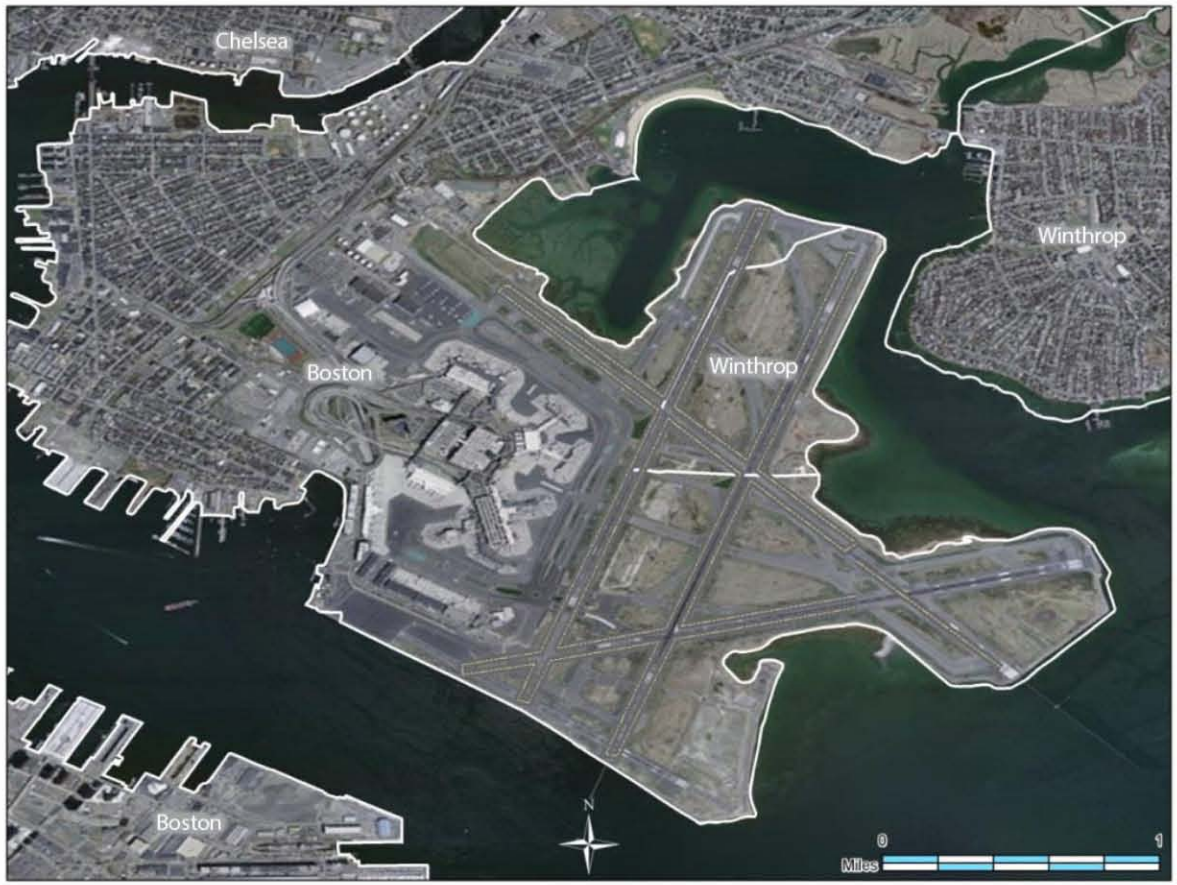
LOGAN AIRPORT HEALTH STUDY



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Bureau of Environmental Health

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Outline

I. Background of the Logan Airport Health Study
II. Study Design/Methods/Peer Review
III. Health Outcomes Assessment
IV. Data Analysis Methods
V. Exposure Assessment
VI. Results
VII. Conclusions and Recommendations
VIII. Questions

