SOURCE IDENTIFICATION AND APPORTIONMENT OF PARTICULATE MATTER IN ACCRA, GHANA

Zheng Zhou[a,b], Kathie L Dionisio[a,b], Raphael E Arku[b], Thiago G Verissimo[c], Brent Coull[bd], Americo S Kerr[c], Allison F Hughes[e], Jose Vallarino[b], John D Spengler[b], Samuel Agyei-Mensah[f,g], Majid Ezzati[h]

[a]Department of Global Health and Population, Harvard School of Public Health, Boston, MA 02115; [b]Department of Environmental Health, Harvard School of Public Health, Boston, MA 02115; [c]Institute of Physics, University of Sao Paulo, Sao Paulo 05315-970, Brazil; [d]Department of Biostatistics, Harvard School of Public Health, Boston, MA 02115; [e]Department of Physics, University of Ghana, Legon 25, Ghana; [f]Environmental Science Program, University of Ghana, Legon 25, Ghana; [g]Department of Geography and Resource Development, University of Ghana, Legon 25, Ghana; [h]MRC-HPA Center for Environment and Health, Department of Epidemiology and Biostatistics, School of Public Health, Imperial College London, London W2 1PG, UK

Background and objective

Cities in the developing world are growing rapidly, particularly in sub-Saharan Africa, with corresponding increases in economic activity and traffic. Little is known about air pollution sources and their relative contributions to air pollution in African cities. The objective of this study is to identify sources of ambient particulate matter (PM) in Accra, Ghana and to characterize the contribution of each source.

Methods

We collected 48-hour $PM_{2.5}$ (aerodynamic diameter less than 2.5 μm) and PM_{10} (aerodynamic diameter less than 10 μm) samples at 11 residential or roadside sites in four neighborhoods of Accra between November 2006 and August 2008. Elemental composition of PM was assessed by performing X-ray fluorescence (XRF). We developed an extended factor analysis method that accounts for spatial and temporal correlation of data and for site-specific covariates. We applied this method to the elemental concentration data for source identification and apportionment.

Results

XRF results show that crustal elements (Al, Si, Fe, Ca, Mg), sea salt elements (Na, Cl), K and S had the highest concentrations at various sites. Source apportionment results indicate that crustal material, road dust, combustion, and sea salt are the four main sources contributing to the observed concentrations in Accra. Crustal material was found to be the most important contributor at each site, followed by combustion. The sea salt factor was seen at each site, with the highest contribution at the site closest to the coast.

Conclusion

Crustal material, road dust, combustion, and sea salt are primary source contributors to PM in urban Accra.