EVALUATION OF ASTHMA EMERGENCY ROOM AND HOSPITAL DISCHARGE RATES IN RELATION TO AMBIENT AIR CONCENTRATIONS ASSOCIATED WITH THE WHEELABRATOR WASTE-TO-ENERGY FACILITY

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September 25, 2019
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Appendix A Participant CVs
ACRONYMS AND ABBREVIATIONS

AERMOD  American Meteorological Society/Environmental Protection Agency Regulatory Model  
ER  annual age-adjusted asthma emergency room discharge rates  
HD  annual age-adjusted asthma hospital discharge rates  
MDE  Maryland Department of the Environment  
NO$_2$  nitrogen dioxide  
NWS  US National Weather Service  
PM$_{2.5}$  particulate matter less than or equal to 2.5 microns in size  
SO$_2$  sulfur dioxide  
TRAP  traffic related air pollution  
USEPA  US Environmental Protection Agency  
WTE  waste-to-energy
EXECUTIVE SUMMARY

This report describes an environmental epidemiology study conducted to evaluate if there is an association between asthma rates in the City of Baltimore and emissions from the Wheelabrator Baltimore waste-to-energy (WTE) facility.

Asthma hospital and emergency room annual age-adjusted discharge rates for 2011, 2012 and 2013 in 21 zip codes categorized as City of Baltimore zip codes in Maryland’s Environmental Public Health Tracking Web portal were selected for investigation. In addition, several socio-demographic factors from the US census were included by zip code — race, median family income, housing vacancy rate and homeownership rate. Median family income, vacancy rate and homeownership rate are all proxies for “social determinants of health”. Social determinants of health are conditions in which people are born, grow, live, and work which in turn relate to income, poverty, education, race, and neighborhood and housing conditions. They have been found in scientific studies to be the main drivers of asthma.

Annual average ambient air concentrations due to emissions from the WTE facility in the 21 zip codes were calculated using the latest USEPA-approved air dispersion model (AERMOD) for particulate matter less than or equal to 2.5 microns in size (PM$_{2.5}$), nitrogen dioxide (NO$_2$), and sulfur dioxide (SO$_2$). Inputs to the modeling included annual average WTE facility emission rates, as reported to the Maryland Department of Environment (MDE), and hourly meteorological data for the same three years. The modeled incremental impacts of WTE facility emissions on annual average air concentrations of PM$_{2.5}$, NO$_2$, and SO$_2$ were shown to be negligible compared to background air quality levels.

The environmental epidemiology study statistically analyzed the annual asthma health data and the modeled annual average air concentrations, taking into account the socio-demographic parameters, across the 21 Baltimore City zip codes for each of the three years. The study showed there were no statistically significant associations between annual age-adjusted emergency room or hospital discharge rates for asthma in relation to annual average PM$_{2.5}$, NO$_2$ or SO$_2$ air concentrations due to emissions from the WTE facility during 2011, 2012 and 2013. The study did, however, identify consistent statistically significant associations between discharge rates for asthma and median family income for all three years and instances where discharge rates were also significantly associated with other socio-demographic parameters, such as race, homeownership rate and housing vacancy rate. These results suggest that social determinants of health at the zip code level, for which income and housing characteristics are proxies, are driving the rates of emergency room discharges and hospital discharges due to asthma in Baltimore City.

The results of the environmental epidemiology study are in agreement with scientific research showing the importance of social determinants of health on asthma in urban US areas like the City of Baltimore. Examples of social determinants of health include: poverty, unsafe and stressful neighborhoods, and unhealthy neighborhood and home environments. Home environments, where people spend most of their time, can be unhealthy due to indoor pollution which includes household dust, pet dander, smoking, rodents, mold, cockroaches and unvented indoor gas stoves. Elevated asthma rates that have been documented in Baltimore are similar to those in many other large urban areas in the US. These similarities are likely to be related to the importance and presence of social determinants of health as well as traffic related air pollution (TRAP) which has been shown in scientific studies to be a major factor affecting asthma rates in cities.
1.0 INTRODUCTION

This report describes an environmental epidemiology study conducted to evaluate if there is an association between asthma rates in the City of Baltimore and emissions from the Wheelabrator Baltimore waste-to-energy facility (WTE), formerly BRESCO. The objective of the study was to understand if there was any relationship between ambient air concentrations due to emissions from the WTE facility and asthma rates in surrounding communities. The ambient air concentrations due to facility emissions were also compared to background ambient air concentrations.

There were several key steps in the study process which are described below:

- Obtaining asthma and socio-demographic data\(^1\) for the City of Baltimore
- Calculating ambient air concentrations due to emissions from the WTE facility
- Conducting statistical analyses to evaluate associations between the asthma data and the ambient air concentrations

This work was conducted at the request of Wheelabrator by a multidisciplinary team of independent environmental consulting firms and scientists. The project team consisted of: Dr. Ben Hoffman, MD, MPH; Ms. Sarah Foster, MS (CPF Associates, LLC); Dr. Rafael E. Guerrero-Preston, DrPH, MPH; and Mr. Gary Hunt, MS, QEP (TRC). The TRC Team led by Mr. Hunt (with Dana Lowes-Hobson and Doug Smith) conducted a study to model air concentrations associated with facility emissions (TRC 2019). Dr. Guerrero-Preston conducted the environmental epidemiology study to examine the association between annual average air concentrations due to WTE facility emissions (provided by TRC) and publicly available asthma hospital and emergency room discharge rates in Baltimore City for the years 2011, 2012 and 2013 (Guerrero-Preston 2019). Dr. Hoffman and Ms. Foster provided overall support and compiled the two studies, as provided by TRC and Dr. Guerrero-Preston (TRC 2019, Guerrero-Preston 2019), into this document. Team biographies are provided in Appendix A.

The Wheelabrator WTE facility began operations in 1985. It is located in the City of Baltimore, adjacent to the intersection of Interstate 95 and Maryland 295 (Baltimore-Washington Parkway), and 0.6 miles southwest of the M&T Bank Stadium (home of the Baltimore Ravens) (see Figure 1). The facility processes up to 2,250 tons of post-recycled solid waste from Baltimore area homes and businesses and other areas. Solid waste received at the facility is screened in order to remove recyclable metal materials, which totaled more than 11,500 tons in 2018. The facility supplies up to 52 megawatts (MW) of electricity for sale to the local utility, equal to the amount of power used by approximately 38,000 Maryland homes. Additionally, the facility provides steam to the downtown Baltimore heating loop, serving more than 255 businesses including M&T Bank Stadium. Emissions from the plant are regulated under the US Clean Air Act and the State of Maryland. Facility emissions are controlled by emission control technology meeting US Clean Air Act Maximum Achievable Control Technology standards. These standards include emission limits for many compounds, monitoring systems which continuously track emissions and the performance of emission control devices, and additional periodic stack testing.

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\(^1\) Socio-demographic data describe characteristics of a population, such as age, sex, education, ethnicity, religious affiliation, marital status, household, employment, and income.
Figure 1
Site Setting
2.0 ASTHMA AND SOCIO-DEMOGRAPHIC DATA

2.1 Asthma Health Data

The first step in the environmental epidemiology study required obtaining asthma health data for the City of Baltimore. Sources of publicly available data on as fine a geographic scale as possible were investigated in order to evaluate potential relationships between air concentrations and asthma rates across the city. A description of the environmental epidemiology study conducted by Dr. Rafael Guerrero-Preston, including compilation and statistical analysis of the asthma data, is provided in a separate report (Guerrero-Preston 2019) and is briefly summarized below.

Asthma hospital and emergency room annual age-adjusted discharge rates available from the State of Maryland at the zip code geographic level within the City of Baltimore data were selected for investigation. The Maryland Environmental Public Health Tracking Web portal provides these two types of health data by zip code. The three most recent years of published data, for 2011, 2012 and 2013, were used in the environmental epidemiology study. Figure 2 shows the boundaries of the city, zip codes, and the location of the WTE facility. Table 1 presents the asthma health data by zip code. Twenty-one (21) zip codes categorized as City of Baltimore zip codes in the Public Health Tracking Web portal with reported asthma discharge rates for the three years were included.

2.2 Socio-Demographic Data

Asthma is a well-studied and complex disease. It can be triggered by a wide variety of different factors leading to different symptoms in different people. These factors include biology and genetics (e.g., age and sex), individual behaviors (e.g., smoking), social determinants of health (i.e., conditions in which people are born, grow, live, and work which in turn relate to income, poverty, education, race, and neighborhood and housing conditions), outdoor air pollution and access to preventive medical care.

Due to the complexity of this disease, a number of factors known to be associated with asthma for which data are readily available at the zip code level were also included in the environmental epidemiology study – race, median family income, housing vacancy rate and homeownership rate.

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2 Age-adjusted rates are commonly used in epidemiology to compare disease information across different geographical areas in which the age-distribution of the populations can vary. Age-adjusted rates are standardized using statistical methods to account for differences in the age structure of the populations being compared.

3 https://maps.health.maryland.gov/epht/query.aspx. The data were based on inpatient and outpatient discharge medical records in 47 hospitals in Maryland. The hospital discharge data includes patients admitted for asthma to one of the hospitals (inpatients), and includes patients admitted through the emergency room (ER). The ER discharge data includes individuals treated at an emergency room for asthma and released (outpatients) and individuals admitted to the hospital for asthma from the ER (inpatients) (EIP 2017). The asthma discharge data used in the Guerrero-Preston (2019) study were age-adjusted rates per 10,000 persons.

4 These asthma data were also evaluated in a report prepared by the Environmental Integrity Project (EIP 2017).

5 Some zip codes within the City of Baltimore extend beyond the city boundary into adjacent counties. Some of these are categorized in the MD Public Health Tracking Portal as county-based zip codes. This study included zip codes categorized as City of Baltimore zip codes in the MD Public Health Tracking Portal.

These parameters were obtained from the 2010 US census. Median family income, housing vacancy rate and homeownership rate are all proxies for social determinants of health. Table 2 presents the socio-demographic data by zip code included in the environmental epidemiology study (Guerrero-Preston 2019).

