Advances of Epidemic and Toxicological Studies of Dust Storms on Human Health in China

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2009.8.5

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Outlines

1. Introduction to dust events in China

2. Epidemic study on dust storms

3. Toxicological study of dust storm fine particles（$PM_{2.5}$）

(1) Toxicological effects on rat alveolar macrophages

(2) Cellular genetic toxicological effects on human blood lymphocytes

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1. Introduction to dust events in China

1.1 Definition of floating dust, blowing dust, dust storm and intense dust storm

- (1) **Floating dust**: widespread dust in suspension, not raised at or near the station at the time of observation; surface horizontal visibility is usually not greater than 10 km;
- (2) **Blowing dust**: raised dust or sand due to strong winds at the time of observation, reducing horizontal visibility from 1 to 10 km;
- (3) **Dust storm**: strong winds lift large quantities of dust particles, reducing visibility to <1 km;
- (4) **Intense dust storm**: with maximal destructive power which can reduce the surface horizontal visibility to < 50 m or even 0 m.

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Fig. 1-1 Dust storm coming

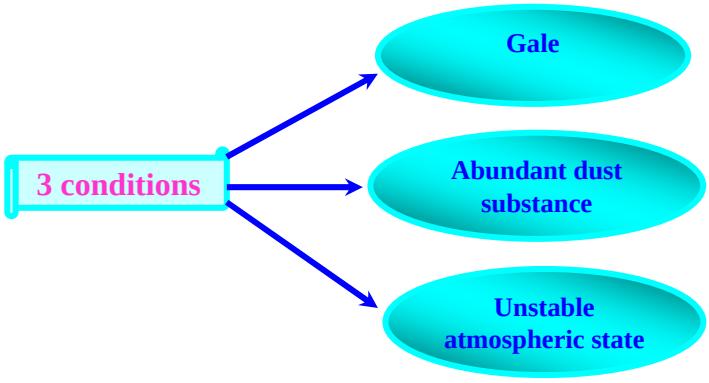
Fig.1-2 Dust Events in China

Fig.1-3 The vision after dust events in Tianjin, China

Fig.1-4 The vision after dust events in Beijing , China

1.2 Cause of formation of dust storm

Formative condition of dust storm:



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1.3 Frequency of dust events in China

Lunar change character

- Most in April
- March and May take second place
- Least in September

Daily change character

- Relatively high from noon to evening — 65.4% of the total
- Lesser from evening to noon

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1.4 Mobile paths of dust storm in northwest China

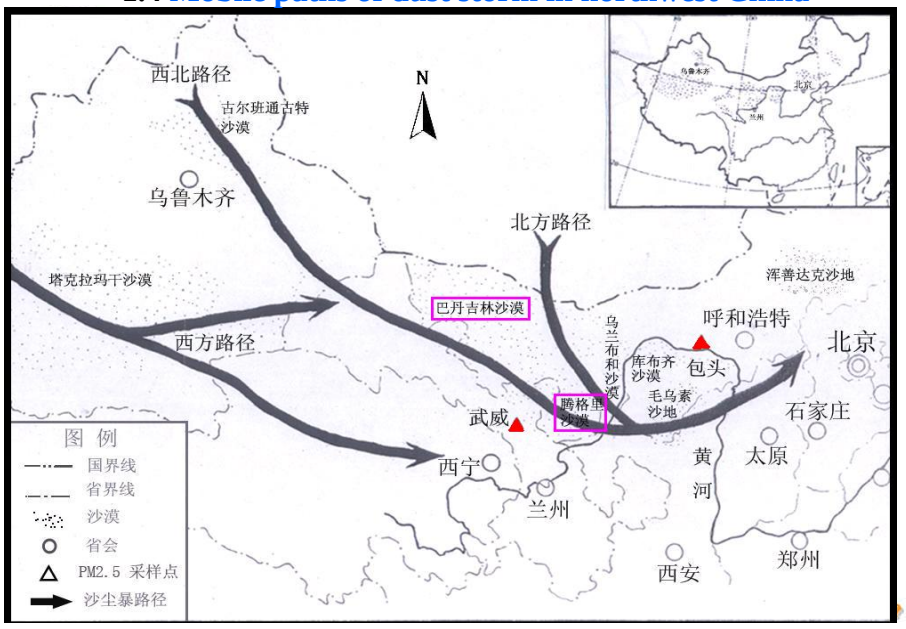

Fig.1-5 Mobile paths of dust storm in China

2. Epidemiological study of dust storms

- **2.1 Time series study of dust events on hospital admissions of respiratory and cardiovascular system diseases for consecutive ten years (1994-2003) in Minqin County, Wuwei City, Gansu Province, Northwest China**

