The current issues and study on health effects of Asian dust storm in China

Xinbiao GUO
Department of Occupational and Environmental Health Sciences, Peking University School of Public Health
e-mail: xguo@bjmu.cn

- Dust storm is a serious natural disaster. there were a total of 288 strong dust storms in northern China from 1950 to 1999. There were 10 times the number of dust storm recorded in 2000.
- Dust storms have transported dust from their sources to southern China, Korea, Japan, and even to the United States.

• Asian dust storm has been investigated for two decades from its source, mechanism of transport, chemical composition and the concentration of the components.

• However, there have been few studies on health effects of dust storm in China, although people are worried about the impact of dust storm on human health.

Published studies in China on the health effects of dust storm PM or desert dust

- Pang et al., Study on fibrogenicity of desert dust on rat lung, *Occup Med*, 21(5), 4-7, 1994.
- Jing et al., Epidemiological study on "desert lung" in Talimu desert district, *Lab Med*, 12(3), 25-26, 1995.
- Pang et al., The cytotoxic effect of desert dust on rat alveolar macrophages, *Chin J Ind Hyg Occup Dis*, 16(5), 305-306, 1998.
- Huang et al., Study on the effects of dust storm PM2.5 and PM10 on the secretion of inflammatory factors in rat alveolar macrophage, *J Environ Health*, 21(1), 38-40, 2004.
- Huang et al., Effects of dust storm PM2.5 and PM10 on the phagocytic function of rat alveolar macrophages, *J Hyg Res*, in press.

Table 1. Cytotoxicity of dust storm $PM_{2.5}$ and PM_{10} on rat alveolar macrophages

Treatment	Concentration (μg/ml)	OD_{570}	Viability (%)
Control	0	0.253±0.031	100
$PM_{2.5}$	20	0.243±0.029 #	96
	50	0.238±0.032 #	93
	100	0.219±0.028 ##	87
	150	0.199±0.022 ##	78
PM_{10}	20	0.245±0.023	97
	50	0.244±0.032 #*	96
	100	0.237±0.022 ##*	90
	150	0.216±0.035 ##**	85

Note: n=9. Values are expressed as mean±S.D. Compared with controls, #P<0.05, ##P<0.01; Compared with the values in corresponding $PM_{2.5}$ groups, *P<0.05, **P<0.01.

Table 2. Phagocytic activity of rat alveolar macrophages loaded with dust storm $PM_{2.5}$ and PM_{10}

Treatment	Concentration (μg/ml)	Mean intensity of fluorescence (% of control)	Mean intensity of side light scatter (% of control)
Control	0	100.0± 4.6	100.0± 4.0
$PM_{2.5}$	20	92.1 ± 3.8 ##	96.1 ± 2.0 #
	50	81.3 ± 4.4 ##	91.8 ± 3.9 ##
	100	67.8 ± 2.1 ##	87.3 ± 3.0 ##
	150	55.4 ± 3.6 ##	83.1 ± 3.3 ##
PM_{10}	20	95.3 ± 2.2 #	97.5 ± 2.9
	50	87.0 ± 4.0 ##*	94.6 ± 3.7 #*
	100	76.7 ± 4.2 ##**	91.6 ± 5.5 ##**
	150	67.1 ± 6.2 ##**	87.1 ± 6.4 ##**

Note: n=8. Values are expressed as mean±S.D. Compared with controls, # P<0.05, ## P<0.01; Compared with the values in corresponding $PM_{2.5}$ groups, * P<0.05, ** P<0.01 .

Table 3 Effects of dust storm $PM_{2.5}$, PM_{10} on NO, IL-8 and TNF-α secretion by rat alveolar macrophages

Treatment	Concentration (μg/ml)	NO (μmol/ml)	IL-8 (pg/ml)	TNF-? (pg/ml)
control	0	9.65±6.7	114.05±8.32	62±9.96
$PM_{2.5}$	20	40.55±5.56 ##	181.67±6.53 ##	112.92±7.98 ##
	50	50.94±7.5 ##	207.92±16.18 ##	145.42±8.54 ##
	100	58.06±8.28 ##	224.17±23.53 ##	165.83±5.69 ##
	150	62.8±6.68 ##	249.17±22.17 ##	195.42±14.04 ##
PM_{10}	20	44.06±6.79 ##**	169.17±4.19 ##**	139.58±8.65 ##**
	50	56.10±8.88 ##**	198.33±7.58 ## *	171.25±9.85 ##**
	100	62.84±8.77 ##**	211.67±6.80 ##	192.08±11.00 ##**
	150	67.04±6.67 ##*	241.67±8.87 ##	217.92±19.41##**
LPS	10μg/ml	63.94±6.27 ##	248.33±11.79 ##	183.33±4.71##

Note: n=10. Values are expressed as mean±S.D. Compared with controls, #P<0.05, ## P<0.01; Compared with the values in corresponding $PM_{2.5}$ groups, * P<0.05, ** P<0.01.

