Traffic-related air pollution and pregnancy loss in Eastern Massachusetts, USA

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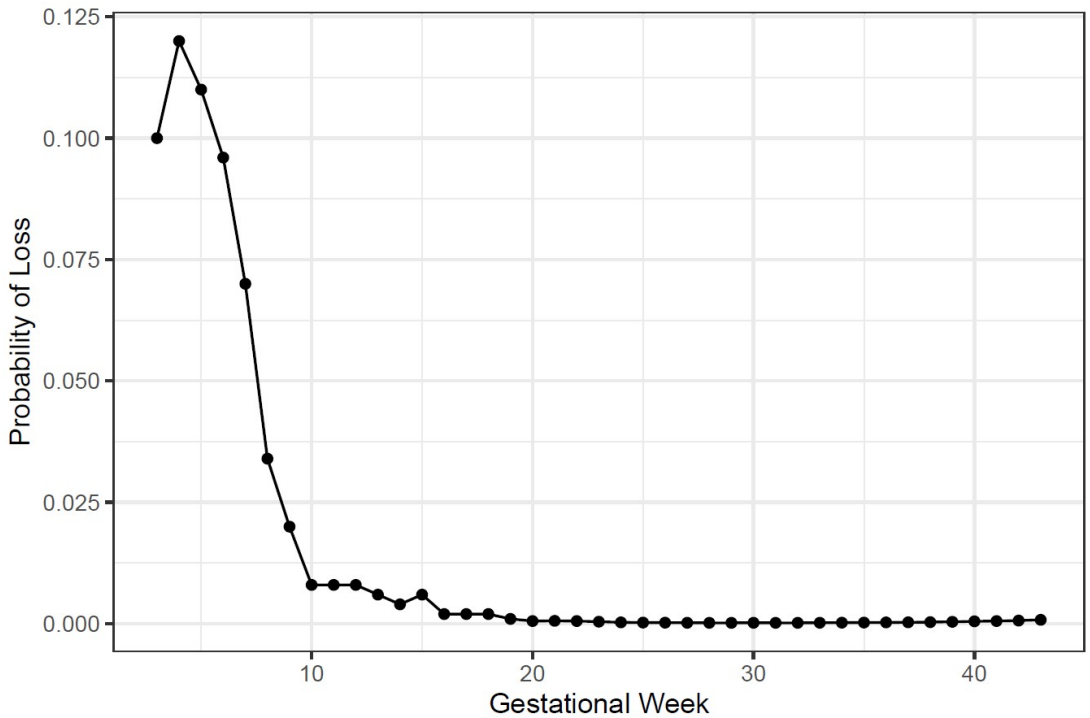
Background

- Many pregnancy loss studies rely on losses identified by medical records
  - Almost 50% of all pregnancies not intended
  - Among pregnancy planners, early loss estimated ~30%
- Studying subset of all losses can potentially compromise internal and/or external validity



Challenge

- Pregnancy loss is difficult to study because of the internal, and therefore hidden, nature of conceptions
- How do you study something that cannot be seen directly?

Challenge

- The challenge of studying something that cannot be seen is not unique to epidemiology
- Example: subatomic particles are too small to see
  - Physicists & engineers developed the cloud chamber to visualize tracks that the particles leave as they move to infer properties

Approach

- We look at the shadow (i.e., live births at the end of pregnancy) to infer about what happened during pregnancy

