Assessment of Effects of Air Pollution on Daily Outpatient Visits using the Air Quality Index

Haosheng Mu,* Shinji Otani,† Mikizo Okamoto,‡ Yae Yokoyama,* Yasuko Tokushima,§ Kazunari Onishi,* Takenobu Hosoda* and Youichi Kurozawa*

**Division of Health Administration and Promotion, Department of Social Medicine, School of Medicine, Tottori University Faculty of Medicine, Yonago 683-8504, Japan, †Division of Surgical Oncology, Department of Surgery, School of Medicine, Tottori University Faculty of Medicine, Yonago 683-8504, Japan, ‡Cancer Center, Tottori University Hospital, Yonago 683-8504, Japan and §Department of Nursing Care Environment and Mental Health, School of Health Science, Tottori University Faculty of Medicine, Yonago 683-8503, Japan*

ABSTRACT

Background The air quality index (AQI) is widely used to characterize the quality of ambient air. Chinese cities officially report the AQI on a daily basis. To assess the possible effects of air pollution on daily outpatient visits, we examined the association between AQI and the daily outpatient count.

Methods Daily data on outpatient visits to each clinical department were collected from the Z county hospital of Datong City, China. The collection period was between 5 April and 30 June, 2012. Daily AQI data and meteorological information were simultaneously recorded. We compared outpatient counts between the index days and comparison days, and calculated Pearson's product moment correlation coefficient between outpatient counts and AQI levels.

Results The average AQI level for index days was significantly higher than that for comparison days. No significant difference was observed in temperature or relative humidity between index days and comparison days. The outpatient counts for pediatrics were significantly higher on index days than on comparison days, and no significant difference was noted in other clinical departments. The outpatient counts for pediatrics positively correlated with the AQI level, and no correlation was noted in other clinical departments.

Conclusion The present study assessed the association between daily outpatient visits and air pollution using AQI. The results obtained suggest that air pollution could increase the outpatient count for pediatrics.

Key words air pollution; air quality index; daily outpatient visit

The World Health Organization estimated that more than 2 million deaths annually could be attributed to air pollution, half of which occurred in the developing world.[1] Ambient air pollution is one of the major environmental problems in China, and from January 2013, a large area around Beijing has had the worst air quality, with the Beijing Environmental Protection Bureau recording peak hourly $PM_{2.5}$ (particulate matter with aerodynamic diameters less than 2.5 μm) above 400 μg/m^3 on 12 January, 2013.[2] Previous studies reported that an elevated level of ambient air pollution increased the risks of mortality and morbidity.[3, 4]

The air quality index (AQI) is widely used to characterize the quality of ambient air. AQI values are generally divided into ranges assigned with certain public health messages, mainly in order to meet air quality management objectives.[5] Chinese cities started to officially report the Air Pollution Index (API) on a daily basis from 2000. The existing API is a variant of AQI, which was adopted from 2012. The breakpoints for AQI values are 50, 100, 150, 200 and 300, with an individual score being assigned to the level of each pollutant. Higher numerical values indicate increasingly serious pollution, with values more than 100 representing an unhealthy environment for sensitive groups. This index involves PM_{10}, $PM_{2.5}$, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and ozone (O_3). Acute exposure to these pollutants has been associated with increased adverse health endpoints such as increased cardiorespiratory mortality and morbidity rates in several large multicity studies in Europe, North America, and Asian cities.[6–9] However, few studies have evaluated morbidity risks using the AQI. The objective of this study was to assess the association between AQI and daily outpatient visits.

SUBJECTS AND METHODS

Data sources

We chose Z county of Datong city as our study site. Z county, which is located in the northern part of Datong city, China, is well-known for its coal mining industry. Therefore, some industrial pollutants in this district are caused by coal particles and carbon dioxide (CO_2). It is an ideal candidate site to study the effects of air pollu-

Corresponding author: Haosheng Mu, MD
muhs@med.tottori-u.ac.jp
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Abbreviation: AQI, air quality index

tion on health. The county covers an area of 137.58 km^2 and has a population of 55,031. There are two general hospitals and 23 clinics in this county. Because the county is near Datong, patients also went to the hospitals in Datong City in the case of serious illness.

