The result of this exploratory analysis is a report that consists of the following:

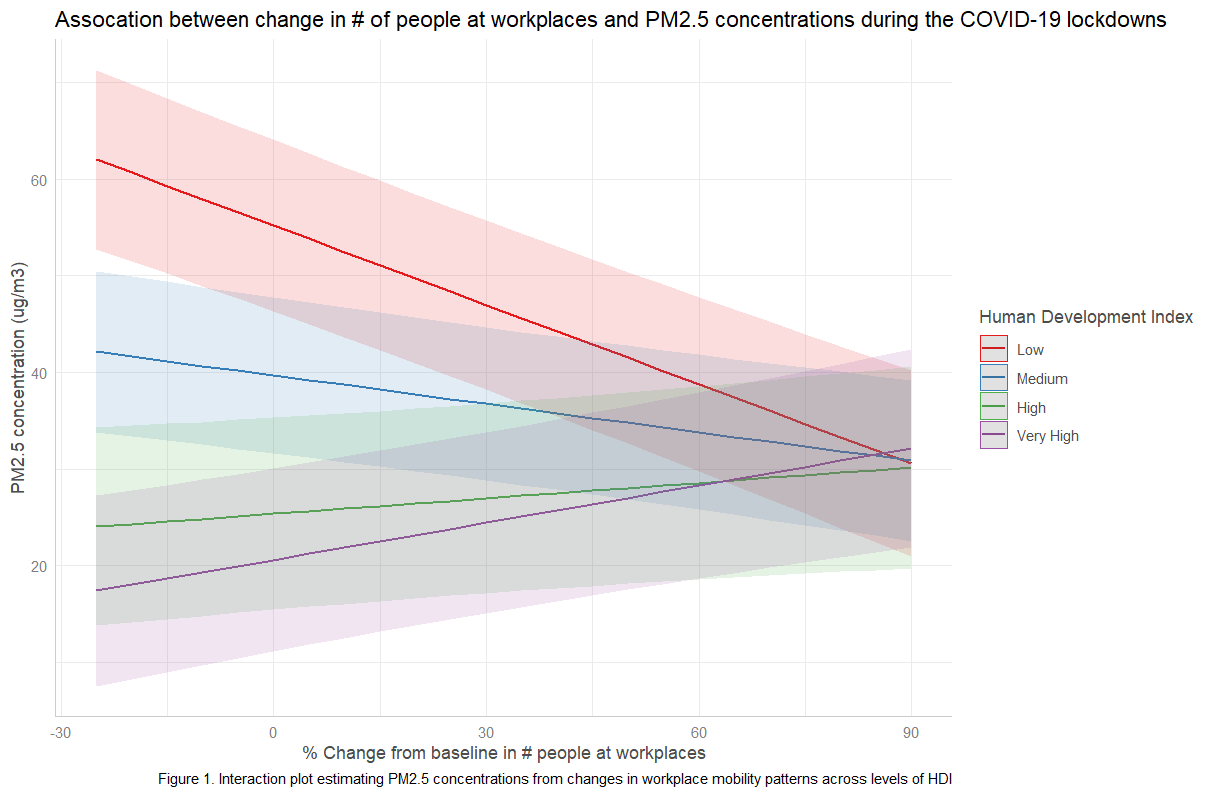
1. One paragraph overview of background and some small number of primary research questions of interest.

