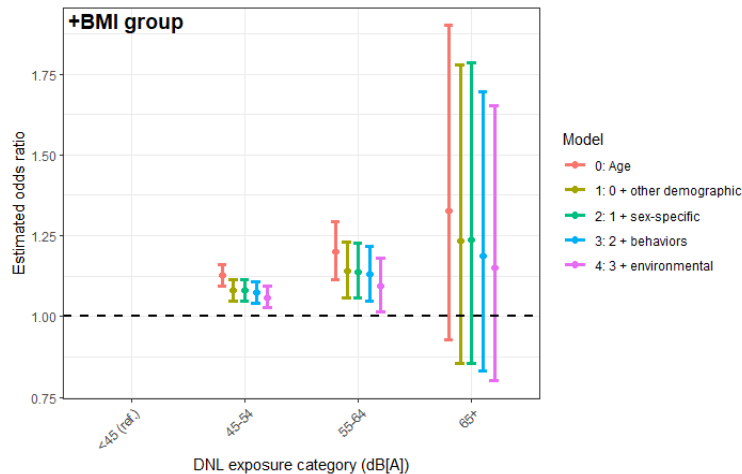




Major Accomplishments

- Developed an analysis plan
- Obtained approval from NHS/HPFS oversight committees
- Produced descriptive statistics of sleep measures and numbers of participants exposed for each measure in NHS
- Determined relevant confounders and effect modifiers
- Performed preliminary analysis of noise in relation to adiposity (results for three ordinal categories of BMI of 18.5–24 [reference], 25–29, and ≥ 30 kg/m² in Figure 3)
- Presented research at the ISEE Conference



0: age; 1: 0 + demographics: region, race, individual socioeconomic status; 2: 1 + sex-specific: parity, menopausal status, hormone therapy; 3: 2+ behaviors: smoking status, alcohol use, diet quality, physical activity; 4: 3 + environmental: neighborhood SES, greenness, environmental noise, light at night.

Figure 3. Odds of increasing BMI groups (reference 18.5–24 kg/m²) relative to increasing exposure group (reference DNL <45 dB); increasing BMI with increasing noise.

Task 6 - Develop a Model for Measuring Changes in Business Activities Attributable to Aircraft Noise Exposure, Prototype a Model City, and Include an Assessment Comparing a Change in the Visibility of Aircraft due to a Change in Aircraft Flight Paths

Massachusetts Institute of Technology

Objective

The long-term goal of Task 6 is to conduct an assessment of the economic impacts of aircraft noise exposure on businesses located underneath flight paths at selected U.S. airports. This goal is achieved through the following objectives:

1. Collect data on noise exposure changes over the past decade (e.g., owing to the introduction of new runways or performance-based navigation (PBN) procedures)
2. Combine noise data with yearly county-level data from the Bureau of Economic Analysis (e.g., GDP and employment), with city-level statistics from the Economic Census (e.g., revenue and employment), and/or with high-resolution business data from business databases
3. Compare economic outcomes while controlling for regional and national economic trends
4. Evaluate whether the spatial resolution of the available data can influence the results

In addition, the MIT team is working to understand how changes in flight paths might have changed aircraft visibility.

Objectives 1-4 were met during previous reporting periods. During the current reporting period, the team worked on the visibility analysis and focused on documenting results in a draft report for policy-makers.

Research Approach

The economic impact of noise exposure changes was studied for Boston Logan Airport and Chicago O’Hare Airport. The methods focused on the difference-in-difference approach, which was applied to identify differences between changes in business trends before and after exogenous noise exposure changes, i.e., the introduction of PBN procedures at Boston Logan Airport and the opening of new runway infrastructure at Chicago O’Hare Airport. Details can be found in previous reports.

During the current reporting period, the team developed a method to gain insights into whether the implementation of PBN procedures at Boston Logan Airport changed the frequency of aircraft sightings on the ground. For this purpose, the MIT team used flight track data from 2010 and 2017 to compare aircraft visibility on peak runway operation days for 33L departures, 27L departures, and 4R arrivals. An aircraft is assumed to be visible if it is above a visibility line of 45° from the ground (Figure 4). Consequently, the team obtains a grid of observation points on the ground, which can subsequently be aggregated to determine the number of aircraft visible that day from each grid location.

