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A Meta-analysis of Association Between Air Particular Matter and Daily Mortality of Inhabitants in China

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Abstract. Epidemiological literature of air particulate matter and daily mortality were extracted using Endnote online research and the relevant data in the literature were extracted, we analyze the relationship using Meta-analysis method. The exposure-response relationships between exposure to ambient PM_{10}, $PM_{2.5}$ and increased percentage of daily mortality was found, as the concentration of PM_{10}, $PM_{2.5}$ increased a certain degree (10μg/m3), the daily mortality of inhabitants increased by 0.29%(95%CI:0.21%-0.38%),0.56%(95%CI:0.40%-0.72%), respectively. The exposure-response relationship recommended in the present paper can be applied to the research of air particulate matter and health response work and provide the scientific basis for further environmental decision-making.

Keywords: PM_{10}, $PM_{2.5}$, Exposure-response, Meta-analysis.

1. Introduction

Particulate matter (PM) is the main air pollutants in China at present [1-3].Inhalable particle (or PM_{10}) is less than 10 μm in aerodynamic diameter while fine particulate matter ($PM_{2.5}$) less than 2.5μm. China has one of the highest PM levels in the world and the average concentration of PM10 is 85μg/m^3 in 2011[2], which is much higher than some developed countries in the world. Numerous studies have compiled evidence indicating that $PM_{2.5}$is more likely to absorb heavy metal, which supports the hypothesis that $PM_{2.5}$may have a larger magnitude effects and toxicity than PM_{10}[3-4]. Among the health effects endpoints death arouses the maximal loss [5-7]. According to the EPA quantify assessment of health effects of$PM_{2.5}$, the economic loss aroused by death contributes 89% to the total loss [6].We used Meta-analysis method 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. The exposure-response relationship recommended in the present paper can be applied to the research of PM and health response work and provide the scientific basis for further environmental decision-making.

2. Methods

2.1. Literature Retrieval

Based on the online search (Endnote) of relevant studies in data library: CNKI, PubMed, Web of Science with the same endpoint, we retrieved 1040 epidemiological literature about PM pollution and the daily mortality of inhabitants. The key words were PM_{10}, $PM_{2.5}$, daily mortality, air pollution, hospitality etc. We extracted the rising percentage of inhabitants' mortality, relative risk, standard deviation, relative error, 95%CI etc.

2.2. Literature Selection

Standards of the literature selection: 1) Epidemiological literature about the relationship between pollution and daily mortality in inhabitants published during 1990 to 2012; 2) The research results express

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the comprehensive assessment to quantitative exposure-response relationship（percentage, standard deviation, relative error etc. of the change of daily mortality in inhabitants）; 3) The time series research in literature used generalized additive model or generalized line additive model. Rules of the literature quality control: 1) Design the data table for Meta-analysis, collect the data from the literature left; 2) Read the literature and reject the ones: repeated information, low degree of accuracy, low authority of journal and low persuasion of data; 3) Entering the data after statistical analysis into the database of the PM exposure-effects relationship of human health.

2.3. Meta-analysis

Meta-analysis method was firstly put forward by Beecher in 1965, Glass named such combined statistics of the comprehensive analysis of the literature method "Meta-Analysis" in 1976. Afterwards, Hedge, Hunte etc. did a further research and development which made the Meta-analysis increasingly clear and systematic. The general step of Meta-analysis involves collection of literature, extract of data and evaluation and explanation of the result. We directly use the percentage and standard error of the daily mortality change of the inhabitants associated with the concentration increase of PM, transform the standard deviation using formula (represents the total sample) into , enter and analysis the data into Revman5.1 software. The final results of Meta-analysis express using the increase of daily mortality of inhabitants associated with the concentration change of air fine particular (increased by 10 μg/m ^{3}).The analysis software used here is Review Manager 5.1.

3. Results

Through statistical tests and analysis, we calculated and adjusted to get the final data with high degree of accuracy. List all the data in Table 1.The forest plot and funnel plot of the influence between the increase of PM_{10} concentration and inhabitants' mortality are showed in Figure 1 and Figure 2.