Approach

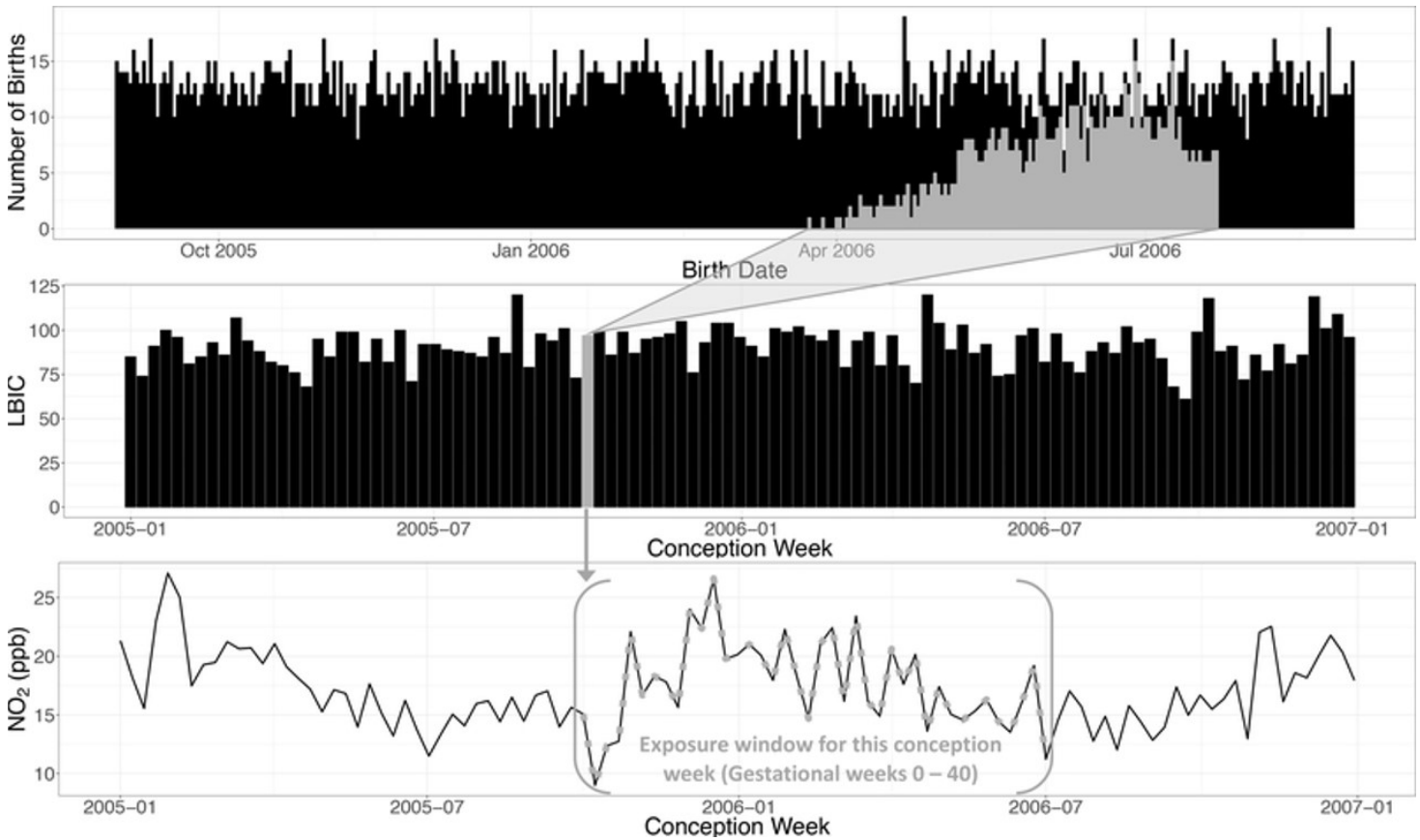
- Unit of analysis is time (e.g., weeks)

$$TC = PL + LBIC$$

  - For a given week, total conceptions (TC) is the sum of conceptions that end in pregnancy loss (PL) and conceptions that end in live births or "live birth-identified conceptions" (LBIC)
  - LBIC (observed) driven by TC (unobserved) and PL (unobserved)
  - **HOWEVER**, post-conception exposures cannot affect TC, and so associations with LBIC necessitates associations with PL
- Here, we show this approach using NO_2 (tracer for traffic-related air pollution)

