The Ambient Particular Matter Pollution Situation and its Health Effect in China

Baoqing Wang, Deqing Wang, Shuai Yin, and Shu Yao

***Abstract*—Particular matter is the main pollutant for the ambient environment in China. Some PM_{10} pollution index data were analyzed for four different cities. Exposure-response between PM_{10}, $PM_{2.5}$ and daily mortality of inhabitants in China was discussed. Epidemiological literature of PM_{10}, $PM_{2.5}$ and daily mortality were extracted using Endnote, and the relationship between PM_{10}, $PM_{2.5}$ and daily mortality of inhabitants using meta-analysis method. The results show that the air pollution index average value is 92.8, 74, 67.9 and 75.1 for Beijing, Shanghai, Guangzhou and Chongqing, respectively. It is more serious for PM_{10} pollution in Beijing than other three cities. The daily mortality of inhabitants increase by 0.29% (95% CI: 0.21%-0.38%) and 0.56% (95% CI: 0.40%-0.72%), as the concentration of PM_{10}, $PM_{2.5}$ increase a certain degree (10μg/m^3). The results of meta-analysis can provide the scientific basis for particular matter pollution control. The related control measurements should be made to reduce PM pollution.**

***Index Terms*—PM_{10}, $PM_{2.5}$, Meta-analysis, pollution situation, control measurement.**

I. Introduction

Inhalable particle matter is less than 10μm in aerodynamic diameter, also called PM_{10}. Fine particle matter is less than 2.5μm in aerodynamic diameter, also called $PM_{2.5}$. Particulate matter (PM) is the main air pollutants in China at present [1]. It is very serious for the atmospheric environment situation in China. It has not been controlled completely for the traditional coal pollution, but it has become increasingly prominent for regional complex atmospheric pollution of $PM_{2.5}$, acid rain and O_3. PM pollution emissions include the primary particle matter, and the secondary particle matte such as SO_2, NO_x, VOCs, NH_3 precursor. In February 2012, the Ambient Air Quality Standard was revised. Among the health effects endpoints death arouses the maximal loss [2], [3]. Meta-analysis method is used to analyze the data collected from the relevant epidemiological literature and found the exposure-response relationship between exposure to the air particulate matter and increased percentage of daily mortality. It is not enough for PM and its health effect in China, so related research should be made in the future.

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II. PM Pollution Situation

With the rapid development of economy and society, the present pollution situation is very serious, for example, coal consumption rose sharply, vehicle quantities increased dramatically, NO_x and VOCs emissions grown significantly, O_3 and $PM_{2.5}$ pollution aggravated. It has not been solved completely for PM_{10} and total suspended particles (TSP) pollution, at the same time it was serious for $PM_{2.5}$ and O_3 pollution in the region of Beijing-Tianjin-Hebei, Yangtze river delta, pearl river delta, and so on.

In September 2011, the WHO declared a global air pollution city report shows that China's air quality ranking is the 77th in 91 countries. Although it has no comprehensive monitoring data for $PM_{2.5}$, the related monitoring has been carried out.

The 30 data were selected and analyzed for PM_{10} from October to November 2012. Air pollution index for Beijing, Shanghai, Guangzhou and Chongqing of China are shown in Fig. 1. The four cities were selected because of their serious PM pollution and different region location. From this it can be reflected to the whole China.