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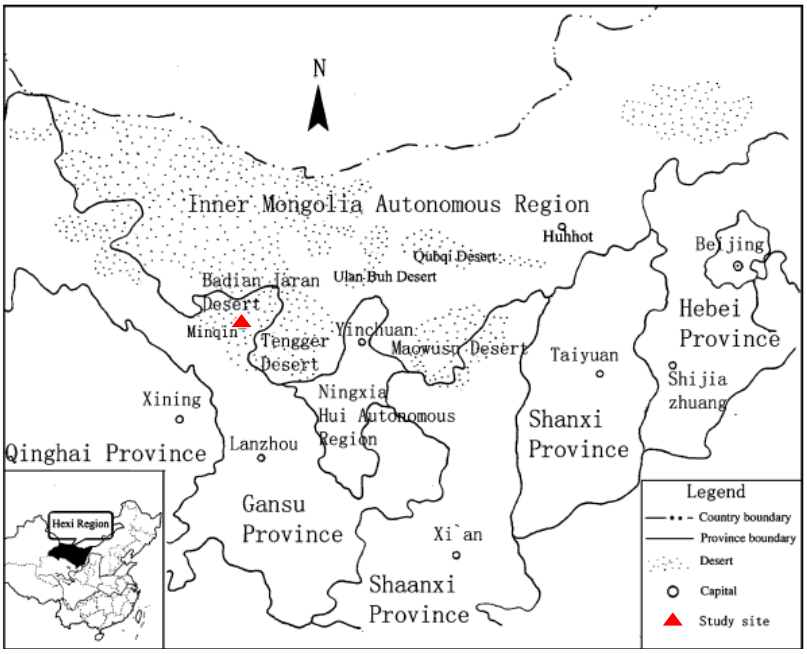

Fig.2-1 Location map of the study site within China

Fig.2-2 Survey on the resident health in Minqin Country

Fig.2-3 Lung examination for the residents

Fig.2-4 Cumulative frequency of dust events during each month from 1994 to 2003 in Minqin Country

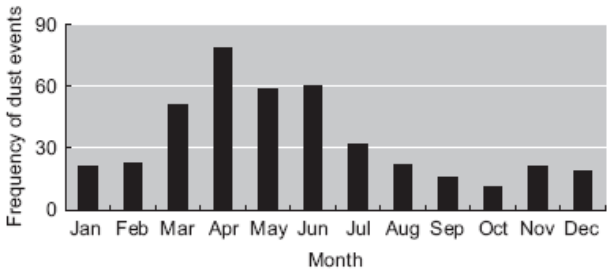

Table2-1 Descriptive analysis of the number of daily respiratory and cardiovascular hospitalizations for Minqin, 1994 to 2003

Hospitalization counts	*n*	Mean	SD	Min	Max
Total respiratory diseases	3435				
Male	2374	0.65	0.95	0	6
Female	1061	0.30	0.60	0	10
URTI	1248				
Male	854	0.23	0.52	0	5
Female	394	0.11	0.35	0	3
Pneumonia	1515				
Male	1104	0.30	0.64	0	5
Female	411	0.12	0.35	0	3
Total cardiovascular diseases	2172				
Male	1263	0.35	0.69	0	6
Female	909	0.25	0.57	0	5
Hypertension	468				
Male	230	0.06	0.28	0	3
Female	238	0.07	0.28	0	3
IHD	930				
Male	590	0.16	0.47	0	5
Female	340	0.09	0.35	0	3

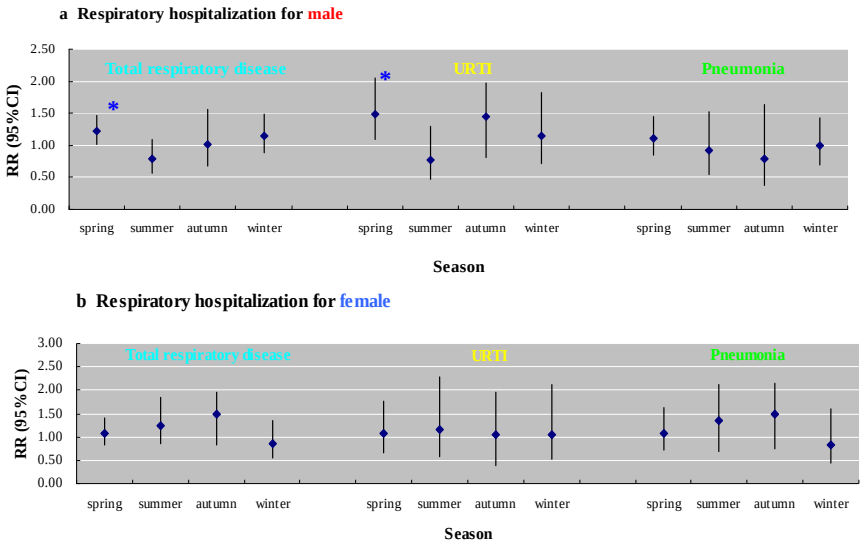

Fig.2-5 Season effects of dust events on hospitalization for total respiratory diseases, URTI (upper respiratory tract infection) and pneumonia. Values shown are RR and 95% CI for dust events with a lag of 3 days.