I. Legislative Directive

Chapter 159 of The Acts of 2000 of the Massachusetts General Court included a line item directive that stated "the Director of the Bureau of Environmental Health Assessment [presently named the Bureau of Environmental Health] of the department shall conduct an environmental risk assessment of the health impacts of the General Lawrence Logan Airport in the East Boston section of the city of Boston on any community that is located within a 5 mile radius of the airport and is potentially impacted by the airport…that the assessment may include, but not be limited to, examining incidences of respiratory diseases and cancers and performing medical and laboratory tests and examinations of residents of these communities…"

II. Study Design/Methods

The Logan Airport Health Study (LAHS) was a cross-sectional disease prevalence study aimed at determining if the prevalence of targeted health outcomes were higher among residents living closer to the airport

Peer Review

Peer Reviewers:

- Dr. Thomas Burke, Associate Dean for Public Health Practice and Training, Johns Hopkins Bloomberg School of Public Health;
- Dr. Thomas Mason, Professor, College of Public Health, Department of Environmental and Occupational Health, University of South Florida; and
- Dr. Philip Hopke, Bayard D. Clarkson Distinguished Professor, and Director of the Center for Air Resources Engineering and Science, at Clarkson University

III. Health Outcome Assessment

- Piloted survey instrument
- Random Digit Dial (RDD) telephone health survey
  - 6,072 eligible adults; 2,215 children
  - Oversampling of areas closest to Logan Airport
- Respiratory disease, cardiovascular disease, and auditory outcomes
- Information on risk factors
  - Age, sex, race/ethnicity, income, education, health behaviors, CVD risk factors, occupational exposures
- Residential history

Health Outcomes Evaluated In Adults

Respiratory Outcomes

- Lifetime, current and probable asthma
- Chronic Obstructive Pulmonary Disease (COPD)

Cardiovascular Outcomes

- Myocardial Infarction
- Coronary Heart Disease (CHD)

Auditory Outcomes

- Hearing Impairment
- Severe hearing loss
- Tinnitus

Health Outcomes Evaluated in Children

Respiratory Outcomes

- Lifetime, current and probable asthma

Auditory Outcomes

- Hearing impairment

Risk Factors Considered In Adults

ADULTS

- Age, Sex, Race, Ethnicity
- Household Income (PIR)
- Education
- Smoking Status, Household Indoor Smoking
- Body Mass Index (BMI)
- Alcohol Intake, Binge Drinking
- Gastroesophageal reflux disease (GERD)
- Diabetes
- Hypertension
- High Cholesterol
- Family History Of Heart Disease
- Background Air Pollution Exposure
- Use Of Chemicals In The Home

Risk Factors Considered In Adults

CHILDREN

- Age, Sex
- Household Income (PIR)
- Maternal Education
- Household Indoor Smoking
- Household NO_2 Sources
- Household Allergens
- Household Mold
- Background Air Pollution Exposure

IV. Data Analysis Methods

- Descriptive statistics of the population
  - Produced crude prevalence estimates by exposure category
  - Explored associations between other risk factors and outcomes
- Trend tests were also conducted for any observed associations
- All statistics performed using SUDAAN – a statistical software package