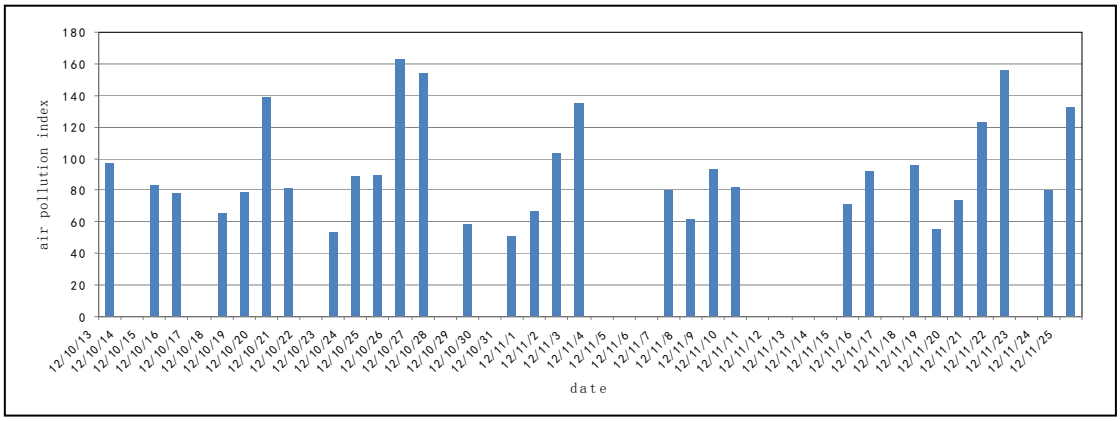
As the Shown from Fig. 1, the air pollution index average value is 92.8, 74, 67.9 and 75.1 for Beijing, Shanghai, Guangzhou and Chongqing, respectively. PM_{10} is prior and main pollutant. For Beijing, PM_{10} pollution is more serious than other three cities.

For Beijing, the sources of PM_{10} were soil/crustal, coal combustion, motor vehicle, oil combustion, the secondary particulate and biomass combustion, which contributed 21.3%, 18.2%, 16.5%, 14.7%, 6.6% and 22.8, respectively [4].

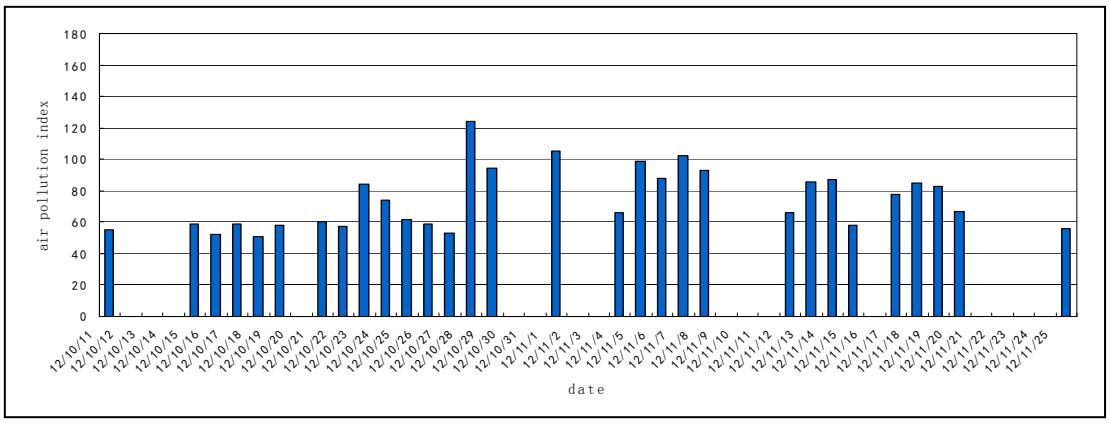
For Shanghai, the sources of $PM_{2.5}$(no PM10 data) were soil/crustal, coal combustion, motor vehicle, oil combustion, steel and other, which contributed 11%, 9%, 22%, 2%, 18% and 37, respectively [5].

For Guangzhou, it showed that urban dust, coal combustion, oil combustion, the secondary particulate, biomass combustion, industrial emission and other were the sources of PM_{10}, which contributed 20.7%, 14.3%，17.8%，10.4%，6.3%，16.3% and 14.2%, respectively [6].

For Chongqing, the sources of PM_{10} were coal combustion, motor vehicle, road dust, cement, steel and other, which took 18.35%, 15.11%, 20.48%, 27.22%, 3.74% and 15.10%, respectively [7].