Figure 2
City of Baltimore Zip Codes and Waste-to-Energy Facility Location

https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_DP02&src=pt. The 2010 census data were determined to be representative of the three evaluated years (2011, 2012 and 2013) (see Guerrero-Preston 2019). The census parameter units were as follows: race = percent of population, all ages, which was of Black, White, Asian, or American Indian or Alaska Native origins; Median family income = US dollars; homeownership rate = percent of houses owned by residents; and housing vacancy rate = percent of housing units that were unoccupied.
Table 1
Asthma Health Data for 2011, 2012 and 2013 (a)

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(a) Data obtained from https://maps.health.maryland.gov/epht/query.aspx. For additional information about the statistical analyses of the data, see Guerrero-Preston (2019).
### Table 2
Socio-Demographic Data from the US Census for 2010 (a)

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</table>

AI-AN = American Indian-Alaska Native

(a) Data obtained from https://factfinder.census.gov/faces/pages/productview.xhtml?pid=ACS_17_5YR_DP02&src=pt. For additional information about the statistical analyses of the data, see Guerrero-Preston (2019).
Other factors related to asthma that are known to be important were not addressed, as this was beyond the scope of the environmental epidemiology study and due to lack of readily available population data at the zip code level. Other factors include indoor pollution in the home (household dust, pet dander, rodents, mold, cockroaches, smoking and use of unvented gas stoves) and traffic related air pollution. Many studies have documented the significant impact on asthma of the indoor environment, where people generally spend more time than outdoors (e.g., Matsui 2014, Matsui et al. 2016, Alicea-Alvarez et al. 2017, Paulin et al. 2013, 2017, Kreiger et al. 2000, Breysse et al. 2010). Studies have also shown that traffic related air pollution (TRAP) is the primary outdoor air pollution source affecting asthma rates in large cities, including Baltimore (e.g., Alotaibi et al. 2019, EIP 2017, Khreis et al. 2018, Hime et al. 2018).

3.0 AIR DISPERSION MODELING

Air dispersion modeling was conducted to calculate ambient air concentrations due to emissions from the WTE facility in the surrounding area. A detailed description of the air modeling study performed by TRC is provided in a separate report (TRC 2019). A brief summary of the modeling is provided below.

3.1 WTE Emissions

The air modeling study addressed emissions of three criteria pollutants from the WTE facility that may be associated with asthma: particulate matter less than or equal to 2.5 microns in size (PM$_{2.5}$), nitrogen dioxide (NO$_2$), and sulfur dioxide (SO$_2$). These criteria pollutants are regulated under the US Clean Air Act for which National Ambient Air Quality Standards have been set by the US Environmental Protection Agency (USEPA) to protect public health with an adequate margin of safety.

Annual average emission rates for years 2011-2013 used in the air modeling were taken directly from the annual emission inventory reports submitted to the Maryland Department of the Environment (MDE). Emission rates for total PM$_{2.5}$ were based on periodic stack testing using USEPA Method 5 for filterable PM$_{2.5}$ and Method 202 for condensable PM$_{2.5}$. Method 202 accounts for secondary PM$_{2.5}$ particulate that forms in the atmosphere from SO$_2$ and NO$_2$ after leaving the facility stack. Collectively the Method 5 and Method 202 results are combined to provide total PM$_{2.5}$ emissions. NO$_2$ and SO$_2$ emissions were based on measurements from the continuous monitoring systems during 2011, 2012 and 2013. Annual average emission rates were calculated from these stack monitoring data for each of the three years examined in the TRC (2019) study, as shown in Table 3.

<table>
<thead>
<tr>
<th>Year</th>
<th>Stack</th>
<th>NO$_x$ Emissions (lbs/hr)</th>
<th>NO$_x$ Emissions (g/s)</th>
<th>PM$_{2.5}$ Emissions (lbs/hr)</th>
<th>PM$_{2.5}$ Emissions (g/s)</th>
<th>SO$_2$ Emissions (lbs/hr)</th>
<th>SO$_2$ Emissions (g/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1</td>
<td>285.7</td>
<td>35.99</td>
<td>5.2</td>
<td>0.65</td>
<td>65.9</td>
<td>8.30</td>
</tr>
<tr>
<td>2012</td>
<td>1</td>
<td>260.7</td>
<td>32.85</td>
<td>4.6</td>
<td>0.58</td>
<td>50.1</td>
<td>6.31</td>
</tr>
<tr>
<td>2013</td>
<td>1</td>
<td>273.0</td>
<td>34.39</td>
<td>8.2</td>
<td>1.03</td>
<td>82.25</td>
<td>10.36</td>
</tr>
</tbody>
</table>
3.2 Modeling Methodology

Ambient air concentrations were calculated using the most recent version of a state-of-the-art air dispersion model called The American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) (version 18081).8 As described by the USEPA, AERMOD is a preferred air quality model that can assess potential air concentration impacts within 50 km of an emission source, taking into account both simple (flat) and complex terrain.

The AERMOD model incorporated a variety of inputs that describe the WTE facility (e.g., stack height, stack gas exit velocity and temperature), the surrounding area (e.g., urban land use and ground terrain elevations) and meteorological weather data. Table 4 presents the stack parameters input to AERMOD for each of the three years under study; these were based on operating data collected at the facility during 2011, 2012 and 2013. Two meteorological datasets were used in AERMOD from the closest U.S. National Weather Service (NWS) stations to the facility: 1) hourly surface meteorological observations from Baltimore-Washington International Airport (BWI) for three years (2011, 2012 and 2013) and 2) upper air data from Dulles International Airport at Sterling, VA for the same three years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Stack*</th>
<th>Stack Height (m)</th>
<th>Stack Exit Temperature (F)</th>
<th>Stack Exit Temperature (K)</th>
<th>Stack Exit Velocity (ft/s)</th>
<th>Stack Exit Velocity (m/s)</th>
<th>Stack Diameter (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1</td>
<td>96</td>
<td>301</td>
<td>423</td>
<td>77.3</td>
<td>23.5</td>
<td>3.70</td>
</tr>
<tr>
<td>2012</td>
<td>1</td>
<td>96</td>
<td>299</td>
<td>422</td>
<td>79.2</td>
<td>24.1</td>
<td>3.70</td>
</tr>
<tr>
<td>2013</td>
<td>1</td>
<td>96</td>
<td>307</td>
<td>426</td>
<td>89.2</td>
<td>27.2</td>
<td>3.70</td>
</tr>
</tbody>
</table>

*Stack Location is NAD 83 zone 18 (meters)- Easting: 359354.09, Northing: 4348002.51, Elevation: 4.6

Air concentrations were calculated by AERMOD at over 17,600 points (called receptor points) that were evenly spaced at 250-meter intervals extending outwards from the WTE stack. Figure 3 illustrates the receptor grid across the modeling area.

3.3 Modeling Results

Annual average concentrations of PM$_{2.5}$, NO$_2$ and SO$_2$ were calculated at every 250-meter spaced receptor point for each of the three modeled years. The modeled results were then post-processed by TRC to calculate an annual average concentration within each zip code.9 This was done by averaging the results for all receptor points located within each zip code. The resulting concentrations are shown in Table 5.

8 An air dispersion model uses mathematical equations to calculate ambient air concentrations across an area due to emissions sources.

9 Since the asthma health data are not publicly available for time increments less than one year, annual average air concentrations were calculated to match the annual asthma data time frame.
Figure 3

250 Meter Spaced Receptor Points Used in Air Modeling Study
Table 5
Annual Average Ambient Air Concentrations for PM$_{2.5}$, NO$_2$ and SO$_2$ by Zip Code and Year (a)
(All concentrations in μg/m$^3$)

<table>
<thead>
<tr>
<th>Zip code</th>
<th>Modeled Annual Average Concentrations Associated with WTE Facility Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nitrogen Dioxide (NO$_2$) Concentration</td>
</tr>
<tr>
<td>21201</td>
<td>0.388</td>
</tr>
<tr>
<td>21202</td>
<td>0.421</td>
</tr>
<tr>
<td>21205</td>
<td>0.292</td>
</tr>
<tr>
<td>21206</td>
<td>0.178</td>
</tr>
<tr>
<td>21209</td>
<td>0.103</td>
</tr>
<tr>
<td>21210</td>
<td>0.123</td>
</tr>
<tr>
<td>21211</td>
<td>0.181</td>
</tr>
<tr>
<td>21212</td>
<td>0.122</td>
</tr>
<tr>
<td>21213</td>
<td>0.283</td>
</tr>
<tr>
<td>21214</td>
<td>0.18</td>
</tr>
<tr>
<td>21215</td>
<td>0.134</td>
</tr>
<tr>
<td>21216</td>
<td>0.216</td>
</tr>
<tr>
<td>21217</td>
<td>0.248</td>
</tr>
<tr>
<td>21218</td>
<td>0.225</td>
</tr>
<tr>
<td>21223</td>
<td>0.3</td>
</tr>
<tr>
<td>21224</td>
<td>0.341</td>
</tr>
<tr>
<td>21225</td>
<td>0.171</td>
</tr>
<tr>
<td>21229</td>
<td>0.198</td>
</tr>
<tr>
<td>21230</td>
<td>0.44</td>
</tr>
<tr>
<td>21231</td>
<td>0.437</td>
</tr>
<tr>
<td>21239</td>
<td>0.145</td>
</tr>
</tbody>
</table>

(a) Zip codes with asthma health data within the City of Baltimore are shown in this table. Also see TRC (2019).
Over the three years considered, the incremental annual average modeled PM2.5 concentrations across the 21 zip codes associated with WTE facility emissions ranged from 0.002 µg/m³ to 0.013 µg/m³. Annual average concentrations of SO₂ ranged from 0.015 – 0.13 µg/m³ and NO₂ concentrations ranged from 0.082 – 0.464 µg/m³.

3.4 Evaluation of Modeling Results Relative to Background Air Quality

The incremental impact of the WTE facility on air quality can be examined by comparing the modeled annual average air concentrations to background concentrations. As described in TRC (2019), annual average background concentrations of PM₂.₅, NO₂, and SO₂ were compiled from two different data sources, a study by Alotaibi et al. (2019a,b) and USEPA and MDE ambient air quality monitors. Figure 4 shows the locations of the ambient air quality monitoring stations.