Table 4. The annual average concentrations of ambient TSP in some big cities in northern China (μg/m³)

City	1991	1993	1995	1997	1999	2001
Beijing	307	340	370	377	364	370
Tianjin	247	269	306	318	348	283
Taiyuan	627	641	568	504	416	311
Changchun	301	312	381	341	295	220
Harbin	373	345	359	310	260	219
Zhengzhou	440	421	474	469	360	191
Xi'an	523	504	370	385	372	262
Lanzhou	770	539	732	741	655	892
Wulumuqi	433	424	515	481	463	501

Table 5. The annual average concentrations of ambient TSP in some big cities in southern China ($\mu g/m^3$)

City	1991	1993	1995	1997	1999	2001
Shanghai	327	337	246	229	168	162
Fuzhou	187	264	188	163	129	113
Nanchang	137	191	279	178	176	179
Changsha	260	222	249	226	203	185
Guangzhou	260	297	295	217	182	151
Chengdu	341	372	366	248	231	214
Guiyang	331	392	330	216	221	211
Kunming	331	331	253	278	186	143

Table 6. The annual average concentrations of ambient TSP and PM_{10} in Beijing from 1999 to 2002 ($\mu g/m^3$)

Year	TSP	PM_{10}
1999	364	180
2000	353	162
2001	370	165
2002	373	166

Table 7. PM_{10} concentrations in Beijing on April 6 and 7, 2000 ($\mu g/m^3$)

Monitoring site	2000.4.6	2000.4.7
Chegongzhuang	931	298
Qianmen	924	388
Dongsi	941	354
Tiantan	906	361
Aotizhongxin	862	237
Nongzhanguan	909	296
Gucheng	956	284

Table 8. Size distribution of dust storm PM collected on April 6, 2000

Size range (μm)	<0.4	<0.7	<1.1	<2.1	<3.3	<4.7	<5.8	<9.0	>9.0	total
Concentration ($\mu g/m^3$)	73.62	89.82	163.44	340.12	590.41	914.32	1208.78	1621.03	485.87	2106.9
%	3.49	4.26	7.75	16.14	28.02	43.39	57.37	76.94	23.06	100

From Zhuang *et al.*, 2001

Table 9. Concentrations of ambient air pollutants in Beijing before and during the dust storm in on April, 2000

Date	Concentrations of ambient air pollutants ($\mu g/m^3$)			
	PM_{10}	SO_2	NO_2	CO
3.30-4.4 (before dust storm)	200	56	78	2750
4.5-4.10 (during dust storm)	464 (330-1650)	26	47	1260
Spring average in 2000	212	53	67	2270

From Fang *et al.*, 2003; Wang *et al.*, 2001

Table 10. The annual average concentrations of ambient air pollutants in zone A, B and C of Beijing (from 1996 to 2000)

	Concentrations of ambient air pollutants(mg/m^3)			
District	SO_2	NO_X	CO	TSP
zone A	0.025	0.026	1.0	0.186
zone B	0.134(2.23)	0.222(4.44)	3.4(0.85)	0.418(2.09)
zone C	0.129(2.15)	0.129(2.58)	4.0(1.00)	0.361(1.81)

Values in parenthesis represent times over national grade II standards

Table 11. Prevalence rates of Children's respiratory symptoms and illnesses in three zones

Symptoms or illnesses	Crude rate (%)			Standardized rate (%)		
	A	B	C	A	B	C
Cough	46.61	61.07**	61.67**	47.39	60.90**	61.41**
Phlegm	25.93	39.90**	42.51**	25.75	39.76**	42.42**
Wheeze	2.88	5.73**	5.29**	2.90	5.68**	5.28**
Asthma	0.77	3.58**	3.20**	0.79	3.57**	3.26**
Bronchitis	11.52	21.06**	24.50**†	11.75	21.09**	24.67**†

