Reproducible Research Case Study

Identifying Harmful Constituents in Particulate Matter Air Pollution

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What Causes PM to be Toxic?

- PM is composed of many different chemical elements
- Some components of PM may be more harmful than others
- Some sources of PM may be more dangerous than others
- Identifying harmful chemical constituents may lead us to strategies for controlling sources of PM

NMMAPS

- The National Morbidity, Mortality, and Air Pollution Study (NMMAPS) was a national study of the short-term health effects of ambient air pollution
- Focused primarily on particulate matter (PM_{10}) and ozone (O_3)
- Health outcomes included mortality from all causes and hospitalizations for cardiovascular and respiratory diseases
- Key publications
  - http://www.ncbi.nlm.nih.gov/pubmed/11098531
  - http://www.ncbi.nlm.nih.gov/pubmed/11354823
- Funded by the Health Effects Institute
  - Roger Peng currently serves on the Health Effects Institute Health Review Committee

NMMAPS and Reproducibility

- Data made available at the Internet-based Health and Air Pollution Surveillance System (http://www.ihapss.jhsph.edu)
- Research results and software also available at iHAPSS
- Many studies (over 67 published) have been conducted based on the public data http://www.ncbi.nlm.nih.gov/pubmed/22475833
- Has served as an important test bed for methodological development

What Causes Particulate Matter to be Toxic?

Research

Cardiovascular Effects of Nickel in Ambient Air

Morton Lippmann,[1] Kazuhiko Ito,[1] Jing-Shiang Hwang,[2] Polina Maciejczyk,[1] and Lung-Chi Chen[1*]*

[1]New York University School of Medicine, Nelson Institute of Environmental Medicine, Tuxedo, New York, USA; [2]Insti
Science, Academia Sinica, Taipei, Taiwan

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1665439/

- Lippmann *et al.* found strong evidence that Ni modified the short-term effect of PM_{10} across 60 US communities
- No other PM chemical constituent seemed to have the same modifying effect
- To simple to be true?

A Reanalysis of the Lippmann *et al.* Study

Research

Does the Effect of PM_{10} on Mortality Depend on PM Nickel and Vanadium Content? A Reanalysis of the NMMAPS Data

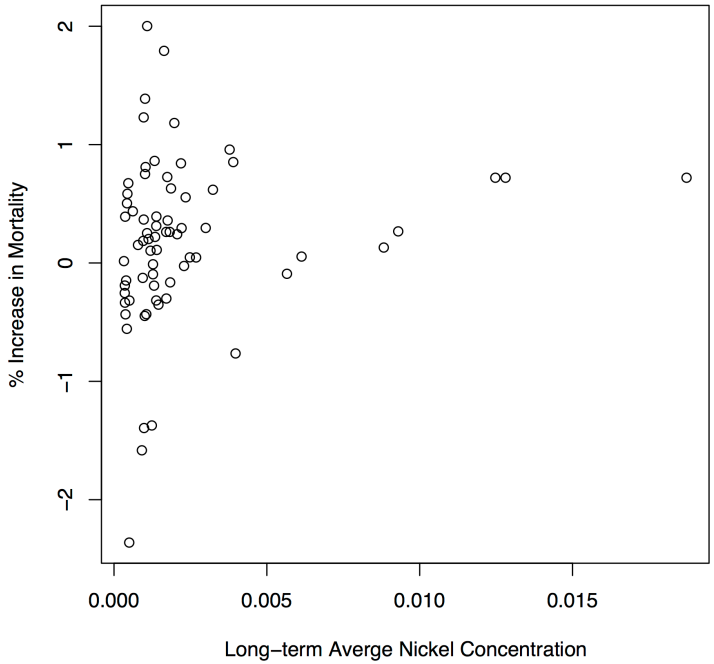
Francesca Dominici,[1] Roger D. Peng,[1] Keita Ebisu,[2] Scott L. Zeger,[1] Jonathan M. Samet,[3] and Michelle L. Bell[2]

[1]Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA; [2]School of Forestry and Environmental Studies, Yale University, New Haven, Connecticut, USA; [3]Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2137127/

