Covariates for an in-home High-Efficiency Particulate Arrestance filtration intervention in a Puerto Rican population in the Boston area

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Community Health Senior Honors Thesis
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Introduction

Airborne ultrafine particles (UFP) are elevated near roadways, linked to increased risk of cardiovascular morbidity and mortality, and decreased by the use of High efficiency particulate air (HEPA) filtration in residences near roadways. Thanks, in part, to previous work from a Community-Based Participatory Research (CBPR) collaboration in the Boston area, the Community Assessment of Freeway and Health (CAFEH) study, the scientific and public health communities have recently begun to consider the potential health threat posed by UFP exposure. This threat is disproportionately borne by those who live close to major roadways and implementing actionable interventions, such as the use of HEPA filtration, to protect the health of these individuals is of critical importance to environmental health as well as a matter of environmental justice.

This paper focuses on a randomized intervention study that installed HEPA filters and alternated their use with fake, or "sham" filters in the homes of 24 Puerto Rican participants in the Boston area. This intervention study is a collaboration between the CAFEH study and the Boston Puerto Rican Health Study (BPRHS).

Specifically, this thesis will 1) discuss the context and importance of this intervention; 2) consider covariates that may affect associations between exposure to airborne particles and the dependent variables of the intervention study; 3) become fully immersed in the intricacies of data collection, and contribute to the management of these data from a variety of quantitative and qualitative sources; and 4) summarize the information collected on participants' covariates from raw data in a manner useful to future publications. This fourth aim will include the comparison and combination of the covariate data of the ongoing BPRHS intervention study with a

completed HEPA filter CAFEH intervention study in Somerville. The process is an incredibly valuable learning experience as well as a necessary step towards any future publication of the collected data.

Statement of Significance/Background

Ultrafine particles: a critical public health concern

The Global Burden of Disease project is an ongoing, quantitative assessment of mortality and Disability-Adjusted Life Years (DALYs) supported by the WHO and the World Bank (1). In 2010, it found that Ambient Particulate Matter ($PM_{2.5}$) pollution was the 9th leading cause of DALYs for the world, below childhood undernourishment and above physical inactivity and iron deficiency (2). The 2010 GBD results also found $PM_{2.5}$ to be responsible for 3.1 million (2.7 to 3.5 million) premature deaths and 3.1 % (2.7 – 3.4%) of all global DALYs (3). This assessment focused on fine particulate less than 2.5 µm in size (referred to as $PM_{2.5}$), and did not include ultrafine particles, or UFP (less than 100 nanometers in diameter).

In both the developing and developed world, the major burden associated with ambient PM pollution as well as indoor pollution levels (these measures are relevant as they are correlated with outdoor PM levels) is seen in the etiology of cardiovascular and circulatory diseases (4), as shown in **Figure 1**. In the United States, airborne particulate matter is a well-documented risk factor for cardiovascular morbidity and mortality. The Harvard University Six Cities cohort, a study population of 8,111 adults followed for 14 to 16 years, found that each 10 $\mu g/m^3$ increase in $PM_{2.5}$ was associated with a 26% increase in cardiovascular mortality (5). The exact pathological connection between PM and cardiovascular disease is not completely

understood, but current research suggests a relationship between inhalation of these particles and systemic inflammation and atherosclerosis (6 - 8).

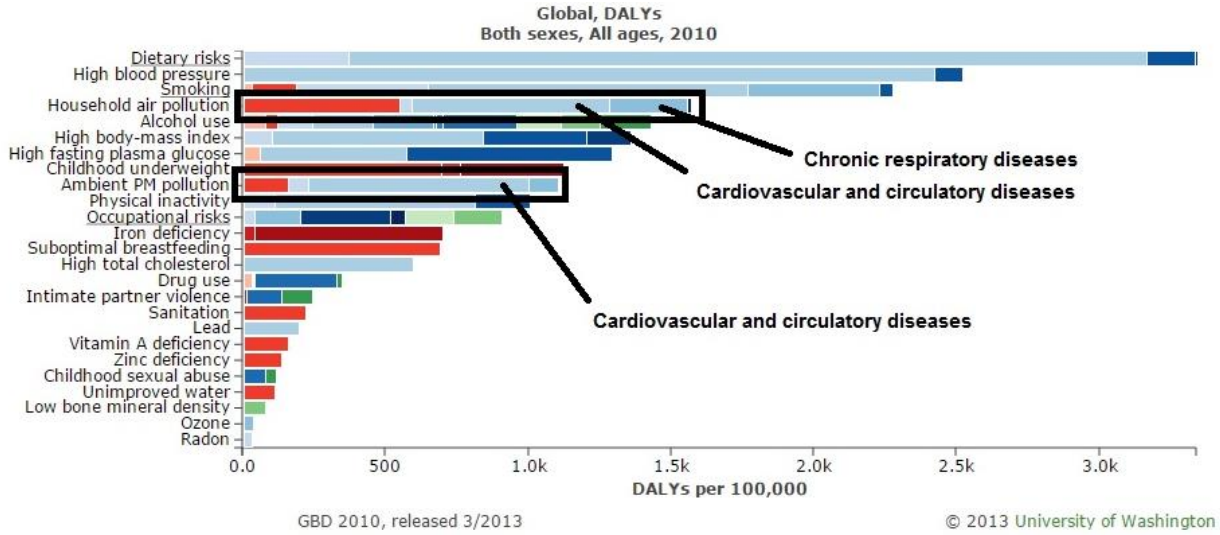

Figure 1: A representation of the contribution of global risk factors to Disability Adjusted Life-Years, with a breakdown of the causes of these DALYs. Red bars represent acute and infectious causes of DALYs, such as lower respiratory infections, whereas blue bars represent the DALY contributions due to chronic conditions. The major contribution of DALYs from both household air pollution and ambient PM pollution is seen in their contribution to cardiovascular and circulatory diseases. (Accessed in November 2014 from the Institute of Health Metrics and Evaluations interactive data visualizations from the 2010 Global Burden of Disease study (4).

All studies referenced so far in this introduction assessed $PM_{2.5}$ and/or $PM_{10,}$ not UFP. UFP does not always correlate with other forms of particulate matter; in particular $PM_{2.5}$ levels often do not correlate well with UFP concentration (9). However, these ultrafine particles are potentially even more damaging, especially to cardiovascular health. UFP can translocate into the circulation system faster than larger particles and cause inflammation (10). UFP promote greater proatherogenic (related to atherosclerosis) effects than $PM_{2.5}$ or PM_{10}, likely due to the greater concentration of compounds active in redox reactions (the gaining or losing of electrons), such as polycyclic aromatic hydrocarbons, a greater surface-to-mass ratio, and their previously stated increased bioavailability (7). A striking example of this is demonstrated in **Figure 2**,

which displays the results from a mouse model experiment that used air pollution samples from Los Angeles to continuously expose mice to filtered air, $PM_{2.5}$, and UFP. The promoter gene for heme oxygenase-1, a protein involved in oxidative stress and closely associated with inflammation, was visualized via linked expression of the luciferase enzyme. This allowed expression of heme oxygenase-1 to be measured via bioluminescence levels from luciferase expression. UFP were shown to cause greater expression of the heme oxygenase-1 promoter as well as more widespread up regulation throughout the thorax and abdomen (7).

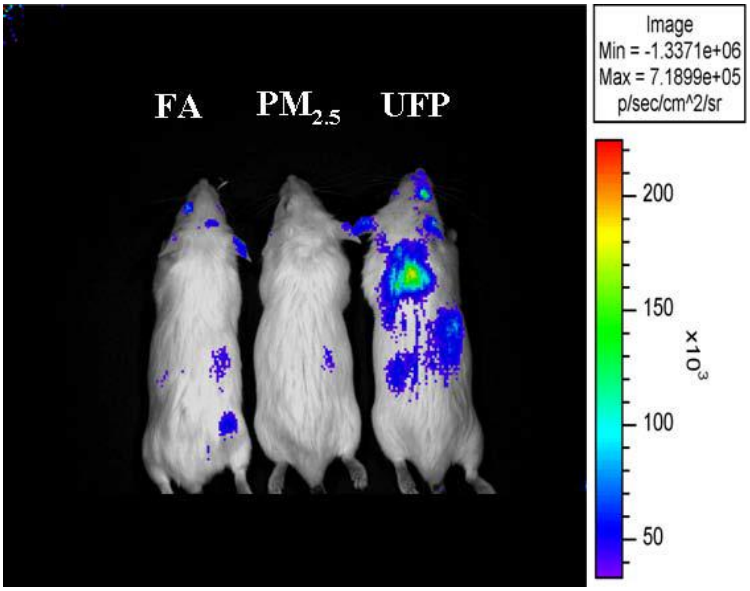

Figure 2: Heme oxygenase-1, an indicator of oxidative stress, as indicated by linked expression of luciferase, is shown to be more heavily up-regulated and in a more widespread fashion in mice continuously exposed to air polluted with UFP over filtered air (FA) and $PM_{2.5}$.

Source: Araujo, J; Nel, A: Particulate matter and atherosclerosis: role of particle size, composition, and oxidative stress. *Particle and Fibre Technology,* 2009.

Unfortunately, due to the technical challenges studying the health effects of UFP, many leading researchers assessing the negative health effects of particulate matter have not yet focused on these particles or devised measurement techniques to assess their concentration (11). The pathophysiology of the effects of UFP on human health is less well understood than the

effects of $PM_{2.5}$. However, in part because of potential therapeutic uses of nanoparticles driving research, the distribution of ultrafine particles throughout the body is becoming more widely studied, leading to insight on biological pathways by which UFP may travel through the body (10).

UFP concentration increases in close proximity to major highways and decreases with distance (12). Padró-Martínez et al., a research team out of the CAFEH study, found that Particle Number Concentration (also known as PNC; this is a proxy variable commonly used to measure UFP in most studies (13)) was especially elevated close to 1-93 in Somerville, MA, a major highway in the Boston area. Farther than 150 meters to the northeastern (predominantly downwind) side of I-93 there was a marked decrease in PNC levels. For the southwestern side of I-93, researchers found elevated PNC much farther out. However, this southwestern side of I-93 contained highly trafficked roadways, so it was not possible to isolate a single source of PNC (12). Similarly, a New York based study found that UFP decreased by 15-20% within the first 100 m of the Williamsburg Bridge and the Brooklyn-Queens Expressway (14). The results of the New York study showed consistent and significant correlation between UFP levels and proximity to these two major highways using a variety of models, although this relationship was strongly affected by variations over space and time and proved difficult to model. See **Figure 3**. 95% Confidence Intervals for UFP levels are shown in blue.

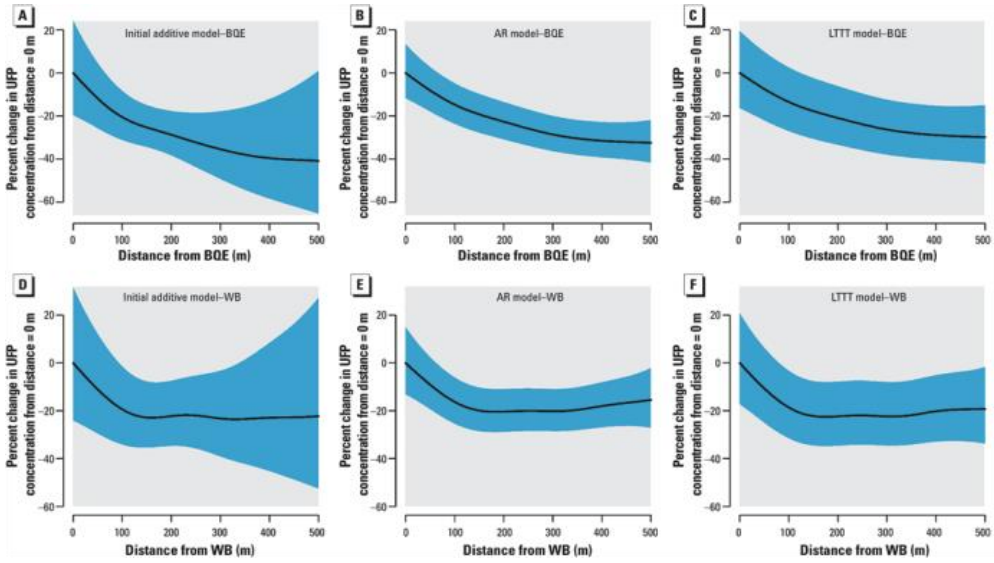

Figure 3: Relationship between UFP levels and proximity to two major NYC roadways using a variety of spatial models (with 95% CI). UFP was shown to increase with increasing proximity to major roadways, and decrease with decreasing proximity.
Source: Zwack, L; Paciorek, C; Spengler, J; Levy, J: Modeling Spatial Patterns of Traffic Related Air Pollutants in Complex Urban Terrain. *Environmental Health Perspectives*, 2011.

While quantifying the distance at which highway proximity becomes a serious threat to cardiovascular health has proven challenging, the literature indicates that those living in close proximity to major highways or roadways are at elevated risk for cardiovascular morbidity and mortality as compared to similar individuals who do not live in close proximity. For example, Hoffman et al. found that individuals living within 100 meters of a major roadway were at elevated risk for coronary artery calcification, a predictor of future cardiovascular health effects (15).

Furthermore, some researchers are currently moving away from major roadway proximity data as advances in engineered exposure models and geographic information systems (GIS) allow for more precise associations between actual PM exposure levels and outcomes (13). An example is a recent study conducted by Patton et al., also a research team out of CAFEH, which utilized mobile monitoring of air quality across three neighborhoods for a year, as well as meteorological, traffic, and geographical data to construct estimates of concentrations of various

pollutants. In general, traffic-related air pollutants, including PNC, were found to increase with highway proximity, although there were significant variations in this trend by neighborhood and season that make these results difficult to generalize (16). The use of models like this one hopefully heralds longitudinal epidemiological studies attempting to quantify the health effects of UFP in the future. A very recent publication (February 2015) out of a collaboration between two University of California campuses and private and public sector representatives looked at such an association, although it did not focus on near-highway pollution. In a cohort of over 100,000 California Teachers followed from 2001 to 2007, statistically significant associations were found between several separate species included in their designation of ultrafine particles (< 1 micron in diameter) and cardiovascular mortality, although no association was found between these particles and pulmonary or all-cause mortality (17).

In the United States, the Clean Air Act is the major piece of Federal legislation that addresses particulate matter and other components of air pollution. It was originally signed into law in 1963, and has been amended several times since. This Act stipulates that the Federal government set National Ambient Air Quality Standards (NAAQS). Geographic regions are then assessed for their "attainment" of NAAQS for each criteria pollutant, and officials can be held accountable for continued nonattainment. Though NAAQs exist for $PM_{2.5}$ and PM_{10}, there is currently no U.S. regulatory standard for UFP (18). Similar regulations for PM_{10}, but not UFP, exist in the European Union (19).

Connection to environmental justice

In the United States, there is some documentation connecting the increased health risks due to highway proximity and exposure with the environmental justice movement. A vigorous

national discourse concerning Environmental Justice has been ongoing in the United States since at least 1971. This discussion concerns the distribution of environmental hazards and the implementation and enforcement of environmental regulations as they relate to race/ethnicity and socioeconomic status (20). In a case study of the greater New York City metropolitan area, which included portions of major surrounding highways to guard against "edge affects" of wealthier inhabitants moving into the inner city and poorer residents to the outskirts, or vice versa, researchers found that recent immigrant status and Hispanic ethnicity were strongly correlated with increased highway proximity. Additionally, these researchers found class and income to be a factor as well, but only when considered in coordination with demographic groups. For example, higher income within certain immigrant demographics was associated with a decrease in highway proximity (21). Analyses using GIS based approaches have found similar results; an EPA team using GIS found that Census tracts with high road and traffic densities had more than twice the percentages of Black and Hispanic residents, a 20% increase in poverty levels, and one third fewer White residents than Census tracts with low road and traffic densities (22).

The environmental justice component of this issue is further supported by analyses of recent proposed transportation planning. Despite the legal requirement for the U.S. Department of Transportation (DOT) to consider potential health consequences for minority communities when proposing changes in transportation loads, a GIS based study in Waterloo, Iowa found that the corridor in which the construction of a new highway was proposed had more nonwhite and low income residents than other areas of the city (23). The researchers indicated that the 1994 mandate that led to the legal requirements for the U.S. DOT to consider environmental justice

implications as well as examples like Waterloo support the need for more attention to be paid to environmental justice implications when considering transportation changes (23) (24).