Compared with zone A, *P<0.05, ** P<0.01; Compared with zone B, † P<0.05

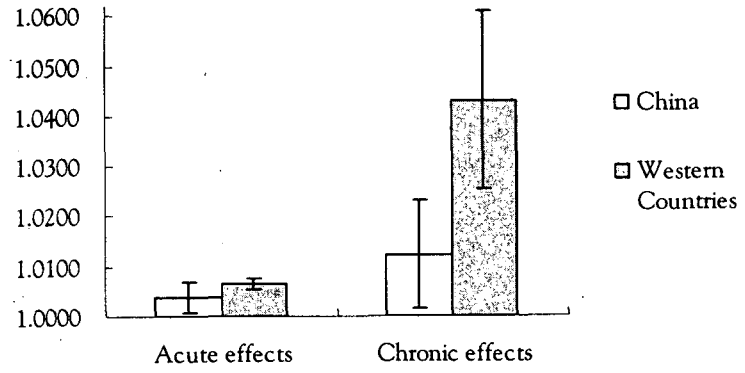
Table 12. Prevalence rates of Children's respiratory symptoms and illnesses in urban areas of some cities in China

Symptoms or illnesses	Prevalence rate (%)								
	Beijing	Guangzhou	Wuhan	Lanzhou	Chongqing	Taiyuan	Benxi	Shenyang	Dalian
Cough	61.4	41.8	55.0	85.2	47.7	53.8	58.6	59.5	43.6
Phlegm	41.3	13.3	24.9	53.2	18.2	33.2	36	37.4	28.1
Wheeze	5.5					38.9	7.3	1.4	2.5
Asthma	3.4	2.8	2.9	4.7	3.0	2.1	2.2	6.1	10.3
Bronchitis	22.9	15.3	30.8	51.4	16.4	22.3	10.2	17.3	22.5

Table 13. Published time-series studies on the acute health effects of ambient particulate matter pollution in mainland China

Location	Time	Pollutants level ($\mu g/m^3$)	Outcomes	results
Beijing	1989	TSP: 375 SO_2: 102	Daily Mortality	A doubling in TSP concentration was significantly associated with 38% increase of COPD mortality
Beijing	1990	TSP: 388 SO_2: 119	Outpatient visit	Positive association between TSP and nonsurgery outpatient visit
Beijing	1990-1991	TSP: 377 SO_2: 121	Daily mortality	Positive association between TSP and cardiovascular, cerebrovascular mortality
Shenyang	1992	TSP: 430 SO_2: 197	Daily mortality	$100\mu g/m^3$ increase in TSP with 1.7% and 2.1% increase on all-cause and cardiovascular mortality, respectively
Chongqing	1995	PM2.5: 147 SO_2: 213	Daily mortality	Negative association between PM2.5. and mortality
Taiyuan	1994-1998	TSP: 517-602 SO_2: 183-274	Daily mortality	positive association between TSP. and respiratory mortality
Taiyuan	1998	TSP: 478-593 SO_2: 278-294	Outpatient visit	positive association between TSP. and emergency department visit
Beijing	1998-2000	TSP: 300-350 SO_2: 30-50 NO_x: 110-120 CO: 2150-2640	Daily mortality	$100\mu g/m^3$ increase in TSP with 3.19% increase of respiratory mortality,
Beijing	1998-2000	TSP: 418 SO_2: 89 NO_x: 87 CO: 2650	Outpatient visit	$100\mu g/m^3$ increase in TSP with 1.04%, 7.67% and 3.19% increases of pediatric department visit for cold, pneumonia and bronchitis, respectively.

Comparison between China and Western countries



Relative risk of mortality in China and Western countries with $10\mu g/m^3$ increase of PM_{10}

Introduction of the NSFC Key Progam on the Health Effects of Dust Storms

- Research team members are from
  - Peking University (Chemical, epidemiological and toxicological studies)
  - Shanxi University (epidemiological and toxicological studies)
  - Beijing Normal Univesity (Chemical studies)
  - China CDC (epidemiological studies).

Chemical Study

- To measure the concentration of ambient PM_{10} and $PM_{2.5}$ in dust storm and collect PM sam-ples for chemical and toxicological studies;
- To analyze the chemical composition of dust storm PM;
- To study the heterogeneous reactions between gaseous pollutants and dust storm PM

- Ambient PM were collected in:
- Four cities in China: Beijing, Taiyuan, Lanzhou and Baotou;
- Three period: before, during and after the dust storms;
- Two size: PM_{10}, $PM_{2.5}$

Epidemilogical Study

- To investigate the effects of dust storm on respiratory and cardiovascular system by cross-sectional study and time-series analysis: 1. commu-nity-based questionnaire survey; 2. daily outpa-tient visit
- To establish forecasting model for the health effect of dust storm

Toxicological Study

- To assess genotoxic and nongenotixic effects of dust storm PM on human and animal cells by analyzing point mutation, chromosome aberration, siter chromatid exchange, DNA damage, cellular proliferation and GJIC.
- To explore the underlying mechanisms for the inflammatory response to dust storm PM *in vivo* and *in vitro*