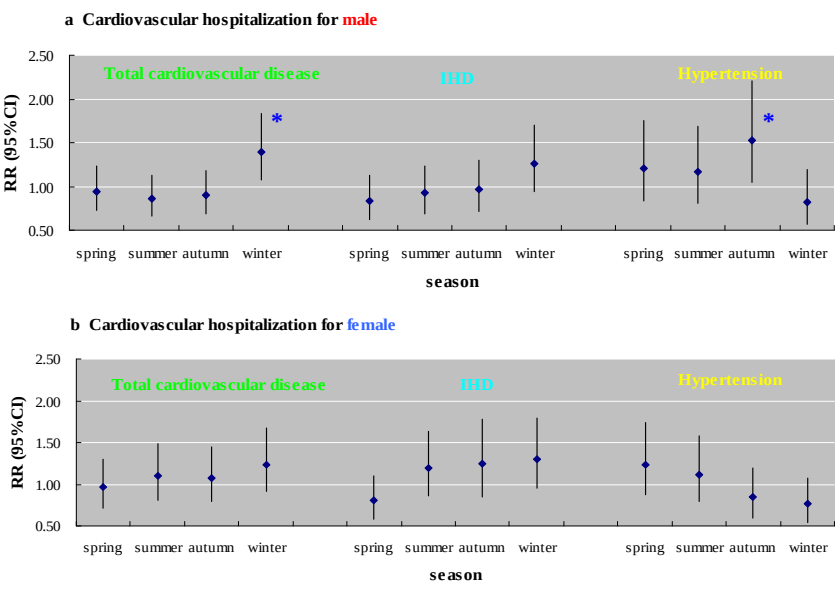

Fig.2-6 Season effects of dust events on hospitalization for total cardiovascular diseases, IHD (ischemic heart disease) and hypertension. Values shown are RR and 95% CI for dust events with a lag of 3 days for males and 2 days for females.

- **2.2 Time series study of dust events on hospital admissions of respiratory system diseases for consecutive nine years (1995-2003) in Wuwei City, Gansu Province, Northwest China**

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2.2.1 Dust storms

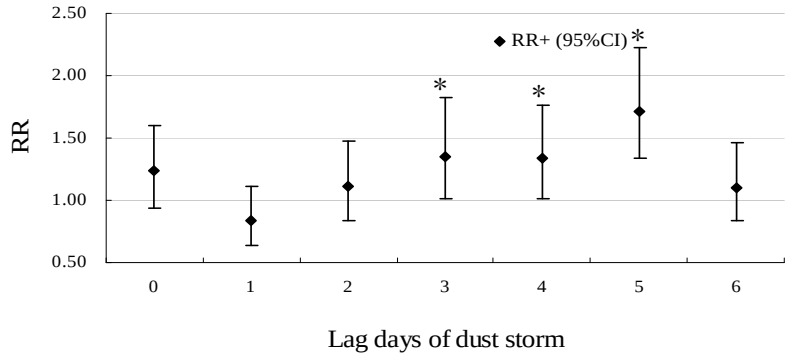

Fig.2-7 Association between lag days of dust storms and relative risk (RR) of hospital admissions for respiratory system diseases

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2.2.2 Blowing dusts

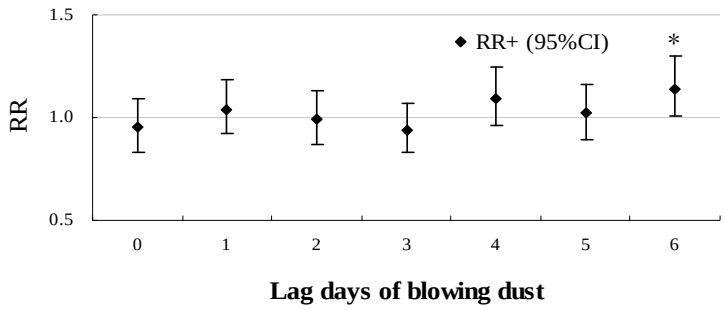

Fig.2-8 Association between lag days of blowing dusts and relative risk (RR) of hospital admissions for respiratory system diseases