Table 1: Mortality change for a 10μg/m^3 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 Haixia[13]	2001-2004	Shanghai	0.54

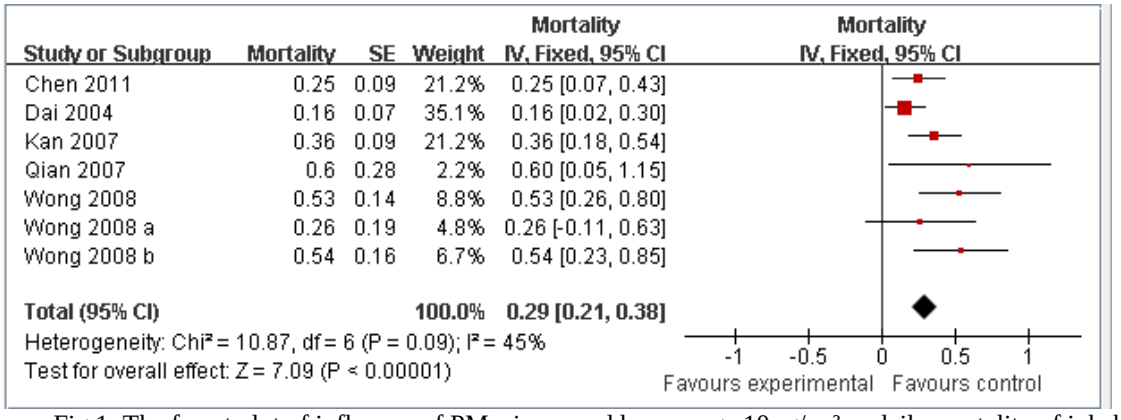

Fig.1: The forest plot of influence of PM_{10} increased by average 10 μg/m ^{3}on daily mortality of inhabitants

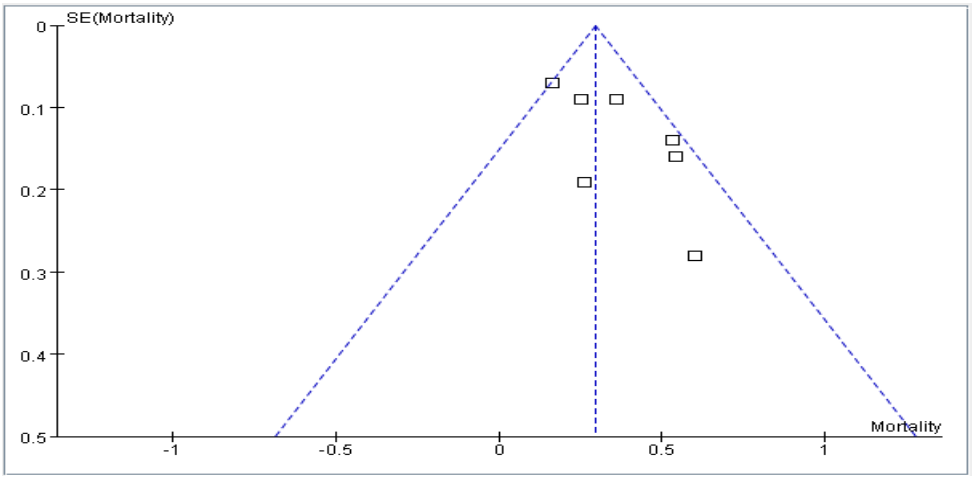

Fig. 2: The funnel plot of influence of PM_{10} increased by average 10μg/m ³on daily mortality of inhabitants

Figure 1 shows that the concentration of PM_{10}increased a certain degree（10μg/m ³）,the daily mortality of inhabitants increased by 0.29%(95%CI:0.21%-0.38%). In the chi-square test,I2=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; The results are well-distributed on the both sides of the central line, reveals the symmetrical funnel shape which means that the publication bias in this analysis is positive.

Table2 listed the information of the increase of $PM_{2.5}$ concentration (10μg/m³) and inhabitants' mortality. The forest plot and funnel plot of the influence between the increase of $PM_{2.5}$ concentration and inhabitants' mortality are showed in Figure 3 and Figure 4.

