴ But most intervention studies target either one. Thus, no concrete information is available on the efficacy of integrated environmental assessment and interventions on lead and asthma health outcomes.^{2, 5, 6} This calls for attention to the unmet need of comprehensive environmental remediation investments addressing these two urban health problems.^{6, 7} The proposed study will address this research gap by implementing a comprehensive environmental assessment and intervention program combining both lead poisoning and allergic asthma under one umbrella. To develop and test this *integrated healthy homes assessment and intervention* (IHAI) regimen, we propose to add supplementary activities (focusing on asthma trigger exposures and mitigation) to the ongoing lead intervention demonstration programs (LIPs) in Memphis and Shelby County, Tennessee. We envisage that this approach will add value to current lead mitigation programs by incorporating additional vulnerable groups (asthmatics) in an efficient, cost-effective manner.

Strategic Value in Informing Policy or Practice. As the nation's top "Asthma Capital", there is a significant need to conduct environmental remediation-focused asthma interventions in Memphis/Shelby County. However, to the best of our knowledge, no such asthma intervention project was conducted in this area in recent past. On the contrary, Memphis City Government has been conducting successful lead hazard and lead paint reduction programs for almost two decades. This gives us the unique strategic opportunity to utilize the existing lead hazard reduction programs as the foundation to expand to potential households with asthmatic children to implement the IHAI component.

Strategic Advantage of University of Memphis School of Public Health (UM-SPH). The CEPH-accredited UMSPH has multidisciplinary faculty, and with its strategic community partners, including city housing agencies, county health department, is uniquely positioned to undertake the proposed project.

Memphis As a "Test Bed" to Develop a Nationally Implementable Model. The proposed IHAI approach will be founded on the on-going HUD recommended lead hazard reduction programs. The IHAI regimen can be implemented *concurrently* with ongoing lead intervention programs (LIPs) or as a *standalone* tool to reduce exposures to residential asthma triggers. Consequently, this will preclude the need of conducting a separate (or additional) home asthma intervention program in venues where lead hazard reduction programs are ongoing. Our approach will enable immediate and long-term cost reduction of healthy home interventions in

regions similar to Memphis and Shelby County, where substandard housing is compounded with both lead and asthma problems.

Technological Innovation. The PI and the Co-PI at UM-SPH have developed a “one stop” Environmental Monitoring Platform with the ability to screen *multiple Indoor Environmental Quality (IEQ) parameters* simultaneously (Table 1) which will be deployed in this project. The approach has excellent scalability in that it can be employed for a group of pollutants. Further, the proposed technology will not only be “rapid in nature”, but importantly will also be “sensitive” in that it can detect very small quantities of environmental hazards.

B. Approach

Study Design and Objectives. The overall objective of this study is to develop and test a novel *integrated healthy homes assessment and intervention (IHAI)* regimen for children in Memphis. There are two specific aims (SAs):

SA 1: To develop and implement a novel integrated healthy homes assessment and intervention (IHAI) regimen for children with asthma (ages 4-13 years). We propose to develop this robust, integrated healthy homes assessment regimen by converging HUD-approved protocols for lead and indoor allergens sampling, and by **introducing a National Institute of Occupational Safety and Health (NIOSH)-developed bioaerosol collection and assessment method available exclusively to UM-SPH researchers.** Under the IHAI regimen, through our community partners, we will implement a multifaceted home assessment and intervention tool based on existing HUD Healthy Homes Maintenance Checklist¹² and Master Home Environmentalist[®] (MHE[®]) Program (developed by the American Lung Association Mountain Pacific Region)¹³ to address asthma morbidities.

SA 2: To evaluate the efficacy of IHAI regimen (pre- and post) in reducing exposure to residential asthma triggers among asthmatic children. We propose to examine the impact of infusing an IHAI component on the effectiveness of an ongoing lead intervention program (LIPs), including Lead Hazard Reduction Demonstration (LHRD) project. Children recruited will be followed-up for a reduction in exposure to asthma triggers resulting in improved asthma control. The control group will consist of children in LIP not receiving IHAI regimen. To evaluate the efficacy, we will conduct a 6-month post-intervention follow-ups which will include (a) the social, environmental, and life-style risk factors that significantly influence the effectiveness of an intervention (through HUD and MHE[®] checklist component of IHAI), and (b) rigorous analytical testing of samples collected during in-home assessment of multi-trigger environmental factors (through in-house environmental monitoring component of IHAI).

Underlying hypothesis: The participants of LIPs with infused IHAI regimen will demonstrate greater reduction of measured asthma triggers levels in corresponding households, in comparison to the intervention without IHAI (control group).

Study Area. The geographic focus of this study is the city of Memphis, Tennessee.