2.2.3 Floating dusts

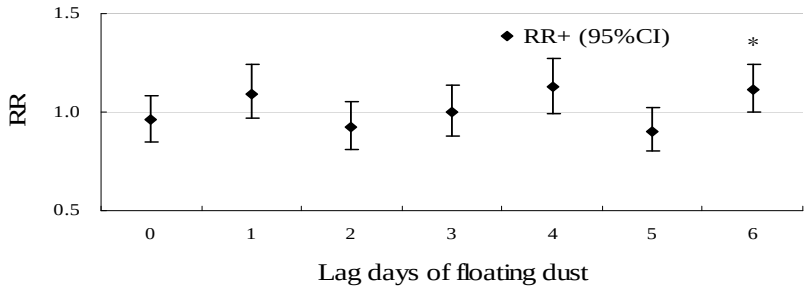

Fig.2-9 Association between lag days of floating dusts and relative risk (RR) of hospital admissions for respiratory system diseases

2.3 The acute effect of dust storms on the health of primary school students

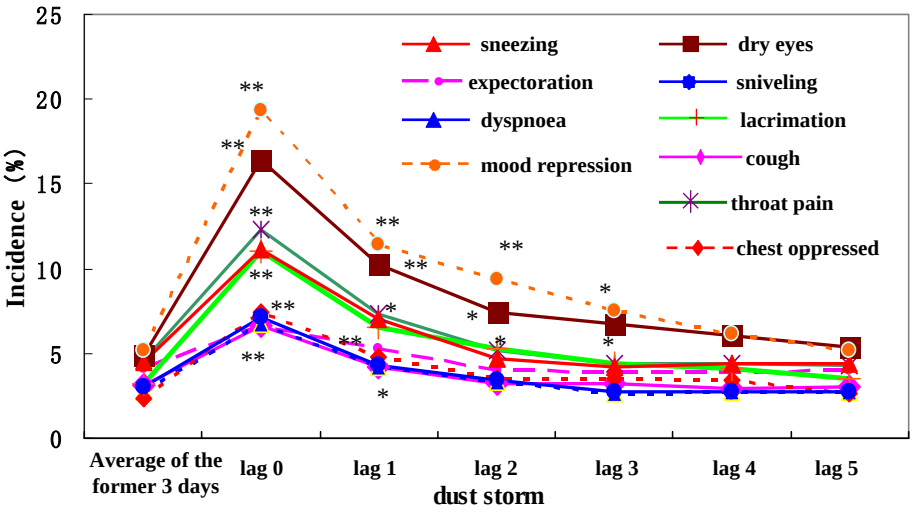

Fig.2-10 The acute effect of dust storm on the health of primary school students

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2.4 Conclusion

(1) Dust storms, blowing dusts and floating dusts were associated with the increases of numbers of outpatients and hospital admissions of respiratory and cardiovascular systems, the effects of dust storms were stronger than those of blowing dusts and floating dusts.

(2) There were three types effects of dust storms and blowing dusts on the health of exposure residents:

A. Acut eeffects
B. Lag effect
C. Cumulative effect
Desert pneumoconiosis

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3. Toxicological Study of Dust Storm $PM_{2.5}$

(1) Toxicological effects on rat alveolar macrophages

A. Cytotoxicity
B. DNA damage
C. Oxidative damage
D. Other indexes

(2) Cellular genetic toxicological effects on human blood lymphocytes

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3.1 Toxicity effect of dust storm $PM_{2.5}$ on rat alveolar macrophages

3.1.1 Cytotoxicity effect of dust storm $PM_{2.5}$

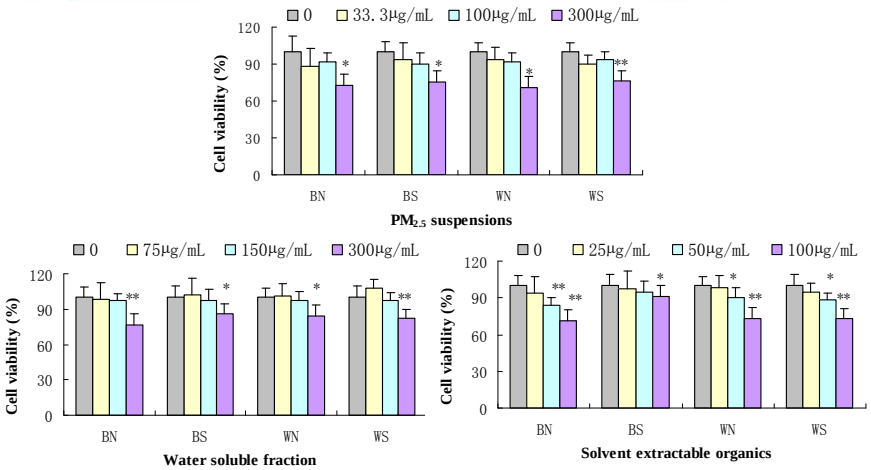

Fig.3-1 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls.

