Project 003 Cardiovascular Disease and Aircraft Noise Exposure

Boston University

Project Lead Investigator

Junenette Peters
Assistant Professor
Department of Environmental Health
Boston University School of Public Health
715 Albany St., T4W, Boston, MA 02118
617-638-4679
petersj@bu.edu

University Participants

Boston University

- P.I.(s): Junenette Peters
- FAA Award Number: 13-C-AJFE-BU-002;
- Period of Performance: September 1, 2014 to August 31, 2015
- Task(s):
  1. Determine airports and time points for which noise exposure could be estimated.
  2. Develop noise surfaces for multiple years and airports using Integrated Noise Model (INM) modeling and other available information based on Task 1.
  3. Develop quantitative estimates of historical noise exposures for time periods when INM modeling data are not available.
  4. Assign aircraft noise exposures over time to geocoded participant addresses.
  5. Link to existing roadway proximity / density exposure measures by geocoded participant addresses.
  6. Link to air pollution measures by geocoded participant addresses.
  7. Link to participant individual data.
  8. Explore the ARIC cohort for combined or sensitivity analysis on noise and CVD.

Project Funding Level

Total Funding $200,000
Matching: $66,667
Source of Matching: Non-federal donor to the Women's Health Initiative (WHI) cohort

Investigation Team

Junenette Peters, PI, Boston University
Dr. Peters is responsible for directing all aspects of the proposed study, including study coordination, design and analysis plans, and organizing co-investigator meetings.
Jonathan Levy, Boston University
Dr. Levy will participate in the noise exposure assessment effort and provide expertise in the area of predictive modeling and air pollution.
Eric Whitsel, University of North Carolina
Dr. Whitsel's team will assign aircraft noise exposures to geocoded WHI cohorts' participant address coordinates. Dr. Whitsel will also provide expertise related to cardiovascular outcomes and the WHI. Eric is our WHI sponsor, which is required for obtaining WHI approval to conduct an ancillary study.
Gregory Wellenius, Brown University
Dr. Wellenius will assist with documentation of data from the Women's Health Initiative (WHI) based on previous experience working on air pollution and cardiovascular disease research in the cohorts.

Project Overview

Aircraft noise is a considerable source of stress among near-airport communities. Exposure has been associated with sleep disturbance, physiological responses and psychological reactions, with corresponding effects on blood pressure. However, the extent to which aircraft noise increases the risk of cardiovascular disease (CVD) has not been fully elucidated. Likewise, the role of CVD risk factors in mediating an association between noise and CVD has not been assessed. Additionally, exposure assessment that includes time-varying and spatially resolved noise exposures has not been systematically incorporated into previous epidemiological studies. This study proposes to evaluate the effects of aircraft noise exposure on CVD in the longitudinal Women's Health Initiative (WHI) study cohorts, in which over 160,000 women were recruited from 1993 to 1998 from 40 clinics in 24 states.

Task 1. Determine airports and time points for which noise exposure needs to be estimated for the WHI cohort.

Objective

The objective of this task is to strategize on the airports and time points to best estimate noise exposure for participants in the WHI cohorts.

Research Approach

Our goal is to develop aircraft noise estimates for participants for multiple years in the study. With noise estimates across multiple years, we will be able to examine the time periods of exposure that are more or less associated with health outcomes.

One of the challenges is that it will be beyond the scope of this effort to model noise exposures from every airport at every point in time from 1993-2012. Using data as shown in Figure 1 below, we will determine the subset of airports and dates that would yield the most participants, and we will develop a modeling strategy that allows us to capture as much of the cohort as possible given a limited number of INM runs.

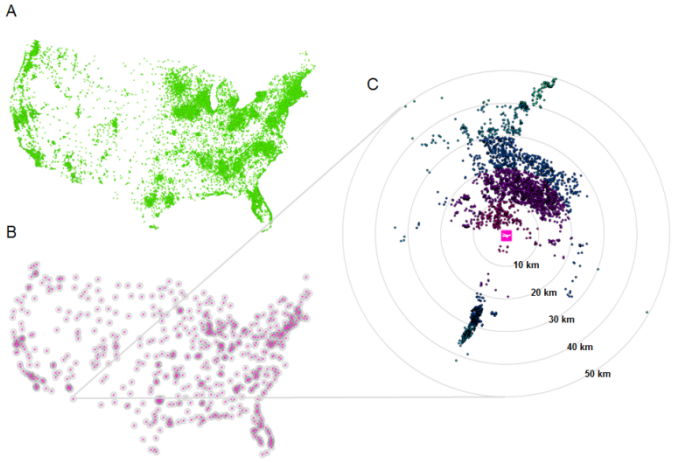

Figure 4. Maps of (A) participants, (B) airports / buffers; and (C) participants in the 10-50 km buffers surrounding e.g. Tucson International Airport