One set of background air concentrations was obtained from a study by Alotaibi et al. (2019a,b) which investigated the relationship between childhood asthma and traffic related air pollution. The annual average air concentrations from Alotaibi et al. (2019a,b) included values for the year 2010 and were provided by census block centroid. The annual average PM₂.₅, NO₂ and SO₂ concentrations were estimated using data from regulatory air quality monitors taking into account geographic variables (e.g., land use, population, satellite-derived estimates of land use and air pollution, impervious surfaces, elevation, and roads). The census block centroid data were grouped and averaged by TRC to calculate average background concentrations by zip code. These results are shown in Table 6, along with the 2011 modeled concentrations associated with emissions from the WTE facility (i.e., the closest modeled year to 2010). As can be seen in Table 6 and Figure 5, the incremental impact of WTE facility emissions on annual average air concentrations is negligible compared to annual average background levels.

The second source of background data was from USEPA and MDE ambient air quality monitors, with locations selected based on their proximity to the WTE facility. Several different monitor locations were considered depending on whether they had collected data during the 2010-2013 time period. Though these monitors are not located very close to the WTE facility, they can still provide some context for the modeling results. The annual average background concentrations measured at the air quality monitoring stations are also presented Table 6. Again, the incremental annual average concentrations associated with emissions from the WTE facility were negligible compared to the monitored background concentrations. Further, modeled concentrations of facility emissions were orders of magnitude below detection limits of USEPA and MDE ambient air quality monitors for PM₂.₅, NO₂ and SO₂.

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10 The air concentrations by census block centroid were provided to Alotaibi et al. from researchers at the University of Washington (e.g., see Bechle et al. 2015 and Kim et al. 2018). The annual average air concentrations by census block centroid for the State of Maryland were provided to S. Foster by R. Alotaibi on 4/29/2019.
Figure 4
Ambient Air Quality Monitoring Stations in Baltimore City Area
Table 6
Comparison of Modeled Annual Average Air Concentrations to Background Air Quality
(All concentrations in µg/m³) (TRC 2019)

<table>
<thead>
<tr>
<th>Location</th>
<th>Modeled Annual Average Concentrations Associated with WTE Facility Emissions</th>
<th>Estimated Background Concentrations from Alotaibi et al. (2019a,b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO₂ Concentration</td>
<td>SO₂ Concentration</td>
</tr>
<tr>
<td>----------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>21201</td>
<td>0.388</td>
<td>0.309</td>
</tr>
<tr>
<td>21202</td>
<td>0.421</td>
<td>0.334</td>
</tr>
<tr>
<td>21205</td>
<td>0.292</td>
<td>0.259</td>
</tr>
<tr>
<td>21206</td>
<td>0.178</td>
<td>0.145</td>
</tr>
<tr>
<td>21209</td>
<td>0.103</td>
<td>0.082</td>
</tr>
<tr>
<td>21210</td>
<td>0.123</td>
<td>0.093</td>
</tr>
<tr>
<td>21211</td>
<td>0.181</td>
<td>0.142</td>
</tr>
<tr>
<td>21212</td>
<td>0.122</td>
<td>0.093</td>
</tr>
<tr>
<td>21213</td>
<td>0.283</td>
<td>0.224</td>
</tr>
<tr>
<td>21214</td>
<td>0.18</td>
<td>0.132</td>
</tr>
<tr>
<td>21215</td>
<td>0.134</td>
<td>0.107</td>
</tr>
<tr>
<td>21216</td>
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<tr>
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<td>0.169</td>
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<tr>
<td>21224</td>
<td>0.341</td>
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<td>0.171</td>
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<tr>
<td>21229</td>
<td>0.198</td>
<td>0.195</td>
</tr>
<tr>
<td>21230</td>
<td>0.44</td>
<td>0.464</td>
</tr>
<tr>
<td>21231</td>
<td>0.437</td>
<td>0.404</td>
</tr>
<tr>
<td>21239</td>
<td>0.145</td>
<td>0.106</td>
</tr>
</tbody>
</table>

Background Concentrations from Air Quality Monitoring Stations (a)

<table>
<thead>
<tr>
<th>Location</th>
<th>NO₂</th>
<th>SO₂</th>
<th>PM₂.₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Town</td>
<td>34.0</td>
<td>30.9</td>
<td>27.5</td>
</tr>
<tr>
<td>Essex</td>
<td>5.2</td>
<td>4.6</td>
<td>3.6</td>
</tr>
</tbody>
</table>

(a) All monitoring stations are in Baltimore City except the Essex station in Essex, MD. PM₂.₅ monitoring stations are Old Town; Northwest Police Station; and BCFD Truck Company (respectively).
Figure 5
Comparison of Background and Modeled Incremental Concentrations by Zip Code

Sources: Background data from Alotaibi et al. (2019a,b). Incremental concentrations due to WTE facility emissions based on modeling in TRC (2019).
4.0 ENVIRONMENTAL EPIDEMIOLOGY STUDY

An environmental epidemiology study of the asthma health data, the modeled air concentrations and the socio-demographic parameters was conducted across the 21 Baltimore City zip codes for each of the three years (2011, 2012 and 2013). The epidemiological approach was a cross-sectional study, which is a type of investigation that focuses on a population (rather than individuals) at specific points in time, in this case in the years 2011, 2012 and 2013. The cross-sectional population study examined the pattern of asthma discharges across city zip codes relative to the modeled air concentrations, taking into account the socio-demographic data. The epidemiological study, which was performed by Dr. Guerrero-Preston, is provided in a separate report (Guerrero-Preston 2019). A summary of the methodology and findings is provided below.

4.1 Methodology

The environmental epidemiology study was conducted to explore if there was an association between annual age-adjusted asthma rates and modeled annual average air concentrations due to emissions from the WTE facility. Bivariate linear analyses (i.e., linear relationships between two variables) were initially explored. Multivariate linear regression models (i.e., looking at linear relationships between multiple variables in one model), were then performed to understand what other factors may be affecting relationships between asthma rates and air concentrations. As described above, two sets of asthma data were evaluated - asthma hospital discharge rates (HD) and asthma emergency room discharge rates (ER). The statistical calculations were performed using a software program called Stata (version 14) (Statacorp 2015).

The relationship between variables was evaluated based on several statistical measures. Collectively these measures indicate the likelihood that there is a relationship (or correlation) between two or more variables (or conversely that there is not a relationship between the variables). One of these measures is called statistical significance, which is measured by a “p value”. The smaller the p value, the more likely that the tested variables are correlated. Common values used to assess statistical significance include p<0.05, p<0.01, and p<0.001. For example, a value of p<0.001 indicates a very strong statistically significant correlation while p<0.05 indicates a moderate statistically significant correlation. Generally, p values greater than 0.05 suggest correlations that are not statistically significant. Another statistical measure is the correlation coefficient (or r-value) which was calculated in the initial bivariate (two variable) linear analyses. The r-value can be positive or negative, with the sign of the r-value representing the direction of the association. For positive associations, when one variable increases, the other variable increases as well. For negative, or inverse, associations, when one variable increases, the other variable decreases. The magnitude of the r-value indicates the strength of the relationship, with larger r-values indicating a stronger relationship. For example, r-values of 0.8 and higher indicate a strong linear relationship between the tested variables. Scatterplots were also prepared to visualize relationships between the asthma data relative to the air concentrations and socio-demographic variables. Scatterplots display data for two variables at a time, with one variable represented on the x-axis and the asthma data on the y-axis. Lastly, the multivariate linear regression analyses also indicated the direction of statistically significant associations (positive or negative) and further explored which variables best explained the asthma data.
4.2 Results

4.2.1 Bivariate Linear Correlation Analysis

For the two-variable (bivariate) correlation analysis, the HD and ER rates across all of the Baltimore City zip codes were compared individually to each of the other parameters across the same set of zip codes. This step of the investigation resulted in 30 two-variable correlations for HD across the three years and 30 two-variable correlations for ER also across the three years, producing a total of 60 two-variable statistical correlations.

Table 7 presents the bivariate correlation analysis results. It indicates whether each correlation was or was not statistically significant, whether the correlation was strong ($r > 0.8$) and, for statistically significant results, the direction of correlation (positive or negative). Additional discussion and details are provided in Guerrero-Preston (2019).

The bivariate results in Table 7 show that there were no statistically significant associations between age-adjusted asthma discharge rates (ER or HD) and the modeled annual average air concentrations of PM$_{2.5}$, NO$_2$ or SO$_2$ in 2011, 2012 or 2013. Highly significant associations were, however, observed for several socio-demographic parameters in bivariate analyses, particularly for social determinants of health (e.g., median family income and housing vacancy rate) and indicators of race (e.g., percent of population that is black or white). For example, highly significant associations and strong correlations were observed between median family income and both asthma emergency room discharge rates and hospital discharge rates, with p values <0.001 for all three evaluated years. This particular association was negative, meaning that as median family income decreased across the zip codes, both sets of asthma rates increased.

Example scatterplots of 2013 emergency room discharge rates relative to median family income, the most consistent variable shown in the bivariate analyses to be strongly associated with asthma, and to PM$_{2.5}$, SO$_2$ and NO$_2$ air concentrations, are provided in Figure 6. (Additional scatterplots for the tested variables are provided in the supplemental figures in Guerrero-Preston (2019).) Each data point on these plots represents the annual ER rate on the y-axis and the corresponding air concentration or median family income value on the x-axis for one zip code. These example scatterplots support the conclusions noted above. There was no statistically significant correlation between annual emergency room discharge rates and annual average PM$_{2.5}$, SO$_2$ and NO$_2$ air concentrations.$^{11}$ For example, there are zip codes with 2013 annual ER rates of approximately 200-300 (cases per 10,000 persons) that have both high and low annual average PM$_{2.5}$, SO$_2$ and NO$_2$ air concentrations. In contrast, there was a strong inverse correlation between 2013 annual ER rates and median family income ($r = -0.93$) that was highly statistically significant ($p<0.001$). Zip codes with higher median family incomes have lower ER asthma rates, while zip codes with lower median family income have higher ER asthma rates.