Methods: Analysis

- Deliveries from Beth Israel Deaconess MC, 2003-2017, n=20,957
- LBIC outcome: count how many live births per conception week
  - Re-sort live births into their conception weeks based on gestational age
- Assign weekly NO_2 exposure history

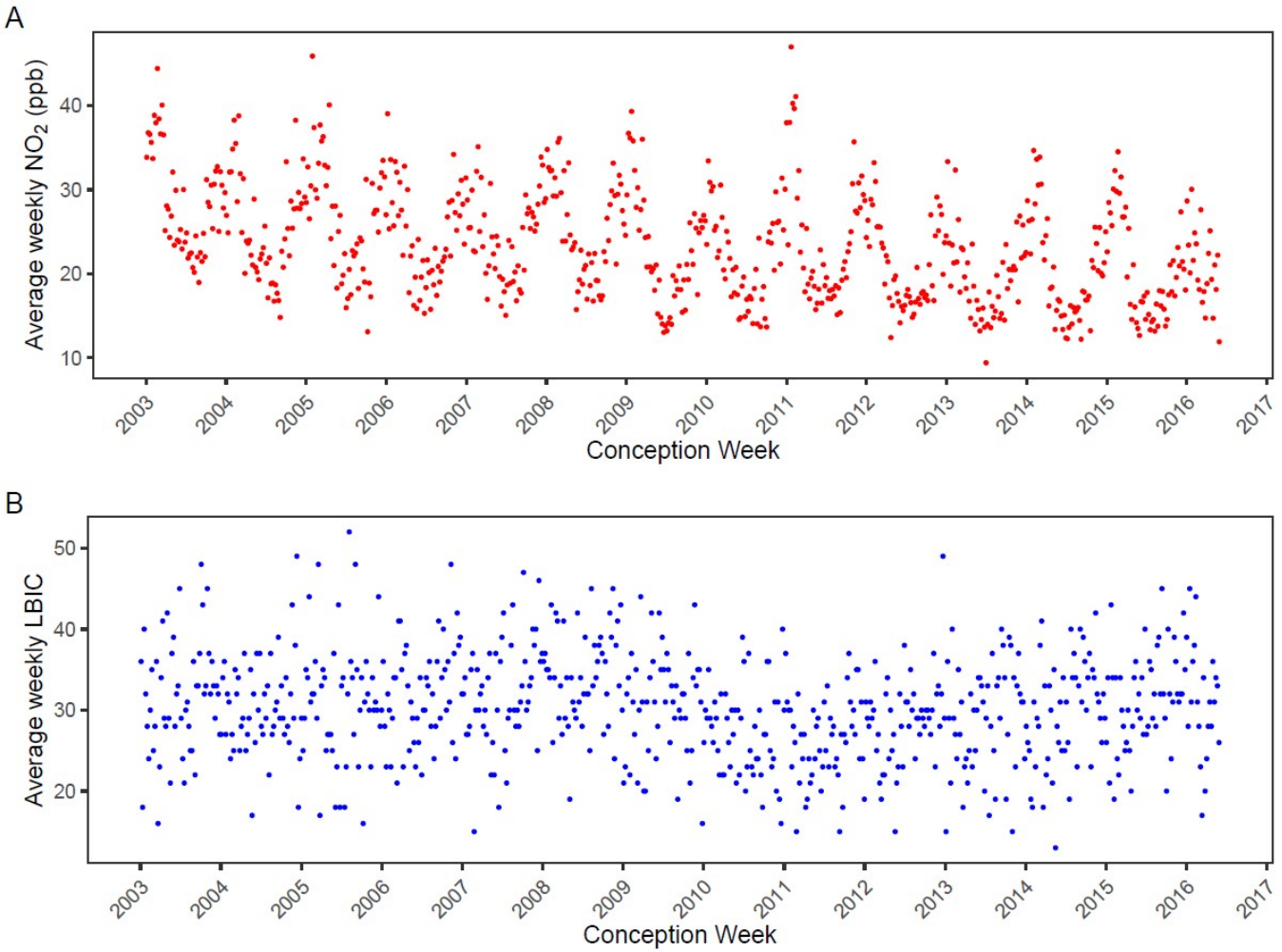


Methods: Analysis

- NO_2 from spatiotemporal ensemble model that estimates daily NO_2 in each 1-km grid in the US (R^2=0.79)
- Temperature from NASA North American Land Data Assimilation Systems (NLDAS-2)