(a)



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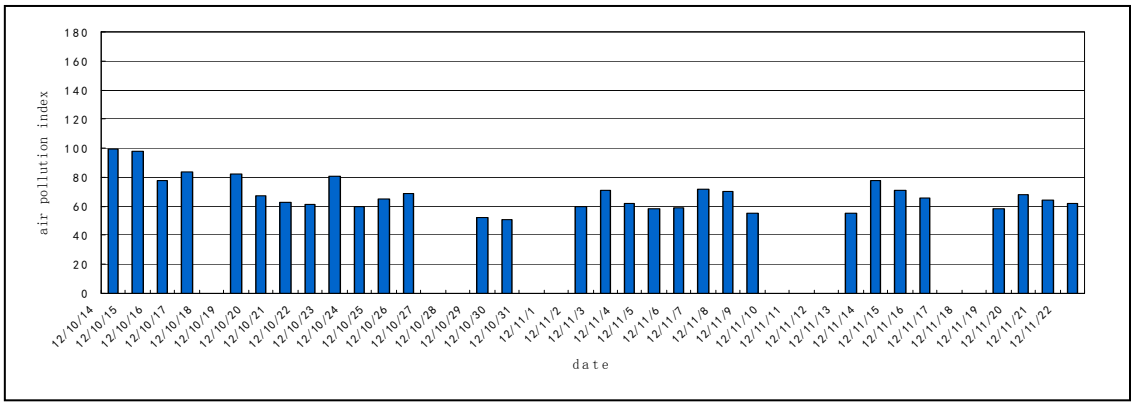

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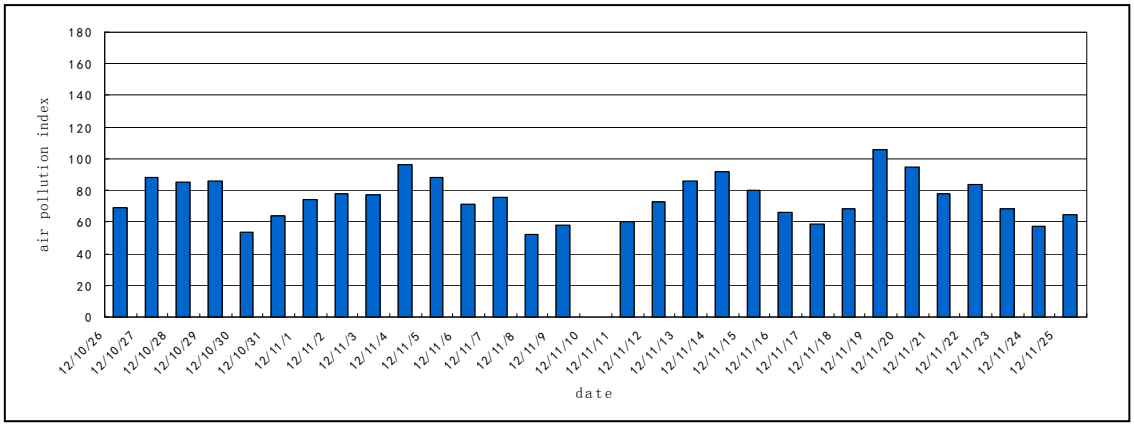

(d)

Fig. 1. Air pollution index for different city in China from October to November 2012,
(a) Beijing (b) Shanghai (c) Guangzhou (d) Chongqing.

III. Health Effect Analyse

A. Meta-Analysis

The general step of Meta-analysis involves collection of literature, extract of data and evaluation and explanation of the result. It has been used for the percentage and standard error of the daily mortality change of the inhabitants associated with the concentration increase of PM, transformed the standard deviation using formula (represents the total sample) and analyzed by Revman5.1 software. The final results of Meta-analysis are expressed by increase of daily mortality of inhabitants associated with the concentration of PM_{10}, $PM_{2.5}$ (increased by 10μg/m³).

Epidemiological literature about the relationship between PM pollution and daily mortality in inhabitants published during 1990 to 2012. For literature, it is necessary to collect the data from the literature left, read the literature and select high persuasion of data, and enter the data and save into the database of the PM exposure-effects relationship of human health.

