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Logistic Regression Analysis on Risk Factors of Chronic Obstructive Pulmonary Disease in Xi'an Based on Environmental Problems*

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Abstract: Background: With the sharp rise of urbanization, nowadays, more and more rural people are flocking into the city in search of jobs and better living to bring about an increasing number of migrant workers from countryside to cities, in which urban diseases are emerging rapidly. Environmental pollution is one of the most popular problems. The environment minister, Chen, Jining, proposed the idea of haze governance in the sessions of 2016 NPC and CPPCC. Environmental pollution can directly result in a decline in the residents' immune defense of respiratory system and then they will be ill. Furthermore, Chronic Obstructive Pulmonary Disease (COPD) is a common and frequently-occurring disease in respiratory-system-related diseases. **Objective:** The relationship between inpatients over 40 years old who are diagnosed with COPD. **Methods:** Simple random sampling and individual matching case-control study were adopted in this research. One hundred and sixty COPD patients (Cases) and the same amount of subjects undergoing physical examinations, respectively selected from secondary and tertiary hospitals and their physical examination centers in 4 different administrative regions of Xi'an, were involved in the questionnaire survey. Finally, logistic regression analysis was used to analyze the risk factors of COPD. **Results:** Males have a higher risk (64.41%) of getting COPD than females. Aging contributes significantly to the increase of cases. It is found that the highest proportion of COPD patients is among those at or over the age of 70 to 79. The environmental factors of COPD are found to be related with pollutions both outdoors (haze, automobile exhaust, catkin, industrial pollutant) and indoors (kitchen fumes, smoking or passive smoking, dust). smoking, ventilation in kitchen, exercise habit, gauze mask wear outside (OR = 0.163、0.044、0.008、0.026) are the main risk factors. **Conclusion:** It is urgent to improve environment in Xi'an. Air pollution (both indoors and outdoors) has long-term effects on COPD in adults. Two major elements are found to contribute to COPD, i.e., haze and smoking. At the end of this paper, the author proposes some suggestions from the perspective of the governors and residents on solutions to environmental problems in Xi'an. It is necessary to popularize related preventive knowledge, raise the awareness of COPD prevention and especially control the production of cigarettes.

Key words: environmental pollution, COPD, Xi'an, logistic regression analysis
JEL code: I120

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1. Background

With the rapid development of urbanization in China, more and more rural people are flocking into the city in search of jobs and better living to bring about an increasing number of migrant workers from countryside to advanced cities, primarily showing a dramatic increase in the number of migrant workers and a rapid redevelopment of city planning. And urban diseases are emerging rapidly during the urbanization, such as saturated population, housing difficulties, environmental pollution, traffic jams and so on, among which environmental pollution is the focus in today's society, and is also a severe test with which Chinese city development has got to face. Environmental pollution has a direct influence on residents' health conditions and the quality of life, which makes which makes the traditional public health problems (such as waterborne diseases, malnutrition, lack of medical services, etc.) transformed into modern health crisis. With time going by, the damage of immune defenses of respiratory system has been more and more prominent and well worth focusing. Furthermore, Chronic Obstructive Pulmonary Disease (hereinafter, COPD) is a common and frequently-occurring disease in respiratory-system-related diseases, and has high morbidity and mortality. One foreign study reported that the morbidity of COPD was 5% to 15% (Halbert R. J., Natoli J. L. & Gano A. et al., 2006; Landis S. H., Muellerova H. & Mannino D. M. et al., 2014). As a critical epidemic problem, COPD has been plaguing many patients.

Xi'an is the capital city of Shaanxi province and an international metropolis, bordering Wei River to the north and Mt.Qinling to the south. Furthermore, Xi'an is also the political, economic and cultural center in north-west area in China. Urbanization in Xi'an has been accelerated in many aspects, including urban village reconstruction, pavement maintenance, subway construction, dismantlement of old buildings and new buildings' walls painting, the optimization of bus routes, real estate development, etc. There is a sharp increase of population-urbanized ratio having reached 49.25% by 2013 (Wu Yuetao & Zhong Weizhou, 2015). Meanwhile, environmental problems has been more and more obvious and the major pollutant is particulate matter (PM) (Wu Yuetao & Zhong Weizhou, 2015), which results from the impact of automotive exhaust emission, the change of energy structure and consumption, the increasing transportation of muck, and urban expansion and construction.

