Air Pollution and Case Fatality of SARS in the People's Republic of China

Yan Cui[1], MD, MS, Zuo-Feng Zhang[1], MD, PhD, John Froines[2], PhD, Jinkou Zhao[3], MD, PhD, Hua Wang[3], MD, Shun-Zhang Yu[4], MD, MPH, Roger Detels[1], MD, MS.

1. Department of Epidemiology, School of Public Health, University of California, Los Angeles, Los Angeles, CA 90095

2. Southern California Particle Center and Supersite, School of Public Health, University of California, Los Angeles, Los Angeles, CA 90095

3. Jiangsu Provincial Center for Disease Control and Prevention, 172 Jiangsu Road, Nanjing 210009,China

4. Department of Epidemiology, School of Public Health, Fudan University, Shanghai 200032, People's Republic of China

Emails: Yan Cui: yancui@ucla.edu; Zuo-Feng Zhang: zfzhang@ucla.edu; John Froines: jfroines@ucla.edu; Jinkou Zhao and Hua Wang: jkzhao@hotmail.com; Shun-Zhang Yu: szyu@shmu.edu.cn; Roger Detels: detels@ucla.edu

Correspondence to

Prof. Zuo-Feng Zhang

UCLA Dept. of Epidemiology

71-225 CHS, Box 951772

10833 Le Conte Avenue

Los Angeles, CA 90095-1772

(310) 825-8418 (Office)

(310) 206-6039 (Fax)

E-mail: zfzhang@ucla.edu

Abstract

Background Severe acute respiratory syndrome (SARS) has claimed 349 lives with 5,327 probable cases reported in mainland China since November 2002. SARS case fatality has varied across geographical areas, which might be explained partially by air pollution level. **Methods** Public accessible SARS data were utilized in the data analysis. Air pollution was evaluated by air pollution index (API) derived from the concentrations of NO2, SO2, PM10, and in some cases CO and O_3. Ecologic analysis was conducted to explore the relationship between air pollution (API) and SARS case fatality. Further analysis focused on comparing fatalities of SARS patients from areas with three levels of air pollution (API<75, 75-99, and >=100). **Results** Ecologic analysis conducted among 5 regions with 100 or more SARS cases showed strong correlation between air pollution index and SARS fatality (Correlation Coefficient=0.8568, p=0.0636). The corresponding fatalities for SARS patients from regions with low, moderate, and high air pollution were 4.08%, 7.49% and 8.90%, respectively. SARS patients had an 84% increased risk of dying from SARS for those from regions with moderate air pollution (RR=1.84, 95% CI: 1.41-2.40) and were twice more likely to die from SARS for those from regions with high air pollution (RR=2.18, 95% CI: 1.31-3.65), compared to those from regions with low APIs. A strong dose-response relationship between air pollution levels and SARS fatality was shown (P for trend < 0.001). **Conclusion** Our study showed that air pollution might be positively associated with SARS case fatality in Chinese population, which deserved adequate evaluation and further investigation.

Background

Severe acute respiratory syndrome (SARS) is an emerging viral infectious disease, which has claimed 349 lives with 5,327 probable cases reported in China since November 2002. SARS case fatality has varied across geographical areas with higher fatality found in the northern areas of China. Although social economic level, availability of health facilities, and clinical practices might be responsible for the geographical difference, air pollution could be an important predictor.

Methods

Public accessible data on SARS morbidity and mortality were utilized in the study.[1,2] Case fatality was estimated by dividing the number of reported deaths by the number of probable cases. Air pollution was evaluated by air pollution index (API) published by the Chinese National Environmental Protection Agency.[3] Daily APIs were derived from the concentrations of NO2, SO2, PM10, and in some cases CO and O_3. API higher than 100 was considered unhealthy for sensitive groups. Since the majority of patients were diagnosed during April and May, the average of daily APIs collected within these two months in each region was used for data analyses. Ecologic analysis was conducted to explore the correlation between air pollution (API) and SARS case fatality. Furthermore, we divided SARS patients into three groups based on their residential air quality. The cut-off points were 75 and 100 of API. Case fatalities of patients from regions with high APIs (API>100) and patients from regions with moderate API (75-100) was compared to that of patients from regions with low API (API<75). The Mantel-Haenszel method was employed to calculate the relative risk (RR) and 95% confidence interval (CI). Trend test was also conducted to investigate whether case fatalities increased with the increase of APIs.