HEPA filtration: a potential intervention

The use of residential High-efficiency particulate arrestance, or HEPA, filtration is a potential public health intervention that can be used to try to protect at-risk individuals, by installing such systems in the homes of residents who are disproportionately exposed to highway air pollution. HEPA filters should decrease not only PM_{10} and $PM_{2.5}$ levels but UFP as well.

HEPA filtration is defined by meeting U.S. Department of Energy standards for the ability to remove of at least 99.97% of 0.3 micrometer sized particles (25). The ability of a filter to remove microscopic particles from the air is referred to as a filter's efficiency (26). HEPA filters have demonstrated superior efficiency; they have been shown to reduce indoor PM by 50% without continuous use (26), and as much by >90% under ideal conditions (9).

Ideal conditions are unlikely to be met in most homes. However, HEPA filtration has also reduced Particle Number Concentration (PNC) by an average of 73% in a study conducted in 126 Detroit homes (27). The ability of HEPA filtration to reduce PNC as well as other PM size fractions demonstrates its potential for lowering residential PM, including UFP, although more research is needed.

To date HEPA filtration is understudied as a public health intervention for improving cardiovascular health. Preliminary results support the need for additional, larger studies. One study in British Colombia, Canada, investigated potential cardiovascular health benefits of HEPA filtration in a community impacted by woodsmoke (a significant $PM_{2.5}$ contributor).

HEPA filters and placebo (sham) filters were used alternatively in consecutive 7 day periods. To assess cardiovascular health, these researchers measured reactive hyperemia index (RHI), which is an indicator of healthy microvascular endothelial function, in 45 healthy participants. Lower RHI scores is an accepted predictor of cardiovascular morbidity and mortality. The investigators also studied biomarkers of oxidative stress and inflammation, which are similarly linked to both endothelial dysfunction and decreased cardiovascular health (28). Aside from the heavy $PM_{2.5}$ exposure, the participants of this study were free of some major risk factors for cardiovascular disease, including smoking and type II Diabetes. These researchers found that HEPA filtration was associated with a 9.4% increase in RHI and a 32.6% decrease in C-reactive protein, as well as a 60% reduction in indoor $PM_{2.5}$ concentration (28). The changes in RHI that were seen with HEPA filtration across the demographics of sex, age, BMI and percentage of time spent in the home are shown in **Figure 4.**

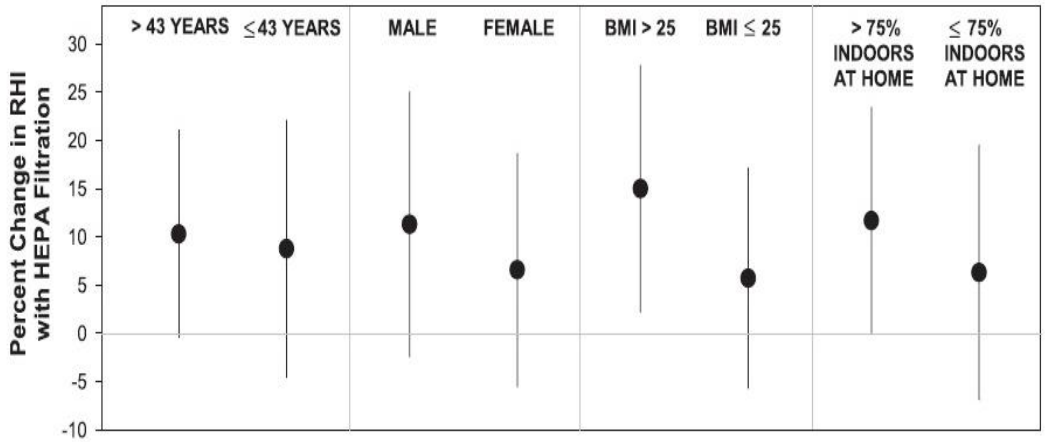

Figure 4: Reactive Hyperemia Index (RHI) , a marker of microvascular endothelial function and a predictor of cardiovascular disease, changes with HEPA filtration across demographics (age, sex, BMI, time spent at home) among healthy adults. This intervention-based study occurred in a community heavily impacted by $PM_{2.5.}$

Source: Allen et al: An air filter intervention study of endothelial function among healthy adults in a woodsmoke-impacted community. *American Journal of Respiratory and Critical Care Medicine*, 2008.

A second study in Copenhagen of 21 non-smoking couples living in close proximity (<350 m) to major roadways (defined as roads with greater than 10,000 vehicles in a 24 hour period) also found limited evidence for cardiovascular health benefits associated with HEPA filtration. These researchers also used biomarkers of inflammation and oxidative stress as well as assessing microvascular function. They found significant improvements in microvascular function after 48 hours of HEPA filtration. However, there were no significant effects found on other markers of cardiovascular function, including C-reactive protein, although this suggests that research should be done with longer periods of filtration to look at potential effects on C-reactive protein (29).

Not only could public health policy benefit from more information regarding the cardiovascular health benefits of HEPA filtration, but policy makers could also benefit from a cost-benefit analysis of this intervention as it relates to the cardiovascular health of individuals living in close proximity to major roadways. Several cost benefit analyses of HEPA filtration as an intervention have been conducted, including the impact of HEPA filtration units installed in the homes of inner city children with asthma (30) and in a hospital setting to reduce invasive nosocomial fungal infections (31). In both research settings, the cost of HEPA unit installation and maintenance was less than the healthcare costs associated with the medical cases estimated to be prevented via the implementation of the HEPA intervention. However, similar cost-benefit analyses have yet to be detailed for the use of this intervention in improving cardiovascular outcomes near major roadways because of the limited empirical evidence to date.

Comparison of HEPA filtration to other interventions

In addition to HEPA filters, other potential interventions include emission reduction and urban planning, which both have potential to reduce cardiovascular disease from traffic-related air pollution. HEPA filtration acts as both a primary and secondary intervention for cardiovascular disease. While it is used to reduce incidence and prevalence of this disease before it occurs, it is also aimed at making an existing exposure (and potentially an existing disease) less severe rather than removing the exposure all together. Other, more universal, air pollution reduction strategies would be superior in that they strive to reduce the source of pollution.

A 2002 study compared cardiovascular deaths in Dublin, Ireland before and after the country banned the marketing, sale and distribution of bituminous coals. These researchers found that the banning of coal sales in Dublin resulted in a 10.3% decrease in cardiovascular mortality when controlling for confounding variables like age (32). Thus, decreasing or reducing the use of especially harmful fuels can have measurable benefits. Diesel fuels are major contributors to particulate matter in the atmosphere, and higher proportions of sulfur in diesel fuel have been associated with more formation of ultrafine particles (33). In 2007, the United Kingdom enacted legislation to ban diesel and super-unleaded petrol that had a sulfur concentration higher than 10 ppm for use on highways. This legislation resulted in a statistically significant reductions in a number of types of air pollution, including UFP (34). This legislation was likely inspired by similar legislation implemented by Denmark in 2005, which also limited sulfur in diesel fuel to 10 ppm. Denmark's law appeared to result in significant UFP reductions near major highways in Copenhagen (35).

Many major cities today are planned in a way that promotes travel by personal cars, through the separation of grocery stores, banks, etc. from residences (36). Additionally, certain areas of cities are often congested with traffic, disproportionately affecting the health of those who live in those areas. In 2003, the Mayor of London implemented a Congestion Charging Scheme to attempt to reduce traffic congestion in the city, mostly for economic reasons. Fortunately, this scheme had benefits beyond direct economic ones, as it resulted in an estimated average 26 years of life gained per 100,000 London residents (37). In the most affected area, where traffic congestion was most reduced by the scheme, this number grew to an estimated 183 years of life gained per 100,000 residents (37). Although promising in its universality, such gains in years in life per 100,000 people are modest when one considers, for example, that 75 minutes per week of moderate exercise, such as brisk walking, has been associated with 1.8 years of life gained for individuals (38).

However, source reductions and creative urban re-design emphasizing re-thought land use and regulatory reform are all likely to be more difficult to implement than HEPA filter-based interventions. First, the aforementioned current lack of epidemiological evidence on the health effects of UFP will need to be addressed. Second, the environmental justice aspect of air pollution-related cardiovascular morbidity and mortality could well play a role. It is documented and modeled in the United States that lower socioeconomic status correlates with less political empowerment (39). While broader restrictions on diesel fuel and major pollutants may be able to gain more universal appeal, urban planning strategies that directly benefit urban neighborhoods with residents of lower socioeconomic status will likely be implemented more slowly. The environmental justice component of this issue enhances the potential of HEPA filtration as a useful intervention because it can be implemented relatively quickly and inexpensively in the

homes of those who are most exposed to UFP while a longer-term uphill battle is fought to improve living conditions for all.

HEPA filtration deserves consideration for future, larger intervention trials when it is compared to other forms of in-home filtration. At first, it may appear appealing to use a different filtration option as an intervention, as they are generally cheaper than HEPA filters (40); the cost of a HEPA filtration unit and installation appears to have a wide range in different settings, from $310 with $100 yearly maintenance fees (40) to a $900 unit price and installation fee in the hospital setting in the nosocomial fungal infection control study mentioned above (31). In the CAFEH/BPRHS intervention study in question, the parts alone for the filters cost $300, not including installation fees (41). Before becoming discouraged by such figures, it is important to keep in mind the economic context of such a cardiovascular health intervention aimed at people living near major roadways; the CDC estimates that in 2010 in the U.S. alone, cardiovascular disease was estimated to cost $444 billion dollars (42). The EPA estimates that 30 million U.S. residents live within 300 m of a major roadway (43). Taken together, these numbers hint at the vast scope of this health issue. Furthermore, other types of filters, while cheaper, do not have the same efficiency as HEPA filters, especially when it comes to very small particles.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), a technical society founded in 1894 dedicated to improving the efficiency and sustainability of energy use and indoor air quality (44), evaluates a variety of in-home filtration devices that cover a spectrum of efficiency. Low to moderate efficiency ASHRAE filters have been shown to be nearly as efficient as HEPA filters in reducing environmental contaminants like cat and dust-mite allergens and tobacco smoke (45). However, these data examined larger particles than are relevant to interventions aimed at UFP reduction, and therefore cannot be used

definitively in an assessment of the efficacy of HEPA filters for the proposed intervention. 85% efficient ASHRAE filters have been shown to reduce $PM_{2.5}$ and PM_{10}, but only on the order of a 5 to 30% decrease. 85% efficient ASHRAE filters are also significantly more effective at removing particulate matter than 40% ASHRAE filters (45), confirming the importance of increased efficiency in the control of smaller particulate matter. However, neither of these ASHRAE filters are nearly as efficient at removing PM of any size as HEPA filters, which can reduce PM by >90% (9). Furthermore, HEPA filters are significantly more efficient at lowering PNC/UFP than ASHRAE filters as well as cost effective when considering the removal of UFP (9). While cheaper filters may present a promising and easier alternative intervention for improving air quality in different scenarios, in interventions specifically aimed at near-highway populations the higher cost of HEPA filtration is warranted due to the increased efficiency of these filters that can remove ultrafine particles.

Furthermore, HEPA filters do not produce harmful by-products, as is the case of the electrostatic participator, or ESP filters. Portable ESP filters have been found to reduce UFP levels by >90% (9). A randomized, double-blind study that assessed indoor $PM_{2.5}$ levels, vascular function and endothelial function in Canada found that ESP filtration significantly reduced $PM_{2.5}$ levels and resulted in vascular health improvement but not endothelial function improvement (46). This contrasts the endothelial function improvement seen in similar studies that used HEPA filters (28 - 29). The researchers hypothesized that the smoking status of many of the participants may have skewed their data on endothelial function, but concluded that their study added to the small but growing body of literature on the potential health benefits of indoor air filtration (46). However, ESP filters such as the type used in this intervention-based study are known to generate ozone, although recent advances in engineering may reduce these emissions

(47). As high ambient ozone concentrations are associated with increased cardiovascular mortality, and acute inhalation of ozone has been shown to induce artery vasoconstriction (48), HEPA filters remain superior until engineering advances can reduce or eliminate ozone generation of ESP filters. Additionally, recent research has called into question the ability of ESP filters to capture particles under 15 nm in diameter without increasing their ionizing voltage, which could in turn increase ozone generation (49).

Another reason to consider HEPA filtration interventions is the ability to specifically target at-risk individuals. Such individuals could live in the homes at highest risk of UFP exposure, which should become easier to pinpoint with advances in environmental exposure modeling. Individuals most at risk for cardiovascular morbidity and mortality could also be selected; namely middle-aged men, with high blood pressure, diabetes, family history of cardiovascular disease or those with certain risky behaviors, such as tobacco or alcohol use, unhealthy diet or lack of exercise (50). Tailoring interventions to reach the most at-risk populations has worked well throughout the history of public health. For example, a systematic review that compared the relative effectiveness of 37 different HIV/AIDS interventions and prevention strategies found that budgeting resources to reach the most at-risk populations, such as sex workers, was a key factor in effective interventions (51). The same principle could apply to HEPA filtration interventions. Surveys, focus groups, and interviews could be used to identify and enlist the participation of individuals at the highest risk and empower the community to be aware of the health risk, just as has been successful in HIV/AIDS interventions (51). When such individuals live in close proximity to a major highway, disproportionately high residential UFP concentration could be a critical comorbid factor contributing to the development of disease.

These vulnerable populations might especially benefit from HEPA filtration, and the tailoring of an intervention to reach them could make the effort both cost effective and efficient.

Finally, while HEPA filtration could be most effective at preventing cardiovascular morbidity and mortality in populations disproportionately affected by UFP, this intervention could have other positive health impacts on this population. Other benefits from HEPA filtration are found in preventing and reducing the severity of respiratory disease. UFP can trigger and/or exacerbate symptoms of asthma (52), and lung deposition of UFP is greater in individuals with COPD and asthma (53). HEPA filtration has proven an effective health intervention for people suffering from chronic asthma (27) (30). Additionally, it is likely that populations at risk of exacerbation of asthma and cardiovascular health problems could overlap. Current research suggests that, due to the underlying oxidative stress and inflammatory characteristics of being overweight or obese, these individuals may be more heavily affected by particulate matter and at increased risk of asthma, an inflammatory condition (54). HEPA filtration that addresses indoor concentrations of particulate matter could at the same time reduce a critical comorbid factor of disease and mortality in such individuals.

Synthesis of the Utility of HEPA Filtration

Although there are challenges to overcome in the implementation of this intervention, HEPA filtration represents a promising intervention to prevent cardiovascular morbidity and mortality that is worthy of further research. One potential area for future research to consider is a way to lessen noise these units produce and the variability of their filtration effectiveness under different conditions, as researchers attempting to implement intervention studies with HEPA filters have received feedback that these can be barriers to participation (13).

In an intervention based study of HEPA filtration, one of the chief complaints and reasons for participants dropping out of studies has been complaints about noise being annoying and disrupting sleep. While the units generally sound similar to the typical air conditioner , a noise that many participants may already be comfortable with, the air monitoring equipment often associated with these types of intervention studies also contributes to the ambient noise, which may add to the discomfort factor for participants (55). Additionally, participants who were less used to ambient noise levels from air conditioning in their home experienced more annoyance from the presence of the HEPA units (55). More data on the efficacy of the filtration if placed farther away from bedrooms to reduce noise annoyance, and a cost benefit analysis of more expensive but quieter units should be considered.

Another complaint of participants from the same study was the researchers' request to keep windows closed, even during a hot summer (13). This request resulted from data on the efficacy of HEPA filtration, which shows that increased indoor airflow exchange rates lower the efficiency of these residential units because under such conditions they treat a smaller fraction of the air (26). Additionally, researchers are concerned that such airflow that mixes outdoor and indoor air can skew results of filter efficiency, as readings on air quality may not actually reflect the air quality within homes (26). This is a major drawback to this intervention, because ambient UFP levels have been shown to increase seasonally during warmer months in some areas of the country (56), although an increase in UFP levels was seen during colder months in the Boston area (16). Engineering research to permit increased airflow while still filtering air efficiently is needed to improve the effectiveness of HEPA filtration.

In summary, HEPA filtration is a potentially useful strategy for improving cardiovascular health in individuals living near major highways by reducing indoor UFP levels. It is efficient at

removing very small particles and does not emit harmful by-products. Though this intervention does not have the same far reaching benefits that source reductions strategies can have, it can be implemented quickly and locally without changing federal regulations. HEPA filtration can be used to target high risk individuals at increased risk for cardiovascular morbidity and mortality both due to individual factors and proximity to major highways. More research, trials, and engineering innovations are necessary before any wide scale implementation of HEPA filters is advised. The public health community should make this a priority in the face of serious health challenges that UFP poses, a threat that the world is just beginning to comprehend. In 2009, a panel of expert toxicologists, epidemiologists, and clinicians was convened by the Dutch National Institute for Public Health and the Environment to reach the conclusion that increases in UFP concentration and cardiovascular hospital admissions as well as all-cause mortality constituted a medium to high likelihood (57). They urged public health researchers and policy makers to study and combat the health threat posed by UFP as distinct from $PM_{2.5}$ and PM_{10} (57). HEPA filtration represents an intervention that can address this underserved need in historically underserved populations.

