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Short-term associations of ambient air pollution and cause-specific emergency department visits in Guangzhou, China

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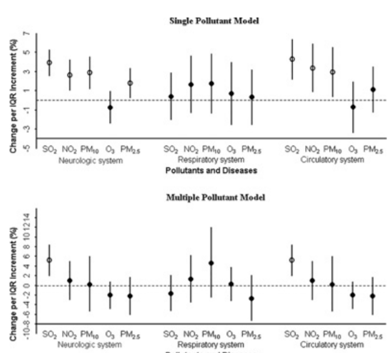
HIGHLIGHTS

- Short-term associations of air pollution and emergency department visits (EDVs) were assessed.
- Associations between SO_2 exposure and EDVs of neurologic and circulatory diseases were significant.
- Most positive associations were observed in the cold season.

GRAPHICAL ABSTRACT



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ABSTRACT

Background: Evidence of association of ambient air pollution with cause-specific emergency department visits in China is still limited. This study aimed to investigate short-term associations between exposures to air pollutants and daily cause-specific emergency department visits using a large-scale multicenter database involving a total of 65 sentinel hospitals in Guangzhou, the most densely-populated city in south China, during 2013–2015.
Material and methods: We obtained data on 162,771 emergency department visits from 65 hospitals from the Emergency Medical Command Center in Guangzhou between January 1, 2013 and December 31, 2015. Daily air pollution data on particulate matter (PM) of aerodynamic diameter < 10 and 2.5 μm (PM_{10}, and $PM_{2.5}$, respectively), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and ozone (O_3) were collected from the Daily Quality Report of the Guangzhou Environmental Protection Bureau during the study period. Visits for neurologic, respiratory and circulatory diseases were assessed in relation to air pollutants using Poisson generalized additive models.
Results: Mean daily number of emergency department visits for neurologic, respiratory and circulatory diseases was 89, 24 and 35, respectively. After adjustment for other pollutants ($PM_{2.5}$, PM_{10}, NO_2 and O_3), meteorological factors and time-varying confounders, a 7.98-μg/m^3 (interquartile range) increment in 2-day moving average of same-day and previous-day SO_2 concentrations was associated with the statistically significant increase of 4.89% (95% confidence interval: 2.86, 6.95) in neurologic emergency department visits; elevation in SO_2 level (per 7.98 μg/m^3) was linked to a 5.19% (95% confidence interval: 2.03, 8.44) increase in circulatory emergency department visits. Most positive links were seen during the cold season.

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Conclusions: The results of this study contribute to the evidence of the significant associations between SO_2 and specific neurologic and circulatory conditions, and also provide insight into the planning of clinical services and emergency contingency response for air pollution exposures in Guangzhou.

1. Introduction

An increasing number of studies have documented the elevated risk of cardiovascular diseases linked to the exposure to ambient concentrations of particulate matter (PM) in recent years (Huang et al., 2016; Alessandrini et al., 2013; Kan et al., 2008; Wang et al., 2014). However, with respect to the association between the exposure to PM and the morbidity and mortality of cardiovascular disease, significant heterogeneity in risk estimates were suggested (Alessandrini et al., 2013; Slaughter et al., 2005; Szyszkowicz, 2009; Kloog et al., 2012). In China, recent studies from Beijing city have investigated the effects of elevated concentrations of PM, sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and ozone (O_3) on the emergency hospital admissions for diseases such as stroke and hypertension, and identified the adverse health effects of air pollution (Huang et al., 2016; Guo et al., 2010). Another study conducted in three northeastern Chinese cities found significant associations between PM with aerodynamic diameter ≤ 10 μm (PM_{10}) and SO_2 levels and stroke prevalence (Dong et al., 2013).

As for southern Chinese cities, several epidemiologic studies examined the effects of ambient air pollutants on daily mortality in Guangzhou (Yu et al., 2012; Yang et al., 2012; Li et al., 2016). These early time-series studies mainly focused daily mortality of diseases as outcome events to examine the adverse health effects of ambient air pollution. However, more precise effect estimates of air pollution exposure on the attack risks of different diseases have been limited by study size and available air quality data in China. Although early air pollution studies conducted in China identified evidence of adverse health effects of air pollution, more refined assessment including analysis of subgroups defined by specific illness or of air pollution components has been limited by routinely available health outcome and air-quality datasets. Hence, the overall epidemiologic evidence of adverse health effects of air pollution based on a relatively large number and high quality of daily air pollution surveillance and health outcome records are needed to enhance our understanding of air pollution–related health effects in China.

