ASCENT Project 003

Cardiovascular Disease and Aircraft Noise Exposure

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Cost Share Partner: Donators to Nurses' Health Study

Objective:

To evaluate the relationship between aircraft noise exposure and health including hypertension and sleep disturbance in existing health cohorts (Health Impacts)

Project Benefits:

Addresses gap of limited health and noise studies in the U.S., important for policy models

Overall, contributes to the body of knowledge of potential health impacts of aircraft noise.

Responsive to Section 189 of the 2018 FAA Reauthorization.

Research Approach:

Exposure

Noise contours for 90 airports for 1995-2015 in five-year intervals; metrics day-night noise level (DNL) and nighttime sound level (Lnight)

Cohorts:

Nurses' Health Study (NHS) and NHS II

Study Areas

1. Sociodemographic patterns of noise
2. Associations between noise and hypertension and noise and cardiovascular disease (CVD)
3. Associations between noise and sleep markers

Major Accomplishments (to date):

1. Papers accepted for publication
   a. Sociodemographic patterns of exposure to civil aircraft noise in the United States – Provisional acceptance *EHP*
   b. Long-term aircraft noise exposure and risk of hypertension in the Nurses' Health Studies – Accepted *Environ Res*
2. Presented at international conferences
   a. Associations between nighttime aircraft noise exposure and insufficient sleep in the US-based prospective Nurses' Health Study cohort
   b. Long-term aircraft noise exposure and incident hypertension in national US cohort studies

Future Work / Schedule:

1. Continue analysis on noise and sleep – 12/2021
2. Continue analysis on noise and CVD – 2/2022

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Health Impacts – Project Outline
Project current scheduled end date February 28, 2022

Spring 2021

1 Finalize Phase I CVD Analysis (Ascent 3)

- Analysis of sociodemographic patterning of noise exposures
- Analysis of trends of aircraft noise exposures
- Analysis of aircraft noise (DNL and Lnight) and hypertension

2 Perform CVD Phase II Analysis (Ascent 3)

- Analytical approaches and analysis of relationship of aircraft noise and CVD
- Analytical approaches and analysis of relationship of additional metrics of aircraft noise and health outcomes.

+ 3 Develop Analytical Approach & Sleep Analysis (Section 189)

- Assessment of potential approaches for analysis and appropriateness of sleep quality data.
- Analysis of annual average aircraft noise exposure with general sleep length and quality (NHS).
- Explore analysis of living under flight paths with sleep disturbance (WHISPER).

Winter 2022

Sociodemographic Patterns of Noise

Status:

- Completed analysis on sociodemographic patterns of noise
- Manuscript **provisionally accepted at *Environmental Health Perspectives***; resubmitted response for final acceptance

Highlights:

- Compared exposure of U.S. Census block groups by race/ethnicity, education, and income across three noise groups/thresholds (DNL 45 dB, 55 dB, 65 dB). *
- Block groups with higher Hispanic population and proportion of residents with ≤ high school education had higher odds of noise exposure.

In progress:

- Analysis of trends in noise exposure over time

Noise and Hypertension

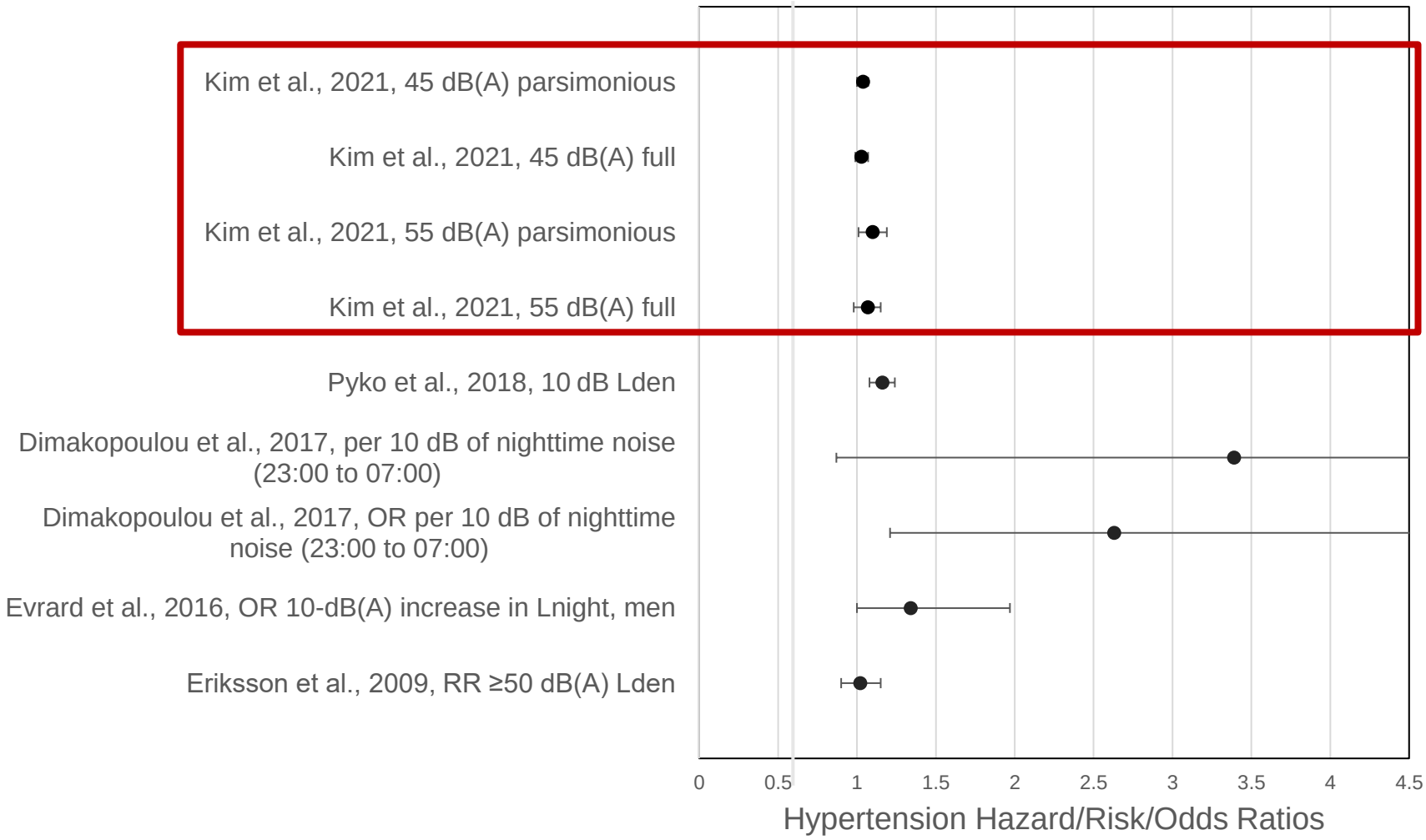
Status:

