

Aviation Health Research: Ongoing Research on Noise and Cardiovascular Outcomes

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Aviation Noise & Emissions Symposium

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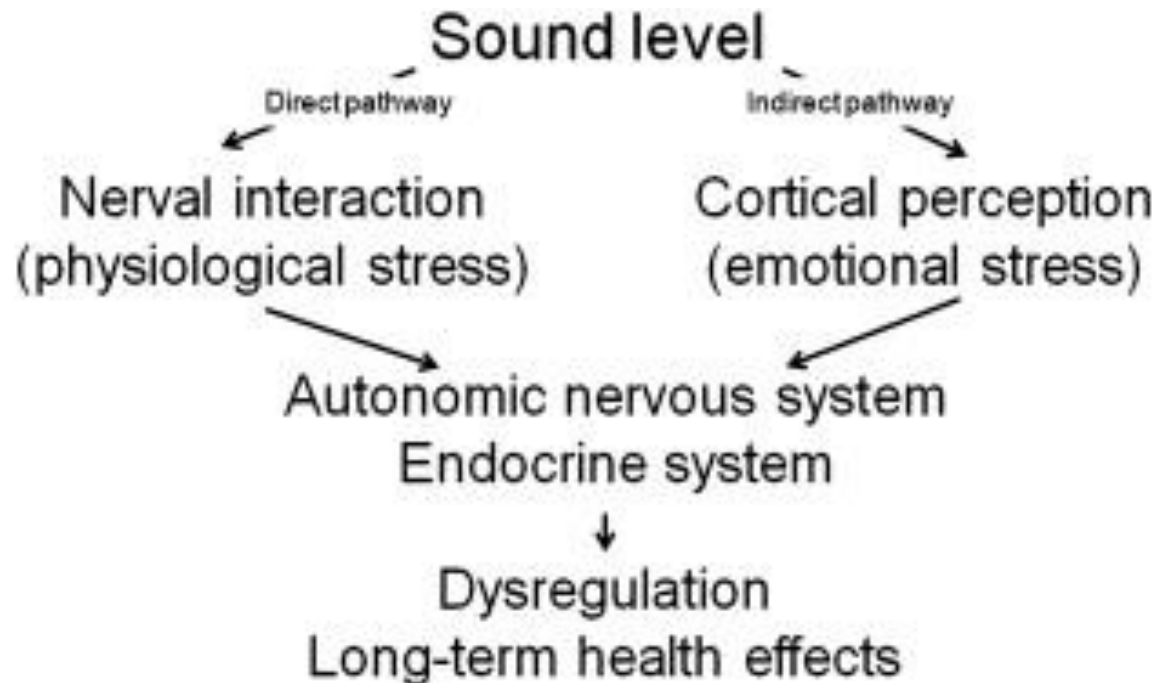
Background

- Noise is a primary community concern with airports particularly in urban areas
 - High aviation demand
 - Strong pressure to develop land around airports
- Exposure
 - Day-night level (DNL) average 65 dB set **based on annoyance not health effects**
 - In 2010, 309,000 exposed to DNL levels >65 dB (US GAO, 2012)
 - 1.5 million people exposed to DNL 60-65 dB (US GAO, 2012)
- Trends in aircraft noise – decline
- Trends in noise concerns –
 - Local: continuous and in areas not considered highly exposed
 - International: pressure to reduce noise exposure

Motivation

- Reported associations between noise and hypertension and heart disease
- Reported link between aircraft noise and sleep disturbance, nervousness and annoyance
- Reported relation of aircraft noise to hypertension
- Few studies of relationship between aircraft noise and cardiovascular disease (CVD)
 - Studies surrounding small # of airports typically underpowered
- Studying health effects of aircraft noise important in policy making, but limited studies exist in US

Possible Mechanisms



- 'Direct' pathway - determined by instantaneous interaction of acoustic nerve with structures of the central nervous system (CNS).
- 'Indirect' pathway – determined by cognitive perception of sound, its cortical activation and related emotional response. Noise level and noise annoyance related to CVD.