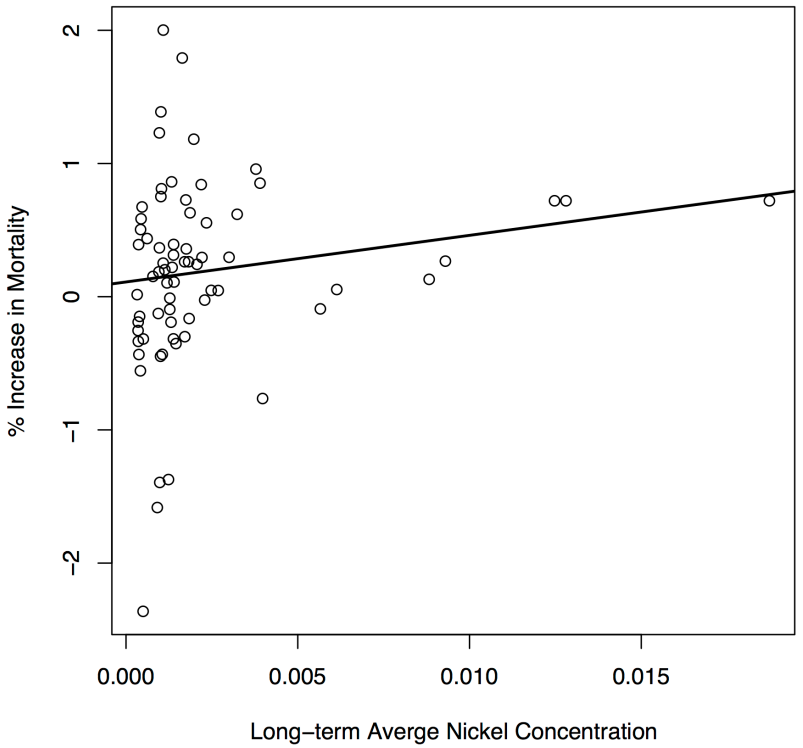
- Reexamine the data from NMMAPS and link with PM chemical constituent data
- Are the findings sensitive to levels of Nickel in New York City?

Does Nickel Make PM Toxic?



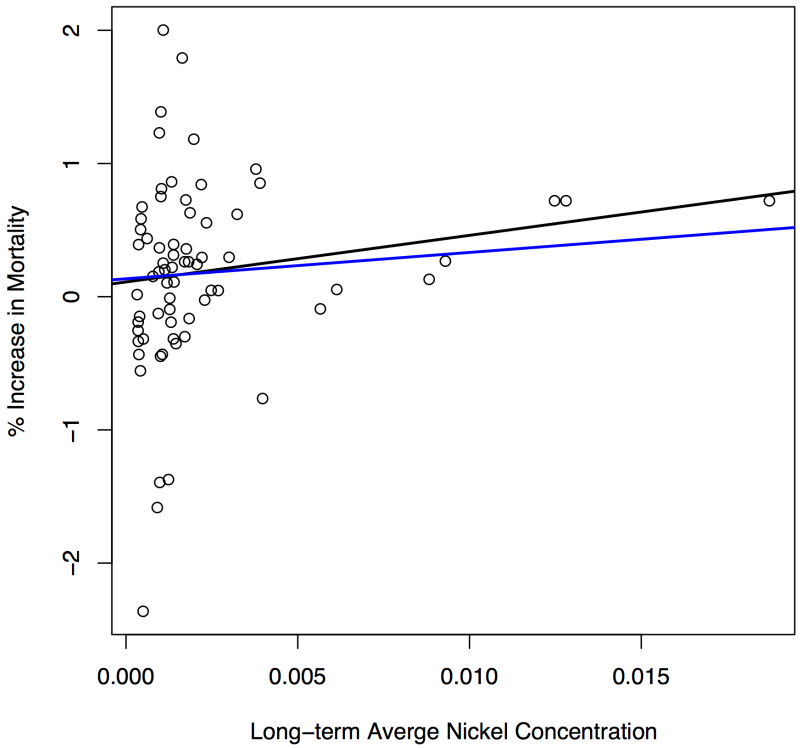
- Long-term average nickel concentrations appear correlated with PM risk
- There appear to be some outliers on the right-hand side (New York City)

Does Nickel Make PM Toxic?