Ethical Approval. We have recently obtained IRB approvals for conducting a pilot asthma intervention study of this type (funded by the Memphis Research Consortium).

| Table 1. Indoor Asthma Trigger Monitoring | | |
|---|--|--|
| | IEQ parameters | Methods and Instrumentation |
| 1 | Airborne mold, bacteria, and viruses | Sampling: NIOSH bioaerosol sampler Analysis: qPCR, genomics based identification (next generation sequencing) |
| 2 | Allergens: dust mite, cockroach, endotoxin | Sampling: Dust vacuum, aerosol sampler Analysis: ELISA, later-flow |
| 3 | Particulate matter | Mass and number concentration (TSP, PM10, 2.5, 1.0), Particle count |

Study Population and Recruitment.

The study and comparison group will be drawn from ongoing LIPs run by City of Memphis Lead Paint Program. We aim to enroll 75 households. The recruitment

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|---|---|---|
| 4 | NO ₂ , CO ₂ , temperature, and humidity | Sampling: Ogawa passive badges Analysis: Spectrophotometry, Environmental logger |
| 5 | Volatile organic compounds (VOCs) | Sampling: Passive adsorbent tubes Analysis: Thermal desorption-GC/MS system |

will occur when the household is accepted to be included in the ongoing LIPs. We will screen for the household with an asthmatic child aged 4-13 years. Households will receive a baseline visit, and a 6-month follow-up visit.

Data Collection and Analysis In-home environmental

assessment. During each home visit, we will conduct in-home asthma trigger assessments using a questionnaire survey and a multiparameter environmental monitoring developed by our group at UM-SPH. (1) *Home walkthrough questionnaire.* We will use an abridged homeenvironment survey based on standardized HUD¹² and MHE^{©13} checklists to examine house conditions, housing-related asthma triggers, and health hazards.

(2) *Environmental monitoring.* Asthma trigger parameters^{17, 18} and the **UM-SPH developed novel integrated monitoring methods** are summarized in [Table 1](#).

Asthma symptom survey. We will use the 4-Week Children's Health Survey for Asthma developed by American Academy of Pediatrics.¹⁹

In-home environmental education. We will use the results from in-home environmental assessment to educate and equip asthma patients with the tools based on MHE[©] program guidelines. That will help reduce environmental hazards through behavioral changes, use of green cleaning products (supplied by us), and/or through referrals to outside resources or agencies.

Impact of IAHI on LIP. To ensure the infusion of IAHI does not negatively impact the assessment and remediation of the lead hazard, we will compare the results (of lead hazard reduction) from the existing LIP with LIP+IAHI regimen, and will develop any control measure(s), if needed.

Efficiency of Design and Statistical Basis. Out of the eligible households, we will randomly assign equal number of homes in each of the two groups (treatment = LIP+ IHAH, control = LIP only). This sample size setting will achieve 80% power to detect longitudinal difference in environmental exposure, without multiplicity correction. Multiple exposure variables will first be grouped by cluster analyses using baseline data, and each cluster represents a group of triggers from a common source. Let ΔE_{ijk} be the change of exposure at time T_j ($j=1, 2, 3$) in comparison to its baseline for house i with intervention k ($k=0$, LIP only; $k=1$, LIP+ IAHI). Linear mixed models will be applied to examine intervention effect: $\Delta E_{ijk} = \beta_0 + \beta_1 G_k + \beta_2 T_j + \gamma Z_i + S_i + \epsilon_{ijk} \dots (1)$; where β_1 denotes the group effect with the control group as reference, β_2 is the fixed time effect, γ represents effects of a collection of adjusting variables, Z_i , and S_i and ϵ_{ijk} denote household random effect and random errors, respectively. We will fit model (1) using PROC MIXED in SAS. The SAS procedure PROC GENMOD, which applies generalized estimating equations to estimate parameters, will also be applied.

The Project Director will coordinate with internal and external partners on a regular basis and will oversee the progress of the project. Monthly meeting with all Co-PIs, collaborators, and community partners will be held to update and plan the activities. A Project Management Plan (PMP) consisting of work breakdown schedules, budget, procurement, quality, communication, and risk management will be created to ensure timely accomplishment of stated project milestones. The evaluation of the project will be conducted by internal and external panels. A tentative Project Timeline is depicted in [Figure 2](#).

| Figure 2. Project Timeline | Months | | | | | | | |
|--------------------------------------|--------------------------------|---|---|---|---|---|---|---|
| | (Nov 16, 2016 - June 30, 2017) | | | | | | | |
| Task Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1. Project Initiation | | | | | | | | |
| 2. Human Subject Approval (IRB) | | | | | | | | |
| 3. Recruitment/Consenting | | | | | | | | |
| 4. Home Walkthrough Questionnaire | | | | | | | | |
| 5. Field Sampling/Lab Analysis | | | | | | | | |
| 6. Intervention and Asthma Education | | | | | | | | |
| 7. Data Organization and Analyses | | | | | | | | |
| 8. Project Planning and Management | | | | | | | | |
| 9. Reports | | | | | | | | |

University of Memphis, School of Public Health:

Pratik Banerjee, PhD (Project Director), Overall project aspects, analytical methods; **Chunrong Jia**, PhD (Co-Project Director), analytical methods. Drs. Banerjee and Jia are faculty members of Environmental Health Program and experts in Environmental Monitoring.

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