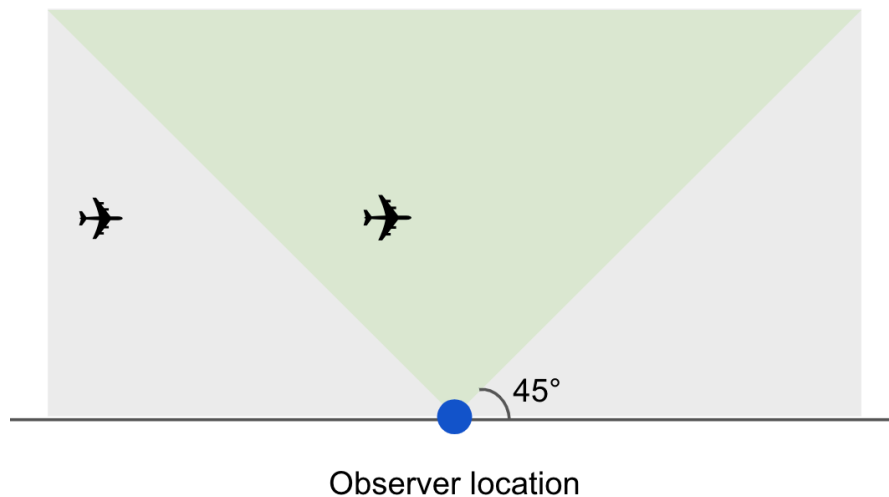


Figure 4. Visibility analysis approach. Aircraft in the green area are assumed to be visible from the observer location (blue dot). In the scenario depicted above, the aircraft on the far left is not visible, whereas the second aircraft in the center is visible.

Milestone

- Perform initial visibility analysis based on Boston Logan Airport

Major Accomplishments

- Perform visibility analysis to incorporate results of the project for policy-makers and the public

Task 7 - Draft a Report on the Study Results for Policy-makers

Boston University, Massachusetts Institute of Technology, Harvard University

Objective

The aim of this task is to develop a report of overall study results in response to Section 189 for policy makers.

Milestone

- Generate an initial first-draft report of overall study results in response to Section 189 for policy-makers

Major Accomplishments

- Drafted report summarizing the overall study results as it relates to Section 189

Publications

Simon, M. C., Hart, J. E., Levy, J. I., VoPham, T., Malwitz, A., Nguyen, D. D., Bozigar, M., Cupples, L. A., James, P., Laden, F., & Peters, J. L. (2022). Sociodemographic patterns of exposure to civil aircraft noise in the United States. *Environmental Health Perspectives*, 130(2). <https://doi.org/10.1289/EHP9307>

Bullock, C. (2021). Aviation effects on local business: Mapping community impact and policy strategies for noise remediation. [S.M. thesis.] Massachusetts Institute of Technology]. <https://hdl.handle.net/1721.1/138966>

Kim, C. S., Grady, S. T., Hart, J. E., Laden, F., VoPham, T., Nguyen, D. D., Manson, J. E., James, P., Forman, J. P., Rexrode, K. M., Levy, J. I., & Peters, J. L. (2021). Long-term aircraft noise exposure and risk of hypertension in the Nurses' Health Studies. *Environmental Research*, 112195. <https://doi.org/10.1016/j.envres.2021.112195>

Outreach Efforts

Presented on current progress orally during the ASCENT Spring Meeting (April 5-7, 2022).

Presented on "Associations Between Aircraft Noise Exposure and Adiposity in the U.S.-based Prospective Nurses' Health Studies" at the International Society for Environmental Epidemiology (ISEE) Conference on September 18-21, 2022.

Presented on "Associations Between Residential Exposure to Aircraft Noise, Cardiovascular Disease, and All-Cause Mortality in the Nurses' Health Studies" at the ISEE Conference on September 18-22, 2022.

Presented on "Long-term Aircraft Noise Exposure and Incident Cardiovascular Disease in National U.S. Cohort Studies" at Inter-Noise 2022 on August 21-24, 2022.

Presented on "Long-Term Aircraft Noise Exposure and Incident Hypertension in National U.S. Cohort Studies" at the 182nd Meeting of the ASA, May 23-27, 2022.

Awards

None

Student Involvement

The dissertation of Chloe Kim (doctoral graduate, BU) included the development and implementation of statistical analyses of noise and hypertension risk. Chloe Kim graduated in the fall of 2019 and is currently working for the Environmental Science, Policy, and Research Institute.