Approach

<u>Context for Senior Honors Thesis</u>

CAFEH and BPRHS Collaboration

The randomized, in-home HEPA filtration intervention study examined in this paper represents collaboration between two ongoing studies that, among many other variables, both examine cardiovascular disease risk in the greater Boston area. CAFEH is a Community-Based Participatory Research (CBPR) study that started in 2008 has been collecting data on pollution in heavily trafficked areas in the Boston metropolitan area since 2009. Since its inception, CAFEH

has partnered with various local partners from community organizations, local government institutions and other universities to study the health effects of heavy traffic. It has expanded to encompass several separate projects with diverse aims and goals, including environmental science projects and health analyses, educational interventions on the health risks associated with exposure to traffic pollution, and assessment of HEPA filtration interventions. CAFEH's Principal Investigator is Professor Doug Brugge, PhD at the Tufts University School of Medicine's Department of Public Health and Community Medicine.

The BPRHS HEPA intervention study builds on and expands a previous CAFEH study conducted in partnership with the city of Somerville, Massachusetts Department of Housing and Urban Development. This randomized cross-over intervention also used HEPA and sham filters along the same 6 week timeline and use the same dependent variables of interleukin-6, fibrinogen, C-reactive Protein, tumor necrosis factor alpha-receptor II, as well as blood pressure. The lead author for the as of yet unpublished manuscript of this study is Dr. Luz Padro-Martinez, and the principal investigator is Professor John Durant from the Department of Civil and Environmental Engineering at Tufts University.

This intervention study (Project 4) is one of the aims of CAFEH's collaboration with the Boston Puerto Rican Health Study, or BPRHS. The BPRHS is one of the National Institute of Health (NIH)'s ten Centers for Population Health and Health Disparities. This study began in 2003 with enrollment of over 1500 Puerto Rican adults living in the Boston area, aged 45 – 75 years at baseline. It has followed participants over time with a rolling recruitment schedule and interviews and data collection that has evolved to reflect findings from earlier results; at the time of the "Year 5 followup", which roughly correlated to a similar time frame as the CAFEH/BPRHS HEPA intervention study (2012 - 2014), around 900 of the participants from

baseline had followed up. One of the primary aims of the BPRHS is to characterize the disproportionate risk of cardiovascular disease that Puerto Ricans in Boston experience. The study has collected many variables related to cardiovascular disease and risk. For the past four years, after realizing that traffic pollution could play a significant role in the cardiovascular health and disease risk in their study population, BPRHS has partnered with CAFEH to characterize the air pollution exposure to the study participants. The primary work from this collaboration will be showcased in future publications from Matt Simon and Laura Corlin, current graduate students at Tufts University developing an air pollution exposure model and assessing long-term health implications to air pollution exposure, respectively. Part of this work also involved the implementation an in-home air filtration intervention, which is the focus of this thesis. Bilingual educational materials on the potential risks of this exposure were also developed and discussed in focus groups with BPRHS study participants. The Principal Investigator of the BPRHS is Katherine Tucker, PhD, from the Department of Clinical Laboratory and Nutritional Sciences at the University of Massachusetts, Lowell.

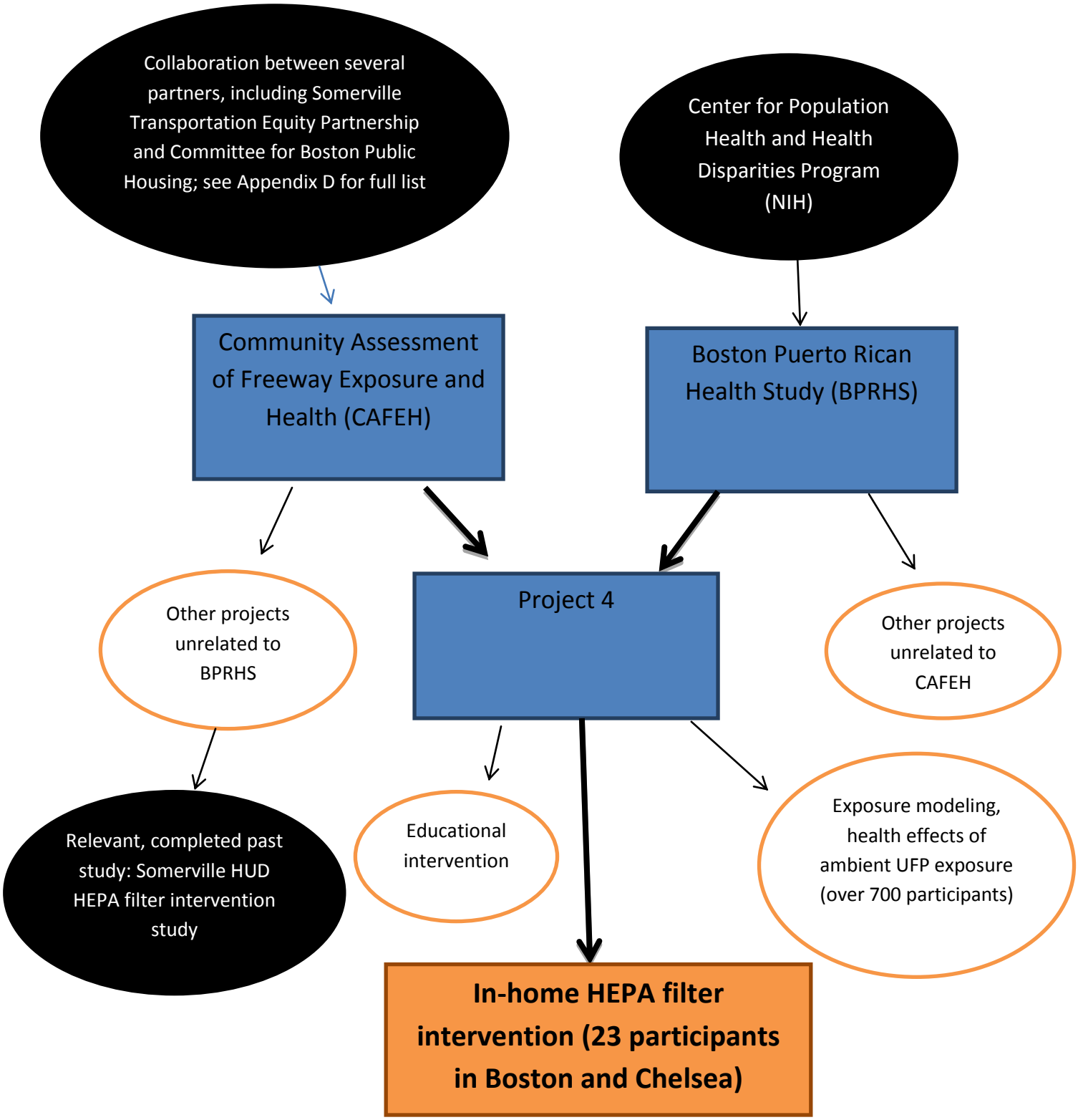

Figure 5: The relationship between the HEPA intervention study in question (shown in orange) and its parent studies, CAFEH and BPRHS. CAFEH and BPRHS both have 4 other Projects; of note, in a separate CAFEH Project an almost identical HEPA intervention study was conducted in Somerville, MA. The CAFEH/BPRHS collaboration is also producing exposure modeling of ambient UFP levels affecting BPRHS participants and an educational intervention.

Study Design

At a baseline study visit, a filter was installed in 24 participant homes and a survey that included information on many potential covariates and exposure assessment was conducted. The filter installed was either High Efficiency Particulate Arrestance (HEPA) filter or a sham filter that looked and sounded the same. Participants were unaware which group they were randomized into (HEPA first or sham first). Blood samples were also taken at baseline. After three weeks, researchers visited the homes a second time, switched the sham for a real filter or vice versa, conducted a shorter, supplementary survey, and once again took blood samples. Three weeks later, six weeks after the start of the intervention, an identical supplementary survey was administered and a final blood sample was taken, and the filter was removed. The blood samples were frozen and stored and analyzed in one batch to reduce discrepancies in measured values. The samples will be analyzed for levels of three biomarkers of cardiovascular disease risk: interleukin-6, C-reactive protein (CRP), and tumor necrosis factor alpha-receptor II. Data collection with the final participant finished in December 2014, and the blood samples were analyzed in early 2015.

PNC data was measured continuously inside and just outside participants' homes for the six week duration of the study. Similar to the previous study in Somerville, this data can be used to see if HEPA filters reduce in-home PNC, and by how much. In contrast to the Somerville study, the PNC values taken just outside the home, which were not measured in the previous study, can be used when modeling PNC exposure inside and outside.

Participants' randomization status was determined by a coin flip. An error in record keeping in the field resulted in an unequal split between the HEPA first and sham first

randomization groups (Matt Simon, 2/17/15). As a participant from the sham group was later excluded on the basis of smoking (see *Missing and Excluded Data*), the HEPA first and sham first groups then became 11 and 12, respectively.

Figure 6: The design of the BPRHS/CAFEH HEPA filtration intervention study. Participants were randomized into HEPA first or sham first at baseline. Each visit corresponded with a blood sample and a questionnaire (comprehensive at baseline, supplementary at Visits 2 and 3).

The Sample

In addition to being adults of Puerto Rican descent followed by the BPRHS, study participants in this randomized HEPA filter intervention study live within 350 meters of a major roadway, as defined by roadway class, not actual traffic (Matt Simon, 11/6/14). It is important to note that proximity to a major roadway was not a factor in selecting this population from the BPRHS cohort. Members of the cohort were chosen because they were also recommended to CAFEH researchers by BPRHS researchers as being likely to be amenable to completing the six week study. It was also necessary for the filter to be able to fit into the apartment, and for there to be no objection from the building owner (Matt Simon 11/5/14). Additionally, smoking was part of the exclusion criteria for this study; however, 2 smokers ended up in the study population (discussed below). 24 participants were followed in total; the first 14 participants live in Boston, and the following 10 live in Chelsea, MA. 1 participant was later excluded.

Dependent Variables

The three dependent measures assessed in this intervention are predictors of cardiovascular disease that have been used in many previous studies (58). Interleukin-6, C-reactive protein and tumor necrosis factor alpha-receptor II are all involved in the inflammatory pathway. Inflammation is a protective biological state characterized by increased blood flow, heat, swelling, pain, and loss of function. Although inflammation is often traditionally thought of in terms of its acute role in the immune system and wound healing, systemic and chronic inflammation is central aspect of many pathological conditions, including cardiovascular disease (59). Inflammation is interrelated with the biological pathway of coagulation, or clotting; these two pathways can activate each other. Similarly to inflammation, coagulation is an essential

biological reaction to various external stimuli, but is also involved in pathology when excessive, including in cardiovascular disease. Interleukin-6 is involved in both the inflammatory and coagulation pathways (60). These markers are not perfect estimations of cardiovascular disease risk, but they are all accepted biomarkers used frequently in current research. CRP in particular is widely accepted and used as highly predictive of adverse outcomes for patients with a pre-established coronary disease, and of future coronary events in healthy subjects (61).

Covariates

Other intervention studies addressing cardiovascular health via in-home air filtration have accounted for age, sex, race/ethnicity, smoking status, BMI, and some variation of an estimation of exposure assessment (28) (29) (46), as well chronic disease status, specifically diabetes and hypertension (28). The previous CAFEH study conducted in Somerville public housing looked at all of these variables, as well as any medications participants may have taken for these chronic diseases, income, education, and employment status. Both the previous CAFEH study and the study in question excluded households with current smokers, and assessed exposure to tobacco smoke.

Many of the variables collected, namely tobacco smoking (62), diabetes (63), hypertension (64), and BMI (65), are well documented to be associated with increased systemic inflammation and imbalances in the coagulation pathway (albeit with varied biological routes to this outcome). Importantly, some studies suggest that a number of these states, especially obesity, diabetes and hypertension, may affect individuals' susceptibility to the inflammation-causing health effects of exposure to air pollution (65). Additional information collected via the

BPRHS regarding physical activity was also included. Prolonged physical activity has been shown to decrease systemic inflammation (66).

Data Entry

In-home surveys

Survey data from the baseline visit and from the two supplementary surveys at Visits 2 and 3 were entered in Microsoft Access. The surveys were conducted in Spanish and the Microsoft Access template used was written in English; however, all persons involved in data entry were bilingual. Data was double entered and checked for consistency to ensure fidelity to the original, hard copy surveys.

There were six portions of data to be entered for every participant: (1) baseline survey questions, (2-3) two sets of (identical) supplement questions, and (3- 6) three separate Time Activity sections. The baseline survey was the most comprehensive, and contained sections on indoor exposure (for example, "Con qué frecuencia usted abre las ventanas entre junio y agosto?"/ "How often do you open your windows from June to August?"), contact with smokers, sound (loud traffic, etc.), occupational exposures, and a basic health status section. The supplement questions, which were asked at Visits 2 and 3, regarded acute exposures and illnesses that may have occurred during the three weeks since the participant was last visited by a researcher (for example, "Ha experimentado la girpe o enfermedad de tip gripal en la semana pasada?" / "Have you had the flu in the past week?"). To see the full questions from both the baseline survey and supplementary visits, see the Appendices B and C.

In-home Time Activity questionnaires

The Time Activity sections will be used to construct personalized exposure models for each participant, adjusting for indoor PNC levels and the time participants spend in different locations throughout a typical week. They were collected by asking participants about a recent work or school day and a recent day when she/he was not at work or school; if the participants did not work, then they were asked to think about a recent week day and a recent weekend day. For each of the two recent days, researchers asked participants where they were for each hour of the day. The options provided were: Home (Inside), Home (Outside), School or Work, and Other (including travel not on highways). Additionally, minutes spent traveling on a highway during each hour of the day were also recorded.

The original intent of the survey design was for researchers to only select "Hogar (Exterior)" / "Home (Outside)" when participants were within one block of their home; this was intended to coincide with the PNC levels measured directly outside the homes. However, over the course of data entry, and after consulting with the interviewers, it became apparent that for the majority of the interviews, "Hogar (Exterior)" was erroneously selected whenever participants were outside of the home in general and the "Other" category was rarely chosen. There was only one interviewer who did not make this mistake; for the Time Activity sections she completed, fidelity to the original survey was maintained. The sections collected by this interviewer were: all three visits for participants 95245 and 95252; the first and second visits for participant 94131; and the third visit for participant 93739. For all other surveys besides these, any answer of "Other" (originally coded as 4) was coded to be "Home (Outside)" (coded as 2), narrowing the options for where participants were during a typical day to inside the home (1), outside the home in general (not necessarily within one block) (2), or at work/school (3).

Data Entry: Formatting

The template used on Microsoft Access only provided space for one Time Activity, the baseline survey, and one supplement. The data from the original 14 study participants from Boston were entered under each participant ID; however, only the Time Activity from the baseline visit, the baseline survey, and the supplement from Visit 2 were entered initially by previous bilingual staff members over the summer of 2014. (The template was designed for the previous Somerville study, and there was no one with the technical expertise on Microsoft Access to adapt it to this study.)

To accommodate the template, the rest of the data from the original 14 study participants (Time Activity from Visits 2 and 3, and the supplementary questions from Visit 3) were entered as new entries labeled "(participant ID)_2" and "(participant ID)_3", to correspond to the second and third visits. The data from the 10 Chelsea participants was then double entered in the same manner.

Data Entry: Final Steps

All of the double entered data was exported to an Excel spreadsheet, where it was checked to ensure that the double entries matched with fidelity to the hard copy. Where necessary, 9999 was used to code for missing data or blank spaces. All other coding, such as the use of 999 to refer to "se niega a" / "refused to answer", was specified in the survey text (see Appendices B and C for full survey texts).

Subsequently, the duplicate copies of the data were deleted, and all of the different entries, which were separate in Microsoft Access due to the limitations of the template used, were combined into multiple tabs on a single spreadsheet.