Table 2 Mortality change for a 10μg/m³ increase of $PM_{2.5}$ concentration in China

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

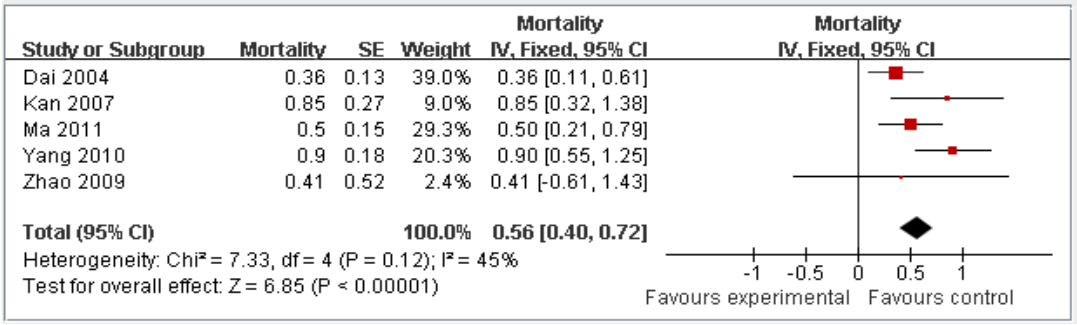

Fig.3: The forest plot of influence of $PM_{2.5}$ increased by average 10μg/m ³on daily mortality of inhabitants

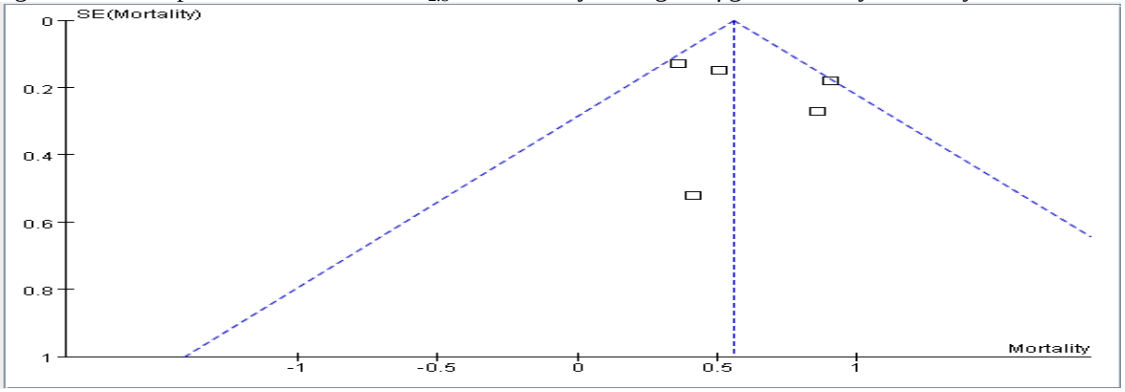

Fig. 4: The funnel plot of influence of $PM_{2.5}$ increased by average 10μg/m ³on daily mortality of inhabitants

Figure 3 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,I2=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; The results aren't well-distributed on the both sides of the central line which means that the publication bias in this analysis is negative.

4. Conclusions

We found the exposure-response relationships between exposure to ambient PM_{10}, $PM_{2.5}$ and increased percentage of daily mortality , as the concentration of 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. Our result is similar to Neuberger's: He found that the concentration of $PM_{2.5}$ increased a certain degree (10μg/m³), the daily mortality of inhabitants increased by 0.60% [19]. In China, the effect of the increase of $PM_{2.5}$ concentration on inhabitants' mortality is more obvious than PM_{10}.

Publication bias is the most common system error in Meta-analysis. The reasons for publication bias in this paper maybe as follows: 1) Due to the subjective influence of the authors, investigators and editors, publication bias is inevitable during the document retrieval; 2) We may omitted some data during the Endnote retrieval and document quotation; 3) The subjective influence of researchers may influenced the Meta-analysis results.

The *Ambient Air Quality Standard (GB3095-2012)* was enacted recently. At present, the monitoring work of fine particle matter is limited only in Beijing, Shanghai, Tianjin and few provincial capital cities. 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.

5. Acknowledge

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