Table. Number of Unique Participants, Participants*Airports, and Participants*Airports* Addresses in Airport-Centric Buffers of Varying Radius: WHI CT & OS, 1993-2012

Radius	Participants	Participants*Airports	Participants*Airports*Addresses
10 km	65,690	84,542	128,962
20 km	127,947	324,619	399,006
30 km	144,272	608,349	664,720
40 km	150,520	869,677	911,882
50 km	153,899	1,121,883	1,156,017

WHI CT & OS = Women's Health Initiative clinical trials and observational study (n=161,808 at baseline).
Addresses = geocoded participant addresses.

Milestone

- A list of airports and years for which noise will be estimated.

Major Accomplishments

We have worked with FAA to decide on INM model runs for 2000 to 2012. Models will be run for 94 U.S. airports.

Publications

None

Outreach Efforts

None

Awards

None

Student Involvement

None

Plans for Next Period

None. Task Completed.

Task 2. Develop noise surfaces for multiple years and airports using Integrated Noise Model (INM) modeling and other available information based on Task 1.

Objective
The objective of this task is to obtain noise surfaces from INM for multiple years and airports.

Research Approach
Noise surfaces will be developed in conjunction with the Federal Aviation Administration (FAA), using INM version 7.0a.[1] As done for past research, INM models will be run where possible on a continuous scale with high spatial resolution and estimate noise exposure out to a minimum of 45 dB. This will allow us to assign a continuum of exposures to the cohort, with those not living proximate to airports being considered unexposed.

Milestone(s)
- Noise surfaces from INM models for airports and times determined in Task 1.

Major Accomplishments
Volpe has contracted with Wyle to provide noise surfaces for airports and years outlined in Task 1.

Publications
None

Outreach Efforts
None

Awards
None

Student Involvement
None

Plans for Next Period
Obtain noise surfaces from Wyle.

Task 3. Develop quantitative estimates of historical noise exposures for time periods when INM modeling data are not available.

Objective
The objective of this task is to interpolate noise estimates for years when INM modeling is not available.

Research Approach
INM modeling may not be available for the baseline (recruitment) period (1993 to 1998). The original WHI study collected the most comprehensive data on the participants during this baseline period and the baseline period is important in determining the prospective risk of CVD associated with aircraft noise. In addition, INM modelling may not be available for all airports even at later time points, and it is not likely that any airport will have directly modeled noise levels for each of the 20+ years of interest. We will therefore need to use different noise-related inputs to estimate noise exposure for these airports and years, anchoring any noise estimates on well-validated approaches and available noise data. We will use information for airports/time-periods for which INM modelling, contour data and radar data are available as well as airport-specific contextual data to assess differences in noise estimates based on the type of data available. We will use this assessment to develop airport-specific time trend prediction models to best estimate historical exposures across all relevant airports and time periods. In general, our approach will closely parallel exposure reconstruction exercises conducted in other cohort studies (e.g., diesel epidemiology), in which extensive data for a recent year are joined with

more limited data available for all years of the study, using available data at discrete time points and locations for validation and calibration.[2-7]

Milestone

- Estimates of noise exposure for those years without INM modeling.

Major Accomplishments

The data from 2009 is being explored to get ideas of how to develop a predictive model for years with no INM modelling data.

Publications

None

Outreach Efforts

None

Awards

None

Student Involvement

Doctoral Student involved in using 2009 data to explore historical modeling in years without INM data.

Plans for Next Period

Continue the process of historical modeling/interpolation once data is obtained for additional years.

Task 4. Assign aircraft noise exposures over time to geocoded participant addresses.

Objective

To intersect geocoded addresses available from 1993 to 2012 with noise surfaces obtained in Tasks 2 and 3.