---

$^{11}$ The p values and r-values for the not statistically significant correlations between 2013 annual emergency room discharge rates and annual average air concentrations were as follows: PM2.5 ($r=0.40$, $p=0.08$), SO2 ($r=0.36$, $p=0.11$) and NO2 ($r=0.35$, $p=0.12$) For more information, see Guerrero-Preston (2019).
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Asthma age-adjusted hospital discharge rates (HD)</th>
<th>Asthma age-adjusted emergency room discharge rates (ER)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO2_2011</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>NO2_2012</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>NO2_2013</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>PM_2011</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>PM_2012</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>PM_2013</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>SO2_2011</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>SO2_2012</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>SO2_2013</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Black_2011</td>
<td>p=0.01 (+)</td>
<td></td>
</tr>
<tr>
<td>Black_2012</td>
<td>p=0.01 (+)</td>
<td></td>
</tr>
<tr>
<td>Black_2013</td>
<td>p=0.01 (+)</td>
<td></td>
</tr>
<tr>
<td>White_2011</td>
<td>p=0.01 (-)</td>
<td></td>
</tr>
<tr>
<td>White_2012</td>
<td>p=0.01 (-)</td>
<td></td>
</tr>
<tr>
<td>White_2013</td>
<td>p&lt;0.01 (-)</td>
<td></td>
</tr>
<tr>
<td>Asian_2011</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Asian_2012</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Asian_2013</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Al_AN_2011</td>
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<td></td>
</tr>
<tr>
<td>Al_AN_2012</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Al_AN_2013</td>
<td>p=0.05 (+)</td>
<td></td>
</tr>
<tr>
<td>Income_2011</td>
<td>p&lt;0.001 (-) (r= -0.83)</td>
<td></td>
</tr>
<tr>
<td>Income_2012</td>
<td>p&lt;0.001 (-) (r= -0.82)</td>
<td></td>
</tr>
<tr>
<td>Income_2013</td>
<td>p&lt;0.001 (-) (r= -0.79)</td>
<td></td>
</tr>
<tr>
<td>Owner_2011</td>
<td>p&lt;0.05 (-)</td>
<td></td>
</tr>
<tr>
<td>Owner_2012</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Owner_2013</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Vacancy_2011</td>
<td>p&lt;0.01 (+)</td>
<td></td>
</tr>
<tr>
<td>Vacancy_2012</td>
<td>p=0.01 (+)</td>
<td></td>
</tr>
<tr>
<td>Vacancy_2013</td>
<td>p&lt;0.05 (+)</td>
<td></td>
</tr>
</tbody>
</table>
Notes for Table 7

For additional details, see Guerrero-Preston (2019).
AI-AN = American Indian or Alaskan Native

P values:
NS  = Not statistically significant. The two variables are not significantly correlated with one another (i.e., p>0.05).
p<0.05 = Statistically significant at the p<0.05 level (not as strong a relationship compared to the p<0.01 level).
p<0.01 = Statistically significant at the p<0.01 level.
p<0.001 = Statistically significant at the p<0.001 level. The association between the two variables is highly significant.

Correlation direction:
(+) = The relationship is positively correlated (i.e., as the value of the parameter increases across zip codes, the asthma discharge rate also increases).
(-) = The relationship is negatively correlated (i.e., as the value of the parameter increases across zip codes, the asthma discharge rate decreases).

Strength of correlation (r-values):
r ≥ 0.8 = The correlation is strong. All r-values greater than or equal to 0.8 are shown (including r-values of 0.75-0.79 which round up to 0.8).
Figure 6
Example Scatterplots: Asthma Annual Age-Adjusted Emergency Room Discharge Rates in 2013 (ER_2013) Relative to 2013 Annual Average Air Concentrations and Median Family Income by Zip Code

6a: ER_2013 and Median Family Income

Statistically significant:
\[ p<0.001 \]
\[ r\text{-value} = -0.93 \]

6b: ER_2013 and PM2.5 Air Concentrations

Not statistically significant:
\[ p=0.08 \]
\[ r\text{-value} = 0.40 \]

6c: ER_2013 and NO\textsubscript{2} Air Concentrations

Not statistically significant:
\[ p=0.12 \]
\[ r\text{-value} = 0.35 \]

6d: ER_2013 and SO\textsubscript{2} Air Concentrations

Not statistically significant:
\[ p=0.11 \]
\[ r\text{-value} = 0.36 \]

For additional details, see Guerrero-Preston (2019).
4.2.2 Multivariate Regression Modeling

The multi-variable (multivariate) statistical analyses explored the relationship between asthma age-adjusted discharge rates and the modeled air concentrations after taking into account (i.e., adjusting for) the socio-demographic parameters. In these models, all of the socio-demographic parameters were simultaneously included in the regression model along with air concentration (i.e., each modeled air concentration in addition to seven socio-demographic parameters across the 21 zip codes). The results of the multivariate analyses are provided in Guerrero-Preston (2019) and summarized in Tables 8 and 9 for ER and HD discharge rates, respectively.

The multivariate regression analyses showed that there were no statistically significant associations between asthma discharge rates (ER or HD) and the modeled air concentrations of PM$_{2.5}$, NO$_2$ or SO$_2$ in 2011, 2012 or 2013. The highly significant associations observed in the bivariate correlation analyses between asthma discharge rates and median family income remained significant in the multivariate regression analyses.

4.3 Statistical Analyses Conclusions

The population-based statistical analyses performed at the zip code level showed there were no statistically significant associations between annual age-adjusted emergency room or hospital discharge rates for asthma in relation to annual average PM$_{2.5}$, NO$_2$ or SO$_2$ air concentrations due to emissions from the WTE facility in Baltimore City during 2011, 2012 and 2013. The analyses did, however, identify statistically significant associations between discharge rates for asthma and median family income for all three years, and instances where discharge rates were also significantly associated with housing vacancy rate, homeownership rates and race. These results suggest that social determinants of health at the zip code level, for which income and housing characteristics are proxies, are driving the rates of emergency room discharges and hospital discharges due to asthma in Baltimore City.

5.0 DISCUSSION

The results of the environmental epidemiology study are in agreement with scientific research on factors associated with asthma in urban US areas like the City of Baltimore. While there are many different triggers for asthma and each person’s triggers can differ, the study found, consistent with studies of urban areas, that asthma in the City of Baltimore is mostly affected by social determinants of health.

Social determinants of health include poverty, unsafe and stressful neighborhoods, and unhealthy neighborhood and home environments. Home environments, where people spend most of their time, can be unhealthy due to indoor pollution which includes household dust, pet dander, smoking, rodents, mold, cockroaches and unvented indoor gas stoves. Several studies have documented the presence of these types of social determinants of health, including high poverty rates, in the City of Baltimore and their relationship to asthma (BCHD 2017, VCU 2012, DePriest et al. 2018, AAFA 2019, EIP 2017, Keet et al. 2015, 2017). These factors all contribute to elevated asthma rates in the city. Indeed, it has been well documented that asthma rates in Baltimore are higher than elsewhere in the State of Maryland and average US asthma rates. The city’s asthma rates are, however, similar to those in many other large urban areas in the US (AAFA 2019, CDC 2018). These similarities are likely to be related to the importance and presence of social determinants of health in many cities across the country (Northridge et al. 2010, Alicea-Alvarez et al. 2017, Hughes et al. 2017).
### Table 8
Multivariate Linear Regression Modeling for Emergency Room Annual Age-Adjusted Discharge Rates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PM$_{2.5}$ Model</th>
<th>NO$_2$ Model</th>
<th>SO$_2$ Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{2011}$</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>PM$_{2012}$</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>PM$_{2013}$</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Median family income</td>
<td>p=0.01 (-)</td>
<td>p&lt;0.001 (-)</td>
<td>p=0.01 (-)</td>
</tr>
<tr>
<td></td>
<td>p&lt;0.001 (-)</td>
<td>p=0.01 (-)</td>
<td>p&lt;0.001 (-)</td>
</tr>
<tr>
<td>Housing vacancy rate</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>p=0.05 (+)</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Home ownership rate</td>
<td>NS</td>
<td>p&lt;0.05 (-)</td>
<td>p&lt;0.05 (-)</td>
</tr>
<tr>
<td></td>
<td>p&lt;0.01 (-)</td>
<td>NS</td>
<td>p&lt;0.001 (-)</td>
</tr>
<tr>
<td>Black</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>White</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Asian</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>AI_AN</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

**Notes**
For additional details, see Guerrero-Preston (2019). AI-AN = American Indian or Alaskan Native.

**P values:**
- NS = Not statistically significant. The two variables are not significantly correlated with one another (i.e., p>0.05).
- p<0.05 = Statistically significant at the p<0.05 level (not as strong a relationship compared to the p<0.01 level).
- p<0.01 = Statistically significant at the p<0.01 level.
- p<0.001 = Statistically significant at the p<0.001 level. The association between the two variables is highly significant.

**Correlation direction:**
- (+) = The relationship is positively correlated (i.e., as the value of the parameter increases across zip codes, the asthma discharge rate also increases).
- (-) = The relationship is negatively correlated (i.e., as the value of the parameter increases across zip codes, the asthma discharge rate decreases).
Table 9
Multivariate Linear Regression Modeling for Hospital Annual Age-Adjusted Discharge Rates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PM$_{2.5}$ Model</th>
<th>NO$_2$ Model</th>
<th>SO$_2$ Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{2011}$</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>PM$_{2012}$</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>PM$_{2013}$</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Median family income</td>
<td>p&lt;0.001 (-)</td>
<td>p&lt;0.001 (-)</td>
<td>p&lt;0.01 (-)</td>
</tr>
<tr>
<td>Housing vacancy rate</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Home ownership rate</td>
<td>p&lt;0.01 (-)</td>
<td>p&lt;0.05 (-)</td>
<td>NS</td>
</tr>
<tr>
<td>Black</td>
<td>NS</td>
<td>NS</td>
<td>p&lt;0.05 (+)</td>
</tr>
<tr>
<td>White</td>
<td>NS</td>
<td>NS</td>
<td>p&lt;0.05 (+)</td>
</tr>
<tr>
<td>Asian</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>AI_AN</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

Notes
For additional details, see Guerrero-Preston (2019). AI-AN = American Indian or Alaskan Native.

P values:
NS = Not statistically significant. The two variables are not significantly correlated with one another (i.e., p>0.05).
p<0.05 = Statistically significant at the p<0.05 level (not as strong a relationship compared to the p<0.01 level).
p<0.01 = Statistically significant at the p<0.01 level.
p<0.001 = Statistically significant at the p<0.001 level. The association between the two variables is highly significant.

