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Association between Air Quality and Hospital Visits — Fairbanks, 2003–2008

Background

Particulate matter (PM) is an important source of air pollution that is made up of solid and/or liquid matter such as dust, metals, smoke, soot, and organic compounds. Exposure to elevated ambient concentrations of PM ≤2.5 µm in diameter ($PM_{2.5}$) has been associated with adverse cardiovascular and respiratory health events.[1] Common sources of $PM_{2.5}$ air pollution include emissions from combustion processes (e.g., from power plants and automobiles) and from wood smoke. The Clean Air Act requires the US Environmental Protection Agency (EPA) to set regulatory standards for air pollutants. In 2006, EPA lowered the 24-hour $PM_{2.5}$ standard from 65 µg/m^3 to 35 µg/m^3.[2] EPA designates areas as "nonattainment" if they do not meet current regulatory $PM_{2.5}$ standards; nonattainment areas are subject to further regulatory requirements.[2] In 2009, EPA designated an area within the Fairbanks North Star Borough (FNSB) as a $PM_{2.5}$ nonattainment area based on air quality data collected from 2006 to 2008.[3]

We reviewed Fairbanks Memorial Hospital (FMH) data and FNSB $PM_{2.5}$ air monitoring data to determine if increases in $PM_{2.5}$ concentrations were associated with increases in hospital visits for selected cardiac and respiratory conditions.

Methods

De-identified data on patients with selected ICD-9 codes were obtained from the Alaska Hospital Discharge Dataset (HDDS) for FMH admissions from September 2003 to December 2008 and emergency room visits from January 2008 to December 2008 (Table). Variables included age, primary diagnosis, and date of hospital visit. Hourly $PM_{2.5}$ concentration data collected from September 2003 to December 2008 were obtained from the FNSB Air Quality Program.

Using a case-crossover study design,[4] daily 24-hour average $PM_{2.5}$ concentrations on the day of, 1 day prior to, and 2 days prior to a hospital visit were compared to $PM_{2.5}$ concentrations on reference days. For each hospital visit day, three reference days were selected; reference days were defined as the first 3 days during the month of the hospital visit that occurred on the same day of the week as the visit, excluding the day of the hospital visit (e.g., if the hospital visit occurred on Monday the 8th of a given month, the three reference days were Monday the 1st, 15th, and 22nd). When cases had multiple hospital visits during a 1-month time period, only the first hospital visit was included in the analysis. Conditional logistic regression was used to determine if the risk of a hospital visit increased as the mean 24-hour $PM_{2.5}$ level increased.[4] Models were stratified by age (i.e., <65 years and ≥65 years). Statistical analyses were conducted in *R* (version 2.11.1).

Table. Number of Patients and Ages by ICD-9 Code — Fairbanks Memorial Hospital, 2003–2008

ICD-9 Code	*Health Condition Group*	*N**	*Mean Age (SD†) in Yrs*
410–414	Ischemic heart disease	661	62 (12)
426–429	Conduction disorders, cardiac dysrythmias, heart failure, ill-defined descriptions of heart disease	1,097	66 (16)
430–438	Cerebrovascular disease	443	67 (15)
440–448	Diseases of arteries, arterioles and capillaries	67	59 (25)
464–466	Respiratory tract infections	884	23 (24)
480–487	Pneumonia, influenza	1,434	44 (31)
490–492	Bronchitis, emphysema	545	60 (20)
493	Asthma	587	30 (24)

**Number of hospital visits (i.e., hospitalizations and emergency room visits)*
†*Standard deviation*

Results

A total of 5,718 hospital visits consisting of 1,596 emergency room visits and 4,122 hospitalizations were analyzed (Table); the mean 24-hr $PM_{2.5}$ level was 20.1 µg/m^3 (range: 0.2–673.8 µg/m^3).

Hospitalizations for the following health conditions were statistically associated with increased mean 24-hr $PM_{2.5}$ levels: for each 10 µg/m^3 increase in the mean 24-hr $PM_{2.5}$ level 1 day prior to a hospital visit, there was a 7% increased risk for a cerebrovascular disease-coded visit in persons aged <65 years ($P<0.05$; 95% confidence interval [CI]: 1%–12%); a 6% increased risk for a cerebrovascular disease-coded visit in persons aged ≥65 years ($P<0.05$; 95% CI: 1%–12%); and a 6% increased risk for a respiratory tract infection-coded visit in persons aged <65 years ($P<0.05$; 95% CI: 1%–11%).

Discussion

These data indicate that increased concentrations of ambient $PM_{2.5}$ levels in FNSB were associated with increased risk of hospitalizations due to cerebrovascular disease in all persons and respiratory tract infections in persons aged <65 years during the study period.

Limitations to this evaluation include the following: 1) the sample size was small as compared to similar studies performed elsewhere, limiting the power of the study; 2) air quality data came from one station in downtown Fairbanks, and may not be representative of air quality throughout FNSB; 3) several hospital visits were excluded from the analysis due to missing 24-hour $PM_{2.5}$ data, 4) potential confounders, such as temperature and humidity, were not included in the model, though they were somewhat controlled for by the case-crossover study design,[5] and 5) this study focused on hospital visits for the selected conditions, but not ambulatory visits and thus might have underestimated the impact of elevated $PM_{2.5}$ on health outcomes that might be more likely to be addressed in an ambulatory care setting (e.g., asthma exacerbations).

These results are consistent with other studies conducted in the United States using similar methods that show associations between short-term PM exposure and hospitalization for cardiovascular and respiratory events.[1,5]

Recommendation

Health care providers should encourage patients at risk for cardiovascular or respiratory disease exacerbations due to elevated $PM_{2.5}$ levels to monitor air quality levels and follow the standardized health advice appropriate for their risk group provided during air quality alerts. Air quality information is available by telephone at 907-459-1312 for FNSB, 907-343-4899 for Anchorage, and 907-269-7676 for the rest of Alaska.

References

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