BPRHS Data

The demographic data for the Puerto Rican participants (see **Table 12** in Results) was extracted from the BPRHS database. Access was granted to the de-identified data from the Year 5 follow-up; these interviews took place in a similar time period to the HEPA filtration intervention study. There was much more information in these interviews than relevant to this HEPA filtration intervention study. Relevant demographic information, such as income, education, and medical diagnoses, was extracted from this data base for summarization. The information to extract was chosen to match the demographic table from the currently unpublished manuscript from the Somerville HUD study (see **Table 13** in Results). However, the BPRHS data did not perfectly match with the demographics collected in that previous study; therefore, the joint demographic table (**Table 14** in Results) differentiates between the two studies in some rows and not in others.

Some specific differences between the two datasets are as follows. Education data in the Puerto Rican cohort was available as a simple yes/no for obtainment of eighth grade education as opposed to the more detailed classifications in the Somerville study. In both studies, household income data was not available for all participants; however, unlike the data from the Somerville study, these values were not specified as “do not know” or “refused” in the Puerto Rican cohort.

All demographic data from the BPRHS study was taken from the Year 5 data; the timeframe for the collection of this data was roughly similar to the time period over which the HEPA filtration intervention was conducted. The only exceptions to this are the education data and migration history data (place of birth), which were both from baseline data. While it is unlikely that any participants received further education since their baseline survey considering their average age, it is possible that this education data is not as accurate as the other demographic characteristics.

Medication lists from the Year 5 data set were classified as Anti-inflammatory, Anti-diabetic, Anti-lipid, Anti-hypertensive, or Other according to the same classification list used by Dr. Luz Padro-Martinez in the Somerville HEPA filtration intervention study (see Appendix A for these classifications). Medications not included in this list were looked up on www.nlm.nih.gov/medlineplus. They were also independently checked by a second CAFEH researcher, Sonja Rivera, and the results were double checked for accuracy.

Missing and Excluded Data

One participant (95252) in the HEPA first randomization group had not followed up for her/his Year 5 interview at the time that this thesis was written. This was unexpected, as participants for the HEPA filtration intervention study were chosen partly based on recommendations from the BPRHS study staff for individuals who might be enthusiastic about the study/receptive to follow up. As of February 2015, this participant was not yet considered lost to follow up by BPRHS study staff, and her/his demographic information may become available in future releases of BPRHS Year 5 data. Three pieces of demographic information are available for this participant, however, as they were not taken from the Year 5 data. Specifically, he/she did not receive an 8th grade education, was born in Puerto Rico, and lives within 50 meters of a major roadway.

Demographic data from the BPRHS revealed that 1 participant in each randomization group (94997 in HEPA first, 94720 in sham first) actively smoked at the time of their Year 5 follow up. Further investigation revealed that there may have been a lack of oversight when selecting 94997 as a participant (they were not in the original list that was checked for smokers – Matt Simon 2/19/15), and that 94720 was not listed as a smoker at baseline, which is probably

how she/he was missed as a smoker. To confirm, Siobhan Torres, the manager for the field operations at the BPRHS, called both participants on 3/3/15. 94720 (in the sham first randomization group) was found to have been a smoker since age 20, and smoked between one half to a pack during the intervention study and was therefore excluded from further analysis. 94720 began smoking at age 14, but quit over a year ago and did not smoke during the intervention, and was therefore included in the data analysis.

Pooling BPRHS Collaboration and Somerville Study data

Future analyses of these data will include consideration of pooled results of the HEPA filter intervention on blood biomarkers in both the Puerto Rican cohort and in the Somerville study to create a larger sample size, as well as separate analyses on each cohort. To that end, **Table 14** (see Results) was constructed to pool demographic results together for future researchers. Not all variables could be pooled perfectly, however. As previously mentioned, the reason for missing income data was not specified in the BPRHS data as it was in the Somerville study. Education was recorded as attainment of 8th grade education in the BPRHS data, as opposed to high school diploma or higher in the Somerville study. Major roadway proximity was both measured to different roads and not part of the inclusion criteria for the Puerto Rican study, while highway proximity was assessed in the Somerville study. Finally, the BPRHS assessed current smoking, but not past smoking.

Summarization of Results

Pertinent results of the surveys conducted at each stage of the intervention (Appendices B and C) were tallied on Excel and displayed in Word tables (Tables 1 – 11), separated by randomization groups to allow for comparison.

Summarization of BPRHS demographic statistics was completed by exporting Excel files to STATA (version IC 13) and generating summary statistics. (The reason behind a differing methodology between generating summary statistics for the CAFEH surveys vs. the BPRHS demographic data is that I began a STATA course in Spring 2015, after which I found STATA to be very helpful.)

Results

The fourth and final aim of this thesis is to summarize the raw data in a manner useful to future publications. After the survey data that was collected at baseline, three weeks, and six weeks of this intervention was completely entered and cleaned, some of the main findings were summarized in tables in Word. These tables are not an exhaustive summary of the results; rather, they provide an overview of participants' responses; analysts working on the final analysis of this data can use these tables to determine where they may decide to dig deeper in the raw data to account for differences in the two randomization groups. For the content of the sections referenced in each of these result tables, refer to Appendices B and C for the text of the survey.

Results from CAFEH/BPRHS Collaboration Surveys Summarized

Randomization group	Windows open in winter (any number/to any degree)	Windows open in summer (any number/to any degree)	Vent to outside (bathroom)	Vent to outside (stove)	Air Conditioners used (any number/to any degree)
HEPA first (n=11)	8	10	7; 1 missing data	6	10
sham first (n = 13)	3	10	9	8	13

Table 1: A summary of the results of the Exposure in the Home (Section C) of the baseline survey

Randomization group	Smoking occurs (to any degree) in the house during a typical week	Smoker(s) live in home	Smoking occurs (to any degree) when participant is in the car during a typical week
HEPA first (n = 11)	0	4	0
sham first (n = 13)	0; one does not know	2	0

Table 2: A summary of the results of the Smoking (Section D) of the baseline survey

Randomization group	Bothered by traffic sound (to any degree)	Own property or rent (not subsidized or public)	Subsidized housing	Public housing	Home built 1975 or earlier
HEPA first (n = 11)	3	2	4	5	3; 7 don't know
sham first (n = 13)	5	1	5	7	2; 9 don't know

Table 3: A summary of the results of the Sound (Section E) of the baseline survey

Randomization group	5+ years of any occupational exposure	Exposed to vehicle exhaust at last job (to any degree)
HEPA first (n = 11)	3; 2 did not report years to reported exposure (missing data)	3; 6 reported “retired”
sham first (n = 13)	2	1;7 reported “retired”

Table 4: A summary of the results of the Occupational Exposures (Section F) of the baseline survey

Randomization group	Heart incident	Angina	Rheumatoid arthritis
HEPA first (n = 11)	3	5	7
sham first (n = 13)	1	2	6

Table 5: A summary of the results of the Health (Section G) of the baseline survey

Randomization group	New condition/illness	Cold	Flu	Pneumonia	Asthma attack
HEPA first (n = 11)	1	1 (*same participant*)	0	0	0
sham first (n = 13)	0	0	1	0	1

Table 6: A summary of the results of the Health (Section N) of the supplemental survey taken at the 2nd visit; questions regarded the two weeks between the Baseline and 2nd visit.

Visit 2	Cooking w/oil	House cleaning	Walk by highway 20 min+	City streets 20 min+	Travel highway 10 min+	Smoke (home)	Smoke (car)	Smoke (work)
HEPA first (n = 11)	11	9	6	3	4	3	1	1

Table 7: A summary of the results of the Exposure (Section R) of the supplemental survey taken at the 2nd visit for the HEPA first group; unlisted exposures were not reported by any participants in this group at this time. Exposures listed in decreasing frequency of participants.

Visit 2	City streets 20 min+	House cleaning	Cooking w/oil	Travel highway 10 min+	Walk by highway 20 min+	Candles	Grilling
sham first (n = 13)	9	8	7	6	4	2	1

Table 8: A summary of the results of the Exposure (Section R) of the supplemental survey taken at the 2nd visit for the sham first group; unlisted exposures were not reported by any participants in this group at this time. Exposures listed in decreasing frequency of participants.

Randomization group	New condition/illness	Cold	Flu	Pneumonia	Asthma attack
HEPA first (n = 11)	1	0	0	0	0
sham first (n = 13)	0	1	1 (*same participant as 2nd visit*)	0	1

Table 9: A summary of the results of the Health (Section N) of the supplemental survey taken at the 3rd visit. Questions referred to the two weeks between the 2nd and 3rd visits.

Visit 3	Cooking w/oil	House cleaning	Candles	Travel highway 10 min+	City streets 20 min+	Walk by highway 20 min+	Sanding	Smoke (home)	Smoke (work)
HEPA first (n = 11)	10	9	4	4	3	2	1	1	1

Table 10: A summary of the results of the Exposure (Section R) of the supplemental survey taken at the 3rd visit for the HEPA first group; unlisted exposures were not reported by any participants in this group at this time. Exposures listed in decreasing frequency of participants.

Visit 3	House cleaning	City streets 20 min+	Cooking w/oil	Travel highway 10 min+	Candles	Walk by highway 20 min+	Sanding	Grilling	Smoke (home)
sham first (n = 13)	10	8	7	6	4	2	2	1	1

Table 11: A summary of the results of the Exposure (Section R) of the supplemental survey taken at the 3rd visit for the sham first group; unlisted exposures were not reported by any participants in this group at this time

Demographic Results

	Total	HEPA First	Sham First
	(N=22)	(N=10) **one missing	(N= 12)
Demographic Data			
Age, Mean (SD), years	64.82 (6.58)	64.8 (5.77)	64.8 (7.44)
BMI, Median (Min- Max)	32.76 (24 – 50)	32.6 (24 – 42)	32.9 (25 – 50)
Female	18 (81 %)	8 (80%)	10 (83 %)
Hispanic (Puerto Rican)	22 (100%)	10 (100%)	12 (100%)
Born in Puerto Rico	22 (100%)	10 (100%)	12 (100%)
Annual Household Income			
<$24,999	18 (82%)	7 (70%)	11 (92%)
$25,000 – $74,999	1 (5%)	1 (10%)	0 (0%)
Income data not available	4 (18%)	2 (20 %)	1 (8%)
Eighth Grade Education	9 (41 %)	4 (40%)	5 (42 %)
Employed	0 (0 %)	0 (0 %)	0 (0 %)
Physical Activity Score, Mean (SD)	30.7 (6.7)	33.1 (9.3)	28.7 (2.4)
< 50 m to a major roadway	7 (32%)	3 (30%)	4 (33%)
> 50 m to a major roadway	15 (68 %)	7 (70%)	8 (67%)
Health data and Medicines used[d]			
Total Cholesterol, mean (SD), mg/dL	209 (51)	200 (64)	220(30)
Triglycerides, mean (SD), mg/dL	194 (141)	191 (120)	198 (172)
Previous Heart Attack	4 (18%)	2 (20%)	2 (17%)
Diabetes	13 (59%)	7 (70%)	6 (50%)
High Blood Pressure or Hypertension	17 (77 %)	8 (80%)	9 (75%)
Arthritis	20 (91%)	9 (90%)	11 (92%)
Anti-hypertension medicine	17 (77%)	8 (80%)	9 (75%)
Anti-inflammatory medicine	9 (41%)	6 (60%)	3 (25%)
Anti-lipids medicine	14 (64%)	7 (70%)	7 (58%)
Anti-diabetes medicine	10 (45%)	7 (70%)	3 (25%)

Table 12: Demographic results for the participants of the CAFEH/BPRHS HEPA filtration intervention study. All data was extracted from the BPRHS database. Participant 95252 is missing, as she/he has not completed the Year 5 follow up; however, while not listed the education and birthplace data are available for this participant (no 8th grade education and born in Puerto Rico, respectively).

	Total (N=20)	HEPA First[a] (N=10)	ShamFirst[b] (N=10)
Demographic Data			
Age, Mean (SD), years	53.6 (9.2)	55.6 (11.4)	51.5 (6.3)
BMI, Median (Range)	31.5 (20–72)	30.5 (20–72)	32 (25–51)
Female	16 (80%)	7 (70%)	9 (90%)
Born in USA	4 (20%)	2 (20%)	2 (20%)
White	6 (30%)	2 (20%)	4 (40%)
Hispanic	7 (35%)	3 (30%)	4 (40%)
AnnualHouseholdIncome			
<$24,999	14 (70%)	8 (80%)	6 (60%)
$25,000 – $74,999	3 (15%)	1 (10%)	2 (20%)
Don'tKnow/Refused	3 (15%)	1 (10%)	2 (20%)
High School Diploma or Higher Degree	8 (40%)	4 (40%)[c]	4 (40%)
Employed	9 (45%)	3 (30%)	6 (60%)
Distance to I-93: ≤100 m	10 (50%)	6 (60%)	4 (40%)
Distance to I-93: 101-200 m	10 (50%)	4 (40%)	6 (60%)
Health data and Medicines used[d]			
Total Cholesterol, mean (SD), mg/dL	290 (122)	264 (124)	317 (120)
Triglycerides, mean (SD), mg/dL	211 (141)	169 (111)	254 (160)
Systolic Blood Pressure, mean (SD), mmHg[e]	123 (15)	126 (15)	120 (14)
Diastolic Blood Pressure, mean (SD), mmHg[e]	77 (10)	80 (10)	75 (9)
Pulse pressure, mean (SD), mmHg[f]	45 (10)	46 (11)	45 (9)
PreviousHeartAttack	1 (5%)	1 (10%)	0 (0%)
Diabetes	2 (10%)	0 (0%)[c]	2 (20%)
High BloodPressure	11 (55%)	8 (80%)	3 (30%)
Arthritis	3 (15%)	2 (20%)	1 (10%)
Anti-hypertension medicine	10 (50%)	7 (70%)	3 (30%)
Anti-inflammatory medicine	7 (35%)	6 (60%)	1 (10%)
Anti-lipids medicine	3 (15%)	2 (20%)	1 (10%)
Anti-diabetes medicine	3 (15%)	1 (10%)	2 (20%)
Formercigarettesmoker	4 (20%)	3 (30%)	1 (10%)

Table 13: Demographic table taken from the currently unpublished manuscript from the HEPA filtration intervention study conducted in Somerville public housing (study PI: Dr. Luz Padro-Martinez). Tables 12 and 14 were modeled off of this table.

	Total	HEPA First[a]	ShamFirst[b]
	(N=42)	(N=20) **missing one Puerto Rican particpant	(N=22)
Demographic Data			
Age, Mean (SD), years	53.6 (9.2)	55.6 (11.4)	51.5 (6.3)
Age, Mean (SD), years	*64.82 (6.58)*	*64.8 (5.77)*	*64.8 (7.44)*
BMI, Median (Min - Max)	31.5 (20–72)	30.5 (20–72)	32 (25–51)
BMI, Median (Min- Max)	*32.76 (24 – 50)*	*32.1 (24 – 43)*	*28.8 (25 – 50)*
Female	**34 (81%)**	**15 (75%)**	**19 (86%)**
White	**6 (14%)**	**2 (10%)**	**4 (18%)**
Hispanic	**29 (69%)**	**13 (65%)**	**16 (73%)**
Annual Household Income			
<$24,999	**32 (76%)**	**15 (75%)**	**17 (77%)**
$25,000 – $74,999	**3 (15%)**	**2 (10%)**	**2 (20%)**
Don'tKnow/Refused	3 (7%)	1 (5%)	2 (9%)
Income Data Missing (Unspecified cause)	*4 (10%)*	*2 (10 %)*	*1 (5%)*
High School Diploma or Higher Degree	8 (19%)	4 (20%)[c]	4 (18%)
Eighth Grade Education	*9 (21 %)*	*4 (20%)*	*5 (23 %)*
Employed	**9 (22%)**	**3 (15%)**	**6 (27%)**
Distance to I-93: ≤100 m	10 (24%)	6 (30%)	4 (18%)
Distance to I-93: 101-200 m	10 (24%)	4 (20%)	6 (27%)
< 50 m to a major roadway	*7 (17%)*	*3 (15%)*	*4 (18%)*
> 50 m to a major roadway	*15 (36 %)*	*7 (35%)*	*8 (36%)*
Health data and Medicines used[d]			
Previous Heart Attack	**5 (12%)**	**3 (10%)**	**2 (9%)**
Diabetes	**15 (36%)**	**7 (35%)**	**8 (36%)**
High Blood Pressure or Hypertension	**29 (69%)**	**16 (80%)**	**13 (59%)**
Arthritis	**24 (57%)**	**11 (55%)**	**13 (59%)**
Anti-hypertension medicine	**27 (64%)**	**15 (75%)**	**12 (55%)**
Anti-inflammatory medicine	**16 (38%)**	**12 (60%)**	**4 (18%)**
Anti-lipids medicine	**17 (40%)**	**9 (45%)**	**8 (36%)**
Anti-diabetes medicine	**13 (31%)**	**8 (40%)**	**5 (23%)**

Legend

Bold: pooled

Italics: Puerto Rican only

Normal font: Somerville only

Table 14: Pooled demographic results for the participants of the CAFEH/BPRHS HEPA filtration intervention study and the Somerville HEPA filtration intervention study. Total N for percentages should actually be 43, but demographic data is missing for one Puerto Rican participant who completed study (95252).