We chose the biggest county hospital as our research organization. The counts of total daily outpatient visits were provided by the county hospital. The study subjects were all people who came to each clinical department including respiratory medicine, pediatrics, dermatology, ophthalmology, and otorhinolaryngology. Surgery, cardiology and gastroenterology were excluded. The survey period was between 5 April, 2012 and 30 June, 2012. The air pollution occurs frequently in the winter season. This survey was to be conducted in spring season, because air pollution occurs sometimes during this time, and the relations with the outpatient visits are easy to be found. Daily AQI data and daily information on temperature (°C) and relative humidity (%) were released at the Datong Environmental Monitoring Center[10] and China Meteorological Administration,[11] and were simultaneously collected from the website.

Statistical analysis

There were 14 clinic holidays between 5 April and 30 June, 2012; therefore, there were 73 days for the analysis. In total, 6 air pollution days (AQI values more than 100) were noted. The effects of air pollution, if any, can be delayed over a period of several days. To test this hypothesis, we examined the effects on the same day, and 1 and 2 days after the air pollution days, and these days were defined as index days.

Outpatient counts on the index days were compared with outpatient counts on the comparison days (days except the index days) in the primary analysis. T tests were used to make comparisons between index days and comparison days because these parameters were normally distributed. Pearson's product moment correlation coefficient was used to determine the correlation between outpatient counts and AQI levels. All data analyses were performed using SPSS version 19.0 (IBM SPSS, Chicago, IL), and a significance level of 5% was used.

Table 1. Average values of the air quality index (AQI), temperature, and relative humidity on index and comparison days

Variable	Index days ($n = 16$)	Comparison days ($n = 57$)
AQI	88.3 ± 49.2**	48.9 ± 18.5
Temperature (°C)	13.5 ± 3.7	14.7 ± 3.8
Humidity (%)	36.2 ± 12.8	41.8 ± 19.6

Values are mean ± SD.
**Significant difference in comparison days ($P < 0.01$).

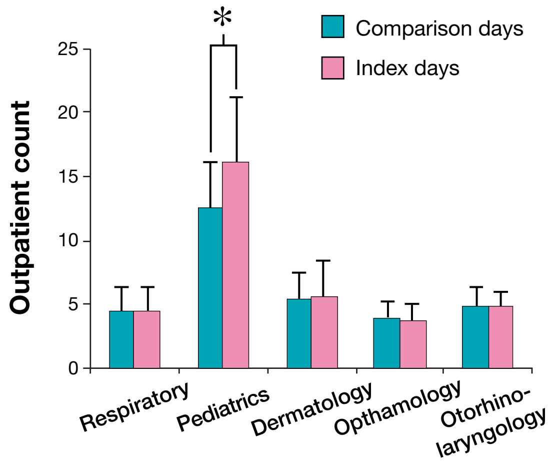

Fig. 1. Comparison of outpatient count in each clinical department between index days and comparison days. *$P < 0.05$.

RESULTS

Table 1 shows the average values of AQI levels, temperature and relative humidity for index days and comparison days. The average AQI level for index days was significantly higher ($P < 0.01$) than that for comparison days. No significant difference was observed in temperature or relative humidity between index days and comparison days.

Figure 1 shows the distribution of outpatient counts in each clinical department between index days and comparison days. The outpatient counts for pediatrics on index days (16.13 ± 5.12) was significantly higher than that on comparison days (12.47 ± 3.74; $P < 0.05$), and no significant difference was noted in other clinical departments.

The correlation coefficients between AQI levels and respiratory medicine, pediatrics, dermatology, ophthalmology and otorhinolaryngology outpatient counts were 0.030, 0.387, 0.012, –0.050 and 0.120, respectively. The outpatient count for pediatrics correlated with the AQI

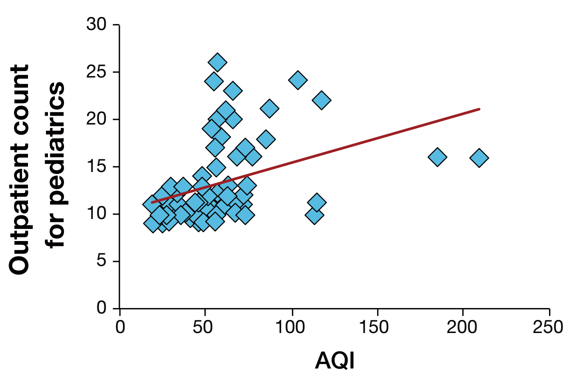

Fig. 2. Correlation between the outpatient count for pediatrics and the air quality index levels ($R^2 = 0.150$, $P < 0.01$). AQI, air quality index.