B. Results

Through statistical tests and analysis, we calculated and adjusted to get the final data with high degree of accuracy. All the data were List in Table I and Table Ⅱ. The forest plot and funnel plot of the influence between the increase of PM_{10} concentration and inhabitants mortality are showed in Fig. 2 and Fig. 3.

TABLE I: Mortality Change For A 10 μG/M³ Increase of PM_{10} Concentration in China

Author	Year	Area	Mortality（%）
Chen [8]	2004-2008	Beijing, Shanghai	0.25
Kan [9]	2004-2005	Shanghai	0.16
Qian [10]	2000-2004	Wuhan	0.36
Wong [11]	1995-1997	Hong Kong	0.6
Wong a[12]	2001-2004	Shanghai	0.26
Wong b[12]	2001-2004	Hong Kong	0.53
Dai [13]	2001-2004	Shanghai	0.54

TABLE II: Mortality Change for A 10 μG/M³ Increase of $PM_{2.5}$ Concentration in China

Author	Year	Area	Mortality（%）
Dai [14]	2002-2003	Shanghai	0.36
Kan [15]	2004-2005	Shanghai	0.85
Ma [16]	2006-2008	Shenyang	0.50
Yang [17]	2007-2008	Guangzhou	0.9
Zhao [18]	2004-2008	Xi'an	0.41

Fig. 2 shows that the concentration of PM_{10} increased a certain degree（10μg/m³）, the daily mortality of inhabitants increased by 0.29% (95%CI:0.21%-0.38%). In the chi-square test, I^2=45%, indicates heterogeneity between different literatures is moderate, Z=7.09（P<0.00001）, illustrates the analysis has some statistical significance, the inspection effect is ideal.

Fig. 3 shows that the data points are well-distributed on the both sides of the center line, reveals the symmetrical funnel shape which means that the publication bias in this analysis is positive.

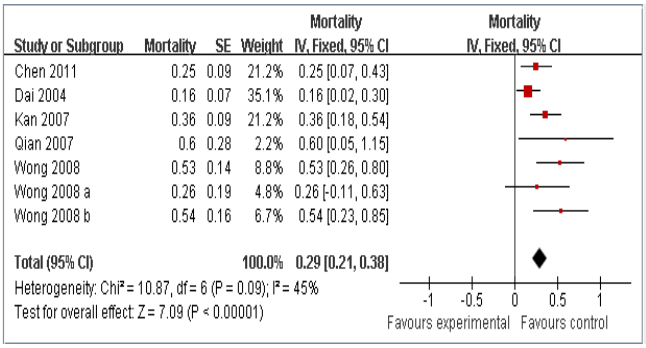

Fig. 2. The forest plot of influence of PM_{10} increased by average 10μg/m³ on daily mortality of inhabitants

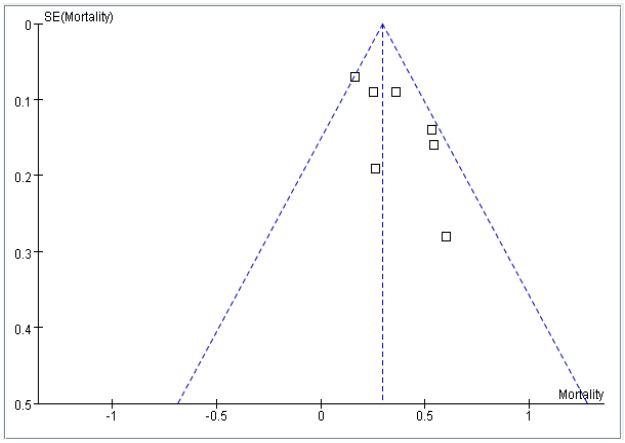

Fig. 3. The funnel plot of influence of PM_{10} increased by average 10 μg/m³ on daily mortality of inhabitants

The forest plot and funnel plot of the influence between the increase of $PM_{2.5}$ concentration and inhabitants mortality are showed in Fig. 4 and Fig. 5.