Discussion

Strengths and Limitations

Homogeneity of Study population

All study participants were from Puerto Rican and non-smokers. Although not actually part of the inclusion criteria, they also all lived within 250 meters of a major roadway at the time of the study, although this distinction is based upon roadway class and not necessarily actual traffic patterns. The majority (18) were female. The lowest annual household income was $2400, and the highest was $25, 860. Additionally, as participants received both HEPA and sham filtration over the course of the six weeks of the study and the dependent variables were assessed after both, they acted as their own controls. This relative homogeneity contributes to the strength of any findings when the blood biomarkers are analyzed, although it may negatively impact the generalizability of these results.

Small Study Population

Only enrolling 23 participants limits the statistical power of this study. The idea behind constructing a joint demographic table of these participants with the ones from the previous CAFEH study in Somerville that also used HEPA filtration is that hopefully the two groups can be combined to yield a study population of 43. Sample size was also negatively impacted by the loss of the active smoker participant.

CBPR Success

The status of this study as one that is both community-based and participatory is an asset. In public health, CBPR is an approach to research in which community members, representatives

from organizations and researchers all contribute and are involved in all aspects of the research process that aims to improve the wellbeing of community members. It has a rich history, with roots in the theory of "action research" from the 1940's, and the so-call "Southern tradition" of participatory research in global health in the 1970's. It has demonstrated success in improving the wellbeing of community members across a wide variety of time periods, locations, and health issues (67). Due to the inclusive involvement of many members, such research also tends to be interdisciplinary in nature within the scope of the academic partners involved as well. The dialogue and exchange between these varied viewpoints help make CBPR studies like CAFEH successful and relevant to the communities they serve.

Communication Errors

Many people are involved in this project, and it has experienced some setbacks due primarily to erroneous information conveyed at times. Notably, the original proposed scope of this thesis was to analyze the intervention using the dependent variable of blood pressure. It was thought that this was collected at baseline and at the two three week follow-up visits; however, only blood samples were actually collected at these visits. Additionally, confusion over what was actually entered into Microsoft Access, the limitations of the template used, the confusion over the correct specification of "Home (Outside)" in the Time Activity data entry, and on active smokers in the study population impeded progress.

The interdisciplinary aspect of this project may have made some communication error more likely. While the broad range of disciplines present and represented is a major asset of this work, it appears to make a streamlined flow of communication difficult at times. An interdisciplinary research team from the University of Massachusetts, Lowell that seeks to

improve occupational health for healthcare workers has reflected that involving research partners of multiple disciplines strains communication; they had to hire program managers and form coordinating committees to conduct their research (68). Given the nature of the CAFEH/BPRHS project, the communication errors that hindered progress can be seen as an understandable inconvenience outweighed by the benefits of the insights of many viewpoints coming together for one study.

Discussion of CAFEH Survey Results

Comparing the results of the surveys conducted at study visits for the two randomization groups revealed some interesting findings. In general, findings were considered interesting when they revealed a sizeable difference between randomization groups, as the exposures asked about in this survey have the potential to affect biomarker and/or PNC results, so any differences that could change readings between the two randomization groups is worth considering when examining the data.

The first sizeable difference noted was that 8 of the 11 HEPA first participants leave their windows open to some degree in the winter, as compared to 3 out of 13 in the sham first group (see **Table 1**). The majority of the participants completed the study during the summertime; however, 8 participants began the 6 week study in October or later (ID numbers 94901, 36201, 93722, 94997, 94328, 95114, 93015, 36201). As leaving windows open could affect PNC counts, it is important to note the discrepancy between the randomization groups.

Looking at the Exposure tables from both the baseline and supplemental visits, especially **Tables 7** and **8** as well as **Table 2**, it appears that the HEPA first randomization group seemed to have been generally more exposed to tobacco smoke than the sham first group. This is important

to note for the potential effect of this exposure on the biomarker levels for the HEPA first group vs. the sham first group.

Also of note is that the majority of participants did major house cleaning and cooked with oil over the course of the study (**Tables 7, 8, 10,** and **11**), two exposures asked about at the supplemental visits. Both of these exposures could potentially affect PNC counts and/or biomarker data, so it is important to realize that they were nearly ubiquitous. In the three weeks between Visits 2 and 3, 8 out of 13 sham first participants walked by busy city streets for 20 minutes or more, as compared to 3 out of 11 HEPA first participants (**Tables 10** and **11**). This is relevant simply because it is fairly large discrepancy between the two randomization groups, and could potentially affect biomarker data.

Comparing Demographics to Somerville Study

The 22 participants with demographic data from the BPRHS/CAFEH HEPA filtration intervention study had some significant differences in comparison to the previous study population living in Somerville public housing. The Somerville study population was only 35% Hispanic, in comparison to the entirely Puerto Rican study population discussed in this thesis (see Demographic **Table 13** in Results). Only 10% of the Somerville population was diagnosed with diabetes, as opposed to 59% of the Puerto Rican study population. 55% of the Somerville study population reported having high blood pressure, whereas 82% of the Puerto Rican participants had been told by a doctor that they had high blood pressure and/or Hypertension. Nearly all of the Puerto Rican participants had arthritis (95%), as compared to just 15% in the Somerville study population.

The physical activity score included in **Table 12** was derived by BPRHS researchers from data collected during this cohort study that was not assessed in the Somerville study. It is used here as a comparison variable between randomization groups, not for comparison to a greater population. It was calculated using the amount of time participants reported performing light, moderate, and vigorous activity, as well as sleeping and sitting. Although calculated at the time of the Year 5 follow up (these data were used in **Table 12**), see the BPRHS Baseline Codebook for a full description of the derivation calculations.

Education was difficult to compare, as it was recorded differently in the two studies; 40% of the Somerville study population had a high school diploma or higher, whereas 41% of the Puerto Rican study population had at least an 8th grade education. Additionally, the Somerville study population was 80% immigrants, whereas all of the participants in the BPRHS collaboration intervention were born in Puerto Rico.

There were also sizeable differences in the number of participants clinically diagnosed with different conditions; likely leading to fairly substantial differences in medication (for example, 64% of Puerto Rican study participants were on anti-lipid medications like statins, as compared to 15% of the Somerville study population). The Puerto Rican study population, from this very limited summary, appeared to be less healthy overall in general; for example, 4 participants of the 22 with demographic data had had a heart attack, as compared to just 1 from the 20 Somerville participants. When combining these study populations for a future pooled analysis, it is important to realize that this pooled analysis will contain more internal variability than a separate analysis would.

Conclusion

Although the shape of this project changed several times over the course of a year, it ultimately achieved its aims of providing background on the intervention, relevant covariates, and a summarization of the data. I learned countless lessons through the process of becoming fully immersed in general data management, all the way from raw data entry to generating summary statistics on STATA, with many steps in between.

In particular, I've gained a huge appreciation for the amount of work it takes to generate clean and succinct summarizations of raw data. Between the double entries and double checking, including interface with multiple software programs like Microsoft Access and Excel, as well as figuring out discrepancies like the "outside the home" answers to the Time Activity, there was a lot of time and effort from many people to get the data into a workable form to be summarized. Learning to be comfortable with this work and the several software packages involved was definitely valuable for me. I also learned not to take data for granted until the raw numbers are in front of you, as was the case with the elusive blood pressure data in this study.

Being involved with a CBPR study like CAFEH has been an incredible experience in terms of meeting people from all different backgrounds working on the study. I also really appreciate that CAFEH's research is actually tailored and receptive to the needs of the communities it serves. However, I definitely learned that it can help to minimize the number of people involved in specific areas if possible, as too many people involved can result in confusing miscommunications.

Overall, this rewarding experience affirmed my desire to stay involved in CBPR health research in my future while giving me some ideas of how to implement things differently in the future.

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Appendices

A) Medication Classifications used by Dr. Luz Padro Martinez

Antihypertension
-Olmesartan
-Hydrochlorothiazide
-Losartan
-Toprol XL
-Lisinopril
-Metoprolol succinate
-Labetalol
-Lismepril

-Atenolol

Antiinflammation
-Naproxen
-Aspirin
-Nabumetone
-Ibuprofen Motrin

Antilipid
-Simvastatin
-Pravistaten

Antidiabetics
-Metformin
-Glipizide
-Humulin
-Insulin
-Lanthus

Others
-Claritin
-Acetaminophen
-Bupropion
-Omeprazole
-Vivemax
-Levothyroxime
-Gabapentin
-Citalopram
-Plavix
-Hydrocodone
-Advair
-Levothyroxine
-Tamsuloson
-Finasteride
-Prolosek

B) Baseline Survey: English and Spanish

Puerto Rican Health Study, Project 4

SURVEY

Participant ID: _____ Interviewer: _____

Date (month/day/year): __ __ / __ __ / __ __

A. Time-Activity

The following section seeks to learn about where you spend time during workdays and non-work days and about how you travel from place to place.

Please think about your most recent school/workday from midnight to midnight and choose the main location in which you spent each one-hour time block. If you were traveling during this period, please indicate when you were a driver or passenger on a highway and how long you were traveling on a highway, to the best that you can recall. If you do not work, report a weekday.

[ASK HOUR BY HOUR WHICH MICRO-ENVIRONMENT THE RESPONDENT SPENT TIME IN.]

[IF THEY SPENT TIME AS A DRIVER OR PASSENGER ON A HIGHWAY, PLEASE INDICATE HOW MANY MINUTES IN THE "TIME ON HIGHWAY" COLUMN ON THE RIGHT-HAND SIDE.]

[BY "OUTSIDE AT HOME" WE MEAN OUTDOORS WITHIN ONE BLOCK OF THE RESPONDENT'S RESIDENCE.]

[BY "HIGHWAY" WE MEAN HIGH TRAFFIC, HIGH SPEED ROADWAYS. EXAMPLES INCLUDE: I-93, I-95, I-90, I-495, RT. 2, RT. 3, RT. 9, RT. 16, RT. 24, STORROW DR., MCGRATH HWY, SUMNER TUNNEL, AND OTHER SIMILAR ROADWAYS. WE DO NOT MEAN LIGHTLY TRAVELED RURAL ROADWAYS OR BUSY URBAN STREETS.]

Work Day	Home (Inside)	Home (Outside)	School/Work	Other: Inc. non-hwy travel	Time On Highway
12 -1 AM					
1-2 AM					
2-3 AM					
3-4 AM					
4-5 AM					

5-6 AM					
6-7 AM					
7-8 AM					
8-9 AM					
9-10 AM					
10-11 AM					
11 AM-12 PM					
12-1 PM					
1-2 PM					
2-3 PM					
3-4 PM					
4-5 PM					
5-6 PM					
6-7 PM					
7-8 PM					
8-9 PM					
9-10 PM					
10-11 PM					
11-12 AM					

- ❑ Don't know 998
- ❑ Refused 999

B1. Was the day reported above typical in terms of time spent on highways?

- ❑ Yes 1
- ❑ No 0
- ❑ Don't know 998
- ❑ Refused 999

B2. On an average work day, how many hours each day do you spend doing the following during your travel time to and from work?

Walking or biking	____ hrs ____ minutes	01
In a private car or taxi	____ hrs ____ minutes	02
On a bus	____ hrs ____ minutes	03
On a subway or trolley	____ hrs ____ minutes	04
On a commuter train	____ hrs ____ minutes	05
Other	____ hrs ____ minutes	06

(Specify): _____

- ❑ Not Working 997
- ❑ Don't know 998
- ❑ Refused 999

Now please think about your most recent non-school/work day and choose the main location in which you spent each time block. If you were traveling during this period, please indicate when you were a driver or passenger on a highway and how long you were traveling on a highway. Please indicate how many minutes in the "Time on Highway" column. If you do not work, report a weekend day.

[FLIP A COIN TO CHOOSE EITHER SATURDAY OR SUNDAY IF THESE WERE THE MOST RECENT NON-WORK DAY. FOR OTHER DAYS USE THE MOST RECENT NON-WORK DAY]

[ASK HOUR BY HOUR WHICH MICRO-ENVIRONMENT THE RESPONDENT SPENT TIME IN. FOR EACH TIME PERIOD IF YOU SPENT TIME AS A DRIVER OR PASSENGER ON THE HIGHWAY DURING THAT HOUR, PLEASE INDICATE HOW MANY MINUTES IN THE "TIME ON HIGHWAY" COLUMN ON THE RIGHT-HAND SIDE.]

[BY "OUTSIDE AT HOME" WE MEAN OUTDOORS WITHIN ONE BLOCK OF THE RESPONDENT'S RESIDENCE.]

[BY "HIGHWAY" WE MEAN HIGH TRAFFIC, HIGH SPEED ROADWAYS. EXAMPLES INCLUDE: I-93, I-95, I-90, I-495, RT. 2, RT. 3, RT. 9, RT. 16, RT. 24, STORROW DR., MCGRATH HWY, SUMNER TUNNEL, AND OTHER SIMILAR ROADWAYS. WE DO NOT MEAN LIGHTLY TRAVELED RURAL ROADWAYS OR BUSY URBAN STREETS.]

Non-Work Day	Home	Home	School/Work	Other: Inc. non-	Time On

	(Inside)	(Outside)		hwy travel	Highway
12 -1 AM					
1-2 AM					
2-3 AM					
3-4 AM					
4-5 AM					
5-6 AM					
6-7 AM					
7-8 AM					
8-9 AM					
9-10 AM					
10-11 AM					
11 AM-12 PM					
12-1 PM					
1-2 PM					
2-3 PM					
3-4 PM					
4-5 PM					
5-6 PM					
6-7 PM					
7-8 PM					
8-9 PM					
9-10 PM					
10-11 PM					
11-12 AM					

- ❑ Don't know 998
- ❑ Refused 999

B3. Was the day reported above typical in terms of time spent on highways? Yes

- ❑ Yes 1
- ❑ No 0
- ❑ Don't know 998
- ❑ Refused 999

B4. How much time do you spend on the following modes of transportation on an average non-work day?

Walking or biking	____ hrs ____ minutes	01
In a private car or taxi	____ hrs ____ minutes	02
On a bus	____ hrs ____ minutes	03
On a subway	____ hrs ____ minutes	04
On a commuter train	____ hrs ____ minutes	05
Other	____ hrs ____ minutes	06

(Specify): _____

- ❑ Don't know 998
- ❑ Refused 999

B5. In an average week, how many hours do you usually spend walking, running, biking, etc within 200 meters/yards of a highway? [*100 METERS/YARDS IS ABOUT ONE SPORT FIELD OR 1/8 OF A MILE; IF YOU NEED TO CLARIFY "HIGHWAY" REFER BACK TO DESCRIPTION ABOVE]*

- ❑ None 01
- ❑ 1 hour or less 02
- ❑ 2 -3 hours 03
- ❑ 4-5 hours 04
- ❑ More than 5 hours 05

B6. What traffic condition best describes the majority of your time traveling by motor vehicle during the day?

- ❑ Light traffic, 01
- ❑ Heavy traffic, 02
- ❑ Congested/stop-and-go 03

- ❑ N/A (Includes zero time in motor vehicle) 04
- ❑ Don't know 998
- ❑ Refused 999

C. Household Exposure/ Indoor Air

[ALL OF THE QUESTIONS IN THIS SECTION APPLY TO THE ADDRESS AT WHICH THE REPSONDENT LIVES IN THE BOSTON AREA]

C1. How often do you open windows during December to February?

❑ Never	01	Skip to C4
❑ Fewer than 2 days a week,	02	
❑ 2-5 days a week,	03	
❑ 6-7 days a week	04	
❑ Don't know	998	
❑ Refused	999	

C2. On those days, how many windows did you usually have open? _____

❑ Don't know	998
❑ Refused	999

C3. On average, how open were your windows on those days that they were open?

❑ Cracked open	01
❑ Part way open	02
❑ Wide open	03
❑ Don't know	998
❑ Refused	999

C4. How often do you open windows during June to August?

❑ Never	01	Skip to C7
❑ Fewer than 2 days a week	02	
❑ 2-5 days a week	03	
❑ 6-7 days a week	04	
❑ Don't know	998	
❑ Refused	999	

C5. On those days, how many windows did you usually have open? _____

❑ Don't know	998
❑ Refused	999

C6. On average, how open were your windows on those days that they were open?