Correlation direction:
(+) = The relationship is positively correlated (i.e., as the value of the parameter increases across zip codes, the asthma discharge rate also increases).
(-) = The relationship is negatively correlated (i.e., as the value of the parameter increases across zip codes, the asthma discharge rate decreases).
Traffic related air pollution (TRAP) can also contribute to elevated asthma rates in cities. Scientific studies, including some focused on the Baltimore area, point to TRAP as a major factor affecting asthma rates in cities (EIP 2017, Alotaibi et al. 2019, Achakulwisut et al. 2019, Khreis et al. 2017a, 2017b, 2018, Hime et al. 2018). Emissions from vehicles traveling on roadways, in particular heavily-trafficked highways like Interstate 95, affect air quality and are related to high asthma rates in cities. While TRAP was not included in the environmental epidemiology study, it is estimated to be the largest contributor to nitrogen oxides and PM$_{2.5}$ concentrations in air in the Baltimore area (EIP 2017, MDE 2018, Orozco et al. 2015, USEPA 2016).

The environmental epidemiology study is similar in some respects to an evaluation of asthma in the City of Baltimore that was conducted by the Environmental Integrity Project (EIP 2017). Consistent with the analysis described above, the EIP study found “a very strong spatial correlation between asthma hospitalization and emergency room visits in Baltimore’s zip codes and demographic measures of poverty, particularly median household income.” The importance of TRAP was also highlighted in the EIP report which stated “it is likely that on-road vehicles are the largest contributor to the air pollution that people breathe in Baltimore” and “There is significant overlap between areas with relatively high roadway traffic pollution and high asthma hospitalization rates in the center of the city and in parts of East and West Baltimore.” The EIP report further concluded that “there is not a significant association between city zip codes with the highest emissions of criteria pollutants from stationary facilities and the zip codes with the highest asthma rates.”

The similarities in conclusions between the environmental epidemiology study and the EIP (2017) study occurred even though there were differences in evaluation approaches. While both studies evaluated asthma data and demographic data by zip code relative to air pollution, the approaches used to characterize air pollution and the methods used to evaluate relationships with asthma data differed. In the environmental epidemiology study, air pollution was characterized as PM$_{2.5}$, NO$_2$ and SO$_2$ concentrations calculated from dispersion modeling specifically for the WTE facility. In other words, the scope of this project was limited to evaluating air concentrations that reflected the incremental impact on air quality due solely to emissions from the WTE facility. In the EIP study, in contrast, air pollution was characterized using several approaches that more broadly reflected air quality in the city. The environmental epidemiology study evaluated zip codes classified by the Maryland Environmental Public Health Tracking Web portal as City of Baltimore zip codes, whereas EIP also included a few zip codes that straddle the city boundary but are classified as neighboring county zip codes. The modeled annual average air concentrations and asthma rates for the few additional zip codes addressed by EIP were at the low end of those included in the environmental epidemiology study (i.e., these zip codes did not have high concentrations due to WTE facility emissions or high asthma discharge rates relative to the zip codes that were included). The methods used to evaluate the data also differed. The asthma, socio-demographic, and air concentration data by zip code were statistically evaluated in Guerrero-Preston (2019) using a well-established public health statistical approach used in environmental epidemiology studies. The EIP study relied mainly on visual comparisons using graphs and maps that compared each of the datasets.

12 Air quality was assessed by EIP using: estimated concentrations by census tract due to vehicles on roadways using a modeling tool from the University of North Carolina and USEPA; estimates of respiratory health risk by census tract based on modeled concentrations of hazardous pollutants in air using USEPA modeling tools; power plant and other large facility emissions data by zip code from USEPA’s National Emissions Inventory; and monitoring data from air quality monitors in the City of Baltimore.
There are many approaches that can help reduce asthma rates among people living in large US cities. Taking preventive medications and removing asthma triggers (such as tobacco smoke, allergens and mold and replacing unvented gas stoves with electric stoves) can help reduce the frequency of asthma symptoms. Identifying household indoor exposure sources that can trigger asthma and developing control strategies to reduce these exposures are important (Colton et al. 2015, Matsui et al. 2016, Paulin et al. 2017). Reducing emissions from major air sources known to strongly affect air quality, such as TRAP, can also help. The air modeling study for this project (TRC 2019) showed that the annual average modeled air concentrations due to WTE facility emissions were substantially lower than background air quality levels. Increasing access to medical care and ensuring that patients see and follow-up with health-care providers are also critical factors that impact asthma ER and HD rates (KHN 2017). Programs that can provide help to Baltimore City residents with asthma include Baltimore’s Community Asthma Program for children (BCHD 2019), Maryland’s Asthma Control Program and the Greater Baltimore Asthma Alliance.13

6.0 SUMMARY AND CONCLUSIONS

This report describes an environmental epidemiology study conducted to evaluate if there is an association between asthma rates in the City of Baltimore and emissions from the Wheelabrator Baltimore waste-to-energy (WTE) facility (formerly BRESCO). The aim of the study was to understand the relationship between ambient air concentrations due to emissions from the WTE facility and asthma rates in surrounding communities. This report also describes an air modeling study which provided the ambient air concentrations for the environmental epidemiology study and allowed these concentrations to be compared to background ambient air concentrations. The air modeling study was conducted by TRC (TRC 2019). The environmental epidemiology study was conducted by Dr. Rafael Guerrero-Preston, DrPH, MPH (Guerrero-Preston 2019).

Asthma hospital and emergency room annual age-adjusted discharge rates available at the zip code geographic level within the City of Baltimore were selected for investigation. These data were obtained for 21 zip codes categorized as City of Baltimore zip codes in Maryland’s Environmental Public Health Tracking Web portal for 2011, 2012 and 2013. In addition, several socio-demographic factors known to be associated with asthma at the zip code level were also included – race, median family income, housing vacancy rate and homeownership rate. These parameters were all obtained from the 2010 US census. Median family income, vacancy rate and homeownership rate are all proxies for “social determinants of health”. Social determinants of health are conditions in which people are born, grow, live, and work which in turn relate to income, poverty, education, race, and neighborhood and housing conditions. They have been found in scientific studies to be major drivers of asthma.

The air dispersion modeling study, using the latest USEPA-approved model, was conducted to calculate ambient air concentrations due to emissions from the WTE facility in the surrounding area. Annual average air concentrations were calculated for particulate matter less than or equal to 2.5 microns in size (PM$_{2.5}$), nitrogen dioxide (NO$_2$), and sulfur dioxide (SO$_2$), the three types of emissions from the WTE facility that may be associated with asthma. Annual average WTE facility emission rates for 2011-2013 as reported to the Maryland Department of Environment (MDE) along with hourly meteorological data for the same years were used to calculate corresponding annual average ambient air concentrations for each zip code for each of these three years.

13 See www.asthmacommunitynetwork.org and phpa.health.maryland.gov/mch/Pages/asthma.aspx.
The incremental annual average air concentrations of PM$_{2.5}$, NO$_2$, and SO$_2$ were also compared to background concentrations from two different data sources - a study providing modeled 2010 concentrations and actual measurements from USEPA air quality monitors. Both sets of background data showed that the incremental impact of WTE facility emissions on annual average air concentrations was negligible compared to annual average background levels. Further, modeled concentrations of facility emissions were orders of magnitude below detection limits of USEPA and MDE ambient air quality monitors for PM$_{2.5}$, NO$_2$ and SO$_2$.

The environmental epidemiology study statistically analyzed the asthma health data and the modeled annual average air concentrations, taking into account the socio-demographic parameters, across the 21 Baltimore City zip codes for each of the three years (2011, 2012 and 2013). The analysis showed there were no statistically significant associations between annual emergency room or hospital discharge rates for asthma in relation to annual average PM$_{2.5}$, NO$_2$ or SO$_2$ air concentrations due to emissions from the WTE facility during 2011, 2012 and 2013. The analysis did, however, identify statistically significant associations between discharge rates for asthma and median family income for all three years and instances where discharge rates were also significantly associated with housing vacancy, homeownership rates and race. These results suggest that social determinants of health at the zip code level, for which income and housing characteristics are proxies, are driving the rates of emergency room discharges and hospital discharges due to asthma in Baltimore City.

The results of the environmental epidemiology study are in agreement with scientific research on factors associated with asthma in urban US areas like the City of Baltimore. While there are many different triggers for asthma and each person’s triggers can differ, the study found, consistent with studies of urban areas, that asthma in the City of Baltimore is mostly affected by social determinants of health. Examples of social determinants of health include: poverty, unsafe and stressful neighborhoods, and unhealthy neighborhood and home environments. Home environments, where people spend most of their time, can be unhealthy due to indoor pollution which includes household dust, pet dander, smoking, rodents, mold, cockroaches and unvented indoor gas stoves. Several studies have documented the presence of these types of social determinants of health, including high poverty rates, in the City of Baltimore and their relationship to elevated asthma rates in the city. It has been well documented that asthma rates in Baltimore are higher than elsewhere in the State of Maryland and average US asthma rates, but the city’s asthma rates are similar to those in many other large urban areas in the US. The similarities with other large cities is likely to be related to the importance and presence of social determinants of health in many cities across the country as well as traffic related air pollution (TRAP), which has been shown in scientific studies to be a major factor affecting asthma rates in cities.

7.0 REFERENCES


StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP.