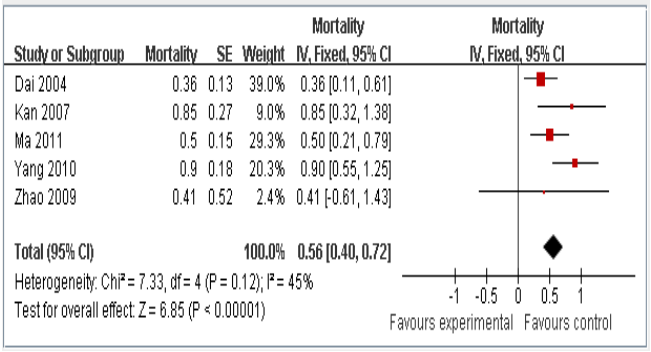

Fig. 4. The forest plot of influence of $PM_{2.5}$ increased by average 10μg/m³ on daily mortality of inhabitants

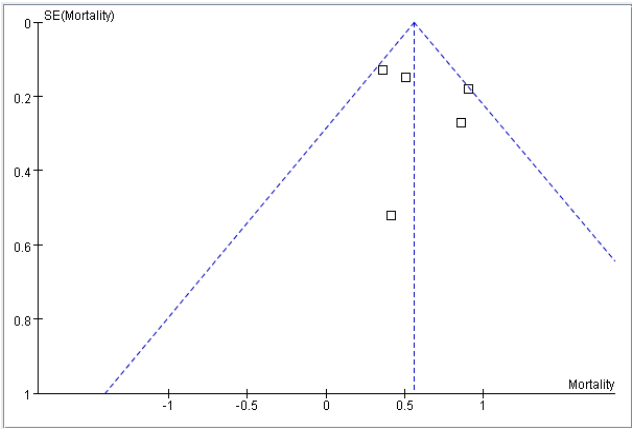

Fig. 5. The funnel plot of influence of PM2.5 increased by average 10μg/m³ on daily mortality of inhabitants

Fig. 4 shows that the concentration of $PM_{2.5}$ increased a certain degree（10μg/m³）, the daily mortality of inhabitants increased by 0.56% (95%CI:0.40%-0.72%). In the chi-square test, I^2=45%, indicates heterogeneity between different literatures is moderate, Z=7.33（P<0.00001）, illustrates the analysis has some statistical significance, the inspection effect is ideal.

Fig.5 shows that the data points aren't well-distributed on the both sides of the center line which means that the publication bias in this analysis is negative.

Ⅳ. CONCLUSION

The PM pollution is serious in China, although its pollution level is different. So we should pay attention to PM pollution and its health effect.

The relationship between increased percentage of daily mortality and the concentration of PM_{10}, $PM_{2.5}$ were obtained. PM_{10}, $PM_{2.5}$ increased a certain degree (10μg/m³), the daily mortality of inhabitants in China increased by 0.29% (95% CI: 0.21%-0.38%), 0.56% (95% CI: 0.40%-0.72%), respectively. Publication bias is the most common system error in Meta-analysis. Possible reasons include the followed, such as omitting some data during the Endnote retrieval and document quotation and the subjective influence of researchers.

The Ambient Air Quality Standard (GB3095-2012) was enacted on February 2012. In consideration of the complexity source and component of $PM_{2.5}$, and the increase of the motor vehicle, the difficulties in $PM_{2.5}$ pollution and monitoring increase gradually. As a result, we should develop the particulate matter monitoring and controlling, enhance the research about the health effect and epidemiology studies for the further environmental decision-making.

In order to control PM pollution, the control measurements are followed, such as determining environmental capacity according to the different region character, implementing zone integrated and making the improvement target, emphasizing scientific planning and ensuring the multiple investment, optimizing the economic structure and implementing cooperative pollution control, strengthening monitoring supervision, promoting the policy implementation, and so on.

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