Results

During the outbreak, 5,327 people were diagnosed as SARS probable cases. Among them, 349 died from the disease and the rest recovered, which accounted for the case fatality of 6.55%. The average APIs ranged from 52 to 126 for different regions. Ecologic analysis between API and SARS fatality was conducted for 5 regions with 100 or more SARS cases (Guangdong, Shanxi, Hebei, Beijing, and Tianjin). Inner Mongolia, which had 282 probable cases, was excluded from the analysis due to poor data quality reported by the Chinese Center for Disease Control.[4] 4,870 SARS cases occurred in these five regions, which represented 91.4% of all cases in China. The APIs of Guangdong, Shanxi, Hebei, Beijing, and Tianjin were 75, 95, 98, 99, and 104, and the corresponding fatality were 3.84%, 5.36%, 5.58%, 7.66% and 8%, respectively. There was a strong correlation between air pollution index and SARS fatality (Correlation coefficient=0.8568, p=0.0636). (See figure 1)

1,546 patients came from regions with low APIs, 63 of whom died from SARS. Among 3,590 patients from regions with moderate API, 269 died from the disease. 17 out of 191 patients from regions with high API died also. The corresponding fatalities were 4.08%, 7.49% and 8.90%, respectively. SARS patients from regions with moderate APIs had an 84% increased risk of dying from SARS compared to those from regions with low APIs

(RR=1.84, 95% CI: 1.41-2.40). Similarly, SARS patients from regions with high APIs were twice more likely to die from SARS compared to those from regions with low APIs. (RR=2.18, 95% CI: 1.31-3.65). Trend test showed that SARS case fatality increased with the increase of air pollution level (P for trend <0.001). (See Table 1)

Discussion

Our analyses showed that air pollution was associated with increased risk of dying from SARS. The biological explanation might be that chronic exposure to certain air pollutants could compromise lung function, therefore increasing SARS mortatlity.[5] This study was subject to several limitations. First, we could not assess certain potential confounders such as social economic status, smoking habit, and importantly clinical practice. To be notable, cases from Beijing and Tianjin had relatively higher case fatalities, although these two big cities might have provided better clinical support to SARS patients. If clinical practice confounded the study, the strength of association between air pollution and SARS fatality could have been underestimated. Second, we assumed that air pollution was evenly distributed within each region so that we could use monitoring data colleted within each region as individual’s exposure to ambient air pollutants. Third, ecologic analysis might be subject to ecologic fallacy, which couldn’t be evaluated and excluded by the data available. Nevertheless, this is the first observation showing that air pollution might be associated with increased fatality of SARS patients in Chinese population, which deserves further investigation and might have certain impact on the study of SARS nature history.

Conclusion

Our study showed that air pollution might be positively associated with SARS case fatality in Chinese Population by utilizing public accessible data on SARS statistics and air pollution level. In spite of the presence of certain limitations, it pointed out the potential role of air pollution on the fatality of SARS patients, which deserves adequate evaluation and consideration.

Competing Interests

None Declared

Authors' Contributions

Yan Cui was responsible for data analysis, summarization of results, and manuscript preparation. Zuo-Feng Zhang took the overall responsibility in hypothesis generation, study design, data collection and analysis, and manuscript preparation. John Friones was involved in the generation of hypothesis, interpretation of results, and manuscript preparation. Jinkou Zhao and Hua Wang were involved in data collection and manuscript preparation. Shun-Zhang Yu was involved in generation of hypothesis and study design, and manuscript preparation. Roger Detels was involved in generation of hypothesis and study design, interpretation of results, and manuscript preparation.

Acknowledgements

This work was partially supported by grant number ES 011667 from National Institute of Environmental Health Sciences, CA90833 from the National Cancer Institute, National Institute of Health, Department of Health and Human Services, by the Southern California Particle Center and Supersite, housed in the UCLA School of Public Health and the Institute of the Environment at UCLA, the UCLA Center for Occupational and Environmental Health, and the U.S. Environmental Protection Agency STAR Program (Grant no. R82735201).

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Figure 1. Air Pollution Index and Case Fatality of SARS in People's Republic of China

Table 1. Association between Air Pollution Index and Case Fatality of SARS.