Governors and representatives had been discussing intensely on environmental topics during the sessions of 2016 NPC and CPPCC. The environment minister, Chen, Jining, proposed the idea of haze governance and attracted people's attention and talking. He made a decision to resolutely control air, water and soil pollution. Environment can be divided into two broad categories, indoors and outdoors. In the similar way, the environmental pollution can be also divided into indoor and outdoor pollution. As for Xi'an, haze usually occurs in winter annually, which leads to an excess of PM 2.5. One of the major reasons is the use of boiler room heating in some parts of Xi'an. In this heating pattern, discharged gas from towering chimneys directly affects the air. A number of residents who live in the urban villages use honeycomb briquettes or coal to get warm. Because of the imperfection of their houses, poor ventilation conditions and weak sense of self-protection, the risk of respiratory destruction may be increased to a great extent. Thus, a large number of hospital admissions with clinical manifestations of bronchial asthma, pneumonia, acute upper respiratory tract infection, chronic bronchitis and emphysema tends to appear in respiratory department in winter. If the patients pay less attention to their respiratory diseases, especially chronic bronchitis and emphysema, they will get COPD with no doubt. It seriously affects their labor force and life quality.

In addition, drifting snow-like catkins around Ba Bridge is one of the portraits of the eight scenic spots in Guanzhong Basin. People can see it in every spring. Spring in Xi'an is almost dry, windy, during which the

weather and temperature is also fickle. The catkin drifts away anywhere. It is so inconvenient and uncomfortable for citizens to go outside during that time, particularly for those who are allergic to the catkins, young children and old people.

2. Literature Review

The author collected 14 literatures on epidemiological studies of COPD in part of provinces and cities by surfing cnki.com. It suggests that different areas has different morbidities, including Chengdu (9.6%) (Zeng Xuefeng, Wang Xiaoxia, Bao Yong et al., 2011), Jinan (7.6%) (Wang Wenqiao, 2014), Chongqing (12.78%) (Li Qi, Liao xiuqing & Zhang Qiao et al., 2009), Tianjin (City for 8.3% and rural area for 11.4%) (Shan Shuxiang & Chen Baoyuan, 2007), etc. However, there has not been relevant surveys to explain prevalence of COPD in Xi'an so far. Tang Wenfang and other scholars (Tang Wenfang, Liu Rihui, Yu Yaqin & Liu Jin et al., 2016) conducted a Meta-analysis of COPD morbidities of adults at or over the age of 40 from 2000 to 2014. According to the survey, the morbidity ratio of 17 cities over China is 9.3% (95%CI: 8.4%-10.1%). And COPD morbidity vary from city to city, morbidity in northern China is the highest (10.7%), and the most important hazard is environmental pollution. Li Chunyan and other scholars (Li Chunyan, Zhou Liting & Wang Shuyue et al., 2016) considered that being exposed to PM 2.5, PM 10, SO_2, NO_2, O_3 and CO, particularly NO_2 and CO can increase the risk of COPD in different extent. From the present studies, the hazards of COPD are smoking, cooking fuel, exhausters and ventilation in kitchens and history of occupational dust exposure (Chen Hong, Su Weiqiang,Chen Xiutao et al., 2008). On the other hand, mild winter and greenhouse gas emission can result in AECOPD (Zhong Nanshan, 2011).

It is closely related between the emergence of urbanization and the occurrence of COPD. Government officials pay more attention to reconstruction of urban villages and monitoring the appearance of Xi'an. Therefore, that will have houses in urban villages pulled down, then replan and rebuild new buildings. It also suggests that most of rural residents lose their own lands and have to adjust themselves to city life. Yao Weiqun and other scholars (Yao Weiqun, Dai Baizhang & He Fang et al., 2013) did a comparative study that analyzed morbidity of COPD among the citizens who live in town and countryside. The results show that the morbidity of urban residents is 5.12% and the landless peasants' is 8.15%. Obviously, the latter is higher. The landless people must wait for their affordable housing. During the period, they need to find another simple places. Moreover, their temporary residences, where they need to live for a certain long period of time, are usually not well-ventilated, which give a rise to COPD.