3.1.2 DNA damage effect of $PM_{2.5}$ from dust storm or normal weather

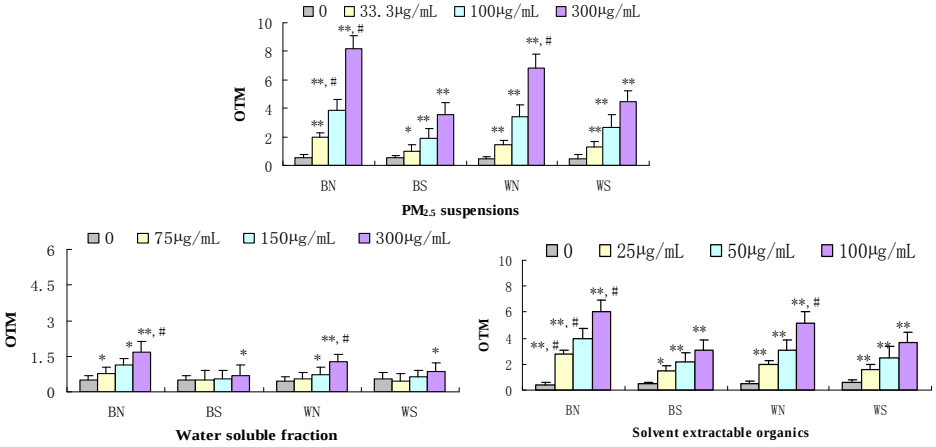

Fig.3-2 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls. # $P \leqslant 0.05$ when compared to dust storm samples at the same treated dosage in the same district.

3.1.3 Effects of dust storm $PM_{2.5}$ on malondialdehyde (MDA) contents

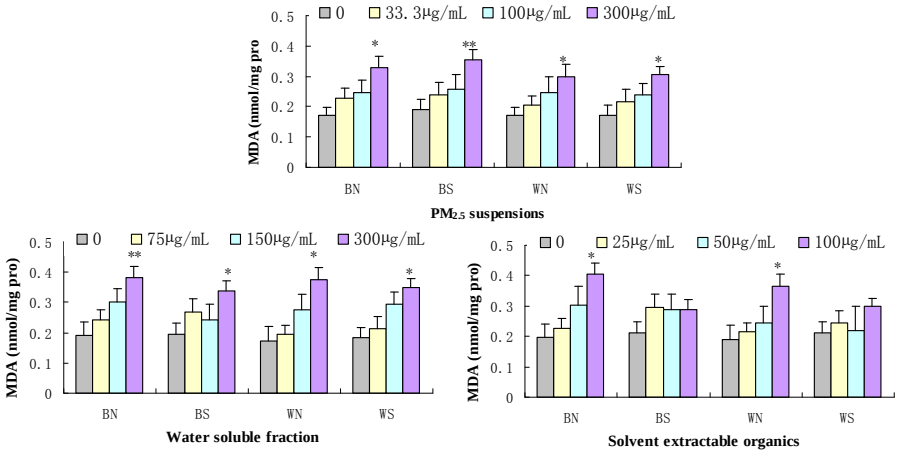

Fig.3-3 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls.

3.1.4 Effects of dust storm $PM_{2.5}$ on glutathione (GSH) contents

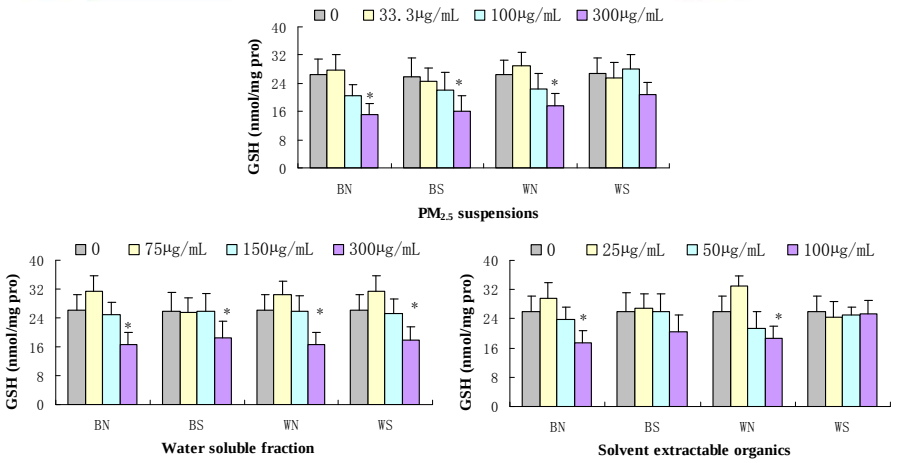

Fig.3-4 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls.