API	Number of Deaths	Number of recovered	Total Number of Cases	Case Fatality	RR & 95% CI
>100	17	174	191	8.90%	2.18 (1.31-3.65)
75-100	269	3321	3590	7.49%	1.84 (1.41-2.40)
<75	63	1483	1546	4.08%	1
Total	349	4978	5327	6.53%	$P_{trend}<.001$

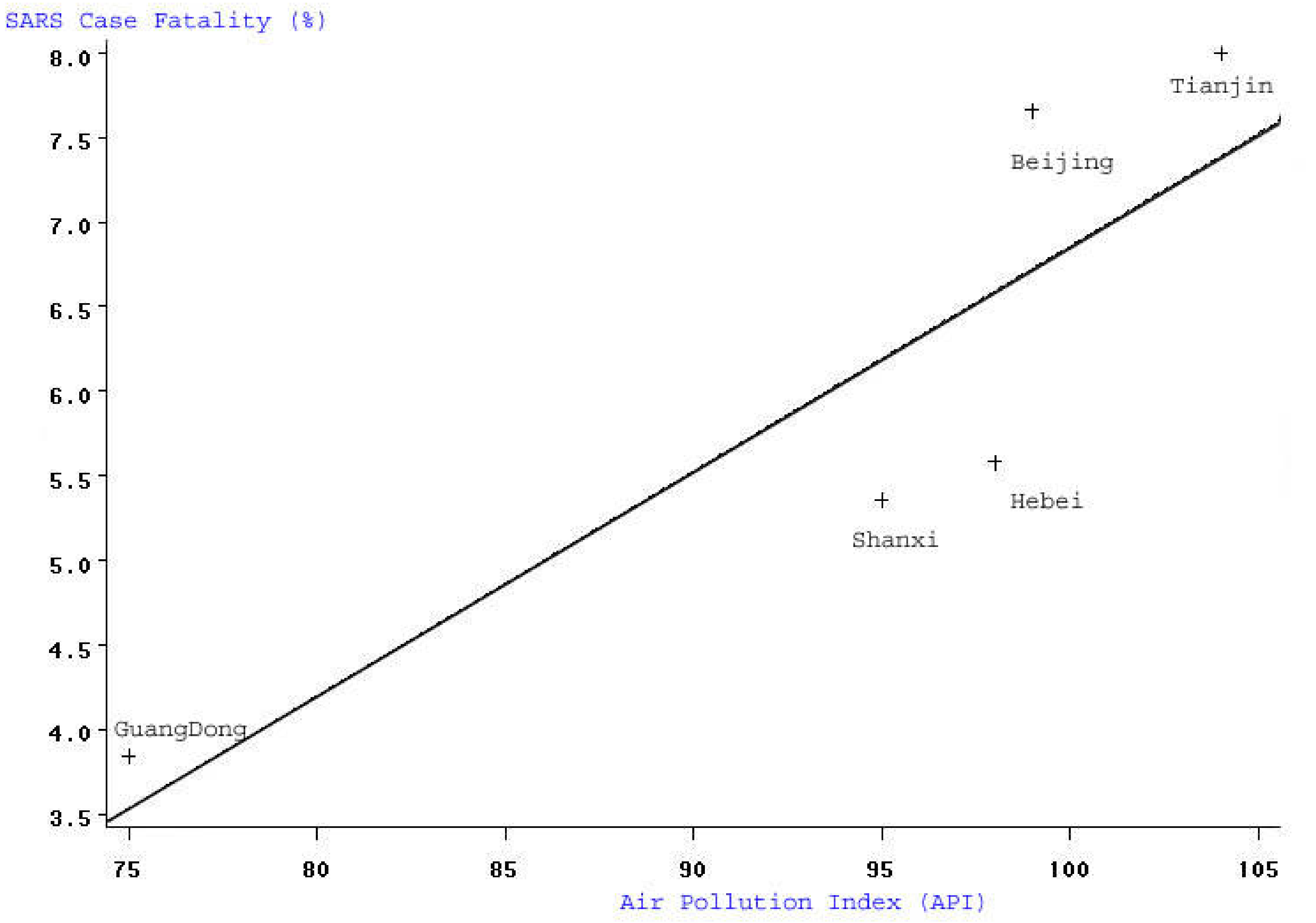
SARS Case Fatality (%)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
Tianjin
Beijing
Hebei
Shanxi
GuangDong
75
80
85
90
95
100
105
Air Pollution Index (API)

Figure 1