COPD is a chronic disease, it is caused by body's own weak immunity and other unknown factors for a long time. One study has pointed out that COPD can vary by different living environment and climate conditions, and impacts greatly by environmental pollution (Hu Dajie, 2012). Besides, PM 2.5 can increase the morbidity and mortality of COPD (Li Hang, Guo Weili, An Zhen, Zhai Chengkai et al., 2016). Thus, the author predicts that environmental problems brought by the urbanization process may urge people in Xi'an to suffer from COPD. And it is necessary to do a survey on correlation between environmental pollution and COPD attacking. In this end, the author conducts the epidemiological investigation of COPD to know about relations between environmental factors and hospitalized patients from partial areas in Xi'an and to supply reference to the prevention of COPD.

3. Method

3.1 Time and Subjects

This study looks into daily hospital admissions in relation to all kinds of environmental pollution, including indoor and outdoor pollution in Xi'an for over 1 month from April 6, 2016 to May 18, 2016 (43 days). The target population included COPD patients (case group) who is at or over the age of 40 and people who were undergoing physical examinations (control group) respectively selected from secondary and tertiary hospitals and their physical examination centers in 4 different administrative regions (Xincheng district, Beilin district, Baqiao district and Lianhu district) of Xi'an. The number of case and control groups are similar.

3.2 Investigation

This study is based on the principle of simple random sampling through questionnaire survey. All data were offered by selected subjects. In addition, the author refers to the results of PFT to further confirm the diagnosis of COPD. The COPD diagnostic criteria is in accordance with the Guideline for Diagnosis and Management of COPD drafted by Respiratory Society of Chinese Medical Association. Questionnaire's designing and compiling refers to SGRQ etc.

3.3 Inclusion and Exclusion Criteria (Cheryl Pirozzi, Anne Sturrock, Patrick Carey et al., 2015) (Table 1)

Table 1 Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
COPD patients and the same amount of subjects undergoing physical examinations, respectively selected from secondary and tertiary hospitals and their physical examination centers in 4 different administrative regions of Xi'an	Apart from cardiovascular and cerebrovascular diseases, other pulmonary diseases
At or over the age of 40	Below the age of 40
Moderate or severe COPD	Unwilling to cooperate with the investigation and do PFT*
Need to refer to PFT (FEV1/FVC < 0.7, suggest that continuous flow has been constrained)	adolescent patients/genital airway stenosis limited airflow

Note: * Actually, we had given out 160 groups of questionnaires, however, it was unfortunate that only 118 groups were satisfying. The rest of 42 groups did not meet standards, because some of people who took part in the investigation were not willing to cooperate, others were suitable for exclusion criteria above. So we had got to give them up.

3.4 Variable Assignment

Table 2 Variable Assignment

Number	Variable	Coded instructions
X_1	Smoking	No = 0; Yes = 1
X_2	Cooking in the kitchen	No = 0; Yes = 1
X_3	Ventilation in kitchen	No = 0; Yes = 1
X_4	Exercise habit	No = 0; Yes = 1
X_5	Wearing a gauze mask outside	No = 0; Yes = 1
X_6	The extent of living in environmental pollution	No = 0; Sometimes = 1; Often = 2
X_7	Allergic history	No = 0; Catkin = 1; Pollen = 2; Dust = 3
Y	COPD	No = 0; Yes = 1

3.5 Data Analysis

The author uses SPSS 17.0 to analyze data. Classification variables are described by morbidity, while the study on risk factors of COPD are achieved with the application of logistic regression analysis.

4. Results

4.1 Data Collection

The author sent out 320 questionnaires, but the number of effective questionnaires is 236 (including case group and control group, 118 available questionnaires for each group).

Table 3 Data of 4 Different Districts in Xi'an, Shaanxi

Number	District	Case group	Control group
1	Xincheng district	16	16
2	Beilin district	24	24
3	Baqiao district	45	45
4	Lianhu district	33	33

4.2 Sex Ratio of Hospitalized COPD Patients

It is found that there are 72 males (64.41%) and 46 females (35.39%) among 118 COPD patients (Figure 1). It seems to be popular with males.