3.1.5 Effects of dust storm $PM_{2.5}$ on lactate dehydrogenase (LDH) activity

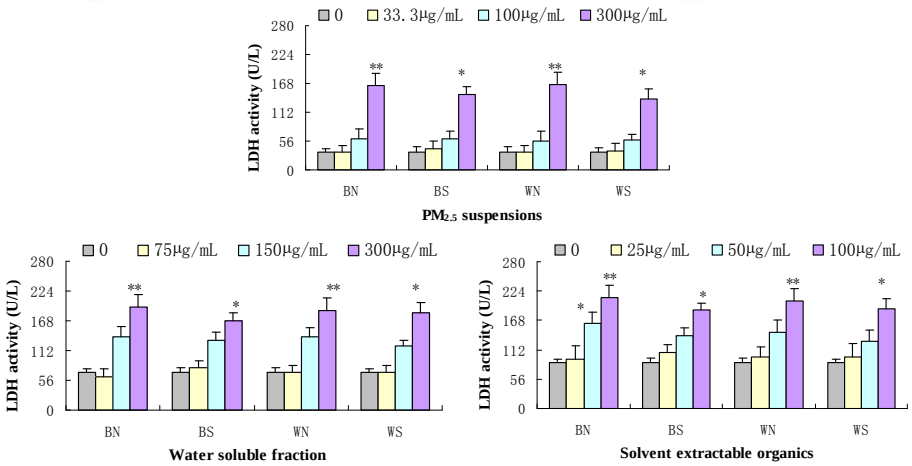

Fig.3-5 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls.

3.1.6 Effects of dust storm $PM_{2.5}$ on Na^+K^+-ATPase activity

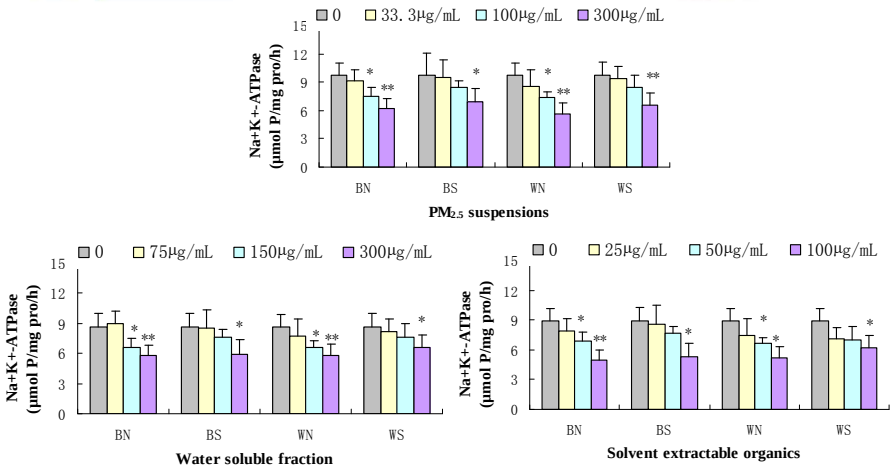

Fig.3-6 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls.

3.1.7 Effects of dust storm $PM_{2.5}$ on Ca^{2+} level

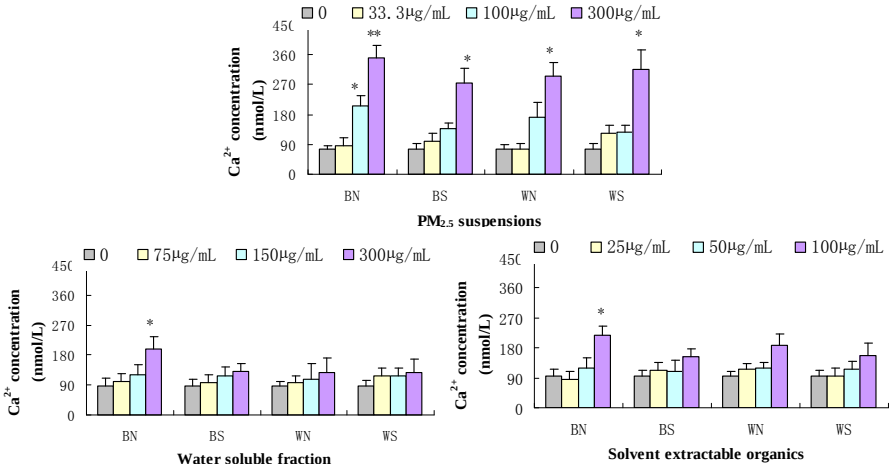

Fig.3-7 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls.