Research Approach

Dr. Whitsel at UNC will intersect geocoded addresses available from 1993 to 2012 with noise surfaces, which will be developed by spatially interpolating between point estimates from INM or predictive models following standard procedures developed by the Physical and Built Environment Scientific Interest Group (SIG) to safeguard confidentiality. Given the longitudinal nature of this study, noise exposures will be assigned reflecting specific residential addresses over time based on participant address histories.

Milestone

- Assign noise exposure to WHI participants over time.

Major Accomplishments

None

Publications

None

Outreach Efforts

None

Awards
None

Student Involvement
None

Plans for Next Period
Use noise estimates obtained in Tasks 2 and 3 to assign noise exposure to participants.

Task 5. Link to existing roadway proximity / density exposure measures by geocoded participant addresses.

Objectives
The objective of this task is link with roadway proximity/density measures for geocoded participant addresses.

Research Approach
We will link to roadway proximity / density measures previously developed for the WHI, which have been estimated for primary highways (A1), primary roads (A2), and secondary and connecting roads (A3) at geocoded addresses of the WHI CT and OS participants, 1993-2012. The estimates are expressed as distances to the nearest roadway of a given type and summed roadway lengths of a given type, each within geocoded participant address-centric buffers of 100-500 meters. This road proximity exposure estimate is considered a surrogate for traffic noise and traffic-related air pollution.

Milestone(s)
- Linked road proximity exposure estimates.

Major Accomplishments
None

Publications
None

Outreach Efforts
None

Awards
None

Student Involvement
None

Plans for Next Period
To link road proximity exposure estimates to dataset of aircraft noise exposure assignments.

Task 6. Link to air pollution measures by geocoded participant addresses.

Objective
To link air pollution exposure data for geocoded participant addresses.

Research Approach

Data will also be linked to air pollution exposure data from the ongoing ancillary study with WHI headed by Dr. Wellenius.

Milestone(s)
- Dataset with linked air pollution exposure data.

Major Accomplishments
None

Publications
None

Outreach Efforts
None

Awards
None

Student Involvement
None

Plans for Next Period
Link air pollution exposure data to dataset of aircraft noise exposure assignments.

Task 7: Link to participant individual data.

Objective
To link to participant individual data.

Research Approach
Exposure estimates will be linked to WHI cohort data. Cohort data will be anticipated to include socio-demographic data (e.g., age, race/ethnicity, education); behavioral (e.g. physical activity/exercise, diet, smoking, alcohol consumption); other (e.g., hearing and hearing loss, sleep disturbance); and clinical (e.g., body mass index; lipids; blood pressures, hypertension; glucose, insulin, diabetes; heart rate and its variability; CVD and CVD mortality).

Milestone
- Dataset with linked participant individual data.

Major Accomplishments
None

Publications
None

Outreach Efforts
None

Awards
None

Student Involvement

None

Plans for Next Period
Link individual participant data to dataset of aircraft noise exposure assignments.

Task 8: Explore the ARIC cohort for combined or sensitivity analysis on noise and CVD.

Objective
The objective of this task is to explore cohorts with both men and women.

Research Approach
We will explore the ARIC cohort for combined analysis with the WHI or to perform sensitivity analysis to determine whether there are significant differences in the exposure-outcome relationship by gender. This task will include determining the number of participants in ARIC surrounding airports.

Milestone(s)
- Knowledge of other cohorts including the ARIC cohort
- Determining the number of participants in the other cohorts surrounding airports

Major Accomplishments
- Team was approached by researchers with the Nurses' Health Study (NHS), which also includes the Health Professional Follow-up Study (HPFS).
- We have had several meeting with these researchers
- We have determined the number of participants of NHS and HPFS surrounding airports.

Publications
None

Outreach Efforts
None

Awards
None

Student Involvement
None

Plans for Next Period
Continue developing the relationship with researchers for the NHS and HPS and strategizing for working with the cohorts.

References
[1]Federal Aviation Administration, Office of Environment and Energy,. Integrated Noise Model (INM) Version 7.0 User's Guide2007: http://www.faa.gov/about/office_org/headquarters_offices/apl/research/models/inm_model/inm7_0c/media/INM_7.0_User_Guide.pdf.
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