The dissertation of Daniel Nguyen (doctoral graduate, BU) included a characterization of the temporal trends in aviation noise surrounding U.S. airports. Daniel Nguyen graduated in the spring of 2022 and is currently working for the Centers for Disease Control and Prevention.

The dissertation of Stephanie Grady (doctoral candidate, BU) includes the development and running of statistical analyses on noise and cardiovascular event risk. Stephanie also worked with Chloe Kim on noise and hypertension risk.

The thesis of Carson Bullock (master's student, MIT) included conducting economic impact analysis. Carson graduated in the summer of 2021.

The thesis of Zhishen Wang (master's student, MIT) includes the visibility analysis.



Plans for Next Period

(October 1, 2022 to September 30, 2023)

Ongoing analyses, Tasks 1–5

- Complete analyses to estimate the risk of CVD events associated with aircraft noise exposure
- Complete analyses to evaluate the relationship between noise and sleep
- Continue analyses to evaluate the risk of hypertension associated with nighttime aircraft noise exposure
- Continue analyses to evaluate the relationship between noise and measures of adiposity
- Verify, document, and publish results

Related to 2018 FAA Reauthorization, Section 189, Tasks 6 and 7

- Complete aircraft visibility analyses and verify results for inclusion in the Section 189 report
- Document results for policy-makers in iterative drafts and a final report

Related to FAA's Office of Environment and Energy Roadmap

- Start processes related to adding noise to an additional cohort, and explore other health outcomes (e.g., mental health)

References

- Allroggen, F., & Malina, R. (2014). Do the regional growth effects of air transport differ among airports? *Journal of Air Transport Management*, 37, 1–4. <https://doi.org/10.1016/j.jairtraman.2013.11.007>
- Brucekner, J. K. (2003). Airline traffic and urban economic development. *Urban Studies*, 40(8), 1455–1469. <https://doi.org/10.1080/0042098032000094388>
- Campante, F., & Yanagizawa-Drott, D. (2018). Long-range growth: Economic development in the global network of air links. *Quarterly Journal of Economics*, 133(3), 1395–1458. <https://doi.org/10.1093/qje/qjx050>
- Lakshmanan, T. R. (2011). The broader economic consequences of transport infrastructure investments. *Journal of Transport Geography*, 19(1), 1–12. <https://doi.org/10.1016/j.jtrangeo.2010.01.00>

Project Overview References

- Almer, C., Boes, S., & Nuesch, S. (2017). Adjustments in the housing market after an environmental shock: Evidence from a large-scale change in aircraft noise exposure. *Oxford Economic Papers*, 69(4), 918–938.
- Bluhm, G., & Eriksson, C. (2011). Cardiovascular effects of environmental noise: Research in Sweden. *Noise and Health*, 13(52), 212–216. doi: 10.4103/1463-1741.80152
- Bristow, A. L., Wardman, M., & Chintakayala, V. P. K. (2015). International meta-analysis of stated preference studies of transportation noise nuisance. *Transportation*, 42(1), 71–100. <https://doi.org/10.1007/s11116-014-9527-4>
- Dimakopoulou, K., Koutentakis, K., Papageorgiou, I., Kasdagli, M. I., Haralabidis, A. S., Sourtzi, P., Samoli, E., Houthuijs, D., Swart, W., Hansell, A. L., & Katsouyanni, K. (2017). Is aircraft noise exposure associated with cardiovascular disease and hypertension? Results from a cohort study in Athens, Greece. *Occupational and Environmental Medicine*, 74(11), 830–837. <http://dx.doi.org/10.1136/oemed-2016-104180>
- Eriksson, C., Bluhm, G., Hilding, A., Ostenson, C. G., & Pershagen, G. (2010). Aircraft noise and incidence of hypertension—gender specific effects. *Environmental Research*, 110(8), 764–772. <https://doi.org/10.1016/j.envres.2010.09.001>
- Evrard, A. S., Lefevre, M., Champelovier, P., Lambert, J., & Laumon, B. (2017). Does aircraft noise exposure increase the risk of hypertension in the population living near airports in France? *Occupational and Environmental Medicine*, 74(2), 123–129. <http://dx.doi.org/10.1136/oemed-2016-103648>
- Floud, S., Vigna-Taglianti, F., Hansell, A., Blangiardo, M., Houthuijs, D., Breugelmans, O., Cadum, E., Babisch, W., Selander, J., Pershagen, G., Antoniotti, M. C., Pisani, S., Dimakopoulou, K., Haralabidis, A. S., Velonakis, V., Jarup, L., & HYENA Study Team. (2011). Medication use in relation to noise from aircraft and road traffic in six European countries: Results of the HYENA study. *Occupational and Environmental Medicine*, 68(7), 518–524. <http://dx.doi.org/10.1136/oem.2010.058586>
- Franssen, E. A., van Wiechen, C. M., Nagelkerke, N. J., & Lebre, E. (2004). Aircraft noise around a large international airport and its impact on general health and medication use. *Occupational and Environmental Medicine*, 61(5), 405–413. doi: 10.1136/oem.2002.005488
- Greiser, E., Greiser, C., & Janhsen, K. (2007). Night-time aircraft noise increases prevalence of prescriptions of antihypertensive and cardiovascular drugs irrespective of social class—the Cologne-Bonn Airport study. *Journal of Public Health*, 15, 327–337. <https://doi.org/10.1007/s10389-007-0137-x>
- Haralabidis, A. S., Dimakopoulou, K., Vigna-Taglianti, F., Giampaolo, M., Borgini, A., Dudley, M. L., Pershagen, G., Bluhm, G., Houthuijs, D., Babisch, W., Velonakis, M., Katsouyanni, K., Jarup, L., & HYENA Consortium. (2008). Acute effects of night-time noise exposure