❑ Cracked open	01
❑ Part way open	02
❑ Wide open	03
❑ Don't know	998
❑ Refused	999

C7. Is there a vent or fan in the bathroom that vents to the outdoors?

- ❑ Yes 1
- ❑ No 0
- ❑ Don't know 998
- ❑ Refused 999

C8. Is there a vent or fan for the stove that vents to the outside?

- ❑ Yes 1
- ❑ No 0
- ❑ Don't know 998
- ❑ Refused 999

C9. How many rooms are there not counting the bathroom or the hallway?

- ❑ 1-2 01
- ❑ 3-4 02
- ❑ 5-7 03
- ❑ 8-10 04
- ❑ 11 or more 05
- ❑ Don't know 998
- ❑ Refused 999

C10. Is an air conditioner used in your house?

- ❑ Yes 1
- ❑ No 0 GO TO QUESTION # C13
- ❑ Don't know 998 GO TO QUESTION # C13
- ❑ Refused 999 GO TO QUESTION # C13

C11. If yes: how many days did you use the air conditioner last summer?

- ❑ < 10 days 01
- ❑ 11-30 days 02
- ❑ Most days for 1-2 months 03
- ❑ Most days for >2 months 04
- ❑ Don't know 998
- ❑ Refused 999

C12. If yes: what type of air conditioner do you have?

- ❑ Central A/C 01
- ❑ Window Units: how many? _____ 02
- ❑ Other (specify): _____ 03
- ❑ Don't know 998
- ❑ Refused 999

C13. Which of the following were used to heat this house in the past year: [MARK ALL THAT APPLY]

- ❑ Radiator or baseboard with hot water, steam or electric heat 01
- ❑ Forced air (vents) 02
- ❑ Electric space heater 03
- ❑ Gas space heater 04
- ❑ Kerosene space heater 05
- ❑ Wood burning stove 06
- ❑ Fireplace 07
- ❑ Oven/stove (other than for cooking) 08
- ❑ Other, please specify _____ 09
- ❑ Don't know 998
- ❑ Refused 999

C14. What is the energy source for producing heat for this house?

- ❑ Electric 01
- ❑ Natural gas 02
- ❑ Oil 03
- ❑ Other (please specify_____) 04
- ❑ Don't know 998
- ❑ Refused 999

C15. If you have a boiler, is it located in the:

- ❑ Living space of your house 01
- ❑ Basement 02
- ❑ A closet or other separated area 03
- ❑ On another floor (other than basement) 04
- ❑ Other 05
- ❑ Do not have a boiler 06
- ❑ Don’t know 998
- ❑ Refused 999

C16. How often do you or does someone else cook in your residence?

- ❑ Never 01
- ❑ A few days a month 02
- ❑ More than half of the days of the month, but less than daily 03
- ❑ Almost daily 04
- ❑ Other, please specify: 05

C17. How often do you or does someone else cook with a *GAS* stove in your residence?

- ❑ Never 01
- ❑ A few days a month 02
- ❑ More than half of the days of the month, but less than daily 03
- ❑ Almost daily 04
- ❑ Other, please specify: 05

D. Smoking

D1. How often do people, including residents and guests, smoke in your home?

- ❑ 5-7 days per week 01
- ❑ 3-4 days per week 02
- ❑ 1-2 days per week 03
- ❑ 0 days per week 04
- ❑ Don't know 998
- ❑ Refused 999

D2. How many people living in your home (other than yourself) smoke? _____

- ❑ Don't know 998
- ❑ Refused 999

D3. On average, how many hours a day are you exposed to cigarette smoke of others:

At home _____ hours _____ min 01

At work _____ hours _____ min 02

In other areas _____ hours _____ min 03

- ❑ Don't know 998
- ❑ Refused 999

D4. How often are you in a car with someone who smokes?

- ❑ More than 5 times/ week 01
- ❑ 1-4 times/ week 02
- ❑ 1-2 times/ month 03
- ❑ Never or almost never 04
- ❑ Don't know 998
- ❑ Refused 999

E. Sound

E1. How much does sound from traffic bother you currently when you are at this address?

- ❑ Never 01
- ❑ Sometimes 02
- ❑ Often 03
- ❑ Always 04
- ❑ Don't know 998
- ❑ Refused 999

E2. In the past five years, has sound from traffic bothered you more, less or about the same as before then?

- ❑ More 01
- ❑ Less 02
- ❑ About the same 03
- ❑ Don't know 998
- ❑ Refused 999

E3. Are there other sounds that regularly bother you when you are at this address? [CHECK ALL THAT APPLY]:

- ❑ Street traffic 01
- ❑ Jets, airplanes, helicopters 02
- ❑ Trains 03
- ❑ Emergency vehicle sirens 04
- ❑ Loud music 05
- ❑ Car alarms 06
- ❑ Other _____ 07
- ❑ Don't know 998
- ❑ Refused 999

E4. Is this house or apartment

- ❑ Owned by you or someone in this household 01
- ❑ Rented (not subsidized, not public) 02
- ❑ Subsidized 03
- ❑ Public Housing 04
- ❑ Don't know 998
- ❑ Refused 999

E5. About when was this building first built? If not sure ask other household members [ENTER ONE]

- ❑ 1995 to present 01
- ❑ 1975 to 1994 02
- ❑ 1950 to 1975 03

❑ 1900 to 1949	04
❑ Before 1900	05
❑ Don't know	998
❑ Refused	999

F. Occupational Exposure

F1. Have you ever been regularly exposed to any of the following?
If "yes," indicate the number of years exposed [MARK ALL THAT APPLY]:

- ❑ Asbestos ____ yrs 01
- ❑ Acids/solvents/other industrial chemicals ____ yrs 02
- ❑ Coal or stone dusts ____ yrs 03
- ❑ Textile fibers/dusts ____ yrs 04
- ❑ Wood dust ____ yrs 05
- ❑ Other dusts, Specify: _____ ____ yrs 06
- ❑ None of these 07
- ❑ Don't know 998
- ❑ Refused 999

F2. How often are you exposed to motor vehicle exhaust, including heavy street or highway traffic, at your current job(s)?

- ❑ Daily multiple hours per day 01
- ❑ Daily for less than an hour 02
- ❑ Once per week 03
- ❑ Once per month 04
- ❑ Never 05
- ❑ Not employed currently 06
- ❑ Don't know 998
- ❑ Refused 999

F3. How often, in your most recent job prior to your current job, were you exposed to motor vehicle exhaust at work?

- ❑ Daily for multiple hours per day 01
- ❑ Daily for less than an hour 02
- ❑ Once per week 03
- ❑ Once per month 04
- ❑ Never or almost never 05
- ❑ Retired 997
- ❑ Don't know 998
- ❑ Refused 999

G. Health Status

G1. Has your doctor ever told you that you had congestive heart failure?

- ❑ Yes 1
- ❑ No (SKIP NEXT QUESTION) 0

G2. Has your doctor ever told you that you had angina pectoris (severe chest pain)?

- ❑ Yes 1
- ❑ No (SKIP NEXT QUESTION) 0

G3. Has your doctor ever told you that you had rheumatoid arthritis?

- ❑ Yes 1
- ❑ No (SKIP NEXT QUESTION) 0

Estudio de la Salud Puertorriqueña, Proyecto 4

ENCUESTA

Identificación del Participante: _____ Entrevistador: _____

Fecha (mes/día/año): __ __ / __ __ / __ __

A. ACTIVIDADES DE TIEMPO

La siguiente sección trata de aprender sobre el lugar donde usted pasa el tiempo en días laborables y los días que no trabaja y sobre cómo usted viaja de un lugar a otro.

Por favor, piense acerca de su más reciente día de escuela/trabajo desde la medianoche hasta la próxima medianoche y elija la ubicación principal en la que pasó cada bloque de tiempo de una hora. Si estuvo viajando durante este período, por favor indique cuando usted era el conductor o el pasajero en la carretera y cuánto tiempo estuvo viajando por la carretera, lo mejor que pueda recordar. Si no trabaja, informe de un día de semana.

[PREGUNTE HORA POR HORA EN CUÁL MICRO-MEDIO AMBIENTE EL QUE RESPONDE PASÓ UN TIEMPO.]

[SI PASÓ UN TIEMPO COMO CONDUCTOR O PASAJERO EN UNA CARRETERA, POR FAVOR INDIQUE CUANTOS MINUTOS "DE TIEMPO EN LA AUTOPISTA" EN LA COLUMNA DE LA MANO DERECHA.]

[POR "FUERA DE LA CASA" NOS REFERIMOS AL AIRE LIBRE A UNA CUADRA DE LA RESIDENCIA DEL QUE RESPONDE.]

[POR "CARRETERA O AUTOPISTA" NOS REFERIMOS AL TRÁFICO, CARRETERAS DE ALTA VELOCIDAD. ALGUNOS EJEMPLOS SON: I-93, I-95, I-90, I-495, RT. 2, RT. 3, RT. 9, RT. 16, RT. 24, STORROW DR., MCGRATH HWY, SUMNER TUNNEL, Y OTRAS CARRETERAS SIMILARES. NO NOS REFERIMOS A CAMINOS LIGERAMENTE TRANSITADOS, CAMINOS RURALES O CALLES CONGESTIONADAS EN LA CIUDAD.]

Día de Trabajo	Hogar (Interior)	Hogar (Exterior)	Escuela/ Trabajo	Otro: Inc. Viaje por no carreteras	Tiempo de Viaje en Carreteras
12 -1 AM					
1-2 AM					
2-3 AM					
3-4 AM					
4-5 AM					
5-6 AM					
6-7 AM					
7-8 AM					
8-9 AM					
9-10 AM					
10-11 AM					
11 AM-12 PM					
12-1 PM					
1-2 PM					
2-3 PM					
3-4 PM					
4-5 PM					
5-6 PM					
6-7 PM					
7-8 PM					
8-9 PM					
9-10 PM					

10-11 PM					
11-12 AM					

- ❑ No sabe 998
- ❑ Se niega a 999

B1. ¿Fue el día reportado anteriormente típico en términos del tiempo que pasó en las carreteras o autopistas?

- ❑ Sí 1
- ❑ No 0
- ❑ No sabe 998
- ❑ Se niega a 999

B2. En un día de trabajo promedio, ¿cuántas horas al día pasa haciendo lo siguiente durante el tiempo de viaje al trabajo y viceversa?

Caminando o en bicicleta	____ horas	____ minutos	01
En un vehículo privado o taxi	____ horas	____minutos	02
En un autobús	____horas	____minutos	03
En el metro o tranvía	____horas	____ minutos	04
En un tren	____horas	____ minutos	05
Otros	____horas	____ minutos	06

(Especifique): _____

- ❑ No trabaja 997
- ❑ No sabe 998
- ❑ Se niega a 999

Ahora por favor piense en <u>su día libre de trabajo o escuela</u> más reciente y elija la ubicación principal donde pasó la mayoría de cada bloque de tiempo. Si viajó durante este período, por favor indique cuando usted era un conductor o pasajero en una carretera y el tiempo que viajó por esta carretera lo mejor que pueda recordar. Por favor, indique el número de minutos en la columna del “Tiempo en la carretera”. Si no trabaja, informe de un día de semana.

[LANZE UNA MONEDA PARA ELEGIR ENTRE SÁBADO Y DOMINGO SI ESTOS FUERON LOS DÍAS DE NO TRABAJO MAS RECIENTES. PARA LOS DEMÁS DÍAS USE EL DÍA MAS RECIENTE DE NO TRABAJO]

[PREGUNTE HORA POR HORA EN CUÁL MICRO-MEDIO AMBIENTE EL QUE RESPONDE PASÓ UN TIEMPO. SI PASÓ UN TIEMPO COMO CONDUCTOR O PASAJERO EN UNA CAREETERA, POR FAVOR INDIQUE CUANTOS MINUTOS "DE TIEMPO EN LA AUTOPISTA" EN LA COLUMNA DE LA MANO DERECHA.]

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Día Sin Trabajo	**Hogar (Interior)**	**Hogar (Exterior)**	**Escuela/ Trabajo**	**Otro: Inc. Viaje por no carreteras**	**Tiempo de Viaje en Carreteras**
12 -1 AM					
1-2 AM					
2-3 AM					
3-4 AM					
4-5 AM					
5-6 AM					
6-7 AM					
7-8 AM					
8-9 AM					

9-10 AM					
10-11 AM					
11 AM-12 PM					
12-1 PM					
1-2 PM					
2-3 PM					
3-4 PM					
4-5 PM					
5-6 PM					
6-7 PM					
7-8 PM					
8-9 PM					
9-10 PM					
10-11 PM					
11-12 AM					

- ❑ No sabe 998
- ❑ Se niega a 999

B3. ¿Fue el día informado anteriormente típico en términos del tiempo que pasó en las carreteras? Sí

- ❑ Sí 1
- ❑ No 0
- ❑ No sabe 998
- ❑ Se niega a 999

B4. ¿Cuánto tiempo pasa en los siguientes medios de transportación en un día que no trabaja regular?

Caminando o en bicicleta	____ horas	____ minutos	01
En un vehículo privado o taxi	____ horas	____minutos	02
En un autobús	____horas	____minutos	03

En el metro o tranvía	____horas	____ minutos	04
En un tren	____horas	____ minutos	05
Otros	____horas	____ minutos	06

(Especifique): _____

a. No sabe 998
b. Se niega a 999

B5. En una semana promedio, ¿cuántas horas suele pasar caminando, corriendo, corriendo en bicicleta, etc. alrededor de los 200 metros/yardas de una carretera? [*100 METROS/YARDAS ES SEMEJANTE A UN CAMPO DEPORTIVO O A 1/8 DE MILLA; SI USTED NECESITA ACLARAR EL TÉRMINO "AUTOPISTA" REGRESE A LA DESCRIPCIÓN ANTERIOR]*

- ❑ □Ninguna 01
- ❑ 1 hora o menos 02
- ❑ 2 -3 horas 03
- ❑ 4-5 horas 04
- ❑ Más de 5 horas 05

B6. . ¿Qué condiciones de tráfico mejor describe la mayoría del tiempo que usted viaja en vehículo de motor durante el día?

- ❑ Tráfico liviano, 01
- ❑ Tráfico pesado, 02
- ❑ Congestionado/para-y-continúa 03
- ❑ N/A (Incluye tiempo cero en vehículos de motor) 04
- ❑ No sabe 998
- ❑ Se niega a 999

C. Exposición en el Hogar/ Aire Interior

[TODAS LAS PREGUNTAS EN ESTA SECCIÓN SE APLICAN A LA DIRECCIN EN LA QUE VIVE EL O LA QUE RESPONDE RESIDENTE EN EL ÁREA DE BOSTON.]

C18. ¿Con qué frecuencia usted abre las ventanas desde diciembre hasta febrero?

- ❑ Nunca 01 Salte al C4

- ❑ Menos de 2 días a la semana, 02
- ❑ 2-5 días a la semana, 03
- ❑ 6-7 días a la semana 04
- ❑ No sabe 998
- ❑ Se niega a 999

C19. En esos días, ¿cuántas ventanas tenía usualmente abiertas? _____

- ❑ No sabe 998
- ❑ Se niega a 999

C20. En promedio, ¿cuál era el grado de apertura de las ventanas que estaban abiertas en esos días?

- ❑ Resquebrada 01
- ❑ Parcialmente abierta 02
- ❑ Totalmente abierta 03
- ❑ No sabe 998
- ❑ Se niega a 999

C21. ¿Con qué frecuencia usted abre las ventanas entre junio y agosto?

- ❑ Nunca 01 Salte al C7
- ❑ Menos de 2 días a la semana 02
- ❑ 2-5 días a la semana 03
- ❑ 6-7 días a la semana 04
- ❑ No sabe 998
- ❑ Se niega a 999

C22. En esos días, ¿cuántas ventanas, por lo general, tenía abiertas? _____

- ❑ No sabe 998
- ❑ Se niega a 999

C23. En promedio, ¿cuál era el grado de apertura de las ventanas que estaban abiertas en esos días?

- ❑ Resquebrada 01
- ❑ Parcialmente abierta 02
- ❑ Totalmente abierta 03
- ❑ No sabe 998
- ❑ Se niega a 999
- ❑

C24. ¿Hay un conductor o un ventilador en baño que ventila el aire hacia afuera?

- ❑ Sí 1
- ❑ No 0
- ❑ No sabe 998
- ❑ Se niega a 999

C25. ¿Hay un conductor o un ventilador para la estufa que ventila el aire hacia el exterior?