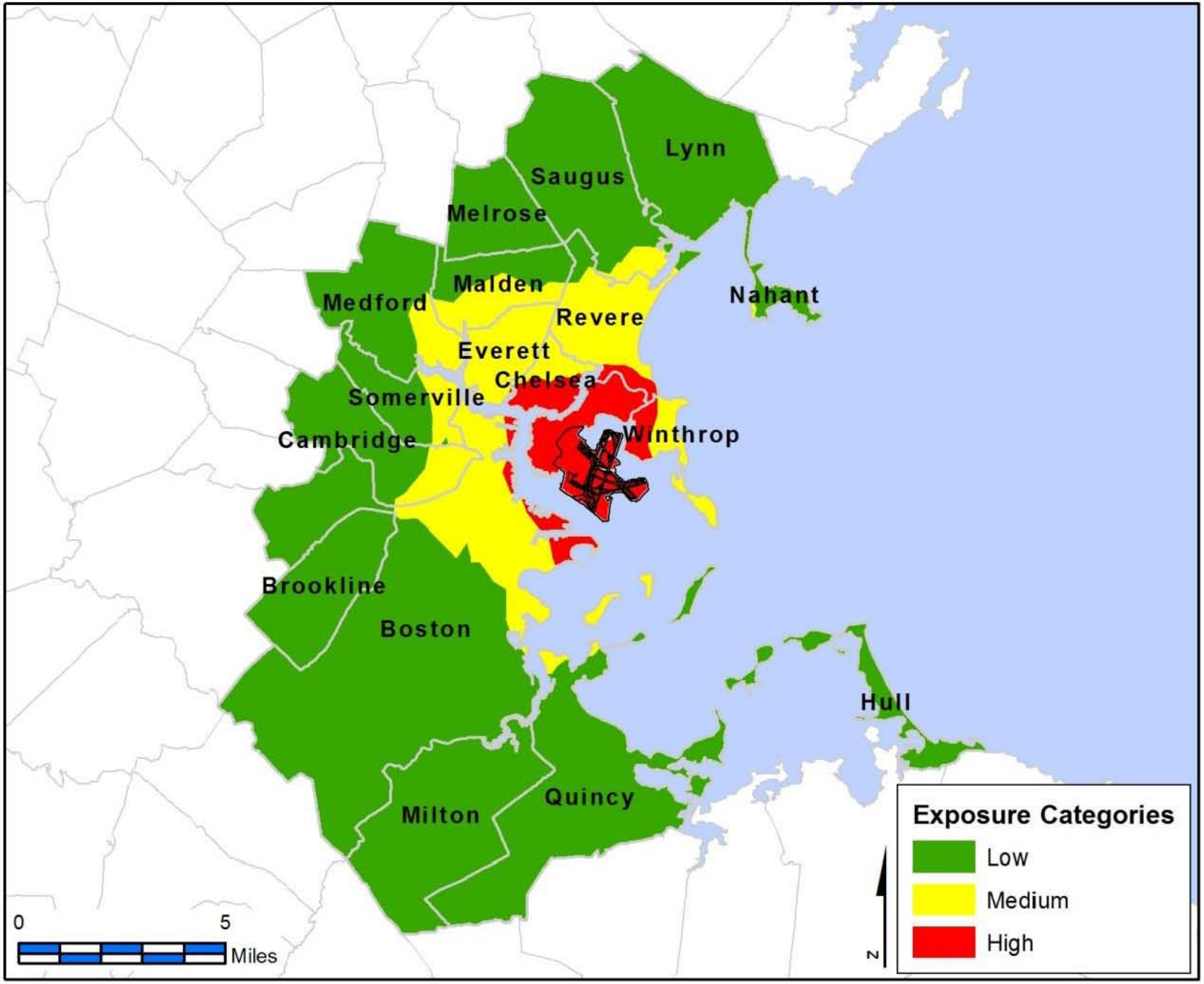
V. Exposure Assessment

- Air dispersion modeling was performed using US FAA's Emissions and Dispersion Modeling System (EDMS including AERMOD) to quantify the ambient air pollution concentrations in the study area and improve exposure classification of the participants in the health survey
- Massport provided 2005 emissions inventory data and daily flight operations for Logan Airport (kg/year)

Source Category	CO	NOx	$PM_{2.5}$	SO_x	VOC
Aircraft	1149808	1193034	21368	111641	434959
Ground Service Equipment	2262228	254757	7425	20161	79166
Auxiliary Power Units	48849	22971	4443	3933	3267
Parking Facilities	545896	74347	1137	N/A	111635
Roadways	378889	85137	2596	N/A	37526
Stationary Sources	11382	74169	11626	115507	663
Training Fires	1371	22	375	2	216
Grand Total	4398423	1704437	48970	251244	667432

Exposure Classification

- Modeling results predicted air concentrations of 5 pollutants (CO, NOx, PM2.5, SOx, and VOCs) from airport operations across the study area.
- Exposure maps were developed using ESRI ArcGIS Spatial Analyst
- Analysis showed a similar location of highest annual, daily, and 1-hour peak concentrations for all pollutants in the high exposure area.
- Annual average concentrations for each pollutant were similar and used to map exposure categories.
- Three exposure categories were assigned:
  - Low category: ≤ 50th percentile
  - Medium category: > 50th – 80th percentile
  - High category: > 80th percentile