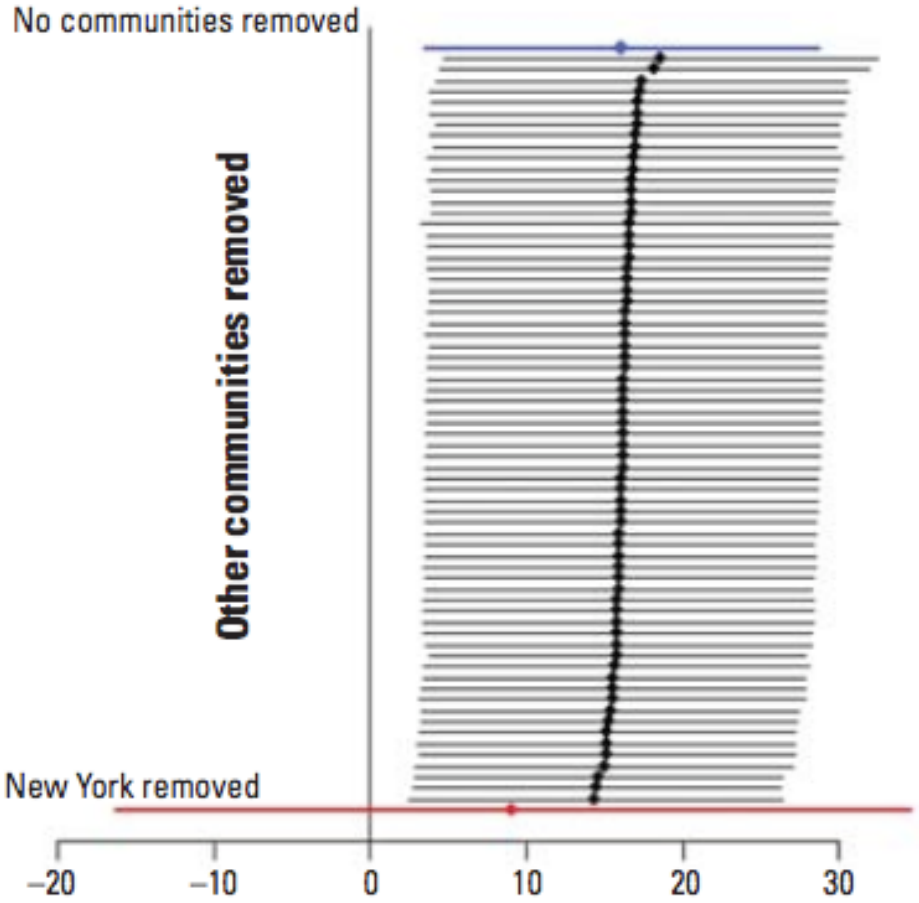
- Regression line statistically significant ($p < 0.01$)

Does Nickel Make PM Toxic?



- Adjusted regression line (blue) no longer statistically significant ($p < 0.31$)

Does Nickel Make PM Toxic?



What Have We Learned?

- New York does have very high levels of nickel and vanadium, much higher than any other US community
- There is evidence of a positive relationship between Ni concentrations and PM_{10} risk
- The strength of this relationship is highly sensitive to the observations from New York City
- Most of the information in the data is derived from just 3 observations

Lessons Learned

- Reproducibility of NMMAPS allowed for a secondary analysis (and linking with PM chemical constituent data) investigating a novel hypothesis (Lippmann *et al.*)
- Reproducibility also allowed for a critique of that new analysis and some additional new analysis (Dominici *et al.*)
- Original hypothesis not necessarily invalidated, but evidence not as strong as originally suggested (more work should be done)
- Reproducibility allows for the scientific discussion to occur in a timely and informed manner
- This is how science works