- ❑ Sí 1
- ❑ No 0
- ❑ No sabe 998
- ❑ Se niega a 999

C26. ¿Cuántas habitaciones hay sin contar el baño o el pasillo?

- ❑ 1-2 01
- ❑ 3-4 02
- ❑ 5-7 03
- ❑ 8-10 04
- ❑ 11 o más 05
- ❑ No sabe 998
- ❑ Se niega a 999

C27. ¿Se utiliza un aire acondicionado en su casa?

- ❑ Sí 1
- ❑ No 0 SIGA A LA PREG. # C13
- ❑ No sabe 998 SIGA A LA PREG. # C13
- ❑ Se niega a 999 SIGA A LA PREG. # C13

C28. En caso afirmativo: ¿cuántos días utilizó el aire acondicionado el verano pasado?

- ❑ < 10 días 01
- ❑ 11-30 días 02
- ❑ Casi todos los días durante 1-2 meses 03
- ❑ Casi todos los días durante >2 meses 04
- ❑ No sabe 998
- ❑ Se niega a 999

C29. En caso afirmativo: ¿qué tipo de aire acondicionado tiene usted?

- ❑ A/C central 01
- ❑ Unidades de ventanas: ¿cuántas? _____ 02
- ❑ Otros (especifique): _____ 03
- ❑ No sabe 998
- ❑ Se niega a 999

C30. ¿Cuál de los siguientes se utilizaron para calentar su casa el pasado año: [MARQUE TODO LO QUE CORRESPONDA]

- ❑ Radiador o tabla de base de agua caliente, de vapor o calefacción eléctrica 01

- ❑ Aire forzado (ventiladores) 02
- ❑ Calentador eléctrico de área 03
- ❑ Calentador de gas 04
- ❑ Calentador de queroseno 05
- ❑ Estufa de leña ardiendo 06
- ❑ Chimenea 07
- ❑ Horno/estufa(que no sea para cocinar) 08
- ❑ Otros, por favor especifique _____ 09
- ❑ No sabe 998
- ❑ Se niega a 999

C31. ¿Cuál es la fuente de energía que produce calefacción para esta casa?

- ❑ Electricidad 01
- ❑ Gas natural 02
- ❑ Aceite 03
- ❑ Otros (por favor especifique_____) 04
- ❑ No sabe 998
- ❑ Se niega a 999

C32. Si usted tiene una caldera, ¿está localizada en:

- ❑ El área de vivienda de la casa 01
- ❑ El sótano 02
- ❑ Un armario u otra área separada 03
- ❑ En otro piso (que no sea el sótano) 04
- ❑ Otros 05
- ❑ No tiene una caldera 06
- ❑ No sabe 998
- ❑ Se niega a 999

C33. ¿Con qué frecuencia usted o alguien más cocina en su casa?

- ❑ Nunca 01
- ❑ Algunos días al mes 02
- ❑ Más de la mitad de los días del mes, Pero menos que a diario 03
- ❑ Casi todos los días 04
- ❑ Otros, por favor especifique: 05

C34. ¿Con qué frecuencia usted o alguien más cocina con una estufa de gas en su casa?

- ❑ Nunca 01
- ❑ Algunos días al mes 02
- ❑ Más de la mitad de los días del mes, Pero menos que a diario 03
- ❑ Casi todos los días 04
- ❑ Otros, por favor especifique: 05

D. Fumadores

D5. ¿Con qué frecuencia las personas, incluyendo a los residentes e invitados, fuman en su casa?

- ❑ 5-7 días a la semana 01
- ❑ 3-4 días a la semana 02
- ❑ 1-2 días a la semana 03
- ❑ 0 días a la semana 04
- ❑ No sabe 998
- ❑ Se niega a 999

D6. ¿Cuántas personas viven en su casa (que no sea usted) fuman? _____

- ❑ No sabe 998
- ❑ Se niega a 999

D7. En promedio, ¿cuántas horas al día está expuesto al humo del cigarrillo de otras personas?:

En casa _____ horas _____ min 01

En el trabajo _____ horas _____ min 02

In otras áreas _____ horas _____ min 03

- ❑ No sabe 998
- ❑ Se niega 999

D8. ¿Con qué frecuencia está en un carro con alguien que fuma?

- ❑ Más de 5 veces/ semana 01
- ❑ 1-4 veces/ semana 02
- ❑ 1-2 veces/ mes 03
- ❑ Nunca o casi nunca 04
- ❑ No sabe 998
- ❑ Se niega a 999

E. Sonido

E6. ¿Qué tanto le molesta el sonido del tráfico en la actualidad cuando está en esta dirección?

- ❑ Nunca 01
- ❑ A veces 02
- ❑ A menudo 03
- ❑ Siempre 04

- ❑ No sabe 998
- ❑ Se niega a 999

E7. En los últimos cinco años, ¿le molesta más, menos o casi lo mismo que antes el sonido del tráfico?

- ❑ Más 01
- ❑ Menos 02
- ❑ Más o menos igual 03
- ❑ No sabe 998
- ❑ Se niega a 999

E8. ¿Hay otros sonidos que habitualmente le molestan cuando usted está en esta dirección?[COMPROBAR TODO LO QUE CORRESPONDA]:

- ❑ El tráfico de la calle 01
- ❑ Jets, aviones, helicópteros 02
- ❑ Los trenes 03
- ❑ Las sirenas de emergencia del vehículo 04
- ❑ La música alta 05
- ❑ Las armas de los automóviles 06
- ❑ Otros _____ 07
- ❑ No sabe 998
- ❑ Se niega a 999

E9. ¿Es esta una casa o un apartamento?

- ❑ Propiedad suya o de alguien en este hogar 01
- ❑ Alquiler (no subsidiado, no público) 02
- ❑ Subsidiado 03
- ❑ Vivienda pública 04
- ❑ No sabe 998
- ❑ Se niega a 999

E10. ¿Cerca de cuándo fue construido este edificio? Si no está seguro, pregunte a otros miembros del hogar [SELECCIONE UNO]

- ❑ 1995 hasta la fecha 01
- ❑ 1975 al 1994 02
- ❑ 1950 al 1975 03
- ❑ 1900 al 1949 04
- ❑ Antes del 1900 05
- ❑ No sabe 998
- ❑ Se niega a 999

F. Exposición Ocupacional

F4. ¿Alguna vez ha estado en contacto frecuente con cualquiera de los siguientes? Si es afirmativo, indique el número de años expuesto [MARQUE TODO LO QUE CORRESPONDA]:

- ❑ Asbestos ____ años 01
- ❑ Ácidos/solventes/otros Productos químicos industriales ____ años 02
- ❑ El carbón o al polvo de piedra ____ años 03
- ❑ Fibras textiles/polvos ____ años 04
- ❑ El polvo de madera ____años 05
- ❑ Otros polvos, Especifique: _____ ____años 06
- ❑ Ninguno de éstos 07
- ❑ No sabe 998
- ❑ Se niega a 999

❑ ¿Con qué frecuencia está expuesto a los gases de los vehículos de motor, incluyendo el tráfico pesado de la calle o de la carretera, en su trabajo(s) actual(es).

- ❑ A diario varias horas por horas 01
- ❑ Diario por menos de una hora 02
- ❑ Una vez a la semana 03
- ❑ Una vez al mes 04
- ❑ Nunca 05
- ❑ No está empleada en la actualidad 06
- ❑ No sabe 998
- ❑ Se niega a 999

❑ ¿Con qué frecuencia, en su trabajo más reciente antes de su empleo actual, estuvo expuesto a gases de los vehículos de motor en el trabajo?

- ❑ A diario varias horas por horas 01
- ❑ Diario por menos de una hora 02
- ❑ Una vez a la semana 03
- ❑ Una vez al mes 04
- ❑ Nunca o casi nunca 05
- ❑ Jubilado 997
- ❑ No sabe 998
- ❑ Se niega a 999

G. Estado de Salud

G1. ¿Le ha dicho su doctor alguna vez que padece de insuficiencia cardíaca congestiva?

- ❑ Sí 1
- ❑ No (SALTE A LA SIGUIENTE PREGUNTA) 0

G2. ¿Le ha dicho su doctor alguna vez que usted padece de angina de pecho (severo dolor en el pecho)?

- ❑ Sí 1
- ❑ No (SALTE A LA SIGUIENTE PREGUNTA) 0

G3. ¿Le ha dicho su doctor alguna vez que usted padece de artritis reumatoide?

- ❑ Sí 1
- ❑ No (SALTE A LA SIGUIENTE PREGUNTA) 0

C) Supplementary Survey: English and Spanish

Puerto Rican Health Study, Project 4

SUPPLEMENTAL SURVEY

Participant ID: _____	Interviewer: _____
Date (month/day/year): __ __ / __ __ / __ __	Visit Number: **1 2 3**

N. HEALTH

N1. **Prior to your visit today, when was the last time you ate or drank anything other than water and medicines?**

- ❑ Less than 5 hours before your visit 1
- ❑ 5 to 8 hours before your visit 2
- ❑ 8 to 12 hours before your visit 3
- ❑ More than 12 hours before your visit 4
- ❑ Don't know 998
- ❑ Refused 999

N2. Have you been diagnosed with any NEW ILLNESS OR CONDITION by your health care provider, since you've been involved in the study?

- ❑ No 0

❑ Yes 1

↓

If yes, please provide the name of the illness or condition.

N2a. _____

N2b. _____

N2c. _____

N2d. _____

Have you experienced any of the following illnesses in the past week?

N3. Cold ❑ Yes 1 ❑ No 0 ❑ Don't Know 998

↓

N3a. If yes, did you take medicine for the illness?

❑ Yes 1 Please name: _____

❑ No 0

N3b. Have you recovered?

❑ Yes 1

❑ No 0

N4. Flu (influenza) or flu-like illness

❑ Yes 1 ❑ No 0 ❑ Don't Know 998

↓

N4a. If yes, did you take medicine for the illness?

❑ Yes 1 Please name: _____

❑ No 0

N4b. Have you recovered?

❑ Yes 1

❑ No 0

N5. Pneumonia ❑ Yes 1 ❑ No 0 ❑ Don't Know 998

↓

N5a. If yes, did you take medicine for the illness?

❑ Yes 1 Please name: _____

❑ No 0

N5b. Have you recovered?

❑ Yes 1

❑ No 0

N6. Severe asthma attack

❑ Yes 1 ❑ No 0 ❑ Don't Know 998

↓

N6a. If yes, did you take medicine for the illness?

❑ Yes 1 Please name: _____

❑ No 0

N6b. Have you recovered?

❑ Yes 1

❑ No 0

N7. Have you experienced any OTHER ILLNESS in the past week?

- ❑ No 0
- ❑ Yes 1

↓

N7a. If yes, please provide the name of the illness or condition. _____

N7b. Did you take medicine for the illness?

- ❑ Yes 1 Please name: _____
- ❑ No 0

N7c. Have you recovered?

- ❑ Yes 1
- ❑ No 0

P. LIFE EVENTS

P1. Have you experienced any major life events in the past month (past 30 days)? Some examples are marriage, loss of a job, major illness, start of a new job or death of a close friend or relative.

- ❑ No 0
- ❑ Yes 1

↓

If yes, please name the event(s)

P1a. _____

P1b. _____

P1c. _____

P2. Are there any other major stressors in you life right now? Some examples are problems at work, financial issues, ongoing conflicts with friends or family.

- ❑ No 0
- ❑ Yes 1

↓

If yes, please name the event(s)

P2a. _____

P2b. _____

P2c. _____

R. EXPOSURE

Have you done any of the following activities in the past week?

	Event	Yes	No	Don't Know
R1.	Cleaned fireplace	1	0	998
R2.	Used outdoor grill for cooking	1	0	998
R3.	Burned wood, leaves or trash	1	0	998
R4.	Burned candles, incense or oil in your home	1	0	998
R5.	Lit or used a wood or coal-burning stove	1	0	998
R6.	Been exposed to smoke from a fire	1	0	998
R7.	Used gasoline powered equipment (eg. lawn mower, leaf blower or snow blower)	1	0	998
R8.	Used kerosene powered equipment (eg. lamp or heater)	1	0	998
R9.	Smoked tobacco	1	0	998
R10.	Been in your home with someone smoking	1	0	998
R11.	Been in a car with someone smoking	1	0	998
R12.	Been at your work/school with someone smoking	1	0	998
R13.	Did major housecleaning (eg. dusting and sweeping)	1	0	998
R14.	Did metal-working (eg. welding)	1	0	998
R15.	Did cooking with oil (frying or grilling)	1	0	998
R16.	Did sanding (eg. furniture or floors)	1	0	998
R17.	Been in a car with the engine running in a garage	1	0	998
R18.	Traveled on a highway for 10 minutes or more	1	0	998
R19.	Traveled on busy city streets for 20 minutes or more	1	0	998
R20.	Walked next to a highway or busy city streets for 20	1	0	998

	minutes or more			

S. TIME ACTIVITY

The following section seeks to learn about where you spend time during workdays and non-work days and about how you travel from place to place.

Please think about your most recent school/workday from midnight to midnight and choose the main location in which you spent each one-hour time block. If you were traveling during this period, please indicate when you were a driver or passenger on a highway and how long you were traveling on a highway, to the best that you can recall. If you do not work, report a weekday.

[ASK HOUR BY HOUR WHICH MICRO-ENVIRONMENT THE RESPONDENT SPENT TIME IN.]

[IF THEY SPENT TIME AS A DRIVER OR PASSENGER ON A HIGHWAY, PLEASE INDICATE HOW MANY MINUTES IN THE "TIME ON HIGHWAY" COLUMN ON THE RIGHT-HAND SIDE.]

[BY "OUTSIDE AT HOME" WE MEAN OUTDOORS WITHIN ONE BLOCK OF THE RESPONDENT'S RESIDENCE.]

[BY "HIGHWAY" WE MEAN HIGH TRAFFIC, HIGH SPEED ROADWAYS. EXAMPLES INCLUDE: I-93, I-95, I-90, I-495, RT. 2, RT. 3, RT. 9, RT. 16, RT. 24, STORROW DR., MCGRATH HWY, SUMNER TUNNEL, AND OTHER SIMILAR ROADWAYS. WE DO NOT MEAN LIGHTLY TRAVELED RURAL ROADWAYS OR BUSY URBAN STREETS.]

Work Day	**Home (Inside)**	**Home (Outside)**	**School/Work**	**Other: Inc. non-hwy travel**	**Time On Highway**
12 -1 AM					
1-2 AM					
2-3 AM					
3-4 AM					
4-5 AM					

5-6 AM					
6-7 AM					
7-8 AM					
8-9 AM					
9-10 AM					
10-11 AM					
11 AM-12 PM					
12-1 PM					
1-2 PM					
2-3 PM					
3-4 PM					
4-5 PM					
5-6 PM					
6-7 PM					
7-8 PM					
8-9 PM					
9-10 PM					
10-11 PM					
11-12 AM					

- ❑ Don't know 998
- ❑ Refused 999

S1. Was the day reported above typical in terms of time spent on highways?

- ❑ Yes 1
- ❑ No 0
- ❑ Don't know 998
- ❑ Refused 999

S2. On an average work day, how many hours each day do you spend doing the following during your travel time to and from work?

Walking or biking	____ hrs ____ minutes	01
In a private car or taxi	____ hrs ____ minutes	02
On a bus	____ hrs ____ minutes	03
On a subway or trolley	____ hrs ____ minutes	04
On a commuter train	____ hrs ____ minutes	05
Other	____ hrs ____ minutes	06

(Specify): _____

- ❑ Don't know 998
- ❑ Refused 999

Now please think about your most recent non-school/work day and choose the main location in which you spent each time block. If you were traveling during this period, please indicate when you were a driver or passenger on a highway and how long you were traveling on a highway. Please indicate how many minutes in the "Time on Highway" column. If you do not work, report a weekend day.

[FLIP A COIN TO CHOOSE EITHER SATURDAY OR SUNDAY IF THESE WERE THE MOST RECENT NON-WORK DAY. FOR OTHER DAYS USE THE MOST RECENT NON-WORK DAY]

[ASK HOUR BY HOUR WHICH MICRO-ENVIRONMENT THE RESPONDENT SPENT TIME IN. FOR EACH TIME PERIOD IF YOU SPENT TIME AS A DRIVER OR PASSENGER ON THE HIGHWAY DURING THAT HOUR, PLEASE INDICATE HOW MANY MINUTES IN THE "TIME ON HIGHWAY" COLUMN ON THE RIGHT-HAND SIDE.]

[BY "OUTSIDE AT HOME" WE MEAN OUTDOORS WITHIN ONE BLOCK OF THE RESPONDENT'S RESIDENCE.]