ATTACHMENT A

PARTICIPANT CVS
Dr. Ben Hoffman MD, MPH is a highly-seasoned physician executive with an extensive background in occupational and environmental health, clinical medicine, and transportation safety. He has been employed by government agencies, non-profits and multinational corporations including GE, Baker Hughes, Waste Management, Anheuser-Busch and DuPont. Dr. Hoffman trained at Yale, Brown and Mt. Sinai School of Medicine and is board certified in internal medicine, preventive medicine and environmental/occupational health. He has published widely and holds Professorships (Adjunct) at the University of Texas School of Public Health and Tufts University Friedman School of Nutrition. He has been active on numerous committees and boards in the past including Global Health at the National Academy of Sciences/IOM, IPIECA/OGP and former Chair, US DOT/FMCSA Medical Review Board.
Ms. Foster has over 30 years of consulting and project management experience in environmental health sciences, with expertise in developing strategies for and conducting exposure and risk analyses related to environmental and public health issues. Ms. Foster has managed and performed numerous comprehensive risk assessment projects and public health evaluations across the US for waste management technologies such as waste-to-energy facilities, landfills, transfer stations and hazardous waste incinerators, contaminated sites including USEPA Superfund sites, and air toxics sources associated with industrial facilities. Projects typically included selection of compounds for evaluation, estimation of emissions, fate and transport modeling, identification of exposure pathways, calculation of potential human and environmental exposures, assessment of potential chronic and acute risks and evaluation of uncertainties. Hazardous waste site projects often included risk assessment of remedial alternatives and development of cleanup goals. Additional areas of work have included assessment of public health and odor impacts based on monitoring and modeling data, reviewing current and emerging public health and waste management issues, public health assessment of odor control products, participating in the evaluation, design and reporting of epidemiologic studies, coordinating multidisciplinary modeling efforts for risk assessments, estimating exposures to volatile compounds due to indoor water uses and peer review of risk assessments, public health evaluations and environmental impact assessments conducted by unaffiliated engineering and consulting firms. Ms. Foster is a member of several professional societies and has authored or co-authored many publications or presentations in the environmental field. Previous to CPF Associates, LLC, Ms. Foster was a Principal and Founding Partner of CPF Associates, Inc., a Senior Consultant with The Weinberg Group, a Project Manager with Clement Associates/ICF Consulting, a Data Reviewer for the Six Cities Study at Harvard School of Public Health, and an Environmental Protection Specialist at the US Environmental Protection Agency. She received a Master of Science Degree in Environmental Health Sciences from Harvard University School of Public Health and a B.A. in Political Science (Environmental Law/Energy Policy) from Williams College in Massachusetts.
CURRICULUM VITAE

RAFAEL E. GUERRERO-PRESTON

DEMOGRAPHIC AND PERSONAL INFORMATION

Appointments

Chief Scientific Officer and PI 2013 - Present
LifeGene Biomarks, Inc.
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Assistant Professor 2012 - 2016
Otolaryngology-Head and Neck Cancer Surgery
Johns Hopkins School of Medicine

Adjunct Professor 2013 - 2018
Obstetrics and Gynecology
University of Puerto Rico School of Medicine

Instructor 2008 - 2012
Otolaryngology-Head and Neck Cancer Surgery
Johns Hopkins School of Medicine

Personal Data

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Baltimore, MD 21215
787-630-7885
rafael.guerrerop@gmail.com

Education and Training

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<thead>
<tr>
<th>Year</th>
<th>Degree</th>
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<th>Field</th>
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<td>1976-1979</td>
<td>BA</td>
<td>Columbia College, NYC</td>
<td>Biology/Psychology</td>
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<td>1979-1981</td>
<td>Basic</td>
<td>Mount Sinai Medical School, NYC</td>
<td>General Public Health</td>
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<td>DrPH</td>
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<td>2005-2007</td>
<td>Post-doc</td>
<td>Mailman School of Public Health</td>
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RESEARCH ACTIVITIES

A. Publications:
Journal Articles


0138


Journal Articles In preparation

[1] Valle BL, Kuhn E, Herman J, Sidransky D, Shih IM, Diaz-Montes T, and Guerrero-Preston R. HIST1H2BB and MAGI2 differential promoter methylation and somatic mutations in multiple body compartments are markers for early detection of high-grade serous ovarian cancers. In-preparation


B. Patents:

Granted:


Pending:

C. Book Chapters

D. Presentations (selected)

**Scientific Meeting Presentations (selected)**


April 2017  Francesca Pirini, Sassan Noazin, Martha Jahuira Arias, Sebastian Rodriguez-Torres, Leah Friess, Christina Michailidi, Jaime Cok, Juan Combe, Goria Vargas, William Prado, Ethan Soudry, Jimena Perez, Tikki Yudin, Andrea Mancinelli, Helen Unger, Carmen Ilí, Priscilla Brebi, Douglas Berg, Masamichi Hayashi, David Sidransky, Robert Gilman, **Rafael Guerrero-Preston**. Early detection of gastric cancer using global, genome-wide and  *IRF4, ELMO1, CLIP4* and  *MSC* DNA methylation in endoscopic biopsies. 2017 ACR Annual Meeting, Washington DC


Minorities and the Medically Underserved, Atlanta GA.

Oct 2015 Blanca L. Valle, Elisabetta Kuhn, Teresa Diaz-Montes, Herman, J, David Sidransky, Shih, IM, **Rafael Guerrero-Preston**. Bumphunting analysis identifies HIST1H2BB and MAGI2 as tumor suppressor genes differentially methylated in ovarian cancer. AACR Advances in Ovarian Cancer Research: Exploiting Vulnerabilities, Orlando FL.


April 2015 Blanca L. Valle, Elisabetta Kuhn, David Sidransky, **Rafael Guerrero-Preston**. DNA promoter hypermethylation of genes as potential diagnostic and prognostic biomarkers for ovarian cancer. AACR Annual Meeting, Philadelphia, PA.


Curriculum Vitae Rafael E. Guerrero-Preston
Revised 2/27/19

Oct 2014 Rafael Guerrero-Preston. Tal Hadar, Christina Michailidi, Luigi Marchionni, Curtis Pickering, Mitchell Frederick, Jeffrey Myers, Srinivasan Yegnasubramanian, Elana Fertig, Nishant Agrawal, Maartje G Nordhuis, William Westra, Wayne Koch, Joseph Califano, Victor E. Velculescu, David Sidransky. Key tumor suppressor genes inactivated by promoter methylation and somatic mutations are associated to survival differences in head and neck cancer. 19th World Congress on Advances in Oncology and 17th International Symposium on Molecular Medicine, Athens, Greece

April 2014 Blanca L. Valle, Elisabetta Kuhn, David Sidransky. Rafael Guerrero-Preston. DNA promoter hypermethylation of HIST1H2BB as a diagnostic and prognostic biomarker for ovarian cancer. AACR Annual Meeting, San Diego, CA.


April 2013 Rafael Guerrero-Preston, Anne Jedlicka, Teresa Díaz-Montes, Liliana Florea, Josefina Romaguera, Juan Carlos Roa, David Sidransky. Identification of circulating HPV Trans renal DNA in urine using qPCR and dual sequence-capture approaches. AACR Annual Meeting, Washington, DC.


April 2012 Rafael Guerrero-Preston, Takenori Ogawa, Mamoru Uemura, Rajani Ravi, David Sidransky, Michael Keidar, Barry Trink. Cold plasma selectively affects HNSCC cell lines by non-apoptotic pathways. AACR Annual Meeting, Chicago, IL.

April 2012 Priscilla Brebi-Mieville, Maartje G. Noordhuis, Carmen Ili, Pamela Leal-Rojas, Patricia García, Jimena Perez, Ethan Soudry, Oscar Tapia, Pablo Guzmán, Sergio Muñoz, Leander Van Neste, Wim Van Criekinge, David Sidransky, Juan Carlos Roa, and Rafael Guerrero-Preston. ZNF516 and FKBP6 promoter hypermethylation as companion diagnostic panel for HPV-positive and
inconclusive-Pap women. AACR Annual Meeting, Chicago, IL.


April 2011 Carmen Ili, Priscilla Brebi, Patricia Garcia, Cynthia LeBron, Pamela Leal, Sonia Montenegro, Alejandro Corvalán, **Rafael Guerrero-Preston** and Juan Carlos Roa. c-FLIP knockdown increases apoptosis in cervical cancer cell lines. AACR Annual Meeting, Orlando, FL.

April 2011 Priscilla Brebi, Carmen Ili, Alejandra Sandoval, Pamela Leal, Patricia García, Kathleen Saavedra, Oscar Tapia, Pablo Guzman, Ethan Soudry, Jimena Pérez, David Sidransky, Sergio Muñoz, Rafael Guerrero-Preston and Juan Carlos Roa. Concurrent gene promoter hypermethylation and reduced immunohistochemical expression of potential biomarkers in cervical cancer: A Phase I biomarker development trial. AACR Annual Meeting, Orlando, FL.

April 2010 Priscilla Brebi, Carmen Ili-Gangas, Pamela Leal-Rojas, Patricia García, Kimberly Ostrow, Jimena Perez, **Rafael Guerrero-Preston,** Ethan Soudry, Juan C. Roa and David Sidransky. Identification of epigenomics biomarkers for early detection and progression of cervical carcinogenesis. AACR Annual Meeting, Washington DC.

April 2010 **Rafael Guerrero-Preston,** Ethan Soudry, Carmen Ili-Gangas, Priscilla Brebi-Mieville, Andrew Jaffe, Andrew Jaffe, Chris Barr, Rafael Irizarry, Maria Berdasco, Yumei Fu, Maria Orera, Julio Acero, Adolfo Blanco, Qiang Yang, Adriana Baez, Manel Esteller and David Sidransky. Genome-wide microarray platforms uncover novel hypermethylated genes in an oral squamous cell carcinoma case-control study: A phase I preclinical biomarker development study. AACR Annual Meeting, Washington DC.

Jan 2010 Pamela Leal-Rojas, Priscilla Brebi-Mieville, Carmen Ili, Mariana Brait, Leonel Maldonado, Patricia Garcia, Juan Carlos Roa, David Sidransky and **Rafael Guerrero-Preston.** Global and gene-specific DNA methylation alterations in gall bladder cancer: a proof of principle study. AACR Special Conference on Cancer
Curriculum Vitae Rafael E. Guerrero-Preston
Revised 2/27/19

Epigenetics, San Juan, PR.

Jan 2010 **Rafael Guerrero-Preston**, Kimberly Laskie Ostrow, Miguel Echenique, David Sidransky, Jaime Matta. Molecular Analysis of Serum DNA for the Early Detection of Breast Cancer by Quantitative Methylation Specific PCR. AACR Special Conference on Cancer Epigenetics, San Juan, PR.

Jan 2010 Priscilla Brebi-Mieville, Carmen Ilí-Gangas, Pamela Leal-Rojas, Ethan SoundryY1, Jimena Perez1, Juan Carlos Roa, David Sidransky, **Rafael Guerrero-Preston**. Comparison of three kits for DNA enrichment with the Methylated DNA Immunoprecipitation (MeDIP) method prior to use in genome-wide DNA methylation analysis. AACR Special Conference on Cancer Epigenetics, San Juan, PR.