Previous Research

Correia AW, Peters JL, Levy JI, Melly S, Dominici F. Residential exposure to aircraft noise and hospital admissions for cardiovascular diseases: multi-airport retrospective study. *BMJ*. 2013;347:f5561

Results

- Positive overall association between noise exposure and CVD hospitalizations, which generally persisted after controlling for some key confounders.
- Observed heterogeneity (- and +) across airports
 - ▣ Effects attributed to within-airport and across-zip code variations in noise rather than between-airport variations
- Population attributable fraction of hospitalizations for cardiovascular disease
 - ▣ Aircraft noise 2.3%
 - ▣ Regional fine particulate matter 6.8%
 - ▣ Regional ozone 4.2 %

Limitations

- Lack of individual exposure data on noise – zip-code resolution
 - All individuals within zip-code assigned the same exposure
- Reliance on International Classification of Disease-coded claims
- Limited individual-level data in Medicare cohort
- Limitation related to noise metric (DNL)

Current Research

Study 1: Cardiovascular Disease and Aircraft Noise Exposure (NIEHS)

- Women's Health Initiative



Study 2: Aircraft Noise Exposure and Cardiovascular Disease (FAA)

- Nurses Health Study/Health Professional Follow-up Study



Nurses'
Health Study

HARVARD
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SCHOOL OF PUBLIC HEALTH

HEALTH PROFESSIONALS
FOLLOW-UP STUDY

Noise exposure

- Noise contours for 90 airports in the contiguous US
 - ▣ Modeled using Aviation Environmental Design Tool (AEDT)
 - ▣ At 5-year intervals (1995, 2000, 2005, 2010, 2015)
- Metrics and contour range

Metric	Contour Range
DNL	45 dB – 75 dB
Equivalent level (Leq) Day	45 dB – 75 dB
Leq Night	45 dB – 75 dB
Time above 65 dB and 85 dB	1-30 min

Study 1: Cohort WHI

- Longitudinal study begun in 1993 with follow-up ongoing
- > 161,000 post-menopausal women recruited from 24 states and DC
- Individual data on traditional CVD risk factors
- High geographical resolution – geocoded addresses over time (1993-2012)
- Systematically ascertained, physician-reviewed and adjudicated outcomes
- Information on proximity to major roadways, land use characteristics, air pollution

