

Interactive comment on “Relationship between particulate matter and childhood asthma – basis of a future warning system for Central Phoenix” by R. Dimitrova et al.

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First, the authors wish to thank the referee for careful review of the manuscript and useful recommendations.

The study found a 12.6% increase in the log odds of asthma emergency room visits/hospitalisations for a 36 microgram*m⁻³ PM10 increase among the 5-17 yr old – a finding well in line with e.g. the 5% increase per 10 microgram*m⁻³ PM10 reported by Sicard et al. (The Aggregate Risk Index: An intuitive tool providing the health risks of air pollution to health care community and public. Atmospheric Environment (2011). It is a common finding that boys are more at risk than girls and therefore somewhat

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worrying that the study did not observe any gender differences. Do the authors have any explanation for this?

Response: Because a case-crossover design was used in the study the direct effect of gender could not be estimated. Consequently, we did not comment on the overall incident rate differences between the genders. We considered the interaction effect between PM10 and gender in our model (excluding pre-schoolers) and did not detect a significant effect (p-value \approx 0.4). This was mentioned briefly in the manuscript.

Other important risks than PM exposure for asthma exacerbations exist, which were not accounted for. Effects of temperature, humidity and in particular aeroallergens were not included in the model and such effects are likely to vary with time so that the case-crossover does not outbalance them. This weakens the results and should be discussed.

Response: The case-crossover design applied here, to some extent, controls for larger, seasonal environmental effects. The controls are selected to fall within the same 28-day window as the case. Larger temperature changes associated with seasons and seasonal aeroallergens can be controlled in this manner. High-frequency changes may not be balanced with the case-crossover format so that some environmental effects (but usually lesser effects) such as temperature or humidity changes within a month may not be controlled. A paragraph from the introduction (lines 94-115) is revised in order to explain better our consideration to use only PM10 concentrations in this study. “A review of historical data of “criteria” pollutants in metropolitan Phoenix shows that PM10 and 8-h ozone concentrations sometimes exceed the NAAQS, but that the two pollutants exhibit distinct seasonal differences. Elevated concentrations of ozone occur in the summer, when PM10 concentrations are at their lowest. Conversely, in the winter ozone concentrations are low, while PM10 concentrations are at their highest. Asthma incidences, expressed as emergency visits and hospitalizations, exhibit the same winter-summer dichotomy as PM10 concentrations, suggesting that of the two pollutants, the major asthma trigger is PM10, not ozone. Other well-known asthma

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triggers, such as temperature, humidity, and aeroallergens, were eliminated from consideration in this work for the following reasons. The winter temperature regimes in Phoenix are of two types: (1) warm, sunny days with light winds and with clear cold nights, brought on by strong high pressure systems and (2) windier, cloudy days, with relatively high humidity and with not infrequently with some precipitation, associated with the passage of Pacific cold fronts. Periods of high pressure dominate throughout the winter, with the "cold-front" weather comprising a small minority of the days (less than 30% of the days). Elevated PM₁₀ concentrations occur only in the first regime. Even though elevated humidity may itself act as an asthma trigger, the warning system envisioned in this work is necessarily dependent on continuous monitoring of particulates concentrations. As far as aeroallergens are concerned, heavily pollinating trees and shrubs are rare in the desert winter; moreover, their concentrations can only be determined through grab sampling with subsequent microscopic analysis."

It is stated in the paper that the goal is "to clarify the association of asthma incidents (primarily emergency department visits and hospital admissions with a diagnosis of asthma)". In the text, however, the word incidence is used, though it would be more appropriate to use "emergency visits and hospitalisations". Distinguishing between these is not necessarily trivial, as the differences observed could be related to changed severity rather than changed incidence of asthma.

Response: The following sentence (lines 145-148) has been corrected to clarify the meaning of asthma incidents. "The goal of this study is to clarify the association of incidents of asthma attacks (as identified by the primarily emergency department visits and hospital admissions; however for brevity are called asthma incidents further) with elevated concentrations of particulate matter 10 microns and smaller (PM₁₀)." [the word incidents was borrowed mainly during discussions with the EPA officials].

Differences in behaviour such as spending more time outdoors or turning on air conditioning are likely to affect the incidence of asthma attacks and hospitalisations and could affect whether PM₁₀, ozone or another pollutant is found to be most strongly

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associated with the disease. These issues are not discussed either.

Response: We agree with the referee that differences in behavior are an important factor. Several potential primary and secondary effects were considered in case-crossover study (paragraph 2.5). Secondary effects were the covariates of age, gender, ethnicity, and place of service. Age is encoded into four categories: 0-4, 5-9, 10-14, and 15-17 years. Our study was emphasized on childhood because of very high number of emergency department visits and hospital admissions in this group (fig. 6) and a specific goal to apply the results of this investigation for warning system development to alarm school authorities. The main findings consider one specific category childhood population excluding the preschool group (age 5-17) and it is an evidence of the effect of behavior differences and unquantified factors. We consider only PM₁₀, because it is the only criteria pollutant of importance in this study case (exceeded NAAQS).

Despite the long introduction (which could be shortened, in my opinion) there is no strong evidence that PM₁₀ is the most important causative pollutant. The purpose of the study is to support development of a future warning system. In this respect, the focus on PM₁₀ may be well chosen. The study does not address other pollutants and could thus not inform decision makers on whether PM₁₀ warning is more efficient than, e.g. ozone or whether there is a risk of false sense of security among asthmatics with a PM₁₀ warning system not warning on "low PM₁₀ high ozone days". In my view, the manuscript in its current form is unbalanced in favour of PM₁₀. A warning system not integrating aeroallergens, weather and possibly ozone may not give best value for the money.

Response: We acknowledge that other factors may have been missed and hopefully these will be addressed in the future studies. Some of these factors are correlated with each other, and hence one may be a surrogate for others. For example, dry cold fronts that typically move through southern Arizona in the spring have high wind speeds and hence high PM₁₀ concentrations from wind-blown dust. Nonetheless, these episodically elevated PM₁₀ concentrations in March and April do not coincide

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with peaks in asthma incidents, which tend to occur most prominently in the stagnant conditions that prevail in November through January. A paragraph in the introduction (lines 94-115) is revised (please, see above), and we hope that it provides stronger evidence why PM10 is the most important causative pollutant.

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