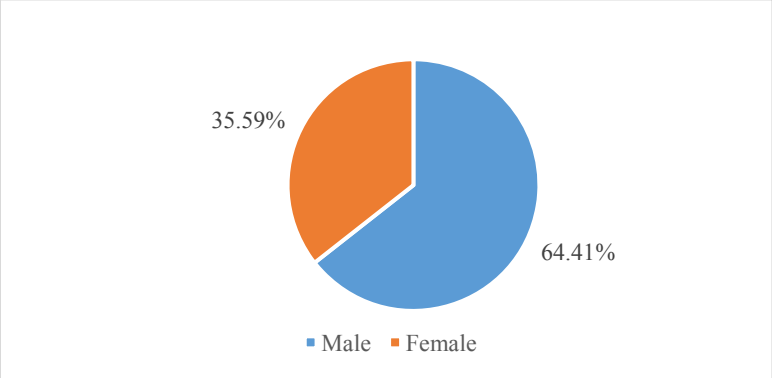

Figure 1 Sex Ratio of Hospitalized COPD Patients

4.3 Age Distribution of Hospitalized COPD Patients

The result shows that there is highest proportion between 70 and 79 years old (34.75%) (Table 1 and Figure 2).

Table 4 Distribution of Hospitalized COPD Patients in Different Ages

Age Section	The Number of Patients	Proportion
40-49	6	5.08%
50-59	18	15.25%
60-69	25	21.19%
70-79	41	34.75%
80-89	21	17.80%
≥ 90	7	5.93%
Total	118	100.00%

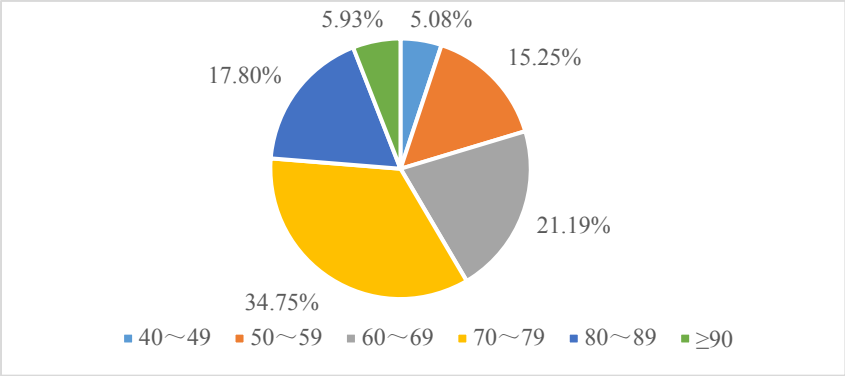

Figure 2 The Proportion of Hospitalized COPD Patients in Partial Areas in Xi'an

4.4 Logistic Regression Analysis

The author conducts variable selection for 7 possible factors of COPD disease with the help of SPSS 17.0 and uses backward selection method (Wald test). Meanwhile, the author determines the elected to the inspection level ($\alpha = 0.05$). By selecting for 4 times, finally, there are 4 variables identified, smoking, ventilation in kitchen, exercise habit, wearing a gauze mask outside or not (Table 5).

Table 5 Variable Selection

		B	SE	Wald	df	Sig.	Exp(B)
Step 1	Smoking	-0.356	0.203	3.064	1	0.080	0.701
	Cooking in the kitchen	0.189	0.192	0.967	1	0.325	1.207
	Ventilation in kitchen	-0.351	0.225	2.438	1	0.118	0.704
	Exercise habit	-0.938	0.222	17.924	1	0.000	0.391
	Wearing a gauze mask outside or not	-0.971	0.224	18.729	1	0.000	0.379
	The extent of living environment pollution	-0.028	0.147	0.037	1	0.848	0.972
	Allergic history	0.052	0.087	0.354	1	0.552	1.053
Step 2	Smoking	-0.358	0.203	3.109	1	0.078	0.699
	Cooking in the kitchen	0.187	0.192	0.953	1	0.329	1.206
	Ventilation in kitchen	-0.350	0.225	2.418	1	0.120	0.705
	Exercise habit	-0.945	0.219	18.563	1	0.000	0.389
	Wearing a gauze mask outside or not	-0.970	.224	18.688	1	0.000	0.379
	Allergic history	0.050	0.086	0.329	1	0.566	1.051
Step 3	Smoking	-0.353	0.203	3.023	1	0.082	0.703
	Cooking in the kitchen	0.201	0.190	1.120	1	0.290	1.222
	Ventilation in kitchen	-0.358	0.224	2.550	1	0.110	0.699
	Exercise habit	-0.976	0.212	21.124	1	0.000	0.377
	Wearing a gauze mask outside or not	-0.960	0.224	18.428	1	0.000	0.383
Step 4	Smoking	-0.360	0.204	3.129	1	0.077	0.698
	Ventilation in kitchen	-0.382	0.223	2.930	1	0.087	0.683
	Exercise habit	-0.981	0.213	21.243	1	0.000	0.375
	Wearing a gauze mask outside or not	-0.943	0.224	17.781	1	0.000	0.389