Lynn
Saugus
Melrose
Malden
Medford
Revere
Nahant
Everett
Chelsea
Somerville
Winthrop
Cambridge
Brookline
Boston
Hull
Milton
Quincy
0
5
Miles
N
Exposure Categories
Low
Medium
High

Estimating "Background" For Air Pollution Not Related to Logan Airport

- To account for background air pollution exposure not related to Logan Airport, two measures of background air pollution exposure were developed:

1. **Each household was assigned a derived background annual average $PM_{2.5}$ concentration**
   - Each household was assigned an annual average $PM_{2.5}$ concentration based on measurements from the ambient air monitoring station nearest their home. The household values were adjusted by subtracting the predicted airport-related contributions of $PM_{2.5}$ from AERMOD predictions.

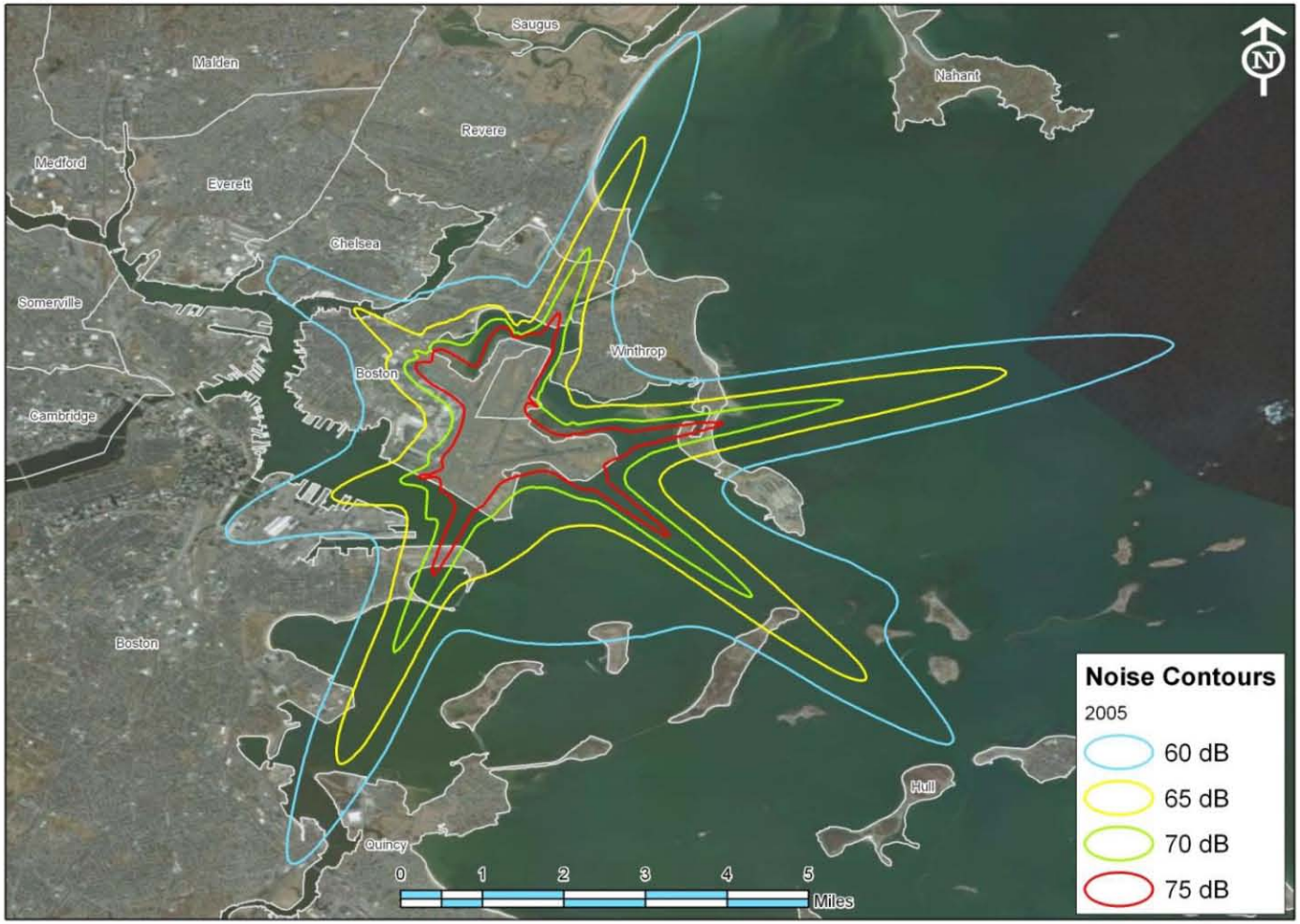
2. **Near-roadway exposures**
   - Households were categorized based on their proximity (200 meters) to major roadways (average daily traffic of 20,000 vehicles)