3.2 Genetic toxicological effect of dust storm $PM_{2.5}$ on human blood lymphocyte

3.2.1 Micronuclei

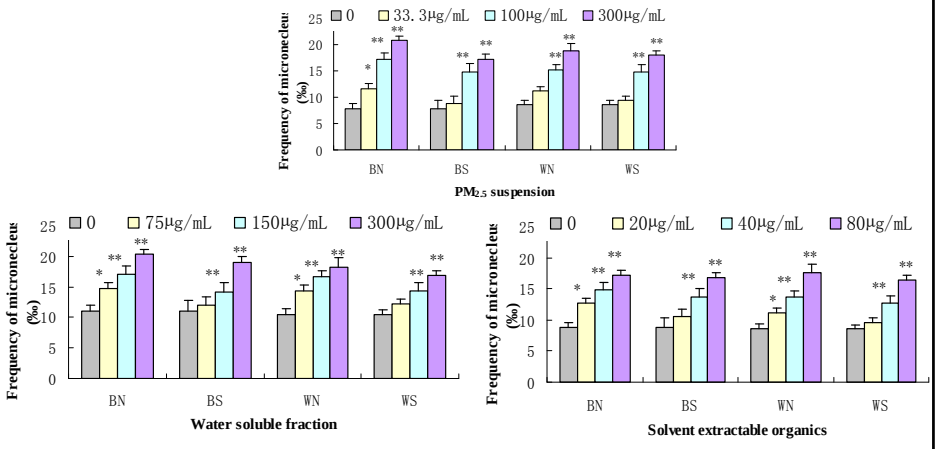

Fig.3-8 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls.

3.2.2 Chromosome aberrations

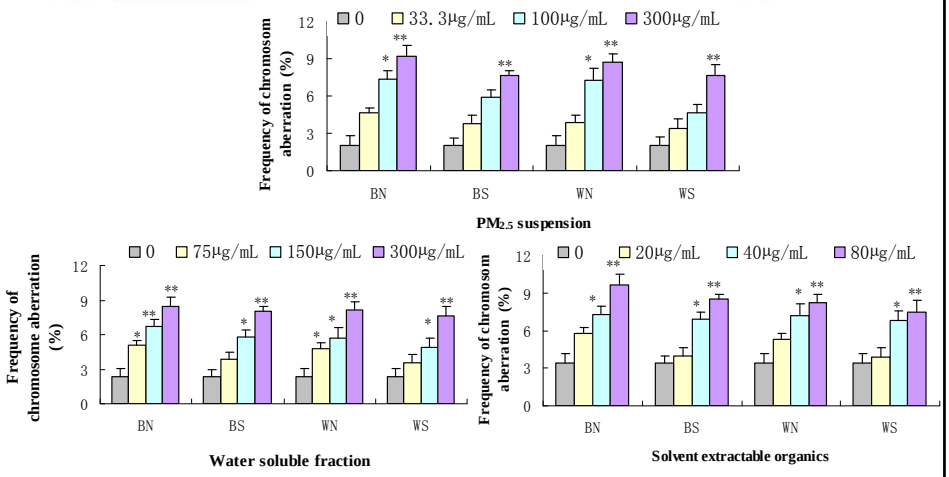

Fig.3-9 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls.

A. Chromatid break

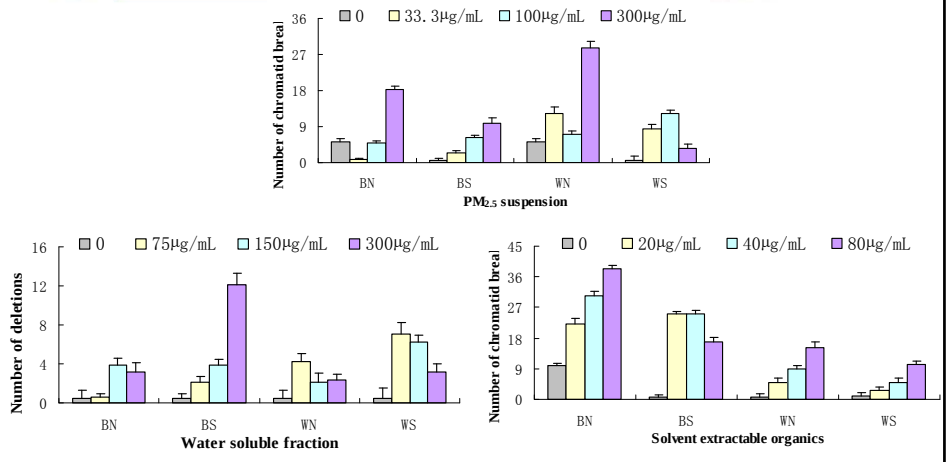

Fig.3-10 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls.