April 2009 **Rafael Guerrero-Preston**, Maria Berdasco, Adriana Báez, Avirum Spira, Manel Esteller and David Sidransky. High-throughput platform uncovers smoking associated methylation landscapes in the upper airways epithelium. AACR Annual Meeting, Denver, CO.


May 2007 **Guerrero-Preston R.**, Baez A., Blanco A., Berdasco M., Ballestar E., Fraga M., Esteller M. Global DNA Methylation as a Common Early Event in Head and Neck Squamous Cell Carcinogenesis in Cases with Exposures to either Environmental Carcinogens or Viral Agents. AACR Special Conference: Approaches to Complex Pathways in Molecular Epidemiology, Albuquerque, New Mexico


*Invited Seminars (selected)*

Nov 2016 **Rafael Guerrero-Preston**. Microbiome modulation of the tumor associated immune response in HNSCC, Tumor Immunology Forum, MD Anderson Cancer Center, Houston, TX.

Oct 2016 **Rafael Guerrero-Preston**. Microbiome modulation of the tumor associated immune response in HNSCC, Microbiome Forum, Johns Hopkins University,
Baltimore, MD.

Oct 2016  **Rafael Guerrero-Preston.** Precision Medicine Tools for Cancer Prevention and Control, Baltimore City Cancer Control Coalition, Center to Reduce Cancer Health Disparities, Sidney Kimmel Comprehensive Cancer Center, Johns Hopkins School of Medicine.

Sep 2016  **Rafael Guerrero-Preston.** Precision medicine tools for early cancer detection, diagnosis and treatment, Biology Department Seminars, University of Puerto Rico, San Juan, PR

Sep 2016  **Rafael Guerrero-Preston.** Integration of microbiomes and epigenomes in Head and Neck Cancer Research. Department of Otolaryngology – Head and Neck Surgery, University of Arizona School of Medicine, Tucson, Arizona.

Aug 2016  **Rafael Guerrero-Preston.** Brief Introduction to the integration of epigenomes and microbiomes. Puerto Rico IDeA Network Biomedical Research Experience, InterAmerican University of Puerto Rico, Metropolitan Campus, San Juan, Puerto Rico

July 2016  **Rafael Guerrero-Preston.** Microbiome modulation of immunotherapy response in HNSCC. Johns Hopkins Clinical Research Network, Baltimore, MD

July 2016  **Rafael Guerrero-Preston.** Precision Medicine: Environment, exposures and epigenetics. Precision Medicine and Latino/Hispanic Health: Contributions to Reducing Health Disparities. National Heart Blood and Lung Institute, NIH, Bethesda, MD

May 2016 Social, Environmental, Psychosocial and Genomic/Epigenomic Causes of Cancer Disparities and the Promise of Precision Medicine.

May 2016  **Rafael Guerrero-Preston.** Social, Environmental, Psychosocial and Genomic/Epigenomic Causes of Cancer Disparities and the Promise of Precision Medicine. Prince Georges County Community Advisory Group, Center to Reduce Cancer Health Disparities, Sidney Kimmel Comprehensive Cancer Center, Johns Hopkins School of Medicine

Mar 2016  **Rafael Guerrero-Preston.** Precision medicine tools for early cancer detection, diagnosis and treatment. The 16th Annual Fellows and Young Investigators Colloquium, Center for Cancer Research, Office of the Director, National Cancer Institute, Shady Grove, Maryland.

Mar 2016  **Rafael Guerrero-Preston.** Social, Environmental, Psychosocial and Genomic/Epigenomic Causes of Cancer Disparities and the Promise of Precision Medicine. Baltimore Community Advisory Group, Center to Reduce Cancer Health Disparities, Sidney Kimmel Comprehensive Cancer Center, Johns Hopkins School of Medicine

Nov 2015  **Rafael Guerrero-Preston.** Health IT and the Transformation of Health Care Delivery. PR HIT Summit 2015, San Juan, PR

Sep 2015  **Rafael Guerrero-Preston.** Genomic, environmental and cultural dynamics of the cancer methylome in the clinic. International Symposium in Cancer Genomics, Buenos Aires, Argentina

Aug 2015  **Rafael Guerrero-Preston.** Methylation portraits from the front lines: Towards a worldwide network for cancer early detection and diagnosis research in low-income countries. National Cancer Institute, Molecular Course in Cancer Prevention, Bethesda, MD

June 2015  **Rafael Guerrero-Preston.** Bumphunting analysis identifies PAX5 promoter
methylation and p53 somatic mutations in genomic instability pathways linked to 
very poor survival in head and neck cancer. Department of Otolaryngology – Head 
and Neck Surgery, University of Arizona School of Medicine, Tucson, Arizona.

Nov 2014 Rafael Guerrero-Preston. Epigenomics in medicine and public health: from 
basic to translational outcomes. Seminario de Ciencias Básicas Biomédicas, 
Universidad de Antioquia, Medellín, Colombia.

Hopkins Consortium of Health Disparities Centers, Baltimore, MD.

Institute, Molecular Course in Cancer Prevention, Bethesda, MD

Apr 2014 Rafael Guerrero-Preston. Identification of HPV Transrenal DNA using a dual 
sequence-capture approach. First South American Human Papilloma Virus 
meeting, Santiago, Chile

Mar 2014 Rafael Guerrero-Preston. Key tumor suppressor genes inactivated by greater 
promoter methylation and somatic mutations in Head and Neck Cancer. 
Universidad de Los Andes, Santiago, Chile

Mar 2014 Rafael Guerrero-Preston. Genomic and epigenomic biomarkers in tissue and 
urine samples uncover pathway alterations associated to clinical outcomes in oral, 
gastric and cervical cancer. Universidad Peruana Cayetano Heredia, Lima, Perú.

Oct 2013 Rafael Guerrero-Preston. Integrating HNSCC Cancer Genomics and 
Epigenomics for Personalized Medicine and Cancer Prevention and Control, Ponce 
Medical School, Ponce Puerto Rico

Mar 2012 Rafael Guerrero-Preston. ZNF516 promoter hypermethylation as biomarker for 
early detection and prevention of cervical cancer. Elmhurst Hospital, New York 
City Health and Hospitals Corporation, NYC, NY

Jan 2012 Rafael Guerrero-Preston. Translational and Public Health Epigenomics: 
Environmental determinants of epigenomic regulation in cancer, Universidad 
Adolfo Ibáñez, Santiago, Chile

Jan 2012 Rafael Guerrero-Preston. Translational and Public Health Epigenomics: 
Environmental determinants of epigenomic regulation in cancer, Universidad 
Católica, Santiago, Chile

Jan 2012 Rafael Guerrero-Preston. Translational and Public Health Epigenomics: 
Environmental determinants of epigenomic regulation in cancer, CEPON, 
Florianopolis, Brazil.

July 2011 Rafael Guerrero-Preston. Translational and Public Health Epigenomics: 
Environmental determinants of epigenetic regulation in cancer. Universidad 
Cayetano Heredia, Lima, Perú

Fundación Universitaria de Ciencias de La Salud (FUCS), Bogotá, Colombia.

Sept 2010 Rafael Guerrero-Preston. Epigenomic biomarkers of diagnosis and progression 
in cervical cancer. Fundación Universitaria de Ciencias de La Salud (FUCS), 
Bogotá, Colombia.

Sept 2010 Rafael Guerrero-Preston. Trans renal HPV DNA: a non-invasive biomarker for 
cervical cancer screening. Fundación Universitaria de Ciencias de La Salud 
(FUCS), Bogotá, Colombia.

Sept 2010 Rafael Guerrero-Preston. HPV genotype prevalence among cervical cancer 
patients in Chile. Fundación Universitaria de Ciencias de La Salud (FUCS),
Curriculum Vitae Rafael E. Guerrero-Preston
Revised 2/27/19

Bogotá, Colombia.

May 2010 Rafael Guerrero-Preston. Public Health Epigenomics: Environmental
determinants of epigenetic regulation in humans. Oral Presentation, Universidad de
La Frontera, Temuco, Chile.

Jan 2010 Rafael Guerrero-Preston, Cynthia LeBron. Genome-wide discovery and
functional analysis of methylation alterations in cancer research. Universidad de
La Frontera, Temuco, Chile.

Universidad de Concepción, Concepción, Chile

Universidad de La Frontera, Temuco, Chile.

Jan 2009 Rafael Guerrero-Preston. Public Health Epigenomics: Environmental
determinants of epigenetic regulation in humans. Universidad Peruana Cayetano
Heredia, Lima, Perú.

May 2008 Rafael Guerrero-Preston. Public Health Epigenomics: Environmental
determinants of epigenetic regulation in humans. University of Puerto Rico, San
Juan, Puerto Rico.

May 2008 Rafael Guerrero-Preston. Public Health Epigenomics: Environmental
determinants of epigenetic regulation in humans. Ponce School of Medicine,
Ponce, Puerto Rico.

April 2008 Rafael Guerrero-Preston. Public Health Epigenomics: Environmental
determinants of epigenetic regulation in humans. University of Puerto Rico, San
Juan, Puerto Rico.

E. Research Program Building / Leadership

Molecular Disparities and Global Health Equity Program
Founder/Coordinator/ Principal Investigator
and controls”. Ponce Medical School, Ponce, Puerto Rico.
Rico”. University of Puerto Rico School of Medicine.
General Universitario Gregorio Marañón, Madrid, Spain.
Universidad de La Frontera, Temuco, Chile.
1/2009 – Present – “Gastric cancer epigenomics case control study”
Universidad Peruana Cayetano Heredia, Lima, Perú.
Universidad de La Frontera, Temuco, Chile.
Institute of Bioinformatics, Bangalore, India.
10/2012 – Present – “Cervical cancer screening biomarkers”
University of Puerto Rico School of Medicine.
10/2013 – Present - “Cervical cancer screening biomarkers”
Universidad de Antioquia, Medellín, Colombia.
Medical Center, Baltimore Maryland.