Guangzhou, a provincial capital, has a population of roughly 13.5 million in 2015 and one of the most densely populated cities in China. As industrial production and traffic within Guangzhou continue to increase, more people are suffering from shortness of breath, coughing, dizziness and related diseases. Guangzhou is a coastal urban city on the boundary region of the Asian continent and the Pacific Ocean. Waste gas pollution from all kinds of vehicles has become one of the main atmospheric polluters in Guangzhou, and its air pollution levels are generally worse than ambient air quality standards for USA, Hong Kong and European Union (Zhou et al., 2007), posing a serious public health threat for the local residents. In Guangzhou, air pollution components originate from several major emissions, such as motor vehicles, petrochemical, automobile and electronics manufacturing units in the densely industrialized Pearl River Delta region (Verma et al., 2010). However, individual air pollution components responsible for adverse health effects and thorough assessment including analysis of subgroups defined by specific illness have rarely been examined in Guangzhou.

Therefore, this present study aimed to investigate short-term associations between exposures to ambient air pollutants including PM with aerodynamic diameter ≤ 2.5 μm ($PM_{2.5}$), PM_{10}, O_3, SO_2 and NO_2 and daily cause-specific emergency department visits using a large-scale multicenter database involving a total of 65 sentinel hospitals as monitoring sites in Guangzhou, China, during 2013–2015.

2. Methods

2.1. Data

Daily air pollution data on $PM_{2.5}$, PM_{10}, SO_2, NO_2 and O_3 were obtained from the Daily Quality Report of the Guangzhou Environmental Protection Bureau between January 1, 2013, and December 31, 2015. 24-hour samples of $PM_{2.5}$, PM_{10}, SO_2 and NO_2 and 8-hour samples of O_3 were collected at 36 general air quality monitoring stations (Fig. 1). Daily 24-hour average concentrations of $PM_{2.5}$, PM_{10}, SO_2 and NO_2 and the maximum 8-hour mean concentration of ozone were calculated at the same monitoring stations. Of the 1095 days in the study period, the $PM_{2.5}$, PM_{10}, SO_2, NO_2 and O_3 concentration data had missing values for the first 36 days (3.29%) in 2013, and the missing values for each pollutant were estimated using month-specific series medians, respectively. All pollutant concentrations are expressed in micrograms per cubic meter (μg/m^3).

We obtained daily mean ambient temperature (in degrees Celsius), relative humidity and wind speed data from the China Meteorological Data Sharing System (http://cdc.nmic.cn/home.do) for the same study period. Daily data of mean temperature, relative humidity and wind speed representing the average exposures of temperature, relative humidity and wind speed throughout the 24-hour period was used to account for the potential confounding effects in the models established.

We obtained daily counts of emergency department visits from the Guangzhou Emergency Medical Command Center between January 1, 2013 and December 31, 2015. At present, the Guangzhou Emergency Medical Command Center covered a total of 65 sentinel hospitals as monitoring sites of emergency department visits. These hospitals provide 24-hour accident and emergency services, and represent a majority of the hospital beds that serve Guangzhou residents (Fig. 1). We considered hospitalizations for all neurologic causes (International Classification of Diseases, Tenth Revision, ICD-10: codes G00–G99), respiratory causes (ICD-10: codes J00–J99) and circulatory causes (ICD-10: codes I00–I99). A sequence of systematic quality control of data was performed during data management. Data entry was done by trained staff in a private medical service unit. A double entry strategy was carried out to input data to reduce errors. Two independent investigators inspected all data of emergency department visits to ensure that patients who transferred between hospitals were treated as only one visit. Repeat visits within a single day were counted as a single visit.

2.2. Statistical analysis

Because each monitoring station respectively collected $PM_{2.5}$, PM_{10}, SO_2, NO_2 and O_3 samples, we applied a centering method to compute the territory-wide mean concentrations of each study pollutant to remove the station-specific influence on the measurements of each pollutant. We calculated the territory-wide mean concentrations of each pollutant by using the following steps: first, calculating the annual mean (X_i) for each monitoring station i; second, subtracting the annual mean from the daily mean concentration for station i on each sample day j (X_{ij}); third, adding the annual mean of all stations (X) to the resulting centered values ($X_{ij} - X_i$) for each station and sampling day to produce $X''_{ij} = X_{ij} - X_i + X$; and finally taking the average of X''_{ij} over all stations. These steps were proposed in previous studies (Wong et al., 2001; Pun et al., 2014).