- Presented at International Commission on Biological Effects of Noise (ICBEN) 2021
- **Accepted in peer-reviewed journal *Environmental Research***

Highlights:

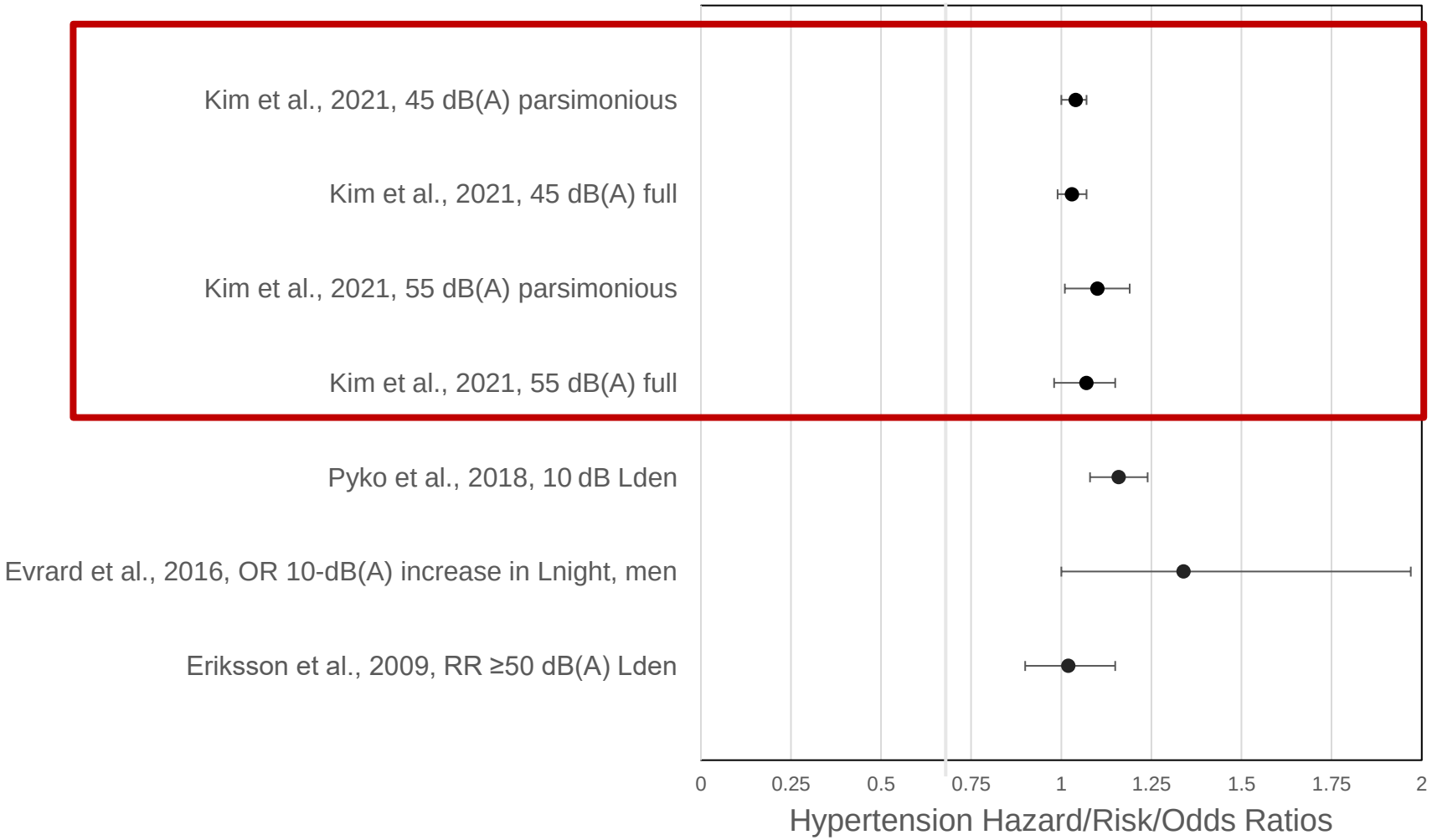
- Examined associations between aircraft noise (DNL) and incident hypertension in NHS and NHS II.
- In combined parsimonious model using a DNL 55 dB cut-point, participants in NHS and NHS II exposed to levels ≥55 dB had a 10% increased risk of hypertension compared to participants exposed to levels <55 dB, with a 95% confidence interval (CI) of 1% to 19%.
- In combined fully-adjusted model participants exposed to ≥55 dB had a 6% increased risk (95% CI: -2%, 15%) compared to the unexposed.
- Relationship between noise and hypertension was not affected by additional control for particulate matter air pollution.