- Distributed lag model
  - Log-linear model (count process)
  - NO_2: linear exposure-response, 5 df for lag constraint
  - Temperature: 3 df for exposure-response, 5 df for lag constraint
  - Time trend adjustment using year indicator and sine-cosine pair
  - LBIC count difference per 10-ppb
    - G-computation
  - Bootstrap for 95% confidence intervals

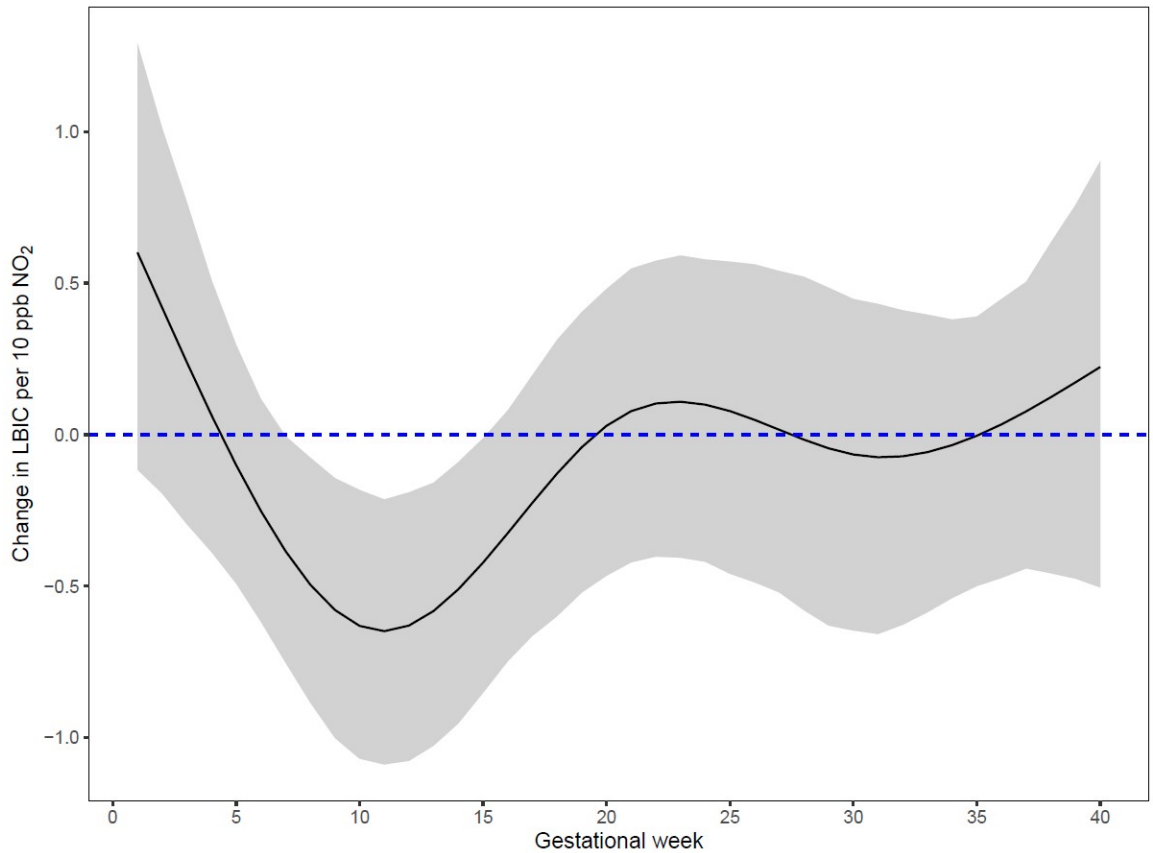
Exposure and outcome distribution

- Mean weekly NO_2 of 23.3 (SD = 6.4)
- Mean weekly LBIC of 30.3 (SD = 6.5)