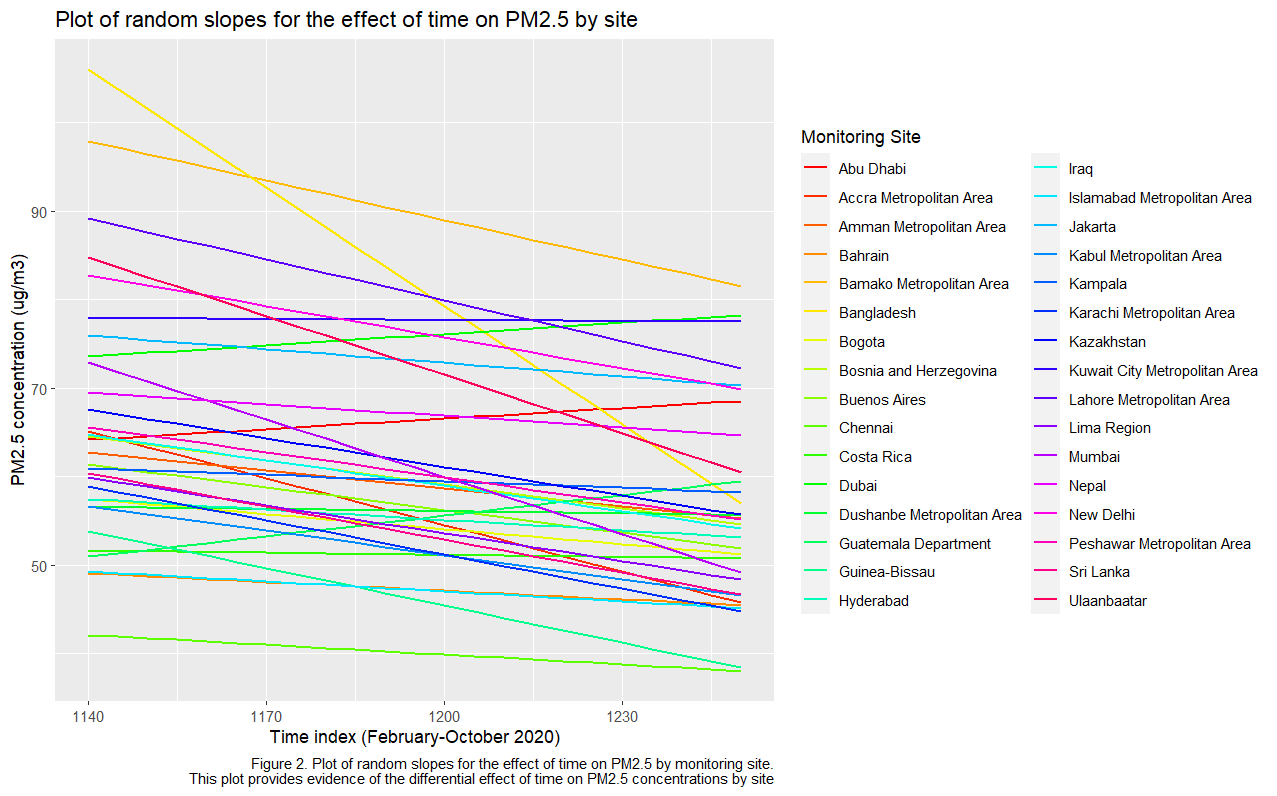
The 2020 COVID-19 global lockdowns reportedly led to decreased ambient particulate matter (PM2.5) concentrations (1). The lockdowns were generally associated with changes in human mobility patterns, including increased time spent in residential locations and a decreased concentration of individual’s visiting workplaces (cite). However, the extent of these changes varied geographically (4), turning the lockdowns into a natural experiment to assess how distinct community mobility patterns influence PM2.5 concentrations. Primary sources of PM2.5 vary geographically and are associated with country development status. Traffic is a primary contributor to PM2.5 in Western European countries, while industrial sources are a main contributor in lower-middle income countries, primary because of the reliance on heavily polluting industries, a hallmark feature of early stage economic development. Further, in low-middle-income countries, a substantial portion of PM2.5 concentration arises from household cooking with solid fuels—a source that is largely absent in high-income settings. This underscores a crucial distinction in pollution sources between stages of economic development.

Our goal is to evaluate how changes in mobility patterns impact PM2.5 concentrations, particularly changes in attendance at workplaces and time spent at home. We hypothesize that there will be differential effects of mobility changes on PM2.5 concentrations according to country development status. Specifically, we predict that decreases in workplace attendance will be associated with larger decreases in PM2.5 in lower-middle income countries as compared to high income countries, reflecting the differences in prevalence and reliance on heavily polluting industries. We also predict that increased time in residential locations will be associated with either an increase, or less dramatic decrease in PM2.5 in lower-middle income countries as compared to high income countries, reflecting increased frequency and/or quantity of cooking with solid fuels.

2) One paragraph describing your data sources: What is the structure of your data files (e.g., student level, school-level, teacher-level, county-level)? Do the variables come from surveys, administrative records, classroom observations, etc.? Please feel free to discuss any data decisions you’ve made or are considering (e.g., you’re dropping certain observations, creating new measures, or are unsure of which measures to use). Make sure you include the sample sizes at each level (e.g., number of time points per unit, average number of students per school, etc.).

3) Two publication ready plots of your data. Publication ready means having things like nicely labeled axes and captions.





4) An analysis of the variability in your data (primarily your outcome). You can do this by fitting an unconditional model (one without any extraneous covariates) to obtain a variance decomposition (allowing for ICC calculations and the like). These unconditional models are good starting point for getting a handle on where variation is, and what your data structure is.

A white sheet with black text and numbers

Description automatically generated

5) One paragraph describing trends in your data, referring to your two plots and your variability analysis.

6) An initial mathematical model describing the primary model you are planning on fitting (or have fit). Try to focus attention on your primary covariates and outcome; keep these initial models simple and straightforward. As you write your model, be sure to define your subscripts! I.e., at the beginning of your model write something like "For time t for student i in school k we have..." Also, to be correct you would then subscript as tik, keeping your levels in order. 11

**x <- lmer(a\_mean ~ workplaces\_reversed\*hdicode + time\_index + month\*hemisphere + pop\_density + (1 + time\_index | Mobility\_SiteName), control = lmerControl(optimizer = "bobyqa"),**

**data = pm)**

7) One paragraph of initial findings. If you have not yet fit a model, you can still describe preliminary findings in terms of trends, etc., in your plots and initial exploratory analysis. 8) One paragraph describing next steps, blocks, barriers, concerns, or other things you would like to discuss and get feedback on.