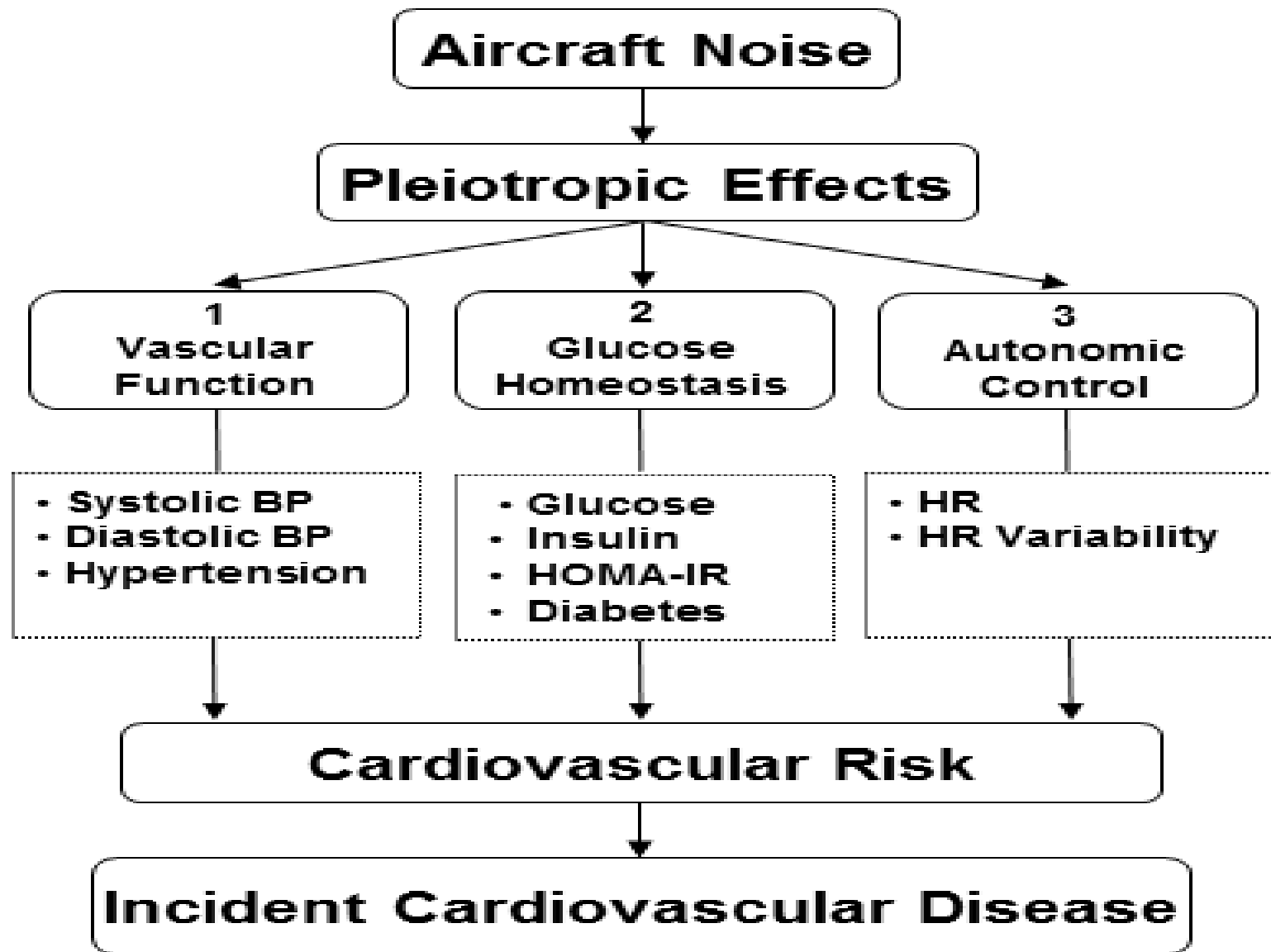


Figure 1. Model for the Mechanism of Action of Aircraft Noise

Study 1: Objectives

- Evaluate the association between aircraft noise and cardiovascular disease.
- Investigate the effects of aircraft noise on CVD risk factors:
 - ▣ Vascular function, glucose homeostasis, and autonomic control
 - ▣ Incident hypertension and diabetes
- Evaluate the aircraft noise – cardiovascular relationship accounting for regional air pollution
- Estimate other environmental noise exposures (e.g. traffic noise) and account for other noise exposures in the aircraft noise – cardiovascular relationships

Study 2: Cohorts NHS/HPFS

- Longitudinal study including females **and** males - nurses and health professionals.

Cohort	Recruited	Area	N	Sex
Original NHS	1976	11 states	121,700	Female
NHS II	1986	14 states	116,000	Female
HPFS	1986	14 states	51,529	Male
NHS III	Current	inc Canada	>40,000	Male & Female

- Individual data on traditional CVD risk factors
- High geographical resolution – geocoded addresses over time (2000-2014)
- Systematically ascertained, physician-reviewed and adjudicated outcomes
- Information on regional air pollution

Study 2: Objectives

- Evaluate the association between aircraft noise and cardiovascular outcomes
 - Cardiovascular disease
 - Hypertension
- Evaluate the aircraft noise – cardiovascular relationship accounting for air pollution
- Evaluate modifying effect of sex on the aircraft noise-cardiovascular relationship
- Collect survey data on participant's physical environment and on noise perception and sleep disturbance

Research Directions

- Determining best outcome measures related to noise
 - ▣ Indicators/biomarkers most appropriate for evaluating biological effects of noise
- Determining noise metrics most relevant to health impacts
- Expanding research efforts in additional cohorts with different biomarkers/populations
- Using modern technology to collect “real time”, personal measures of biological effects of noise

Researchers/Funding

Noise Health (WHI)

- BU
 - Junenette Peters (PI)
 - Jon Levy
 - Matthew Fox
- UNC
 - Eric Whitsel
- Brown
 - Gregory Wellenius
- PSU
 - Michelle Vigeant
 - Victor Sparrow

NIEHS: R01ES025791-01A1

Noise Health (NHS/HPFS)

- BU
 - Junenette Peters (Project PI)
 - Jon Levy (BU PI)
- Harvard/Brigham & Women's
 - Francine Laden
 - Jamie Hart

FAA: 13-C-AJFE-BU-004

[<https://ascent.aero/>]

Noise Health (Medicare)

- Harvard
 - Francine Dominici (Co-PI), Andrew Correia , Steve Melly
- BU
 - Jon Levy (Co-PI), Junenette Peters

FAA: 09-C-NE-HU & 10-C-NE-BU

[<http://partner.mit.edu/>]