[BY "HIGHWAY" WE MEAN HIGH TRAFFIC, HIGH SPEED ROADWAYS. EXAMPLES INCLUDE: I-93, I-95, I-90, I-495, RT. 2, RT. 3, RT. 9, RT. 16, RT. 24, STORROW DR., MCGRATH HWY, SUMNER TUNNEL, AND OTHER SIMILAR ROADWAYS. WE DO NOT MEAN LIGHTLY TRAVELED RURAL ROADWAYS OR BUSY URBAN STREETS.]

Work Day	**Home (Inside)**	**Home (Outside)**	**School/Work**	**Other: Inc. non-hwy travel**	**Time On Highway**
12 -1 AM					
1-2 AM					
2-3 AM					
3-4 AM					
4-5 AM					
5-6 AM					
6-7 AM					
7-8 AM					
8-9 AM					
9-10 AM					
10-11 AM					
11 AM-12 PM					
12-1 PM					
1-2 PM					
2-3 PM					
3-4 PM					
4-5 PM					
5-6 PM					
6-7 PM					

7-8 PM					
8-9 PM					
9-10 PM					
10-11 PM					
11-12 AM					

- ❑ Don't know 998
- ❑ Refused 999

S3. Was the day reported above typical in terms of time spent on highways? Yes

- ❑ Yes 1
- ❑ No 0
- ❑ Don't know 998
- ❑ Refused 999

S4. How much time do you spend on the following modes of transportation on an average non-work day?

Walking or biking	____ hrs ____ minutes	01
In a private car or taxi	____ hrs ____ minutes	02
On a bus	____ hrs ____ minutes	03
On a subway	____ hrs ____ minutes	04
On a commuter train	____ hrs ____ minutes	05
Other	____ hrs ____ minutes	06

(Specify): _____

- ❑ Don't know 998
- ❑ Refused 999

S5. In an average week, how many hours do you usually spend walking, running, biking, etc within 200 meters/yards of a highway? [*100 METERS/YARDS IS ABOUT ONE*

SPORT FIELD OR 1/8 OF A MILE; IF YOU NEED TO CLARIFY "HIGHWAY" REFER BACK TO DESCRIPTION ABOVE]

- ❑ None 01
- ❑ 1 hour or less 02
- ❑ 2 -3 hours 03
- ❑ 4-5 hours 04
- ❑ More than 5 hours 05

S6. What traffic condition best describes the majority of your time traveling by motor vehicle during the day?

- ❑ Light traffic, 01
- ❑ Heavy traffic, 02
- ❑ Congested/stop-and-go 03
- ❑ N/A (Includes zero time in motor vehicle) 04
- ❑ Don't know 998

Refused 999

****

This is the end of the survey.

Thank you for your participation in the Clean Air study.

Estudio de la Salud Puertorriqueña, Proyecto 4

ENCUESTA COMPLEMENTARIA

Identificación del Participante: _____	Entrevistador: _____
Fecha (mes/día/año): __ __ / __ __ / __ __	Número de Visita: **1 2 3**

N. SALUD

N1. **Antes de su visita hoy, ¿cuándo fue la última vez que comió o bebió algo más que agua y medicinas?**

- ❑ Menos de 5 horas antes de la visita 1
- ❑ 5 a 8 horas antes de su visita 2
- ❑ 8 a 12 horas antes de su visita 3
- ❑ Más de 12 horas antes de su visita 4
- ❑ No sabe 998
- ❑ Se niega 999

N2. ¿Ha sido alguna vez diagnosticado con una **NUEVA ENFERMEDAD O CONDICIÓN** por su proveedor de cuidado de salud, desde que usted ha estado involucrado en el estudio?

- ❑ No 0
- ❑ Sí 1

↓

En caso afirmativo, indique el nombre de la enfermedad o la condición.

N2a. _____

N2b. _____

N2c. _____

N2d. _____

¿Ha experimentado alguna de las siguientes enfermedades en la semana pasada?

N3. Frío ❑ Sí 1 ❑ No 0 ❑ No lo sé 998

↓

N3a. En caso afirmativo, ¿tomó medicina para la enfermedad?

❑ Sí

1

Por favor, nombre: _____

❑ No 0

N3b. ¿Se ha recuperado?

❑ Sí 1

❑ No 0

N4. La Gripe (influenza) o enfermedad de tipo gripal

❑ Sí 1 ❑ No 0 ❑ No lo sé 998

↓

N4a. En caso afirmativo, ¿tomó medicinas para la enfermedad?

❑ Sí 1

Por favor, nombre: _____

❑ No 0

N4b. ¿Se ha recuperado?

❑ Sí 1

❑ No 0

N5. La Neumonía ❑ Sí 1 ❑ No 0 ❑ No lo sé 998

↓

N5a. En caso afirmativo, ¿tomó medicinas para la enfermedad?

❑ Sí 1

Por favor, nombre: _____

❑ No 0

N5b. ¿Se ha recuperado?

❑ Sí 1

❑ No 0

N6. Ataque severo de asma

❑ Sí 1 ❑ No 0 ❑ No lo sé 998

↓

N6a. En caso afirmativo, ¿tomó medicinas para la enfermedad?

❑ Sí 1

Por favor, nombre: _____

❑ No 0

N6b. ¿Se ha recuperado?

❑ Sí 1

❑ No 0

N7. ¿Ha experimentado alguna OTRA ENFERMEDAD en la semana pasada?

❑ No 0

❑ Sí 1

↓

N7a. En caso afirmativo, por favor indique el nombre de la enfermedad o condición.

_____

N7b. ¿Tomó medicamentos para la enfermedad?

❑ Yes 1

Por favor, nombre: _____

❑ No 0

N7c. ¿Se ha recuperado?

❑ Yes 1

❑ No 0

P. EVENTOS DE LA VIDA

P1. ¿Ha experimentado algún evento importante de la vida en el último mes (últimos 30 días)? Algunos ejemplos son el matrimonio, la pérdida de un trabajo, una enfermedad grave, el inicio de un nuevo trabajo o muerte de un amigo o un pariente cercano.

❑ No 0

❑ Sí 1

↓

En caso afirmativo, por favor escriba el nombre del evento o eventos

P1a. _____

P1b. _____

P1c. _____

P2. ¿Hay algún otro gran estrés en su vida en este momento de su vida? Algunos ejemplos son los problemas en el trabajo, problemas financieras, conflictos contínuos con amigos o pariente cercano. .

- ❑ No 0
- ❑ Sí 1

↓

En caso afirmativo, por favor escriba el nombre del evento o eventos

P2a. _____

P2b. _____

P2c. _____

R. DE LA EXPOSICIÓN

¿Ha hecho alguna de las siguientes actividades durante la semana pasada?

	Evento	**Sí**	**No**	**No lo Sé**
R1.	Limpió la chimenea	1	0	998
R2.	Usó la parrilla al aire libre para cocinar	1	0	998
R3.	Quemó madera, hojas o basura	1	0	998
R4.	Encendió velas, incienso o aceite en su hogar	1	0	998
R5.	Encendió o usó una estufa con madera o carbón	1	0	998
R6.	Estuvo expuesto al humo de un incendio	1	0	998
R7.	Usó equipo que utiliza gasolina para prender (por ejemplo, la cortadora de césped, sopladores de hojas o para la nieve)	1	0	998
R8.	Usó equipo que utiliza queroseno para prender (por ejemplo, la lámpara o calentador)	1	0	998
R9.	Fumó tabaco	1	0	998
R10.	Ha estado en su casa con alguien fumando	1	0	998
R11.	Ha estado en un automóvil con alguien fumando	1	0	998
R12.	Ha estado en su trabajo/escuela con alguien fumando	1	0	998
R13.	Hizo una gran limpieza en la casa (por ejemplo, quitar el polvo y barrer)	1	0	998
R14.	Trabajó con metal (por ejemplo, la soldadura)	1	0	998
R15.	Cocinó con aceite (para freír o asar en la parrilla)	1	0	998
R16.	Lijó algo (por ejemplo, muebles o pisos)	1	0	998
R17.	Ha estado dentro de un automóvil con el motor encendido dentro de un garaje	1	0	998

R18.	Viajó en una autopista durante 10 minutos o más	1	0	998
R19.	Viajó por las calles congestionadas de la ciudad durante 20 minutos o más	1	0	998
R20.	Caminó cerca de una autopista o calle muy transitada de la ciudad por 20 minutos o más	1	0	998

S. ACTIVIDADES DE TIEMPO

La siguiente sección trata de aprender sobre el lugar donde usted pasa el tiempo en días laborables y los días que no trabaja y sobre cómo usted viaja de un lugar a otro.

Por favor, piense acerca de su más reciente día de escuela/trabajo desde la medianoche hasta la próxima medianoche y elija la ubicación principal en la que pasó cada bloque de tiempo de una hora. Si estuvo viajando durante este período, por favor indique cuando usted era el conductor o el pasajero en la carretera y cuánto tiempo estuvo viajando por la carretera, lo mejor que pueda recordar. Si no trabaja, informe de un día de semana.

[PREGUNTE HORA POR HORA EN CUÁL MICRO-MEDIO AMBIENTE EL QUE RESPONDE PASÓ UN TIEMPO.]

[SI PASÓ UN TIEMPO COMO CONDUCTOR O PASAJERO EN UNA CAREETERA, POR FAVOR INDIQUE CUANTOS MINUTOS "DE TIEMPO EN LA AUTOPISTA" EN LA COLUMNA DE LA MANO DERECHA.]

[POR "FUERA DE LA CASA" NOS REFERIMOS AL AIRE LIBRE A UNA CUADRA DE LA RESIDENCIA DEL QUE RESPONDE.]

[POR "CARRETERA O AUTOPISTA" NOS REFERIMOS AL TRÁFICO, CARRETERAS DE ALTA VELOCIDAD. ALGUNOS EJEMPLOS SON: I-93, I-95, I-90, I-495, RT. 2, RT. 3, RT. 9, RT. 16, RT. 24, STORROW DR., MCGRATH HWY, SUMNER TUNNEL, Y OTRAS CARRETERAS SIMILARES. NO NOS REFERIMOS A CAMINOS LIGERAMENTE TRANSITADOS, CAMINO RURALES O CALLES CONGESTIONADAS EN LA CIUDAD.]

Día de Trabajo	**Hogar (Interior)**	**Hogar (Exterior)**	**Escuela/ Trabajo**	**Otro: Inc. Viaje por no carreteras**	**Tiempo de Viaje en Carreteras**
12 -1 AM					
1-2 AM					

2-3 AM					
3-4 AM					
4-5 AM					
5-6 AM					
6-7 AM					
7-8 AM					
8-9 AM					
9-10 AM					
10-11 AM					
11 AM-12 PM					
12-1 PM					
1-2 PM					
2-3 PM					
3-4 PM					
4-5 PM					
5-6 PM					
6-7 PM					
7-8 PM					
8-9 PM					
9-10 PM					
10-11 PM					
11-12 AM					

- ❑ No sabe 998
- ❑ Se niega a 999

S1. ¿Fue el día reportado anteriormente típico en términos del tiempo que pasó en las carreteras o autopistas?

- ❑ Sí 1
- ❑ No 0
- ❑ No sabe 998
- ❑ Se niega a 999

S2. En un día de trabajo promedio, ¿cuántas horas al día pasa haciendo lo siguiente durante el tiempo de viaje al trabajo y viceversa?

Caminando o en bicicleta	____ horas	____ minutos	01
En un vehículo privado o taxi	____ horas	____minutos	02
En un autobús	____horas	____minutos	03
En el metro o tranvía	____horas	____ minutos	04
En un tren	____horas	____ minutos	05
Otros	____horas	____ minutos	06

(Especifique): _____

- ❑ No sabe 998
- ❑ Se niega a 999

Ahora por favor piense en <u>su día libre de trabajo o escuela</u> más reciente y elija la ubicación principal donde pasó la mayoría de cada bloque de tiempo. Si viajó durante este período, por favor indique cuando usted era un conductor o pasajero en una carretera y el tiempo que viajó por esta carretera lo mejor que pueda recordar. Por favor, indique el número de minutos en la columna del “Tiempo en la carretera”. Si no trabaja, informe de un día de semana.

[LANZE UNA MONEDA PARA ELEGIR ENTRE SÁBADO Y DOMINGO SI ESTOS FUERON LOS DIAS DE NO TRABAJO MAS RECIENTES. PARA LOS DEMÁS DÍAS USE EL DÍA MAS RECIENTE DE NO TRABAJO]

[PREGUNTE HORA POR HORA EN CUÁL MICRO-MEDIO AMBIENTE EL QUE RESPONDE PASÓ UN TIEMPO. SI PASÓ UN TIEMPO COMO CONDUCTOR O PASAJERO EN UNA

CAREETERA, POR FAVOR INDIQUE CUANTOS MINUTOS "DE TIEMPO EN LA AUTOPISTA" EN LA COLUMNA DE LA MANO DERECHA.]

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[POR "CARRETERA O AUTOPISTA" NOS REFERIMOS AL TRÁFICO, CARRETERAS DE ALTA VELOCIDAD. ALGUNOS EJEMPLOS SON: I-93, I-95, I-90, I-495, RT. 2, RT. 3, RT. 9, RT. 16, RT. 24, STORROW DR., MCGRATH HWY, SUMNER TUNNEL, Y OTRAS CARRETERAS SIMILARES. NO NOS REFERIMOS A CAMINOS LIGERAMENTE TRANSITADOS, CAMINO RURALES O CALLES CONGESTIONADAS EN LA CIUDAD.]

Día de Trabajo	**Hogar (Interior)**	**Hogar (Exterior)**	**Escuela/ Trabajo**	**Otro: Inc. Viaje por no carreteras**	**Tiempo de Viaje en Carreteras**
12 -1 AM					
1-2 AM					
2-3 AM					
3-4 AM					
4-5 AM					
5-6 AM					
6-7 AM					
7-8 AM					
8-9 AM					
9-10 AM					
10-11 AM					
11 AM-12 PM					
12-1 PM					

1-2 PM					
2-3 PM					
3-4 PM					
4-5 PM					
5-6 PM					
6-7 PM					
7-8 PM					
8-9 PM					
9-10 PM					
10-11 PM					
11-12 AM					

- ❑ No sabe 998
- ❑ Se niega a 999

S3. ¿Fue el día informado anteriormente típico en términos del tiempo que pasó en las carreteras? Sí

- ❑ Sí 1
- ❑ No 0
- ❑ No sabe 998
- ❑ Se niega a 999

S4. ¿Cuánto tiempo pasa en los siguientes medios de transportación en un día que no trabaja regular?

Caminando o en bicicleta	____ horas	____ minutos	01
En un vehículo privado o taxi	____ horas	____minutos	02
En un autobús	____horas	____minutos	03
En el metro o tranvía	____horas	____ minutos	04
En un tren	____horas	____ minutos	05

Otros ____horas ____ minutos 06

(Especifique): _____

- ❑ No sabe 998
- ❑ Se niega a 999

S5. En una semana promedio, ¿cuántas horas suele pasar caminando, corriendo, corriendo en bicicleta, etc. alrededor de los 200 metros/yardas de una carretera? [*100 METROS/YARDAS ES SEMEJANTE A UN CAMPO DEPORTIVO O A 1/8 DE MILLA; SI USTED NECESITA ACLARAR EL TÉRMINO "AUTOPISTA" REGRESE A LA DESCRIPCIÓN ANTERIOR]*

- ❑ □Ninguna 01
- ❑ 1 hora o menos 02
- ❑ 2 -3 horas 03
- ❑ 4-5 horas 04
- ❑ Más de 5 horas 05

S6. ¿Qué condiciones de tráfico mejor describe la mayoría del tiempo que usted viaja en vehículo de motor durante el día?

- ❑ Tráfico liviano, 01
- ❑ Tráfico pesado, 02
- ❑ Congestionado/para-y-continúa 03
- ❑ N/A (Incluye tiempo cero en vehículos de motor) 04
- ❑ No sabe 998
- ❑ Se niega a 999

****

Este es el final de la encuesta.

Gracias por su participación en el estudio Para un Aire Limpio.

D) <u>List of CAFEH Partners</u>

Tufts University

Metropolitan Area Planning Council (MAPC)

Northeastern University

Chinatown Resident Association

Tufts Community Research Center

Committee for Boston Public Housing
Jonathan M. Tisch College of Citizenship and Public Service
Boston Chinatown Neighborhood Center
Somerville Transportation Equity Partnership
Boston Public Health Commission
Boston University School of Public Health
Harvard School of Public Health
University of Massachusetts Lowell
City of Somerville, MA
Chinese Progressive Association
University of Massachusetts Boston