- on blood pressure in populations living near airports. *European Heart Journal*, 29(5), 658-664. <https://doi.org/10.1093/eurheartj/ehn013>
- Haralabidis, A. S., Dimakopoulou, K., Velonaki, V., Barbaglia, G., Mussin, M., Giampaolo, M., Selander, J., Pershagen, G., Dudley, M. L., Babisch, W., Swart, W., Katsouyanni, K., Jarup, L., & HYENA Consortium. (2011). Can exposure to noise affect the 24 h blood pressure profile? Results from the HYENA study. *Journal of Epidemiology and Community Health*, 65(6), 535-541. <http://dx.doi.org/10.1136/jech.2009.102954>
- Hatfield, J., Job, R., Carter, N. L., Peplow, P., Taylor, R., & Morrell, S. (2001). The influence of psychological factors on self-reported physiological effects of noise. *Noise and Health*, 3(10), 1-13.
- Jarup, L., Babisch, W., Houthuijs, D., Pershagen, G., Katsouyanni, K., Cadum, E., Dudley, M. L., Savigny, P., Seiffert, I., Swart, W., Breugelmans, O., Bluhm, G., Selander, J., Haralabidis, A., Dimakopoulou, K., Sourtzi, P., Velonakis, M., Vigna-Taglianti, F., & HYENA Study Team. (2008). Hypertension and exposure to noise near airports: The HYENA study. *Environmental Health Perspectives*, 116(3), 329-333. <https://doi.org/10.1289/ehp.10775>
- Kopsch, F. (2016). The cost of aircraft noise - does it differ from road noise? A meta-analysis. *Journal of Air Transport Management*, 57, 138-142. doi: 10.1016/j.jairtraman.2016.05.011
- Matsui, T., Uehara, T., Miyakita, T., Hiramatsu, K., Yasutaka, O., & Yamamoto, T. (2004). The Okinawa study: Effects of chronic aircraft noise on blood pressure and some other physiological indices. *Journal of Sound and Vibration*, 277, 469-470. doi: <10.1016/j.jsv.2004.03.007>
- Pyko A., Lind T., Mitkovskaya N., Ögren M., Östenson C.-G., Wallas A., et al. (2018). Transportation noise and incidence of hypertension. *International Journal of Hygiene and Environmental Health*, 221, 1133-1141. <https://doi.org/10.1016/j.ijheh.2018.06.005>
- Rosenlund, M., Berglind, N., Pershagen, G., Jarup, L., & Bluhm, G. (2001). Increased prevalence of hypertension in a population exposed to aircraft noise. *Occupational and Environmental Medicine*, 58(12), 769-773. <http://dx.doi.org/10.1136/oem.58.12.769>
- Wolfe, P. J., Yim, S. H. L., Lee, G., Ashok, A., Barrett, S. R. H., & Waitz, I. A. (2014). Near-airport distribution of the environmental costs of aviation. *Transport Policy*, 34, 102-108. <https://doi.org/10.1016/j.tranpol.2014.02.023>