COMMENT ON REVISION OF THE NAAQS OZONE STANDARD

RICHARD L SMITH

I am Professor of Statistics at the University of North Carolina, Chapel Hill. I have been working on air pollution health-related research since about 1995. The following comments are offered in a personal capacity.

My comments relate to the "Epidemiology" component of CASAC's agenda. The evidence for a direct association between ozone and mortality has sometimes been presented in over-simplistic terms, whereas in fact, there are many questions and obscure points about the true relationship. Smith et al. [1] presented a re-analysis of the NMMAPS dataset, previously analyzed by Michelle Bell and co-authors in a long series of papers, reaching a number of conclusions that differed from theirs. In this discussion, I will concentrate on one aspect of that re-analysis, the evidence that the ozone-mortality coefficient varies substantially in different parts of the USA.

Figure 1 (adapted from Table 3 of [1]) shows the mean and 95% credible interval for the ozone-mortality coefficient, computed in the form of a population-weighted average for each of the seven NMMAPS regions. In [1], reasons are given why this form of analysis should be preferred to the Bayesian hierarchical analysis used in earlier NMMAPS papers. The differences among the 7 regions are clearly significant ($p \approx 0.02$) and show a strong ozone-mortality relationship only in the north east and industrial midwest regions; in several others, including southern California, there is no statistically significant effect. Figure 2 extends this analysis by plotting the spatial variation of the ozone-mortality coefficient using a variant of kriging analysis; this shows hot spots of high ozone-mortality association around New York, Chicago and eastern Texas, but a much lower effect in the rest of the country.

Figure 1: Estimates and 95% credible intervals for ozone-mortality coefficient (percent increased death per 10 ppb 8-hour ozone), by region.

To study possible explanations of these results, we attempted to correlate the variations in the coefficient between mortality and 8-hour ozone with various possible effect modifiers (measured at the level of cities, not individuals). In Table 1, we highlight four effect modifiers that have a strongly significant correlation with the ozone-mortality coefficient, along with two that do not.

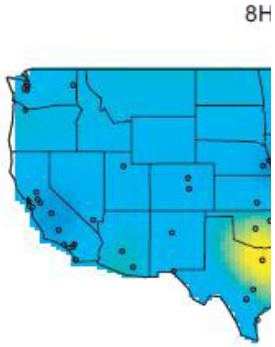

Figure 2: Spatial map of 8-hour ozone-mortality coefficient

The most significant variable in our analysis was "proportion of houses with window AC"; this highlights the important role of air conditioning that has been identified in previous studies of personal exposure to air pollution, e.g. [3], but ours was the first to identify a separate and contrasting role for window and central AC. Another variable that we found highly significant was "Proportion in different house since 1995", which suggests that age (and by implication quality) of housing has an important effect on who is vulnerable to air pollution exposure. In contrast with [2], who proposed a similar analysis based on 24-hour ozone, we did not find any significant result based on the proportion of African Americans within a community, or the proportion unemployed; this suggests that racial or socio-economic factors do not play a large role.

Variable	Estimate	Standard Error	p-value
Proportion with Window AC	2.1	0.5	0.0001
Proportion in different house since 1995	-3.7	1.1	0.001
Proportion taking public transport to work	1.8	0.6	0.002
Proportion with Central AC	-0.9	0.3	0.004
Proportion unemployed	5	3.7	0.19
Proportion African American	0.6	0.5	0.2

Table 1: Six possible effect modifiers and their influence on the 8-hour ozone-mortality coefficient.

Such results show that the relationship between ozone and mortality is by no means a simple one, but depend on many factors that have never been fully evaluated. In its task of determining whether there should be a new ozone standard, I urge CASAC to take these results into account.

References:

[1] R.L. Smith, B. Xu and P. Switzer, Reassessing the relationship between ozone and short-term mortality in US urban communities. Inhalation Toxicology 29(S2), 37-61 (2009).

[2] M. Bell and F. Dominici, Effect modification by community characteristics on the short-term effects of ozone exposure and mortality in 98 U.S. communities. Am. J. Epidemiology 167, 986-997 (2008).

[3] Weschler, C.J., Ozone's impact on public health: Contributions from indoor exposures to ozone and products of ozone-initiated chemistry. Environ. Health Persp. 114, 1489-1496 (2006).

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RESEARCH ARTICLE

Reassessing the relationship between ozone and short-term mortality in U.S. urban communities

Richard L. Smith[1], Baowei Xu[1], and Paul Switzer[2]

[1]Statistics and Operations Research, University of North Carolina, Chapel Hill, North Carolina, USA, and [2]Department of Statistics, Stanford University, Stanford, California, USA