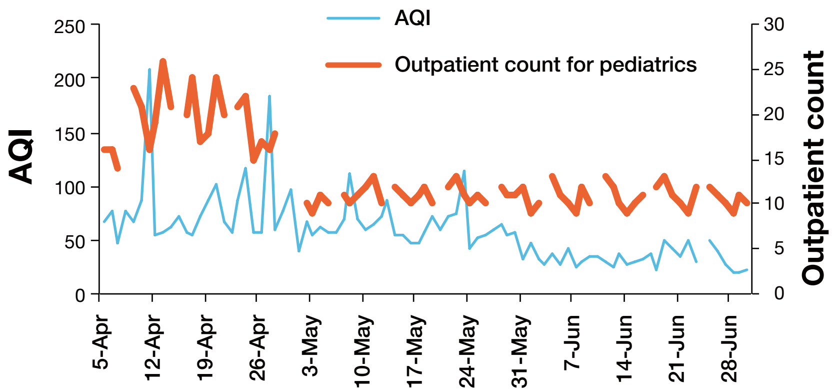

Fig. 3. Time-series of AQI and the outpatient count for pediatrics from 5 April, 2012 to 30 June, 2012 (blanks in the line of outpatient count for pediatrics, off days of the hospital). AQI, air quality index.

level (R^2 = 0.150; P < 0.01; Fig. 2). Time-series of AQI and the outpatient count for pediatrics from 5 April, 2012 to 30 June, 2012 is presented in Fig. 3.

DISCUSSION

Numerous recent studies have assessed the adverse effects of air pollution on elderly people and patients with chronic disease, including mortality, hospital admissions, and emergency hospital visits.[12–15] This study assessed the possible effect of air pollution on the health of the general population according to daily outpatient counts.

The results obtained revealed a correlation between AQI and the outpatient count for pediatrics, which indicated that air pollution increased the outpatient count for pediatrics. A number of epidemiological studies demonstrated that exposure to air pollution causes an increase in respiratory diseases.[16–19] Other studies showed that respiratory defenses became compromised, respiratory resistance decreased, and respiratory inflammation occurred after a child inhaled particulate matter comprising SO_2, Nox and O_3.[20–22]

Children have the following characteristics: A, they are more active than adults; B, they breath more air per body weight than adults; C, their respiratory organs are still developing; and D, the asthma ratio is higher than that in adults. Therefore, children are at a higher risk of developing disorders associated with air pollution than adults. Li and co-authors concluded that increases in PM_{10}, NO_2 and O_3 pollution levels could lead to a corresponding increase in the hospitalization of children.[23] Our result supports this finding. Children will need to take some preventive action such as wearing a mask and the closure of schools due to air pollution based on the AQI level in everyday life.

There are several limitations to the present study. Firstly, both occupational exposure and indoor air pollution, such as smoking, fuel used for cooking and heating in households, are confounding factors. The present study assumed that all individuals were equally and evenly exposed to particulate matter derived from outdoor air pollution and occupational and indoor personal exposures were considered to be either marginal or constant over time. Secondly, each pollutant (e.g., $PM_{2.5}$, NO_2 and SO_2) and meteorological variables (e.g., atmospheric pressure) also may have effect on the outpatient visits. These factors were not considered in this study. Finally, because this study only included one hospital, the sample size was small. These limitations may have resulted in some bias in the magnitude of the relationship between air pollution and human health outcomes; however, we expect that the general trends found in the present study would be unchanged.

In the present study, we assessed the association between daily outpatient visits and air pollution using AQI. The results obtained suggest that air pollution could increase the outpatient count for pediatrics.

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The authors declare no conflict of interest.

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