Boston University Student Project: A Community-Based Feasibility Project Assessing Logan Airport-related Noise Impacts on Sleep Disturbance and Sleep Quality of Area Residents

Project Summary

Student researchers met with community representatives of East Boston, Milton, Somerville, and Winthrop on February 19, 2015 to discuss community concerns about Logan International Airport. The main concern reported by community members was aircraft noise during nighttime hours and the effect of noise on sleep quality.

Purpose & Objective

Student researchers wanted to address community members' concerns by conducting a project to determine whether it is practical to use (1) survey methods to evaluate sleep disturbances and (2) a smartphone app (NoiseTube) to accurately measure noise inside of the residence. The main objectives of this community-based project include:

1. Use the NoiseTube app to measure noise levels within homes in each community.
2. Characterize sleep disturbance (e.g. number of awakenings) and sleep quality (e.g. longer time falling asleep, waking up too early in the morning, less sleep time) and determine associations with noise measured in the home.
3. Explore associations between indoor noise measurements and flights during the noise-sampling period.
4. Decide whether the NoiseTube app could be used reliably in future community studies.

Methods

There were three types of surveys given to participants: an initial survey, as well as evening and morning surveys given each day. The purpose of the surveys was to gather information on each participant's sleeping habits and factors affecting his or her sleep quality. Participants also were asked to download a smartphone noise measurement app, NoiseTube, to conduct overnight noise sampling on at least 3 days between April 5 and April 11, 2015. Student researchers also gathered flight history information for the sample period, which included individual flight tracks with time information. Lastly, student researchers evaluated the accuracy of the NoiseTube app by comparing the smartphone measurements with different phone models to measurements taken by a dosimeter, which is an instrument typically used to measure noise.

Although the noise measurements were not intended to represent the community as a whole, student researchers calculated the distribution of noise levels for each community to provide preliminary insight. In addition, each participant's noise app measurements were compared to his or her survey information for each night of sampling. This showed whether or not increased levels of noise were associated with increased reports of sleep

disturbance and lower sleep quality scores. Finally, flight history information was compared to the noise data gathered from each participant's phone for that same night.

Results & Conclusions

Thirteen people from East Boston, Milton, and Somerville answered surveys and collected noise samples with their smartphones. During the sampling period, background noise levels were generally higher in East Boston, while Milton had the greatest percentage of noise data points over 42 A-weighted decibels (dBA), a noise level that the World Health Organization has identified as a level where people are more likely to experience sleep disturbance. Given the small scale of this project, student researchers could not statistically evaluate the relationship between sleep disturbance/quality and noise data from the app, but the survey instrument as implemented in Google Forms was successful and yielded interpretable information. Overall, student researchers saw a trend between the number of noise measurements greater than 42 dBA and the number of flights that were within 1 mile of a residence across the six nights of the project. Finally, student researchers compared the noise app measurements to the dosimeter measurements and determined that NoiseTube is a reliable tool for measuring noise. The more reliable phones for collecting noise include older phone models, such as the iPhone 4. Additionally, the NoiseTube app developers created calibration updates that improve noise measurements for the following phones: iPhone (models: 3GS, 4, 4s, 5), HTC (models: HERO, Desire HD; Desire S, One X), Dell (models: Streak, 5 mini) and Samsung (model: Galaxy S2).

Based on this project experience and feedback from community participants, student researchers have a number of suggestions on directions for future work. First, although student researchers developed methods to look at noise and sleep impacts, they could not find a relationship between these two factors because there were not enough participants or sampling days. This type of connection may be difficult for a community to make without enough participants and knowledge of statistical methods. This type of analysis may require partnership with other groups including local health and academic partners. Similarly, student researchers found that a pattern between indoor noise and flights may exist, but additional work is needed to see if the noise captured by the phone app is from flights, which would require more intensive statistical analysis.

This project offers new methods and insight to determine noise levels in the indoor environment. An individual may use these methods to collect personal noise measurements within his or her home. The approaches made can be carried out by a community to help members better understand noise levels. Expanding this project to more communities could help draw more general conclusions about noise in the Greater Boston area. Student researchers suggest that in future projects of this sort, enough time be given for planning, as well as finding and training community members. Specific recommendations include:

1. Provide in-person training on how to properly download the NoiseTube app, create a NoiseTube account, and run a test of the app. An in-person meeting is useful to allow participants to review the project's procedures.

2. If possible, use calibrated phones. Calibrated phones generally collect more accurate noise measurements. These phones would only need to have wi-fi capability, so older phones could be gathered and used.

3. Future project surveys should include questions that address additional factors that influence noise exposure, for example home sound insulation and open windows. Survey questions should also address factors that influence sleep, including earplugs and sleep aid medication. The surveys should be tested before use to be sure questions are clear. Collecting survey information along with noise measurements could allow other researchers to look at the relationship between these two factors.

4. Data collection should take place for a longer period and/or for multiple time periods. Taking noise samples during different time periods may account for weather variations and seasonal differences, for example wind patterns and summer versus winter seasons. Collection of data for individuals over longer periods of time would provide important statistical advantages and help to address "learning curve" issues with the NoiseTube app and protocol.

5. Detailed flight information should be obtained or accessed from a website that gathers flight information, such as flightaware.com. Communities could split the membership costs for a flightaware account. Another alternative would be to assign individuals to record flight history using Massport's Flight Monitor website, or to establish working relationships with individuals or organizations with access to these data.

This project highlights the feasibility of understanding noise and its effects within a community. A clear benefit of using the NoiseTube app is that it is a free way for communities to measure indoor noise exposure and evaluate patterns of noise within communities. Community participation is important for this type of project. By collecting noise information, communities can compare noise measurements to noise laws enforced by local departments. This comparison can help show the true impact of noise on quality of life and the health of the public.

The student researchers also found evidence that noise and sleep disturbance can have multiple effects on health. For example, studies have found that lack of sleep has been linked to daytime drowsiness, changes in mood and anxiety/stress, and poor memory. Disruption in sleep during the night is shown to increase heart rate and blood pressure. Long-term sleep disruption can lead to health problems, including diabetes and heart disease. Future studies could evaluate some of these endpoints or could keep them in mind when designing and implementing the study.

This student project was conducted by Hanan Alzaim, Sharon Lee, Melissa Rodriguez-Vodak, and Kirby Valentin as part of EH800 (Community-Based Methods in Environmental Health) at Boston University School of Public Health.

For future questions, please contact Dr. Jonathan Levy at JONLEVY@BU.EDU. Survey instruments and study protocols are available upon request.