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Short communication

Impact of the 1998 Gobi dust event on hospital admissions in the Lower Fraser Valley, British Columbia

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Abstract

The adverse public health impacts of anthropogenically derived particulate matter have been well documented, with measurable increases in both morbidity and mortality rates associated with high particulate matter pollution events. Most current research has focussed on the health impacts of anthropogenically derived particulate matter, and there is a distinct scarcity of literature that examines the role of naturally derived particulate matter and adverse health impacts in the urban context.

This study of a Gobi desert dust event in the Greater Vancouver region of British Columbia, Canada, in spring of 1998 provided a unique opportunity to identify the adverse health effects related to naturally derived particulate matter in a large urban setting. Respiratory and cardiac hospitalizations were examined for a three-year period (January 1997 to December 1999), with the Gobi dust event occurring in late April 1998. A meteorological analogue was identified for spring 1997 in order to identify the public health impacts associated with anthropogenically derived particulate matter and those impacts associated with the presence of the Gobi desert dust.

Results indicate that this Gobi dust event was not associated with an excess of hospitalizations in the Greater Vancouver region. Peak particulate matter concentrations of Gobi desert dust in the airshed were only associated with an additional one or two hospitalizations per 100,000 population for respiratory and cardiac illnesses, and these increases were not distinguishable from the 'normal' variability in hospitalization rates.

Despite high particulate matter concentrations, fine particle size, presence of heavy metals in the dust and extended exposure periods, it appears that the Gobi desert dust event was not associated with significant risk to public health in Greater Vancouver, British Columbia. Therefore it is concluded that naturally derived particulate matter is more benign than particulate matter of anthropogenic origin, and thus poses a low risk to health for the general public.

1. Introduction

Studies of the impact of particulate matter (PM) on human health are broadly consistent in demonstrating increases in both morbidity and mortality rates in the general population during episodes of elevated PM pollution. Although there are multiple adverse health

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effects associated with PM pollution, the majority of effects fall into the broad categories of respiratory and cardiac illnesses, and range from relatively minor irritation to hastened death (Bates et al., 1990; Brauer et al., 2001; Dockery et al., 1993; Pope et al., 1995; Schwartz et al., 2002; Schwartz, 1995; Schwela, 2000; Stieb et al., 2000; Tolbert et al., 2000). There is much debate in the literature on the extent to which particle concentration, composition and/or size has the most deleterious effect on human health, and at what scales such an effect is observable. Particles produced by combustion processes seem to be more consistently pathogenic than crustal particles (naturally generated by mechanical processes and mobilised as "dust" by wind at the earth's surface), but it is not clear whether this is due to the chemical characteristics of particles, or the fact that combustion particles are typically in the fine fraction range (<2.5 μm in aerodynamic diameter) of PM, whereas crustal particles are typically more coarse (Lighty et al., 2000; Schwartz et al., 1996; Vedal, 1997). In recent years, the case has been made that $PM_{2.5}$ may be the component of PM responsible for more adverse health effects, primarily because this smaller size fraction is able to penetrate deeper into the respiratory system, and with far greater efficiency than particles of 2.5–10 μm in diameter (Burnett et al., 2000; Harrison and Yin, 2000; Loomis, 2000; Schwela, 2000; Vedal, 1997).

The majority of health-related PM research has focussed on impacts related to anthropogenically generated PM, while relatively little work has examined the impacts of naturally generated PM, particularly that emanating from large biochemical events such as volcanic eruptions, large-scale biomass burning and dust storms. However, there is a small but growing body of literature that examines the impact of desert dust on urban areas in Taiwan and Korea, which are impacted on a seasonal basis by Asian desert dust. For example, Chen et al. (2004) studied the effects of Asian dust storms on daily mortality rates in Taipei City, Taiwan, for 39 dust events between 1995–2000 in which 24-h average PM_{10} levels were 126±34 μg m^{-3}. Overall, this research found that each 10 μg m^{-3} increase in PM_{10} from an Asian dust event was associated with 0.72% average increase in the all-cause mortality rate. Similar results were found in a study by Kwon et al. (2002) for Seoul, Korea. In the US, Ostro et al. (1999) found that a 10 μg m^{-3} increase in PM_{10} dominated by crustal particles was associated with an approximately 1% increase in mortality, which is in line with many other PM studies to date, and a follow-up study (Ostro et al., 2000) found similar results with $PM_{2.5}$. Hefflin et al. (1994) found small, yet positive, associations between natural dust storms in Washington State and emergency room visits for bronchitis and sinusitis. Other human diseases linked to the inhalation of desert dust are "Desert Storm Pneumonitis" and "Desert Lung Syndrome" (Griffin et al., 2001). In contrast, Laden et al. (2000) and Schwartz et al. (1999) found no associations between crustal $PM_{2.5}$ and daily mortality, or windblown dust (PM_{10}) and mortality risk, respectively.

In this short communication, we focus on the health impacts of an extraordinary dust event in which crustal material from a Gobi desert dust storm was transported across the Pacific and impacted western North America for several days in the spring of 1998 (Husar et al., 2001). In so doing, our intention is to contribute to the debate on the relative importance of particle size and origin on the health impacts of PM. Specifically, was the extraordinary event of 1998, in which a high proportion of PM was composed of fine crustal material, detectable as an upswing in hospital admissions for cardiac and respiratory related morbidity in the region? In addressing this question, several aspects of this study are worthy of note:

- The Asian dust that reached North America was rich in crustal elements such as silicon, aluminium, calcium and iron (McKendry et al., 2001) and was relatively fine (mean diameter 2.5 μm; Husar et al., 2001) due to its considerable distance from source. Consequently, given the assertion that it is fine material that is most deleterious to health, an observed lack of effect in this case would support the argument that crustal material is relatively benign.
- PM concentrations in the Lower Fraser Valley (LFV) of British Columbia were elevated to hourly values in excess of 100 μg m^{-3} and daily averages several times greater than normal, with an east-to-west gradient along the valley axis. PM levels remained elevated for approximately four days, with daytime peaks and night-time minima (a function of downmixing and transport processes, as discussed in Husar et al. (2001) and McKendry et al. (2001)). This constituted a sustained and singular event that might therefore be expected to elicit a measurable response in a susceptible population.
- Meteorological conditions during the LFV PM event were virtually identical to a spring analogue in 1997. During the two episodes, concentrations of pollutants other than PM were remarkably similar. As such, comparison of hospitalization rates with the analogue offered an approximation to a "natural experiment".
- An essentially complete hospitalization database, compiled through the centralised organization of