B. Deletions

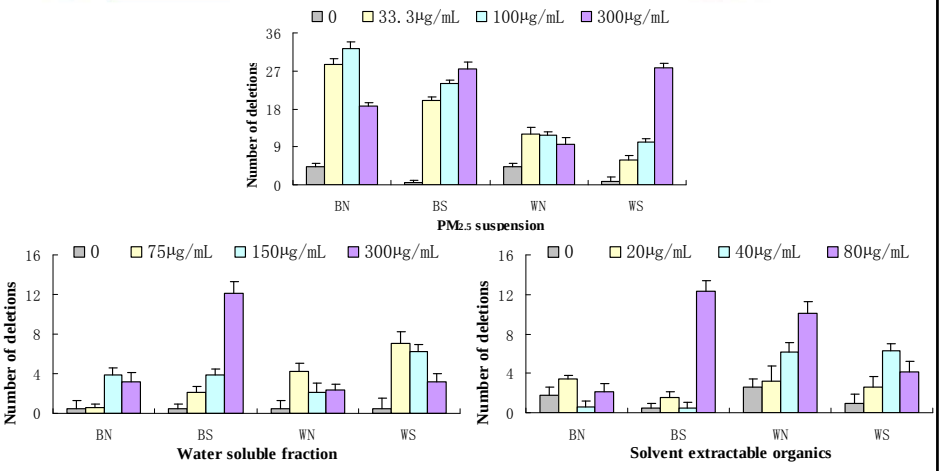

Fig.3-11 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls.

C. Acentric fragments

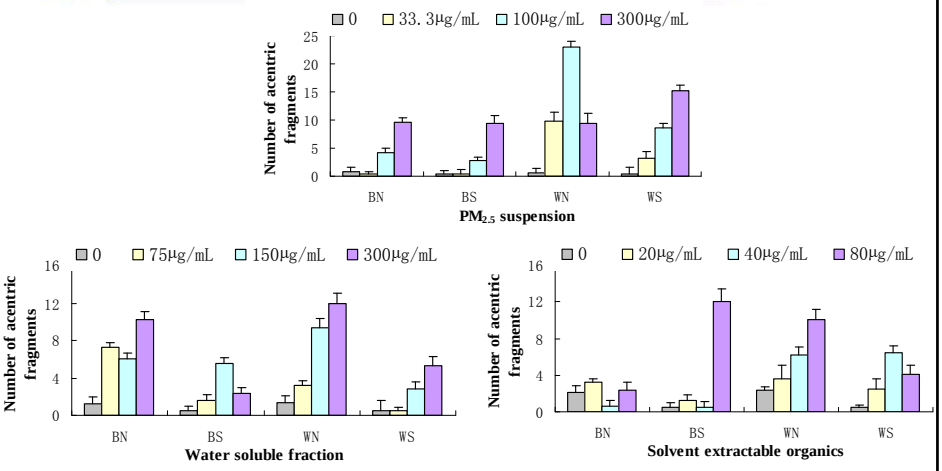

Fig.3-12 BN: normal weather in Baotou city; BS: dust storm in Baotou city; WN: normal weather in Wuwei city; WS: dust storm in Wuwei city. *$P \leqslant 0.05$ and **$P \leqslant 0.01$ when compared to the controls.

3.3 Conclusions

(1) $PM_{2.5}$ total particles, water soluble fraction and solvent extractable organics from both dust storm and normal weather all had damaging effects on alveolar macrophages and genetic toxicity on human blood lymphocytes.

(2) The general toxicity: total particles＞water-soluble fraction ＞ solvent extractable organics.

(3) The effects of dust storm $PM_{2.5}$ from Wuwei and Baotou were similar.

(4) At same concentration, the toxicity of normal weather $PM_{2.5}$ was higher than that of dust storm. But when dust storm occurring, the concentration of $PM_{2.5}$ was greatly increased, so the toxicity of normal weather $PM_{2.5}$ was higher than that of dust storm.

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