F. Research Support

Ongoing:
DOD (Marchionni) 05/01/16-04/30/19
Developing a PTEN-ERG Signature to Improve Molecular Risk Stratification in Prostate Cancer Utilizing a multitude of carefully curated human tumor datasets our studies will clarify the molecular basis for PTEN/ERG interaction in PCa progression and apply a novel technique to model the role of transcriptional network dynamics in this process. In addition to clarifying important questions in PCa biology, this will enable the identification of additional therapeutic targets in the most aggressive subset of tumors.
Role: Co-I

Completed:
5U01CA084986-09 Sidransky (PI) 03/01/08 – 07/31/10
NCI
Supplement to Promote Diversity in Health Related Research under Early Detection Research Network grant
Integrated Development of Novel Molecular Markers
The major goals of this project are aimed at developing early detection markers based on promoter hypermethylation and mitochondrial mutations in lung cancer.
Role: Principal Investigator

1RC2DE20957 Sidransky (PI) 09/24/09 – 08/31/11
NIDCR
Recovery Act Limited Competition: Research and Research Infrastructure “Grand Opportunities” (GO)
The major goal of this project was to identify the combined genetic and epigenetic alterations with clinical impact in HNSCC.
Role: Co-Investigator

EDRN Guerrero-Preston (PI) 09/01/11 – 06/30/14
NCI/UTSW
Trans Renal DNA HPV pilot project
The major goal of this project is to investigate the use of a deep sequencing based molecular platform, HPV transrenal DNA, for the detection of high risk HPV in urine from patients with cervical pre-malignancies.
Role: Principal Investigator

K01CA164092 Guerrero-Preston (PI) 09/22/11 – 08/31/15
NCI
Epigenomic Markers of HNSCC Survival Across Ethnic Groups
The major goals of this project are to study the association between HNSCC survival across ethnic groups and global DNA methylation and promoter hypermethylation.
Role: Principal Investigator

P50DE019032-12 Sidransky (PI) 09/17/10 – 07/31/15
NIDCR
Spore in Head and Neck Cancer: Career Development Core
This project studies novel tumor suppressor genes in HNSCC and their induction of chemoresistance.
Role: Co-Investigator (Career Development)

Clinical Innovator Awards 07/01/12 – 06/30/16
FAMRI (Flight Attendants Medical Research Institute)
Epigenomic Alterations Associated to ETS in Asthma
The major goal of this project is to examine the association of asthma (symptoms and severity of disease) with ETS driven global DNA hypomethylation and promoter hypermethylation in Peripheral Blood Cells.
Role: Principal Investigator

3210000112-16-064 (Dobs) 09/01/15-06/30/18
University of Kentucky Markey Cancer Center – Cancer Center Support Grant - P30CA177558-063S1 (Evers)
Geographical Management of Cancer Health Disparities Program (GMaP)
We propose to increase collaborative regional biospecimen/biobanking collection among racial/ethnically diverse and underrepresented populations for cancer health disparities research.
Role: Co-I

Pending:

SBIR- Fast Track 7/1/18-12/31/20 3 calendar
NCI $183,168
The goal of this project is to demonstrate the feasibility for the commercialization of a molecular triage test to stratify patients for high risk of cervical cancer. Cervical cancer, a largely preventable disease, is one of the most common cancers found in women living in low- and middle-income countries (LMICs). A highly sensitive and specific test that can distinguish which HPV positive women with cervical lesions will progress to cancer, will transform cervical cancer screening practices world-wide.

TEACHING

Advisees

Post-doctoral fellows
Current
Chani Broner, PhD

Prior
Pamela Rojas, PhD
Soledad Reyes Jorquera, MD, MS
Tal Hadar, MD  
Ethan Soudry, MD  
Hayashi Masamichi, MD  
Takenori Owaga, MD  
Maartje Nordhuis, MD, PhD  
Christina Michailidi, PhD  
Cynthia Lebron, PhD  
Rajagowthamee Thangavel, PhD  
Francesca Pirini, PhD  
Blanca Valle, PhD

**Doctoral Students**  
**Current**  
Bianca Rivera, BS  
Barbara Mora Lagos, BS  
Bola Grace Ayandibu, BS

**Prior**  
Priscilla Brebi, PhD  
Carmen Ili Gangas, PhD  
Gustavo Rivera Alvarez, BS

**Master Students**  
**Current**  
Hernando Cadet, MS

**Prior**  
Martha Jahuira Arias, MS  
Fahcina Lawson MS

**Undergraduate/Post-Bac Students**  
**Current**  
Julia Soto

**Prior**  
Jimena Pérez, BS  
José Deschamps, BS  
Christina Engstrom, BS  
Carolina Guerrero-Diaz, BS  
Gabriela Pérez, BS  
Marissa Renehan, BS  
Leah Friess, BS  
Sebastián Rodríguez, BA  
Edgar De Jesus Rodriguez, BS

**ORGANIZATIONAL ACTIVITIES**  
**A. Editorial Activities** – Scientific Journals (2007-Present)
Reviewer: American Journal of Public Health; Cancer Epidemiology, Biomarkers and Prevention; Cancer Prevention Research; Cancer Research; DNA Cell Biology; Cellular and Molecular Life Sciences; Epigenetics; Clinical Epigenetics; Health Affairs; Head and Neck; International Journal of Molecular Sciences; Molecular Cancer; Oncotarget; Scientific Reports; Journal of American Aging Association; Journal of Occupational and Environmental Health; Journal of Urban Health; Molecular Sciences; Oral Oncology; PLoS Medicine; Biomarkers; Cellular and Molecular Neurobiology; Epigenomics; Expert Review of Molecular Diagnostics; Future Oncology; Gene; International Journal of Environmental Research and Public Health; Journal of Translational Medicine; Oncotarget; Scientific Reports; Science; and PLOS ONE.

B. Professional Societies

2005-2010 American Public Health Association
2007- Present American Association of Cancer Research

C. Community Service

2010 - Present Baltimore Community Advisory Group to the Center to Reduce Cancer Health Disparities, Johns Hopkins University Sidney Kimmel Comprehensive Cancer Center. – Member
2010 - Present Center to Eliminate Cardiovascular Disparities, Johns Hopkins University. - Member

D. Conferences

2014 Shifting Portraits: Latinos, Public Health, Inequality - National conference examining the interdisciplinary implications of shifting demographic patterns amongst populations categorized as Hispanic and Latino in the contemporary United States and Baltimore. – Conference Planning Committee

HONORS AND AWARDS

2016-17 Affymetrix Tumor Profiling Grant
2014 Johns Hopkins University Diversity Recognition Award, Baltimore, MD
2011-13 National Cancer Institute Early Detection Research Network Associate Member Award
2010 Comisión Nacional de Investigación Científica y Tecnológica (Conicyt), Visiting Professor Award, Universidad de La Frontera, Chile.
2009 International Union Against Cancer (UICC) ICRETT Training Workshop Award, Geneva, Switzerland.
2007 AACR Minority Scholar in Cancer Research Award
2007 Presidential Scholarship, University of Puerto Rico, Río Piedras, Puerto Rico
2006 Presidential Scholarship, University of Puerto Rico, Río Piedras, Puerto Rico
2005 Presidential Scholarship, University of Puerto Rico, Río Piedras, Puerto Rico
2001 Presidential Scholarship, University of Puerto Rico, Río Piedras, Puerto Rico
2000-03 Pre-doctoral Research Fellow – National Center for Environmental Research, Environmental Protection Agency, Washington, DC.
1999 Presidential Scholarship, University of Puerto Rico, Río Piedras, Puerto Rico
RECOGNITION/TRAINING

2016  Keynote Speaker - The 16th Annual Fellows and Young Investigators Colloquium, Center for Cancer Research, Office of the Director, National Cancer Institute

2015/16  Advanced Health Disparities Training Program, University of Arizona - NHLBI PRIDE Program

2015  Regional DC I-Corps, National Science Foundation

2015  Johns Hopkins Junior Faculty Leadership Program, Baltimore MD

2014  American Association of Medical Colleges Minority Faculty Career Development Seminar, Vancouver, Canada

2014  American Association of Medical Colleges Minority Faculty Career Development Seminar Writers Coaching Group, Vancouver, Canada

2014  Johns Hopkins Boot camp for BioMedical Entrepreneurs, Johns Hopkins University, Baltimore, MD

2013  Intermediate R/Bioconductor for Sequence Analysis, Seattle, WA

2008  Roche/Nimblegen Microarray Technical Training, Indianapolis, Indiana

2008  NIEHS SNP’s Workshop Center for Genetics/Molecular Medicine, Louisville, Kentucky

2007  MALDI-TOF Training, Johns Hopkins Proteomics Core, Baltimore, Maryland

2007  Pathobiology of Cancer: The AACR Edward A. Smacker Memorial Workshop, Aspen, CO

2007  UC Davis Environmental Health Entrepreneurship Academy, Incline Village, NV

2007  Cancer Stem Cells as Targets for Cancer Prevention/Early Detection, National Cancer Institute Bethesda, MD

2006  Cancer Epigenetics Laboratory Internship, Manel Esteller Laboratory, Centro Nacional de Investigaciones Oncológicas (CNIO), Madrid, Spain

2005  Summer Course in Cancer Prevention, National Cancer Institute, Rockville, MD

WEBSITES

Laboratory

1) Lab TV - Rafael Guerrero's Cancer Research Lab: Part 1 – Introduction

2) Lab TV - Rafael Guerrero's Cancer Research Lab: Part 2 – Identity

3) Lab TV - Rafael Guerrero's Cancer Research Lab: Part 3 – HPV Project
Gary T Hunt  
Biographical Sketch  

Mr. Gary Hunt is a Vice-President and Principal Scientist within TRC’s National Air Measurements Practice in their Lowell, MA office. He works principally in the environmental sector and, in particular, the characterization, quantification and control of toxic pollutant emissions from a variety of industrial sources, as well as their transport, fate and measurement in the environment.

Gary is a career environmental consultant for both industry and government and a life-long environmentalist. He has over 40 years of experience in the environmental services industry. He has a BS in Chemistry from Villanova University and an MS in Environmental Sciences from Rutgers University. Some areas of specialization include monitoring of stationary source emissions, ambient air monitoring, environmental chemistry, litigation support, air compliance audits and the distribution, occurrences, transport and fate of Persistent Organic Pollutants (POPs) in the environment. (e.g. Dioxins and PCBs).

Mr. Hunt is a Qualified Environmental Professional (QEP) and Fellow Member of the Air & Waste Management Association. He is also a member of the American Chemical Society (Environmental Chemistry Division), Sigma XI, and the American Society of Mechanical Engineers. Mr. Hunt has authored more than 100 journal manuscripts and symposia presentations on environmental topics.