Exposure to Airport-Related Noise

- Modeled noise contours
  - Contour maps from Massport based on US FAA's Integrated Noise Model (INM)
- Exposure categories chosen using US EPA and the World Health Organization (WHO) health-based guideline to protect against noise-induced hearing loss
  - Cumulative noise exposure over a 24-hour period of less than or equal to 70 dB
- Exposure Categories for Airport-Related Noise
  - Low category ≤ 59 dB
  - Medium category 60-64 dB
  - High category ≥ 65 dB

Logan Noise Contours 2005

Logan Airport Noise Contours, 2005



VI. Results

- Airport-related pollutant concentrations were estimated to be highest near the perimeter of Logan Airport and to fall off rapidly with increased distance
- Air pollution concentrations were low relative to background

Results

- The odds ratio (OR) represents the odds of an outcome given a particular exposure compared to the odds of the outcome in the absence of exposure
  - OR =1 Exposure does not affect odds of outcome
  - OR >1 Exposure associated with higher odds of outcome
  - OR <1 Exposure associated with lower odds of outcome

- The *p*-value is a statistical measure to determine if the findings may be attributed to chance
  - A *p*-value $\leq$ 0.05 indicates that the results are statistically significant

Respiratory Outcomes in Adults

The study did not find statistically significant differences in current asthma or probable asthma in the high vs. the low exposure areas after controlling for risk factors

Health Outcome	Odds Ratio	95% CI	p value
Current Asthma			
Low	1.0	1.0 – 1.0	
Medium	1.0	0.8 – 1.3	0.93
High	1.2	0.8 – 1.8	0.43
Probable Asthma			
Low	1.0	1.0 – 1.0	
Medium	0.8	0.5 – 1.2	0.31
High	1.1	0.6 – 1.9	0.77

Respiratory Outcomes in Adults

COPD among adults who have resided in their respective exposure area for 3 or more years was statistically significantly elevated in the high exposure area compared to the low exposure area

Health Outcome	Odds Ratio	95% CI	p value
COPD			
Low	1.0	1.0 – 1.0	
Medium	1.6	1.1 – 2.3	*0.01*
High	1.8	1.1 – 3.0	*0.02*

Respiratory Outcomes in Children

The study found statistically significant differences in probable asthma in children between the high vs. the low exposure areas after controlling for risk factors

Health Outcome	Odds Ratio	95% CI	p value
Current Asthma			
Low	1.0	1.0 – 1.0	
Medium	1.0	0.7 – 1.6	0.90
High	1.2	0.7 – 2.3	0.52
Probable Asthma			
Low	1.0	1.0 – 1.0	
Medium	1.3	0.5 – 3.0	0.58
High	3.6	1.1 – 11.0	*0.03*

Cardiovascular Outcomes in Adults

The study did not find statistically significant differences in cardiovascular outcomes between the high vs. the low exposure areas

Health Outcome	Odds Ratio	95% CI	p value
Coronary Heart Disease			
Lower	1.0	1.0 – 1.0	
Medium	0.7	0.4 – 1.2	0.22
Higher	1.1	0.4 – 3.1	0.86
Myocardial Infarction			
Low	1.0	1.0 – 1.0	
Medium	1.0	0.7 – 1.6	0.89
High	0.8	0.4 – 1.7	0.62