Noise and Hypertension – Comparison with Other Studies



Noise and Hypertension – Comparison with Other Studies

*Without study with very wide confidence intervals (Dimakopoulou et al., 2017)



Noise and Sleep

Status:

- Manuscript in draft on noise and sleep duration and sleep quality
- Presented at the International Society for Environmental Epidemiology (ISEE) Conference

Highlights:

- Investigated associations between nighttime noise and insufficient sleep and poor sleep quality in NHS.
- In multivariable-adjusted longitudinal models those in block groups exposed to nighttime aircraft noise had higher odds of insufficient sleep compared with those not exposed.
- Relationship pronounced in participants living in the west, near cargo airports, and near water-adjacent airports

Next Step:

- Investigate noise and sleep markers in NHS II

Noise and Sleep - Results

Study Population
- Nurses Health Study I participants
- Study period 2000-2014

Exposure
- Annualized daily and nightly averages (DNL and LAeqN)

Outcome
- Sleep insufficiency defined as ≤6 hr/night (repeated measures)
- Poor sleep quality defined as poor sleep ≥ "a good bit of the time" (one-time measure)

Model	Sleep insufficiency	Poor sleep quality
LAeqN ≥45 vs <45 dB(A)	**OR (95% CI)**	**OR (95% CI)**
Model 1: Crude	1.34 (1.17, 1.53)	0.94 (0.72, 1.21)
Model 2: Adjusted	1.27 (1.11, 1.45)	0.91 (0.70, 1.18)
Model 3; Adjusted + ambient environmental	1.23 (1.07, 1.41)	0.91 (0.70, 1.18)

* OR – Odds Ratio; CI – Confidence Interval
Models adjusted for 1) age, 2) add other demographics, behaviors, comorbidities 3) add ambient environmental factors - particulate matter of size equal to or smaller than 2.5 microns ($PM_{2.5}$), greenness (Normalized Difference Vegetation Index, NDVI), light at night (LAN).

Summary

Next Steps

- Continue analyzing noise and cardiovascular disease events and all-cause mortality in NHS and NHSII.
- Continue noise trends and noise and racial and economic segregation

New Project Ideas

- Investigate noise and cardiovascular outcomes with newer (post 2015), more precise noise measures – including number of events
- Investigate noise and cardiometabolic outcomes in a Boston panel study, the NHS 3 (current recruitment) or the Hispanic Community Health Study / Study of Latinos (2008-present)
- Investigate noise and sleep in WHI WHISPER (2017-current)
  https://www.whi.org/page/womens-health-initiative-sleep-hypoxia-effects-on-resilience-whisper
- Investigate noise and dementia outcomes in NHS or WHI
- Study joint effects of noise and air pollution (w/ ASCENT 18).

Publications

- Kim CS, Grady ST, Hart JE, Laden F, VoPham T, Nguyen DD, Manson JE, James P, Forman JP, Rexrode KM, Levy JI, Peters JL. Long-term aircraft noise exposure and risk of hypertension in the Nurses' Health Studies. Environmental Research 2021; *ahead of print.*
- Peters JL, Zevitas CD, Redline S, Hastings A, Sizov N, Hart JE, Levy JI, Roof CJ, Wellenius GA. Aviation noise and cardiovascular health in the United States: a review of the evidence and recommendations for research direction. Current Epidemiology Reports 2018; 5(2):140–152. doi.org/10.1007/s40471-018-0151-2.

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