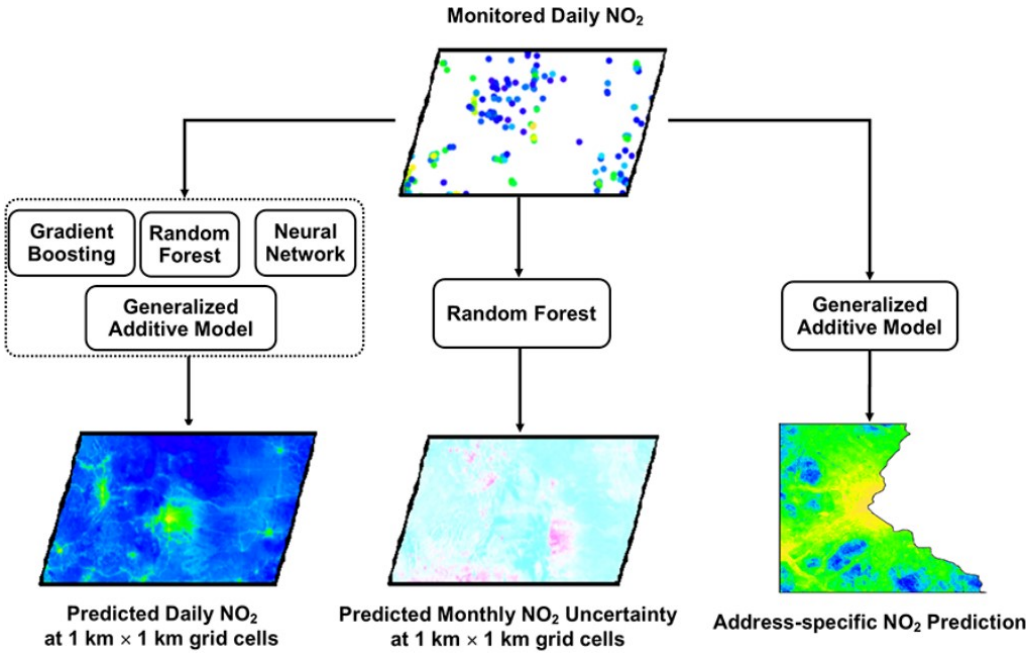
Results: Main Results

- A 10-ppb higher NO_2 exposure sustained during weeks 5-19 was associated with 6.0 (95% CI: 1.3, 11.3) fewer LBICs
  - That is, out of ~30 LBICs per conception week, 6 would be lost if average NO_2 was 10-ppb higher



Potential Limitations

- Exposure measurement error (non-differential)
- Error in gestational age dating (non-differential)
- Residual confounding by seasonality and long-term trends
  - Harmonics do well in controlling for time trends (Poster P-0017)



Conclusion & Future Directions

- The approach quantifies the change in the number of pregnancy losses per conception week as it is the complement of the change in live births
- LBIC analysis - pregnancy loss associated with NO_2 in weeks 5-19
  - Placental blood flow established ~16 weeks
  - Oxidative stress burst
- Future direction: Important to consider health inequities
  - Identify maternal and neighborhood-level factors that modify the association between air pollution and pregnancy loss

Thank You!

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- Want to learn more about the approach?
  - Email: mleung@hsph.harvard.edu
  - Twitter: @epimikey
  - Poster P-0017: Bias amplification and concurvity in DLMs