Auditory Outcomes in Adults

The study did not find differences in auditory outcomes between the high vs. the low exposure areas

Health Outcome	Odds Ratio	95% CI	p value
Hearing Impairment			
Low	1.0	1.0 – 1.0	
Medium	0.6	0.4 – 1.0	0.07
High	0.9	0.3 – 2.5	0.80
Hearing Impairment and Uses Hearing Aid			
Low	1.0	1.0 – 1.0	
Medium	0.6	0.2 – 1.7	0.32
High	1.9	0.2 – 15	0.54
Tinnitus			
Low	1.0	1.0 – 1.0	
Medium	0.8	0.5 – 1.5	0.53
High	0.5	0.1 – 2.1	0.35

Auditory Outcomes in Children

There were no significant differences in hearing impairment between the high vs. the low exposure areas

Health Outcome	Odds Ratio	95% CI	p value
Hearing Impairment			
Low	1.0	1.0 – 1.0	
Medium	0.7	0.3 – 2.0	0.53
High	1.7	0.4 – 7.5	0.50

Conclusions

- After controlling for other risk factors, some respiratory outcomes were found to be statistically significantly higher in the high vs. the low exposure areas
  - Adults
    - COPD was statistically significantly elevated when length of residence was restricted to 3 or more years
  - Children
    - Probable asthma in children was statistically significantly elevated in the high vs. the low exposure areas

Conclusions

- No associations were observed between air pollution exposure areas and cardiovascular outcomes

- No associations were observed between auditory effects (i.e., hearing loss and tinnitus) and exposure areas in adults or children

Recommendations

- The results of this study should be reviewed by Massport and others to determine mitigating steps that can be taken across the study area.

- Massport has undertaken initiatives to reduce air pollution impacts within their control (e.g., providing infrastructure for compressed natural gas (CNG) fuels and electricity charging stations, Alternative Fuel Vehicle Program). Similar initiatives could be considered in consultation with local communities that would serve to further reduce the burden of indoor and outdoor sources of air pollution on residents in closest proximity to the airport.

Recommendations

- Massport has also been working with the East Boston Neighborhood Health Center (EBNHC) to address workforce issues among Massport employees. Massport could expand these efforts with the EBNHC as well as other community health centers to better address respiratory health notably among children in closest proximity to the airport.

- While air dispersion modeling indicates that the contribution from Logan Airport operations across the study area is relatively small, air pollution levels are higher in urban areas. Predicted pollutant concentrations were higher near the perimeter of the airport; thus, any methods that can be implemented to continue to reduce airport-related air pollution should be explored.

Recommendations

- Department of Public Health/Bureau of Environmental Health (DPH/BEH) should work with communities within the high exposure area (in whole or in part) on initiatives that would serve to further reduce exacerbation of pre-existing respiratory diseases (e.g., asthma and COPD) among residents.

- DPH/BEH will continue to support MassDEP's efforts to reduce motor vehicle emissions including expansion of the Low Emissions Vehicle program and diesel engine retrofit initiatives;

- Upon request DPH/BEH's Indoor Air Quality (IAQ) Program staff will work with local municipalities to conduct IAQ assessments in schools and public buildings;

Recommendations

- Upon request DPH will work with local officials to address concerns that may be associated with local development initiatives;

- DPH/BEH will collaborate with the DPH Bureau of Community Health and Prevention's Tobacco Cessation and Prevention Program on their efforts to work with local boards of health and tobacco-free community partnerships. These efforts enforce youth access and secondhand smoking laws and provide educational/outreach resources to support smoke-free workplace and housing programs.

Recommendations

- DPH/BEH will continue to work with state regulatory agencies to review annual filings by Massport (i.e., Logan Airport Environmental Data Report and Environmental Status and Planning Report).

- DPH/BEH will continue to monitor pediatric asthma through its existing pediatric asthma surveillance system.

Questions