The author conducts the conditional Logistic regression analysis among 118 COPD patients (case group) and the same number of subjects undergoing physical examinations (control group). It shows that smoking, ventilation in kitchen, exercise habit and wearing a gauze mask outside or not are dangerous factors of COPD (corresponding OR: 0.163, 0.044, 0.008, 0.026) (Table 6)

Table 6 Logistic Regression Analysis

Factors (X)	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Smoking	-1.813	0.600	9.130	1	0.003	0.163	0.050	0.529
Ventilation in kitchen	-3.128	0.835	14.024	1	0.000	0.044	0.009	0.225
Exercise habit	-4.794	0.731	42.964	1	0.000	0.008	0.002	0.035
Wearing a gauze mask outside	-3.634	0.583	38.908	1	0.000	0.026	0.008	0.083

It is statistically significant for smoking, ventilation in kitchen and wearing a gauze mask outside or not. In addition, smoking and ventilation in kitchen belong to indoor environmental pollution, smoking and wearing a gauze mask outside or not belong to outdoor environmental pollution. It suggests that people should focus on their own healthy lifestyles and government officials should urge to control the outdoor environmental pollution.

5. Discussion and Suggestions

COPD is a common, chronic and frequently occurring disease in respiratory system diseases. The patients' labor and the quality of life have been affected because of impaired lung function, which brings a heavy burden to their families and society. This paper shows that the age distribution and proportion of COPD. And the author carries on Logistic regression analysis with 1 to 1 cases-data comparison on environmental factors of COPD. The result suggests that COPD inpatients are mainly males (64.41%), and female inpatients account for 35.59%. Most of patients are at the age of 70 to 79, which accounts for 34.75%.

Smoking is also one of the most dangerous factors (OR = 0.163). Some information shows that the morbidity of smokers is higher than that of non-smokers'. And 15% to 20% of smokers suffer from COPD (Ran Pixin, 2007). Meanwhile, the trend of COPD is more obvious with the increase of smoking which also directly influences to decrease lung function FEV_1. Among the COPD patients, FEV_1 of smokers decrease 66mL per year and non-smokers decrease 48.1 mL per year and the difference is statistically significant (Zhong Nanshan, 2011). Furthermore, smoking can result in indoor and outdoor environmental pollution. Not only does it do harm to their own bodies, but also affects other people's health. Therefore, it is the most important to sparkplug people to give up smoking, popularize knowledge about tobacco and make residents improve the domestic hygiene and heighten the awareness of environmental protection. The city planners can set "no smoking" public signs and establish independent smoking rooms and appropriative exhaust pipes in some public areas (both indoors and outdoor) to prevent smoke spreading in the atmosphere and causing the secondary pollution.

The analyzed result shows that ventilation in the kitchen is another risk factor of COPD. During the urbanization, there are lots of families living in the lets because of urban village reconstruction. And they don't have good ventilation while cooking. In addition, the living space is so limited and there is no room to install exhaust fans or range hoods. People contact with lampblack in the kitchen for a long time, it is possible for them to suffer from COPD. A survey shows that using coals and biofuels is strongly associated with COPD (PARP = 41.29%) (Zhang Longju, Liang Yi, Zhou Guang, & Liu Wenting, 2015). Thus, the government should focus on the living quality of residents and improve the ventilation of their rooms, the quality of life and productivity.

Besides, this study also finds that exercise habit and wearing a gauze mask outside or not are the dangerous factors of COPD. According to a literature, the economic evaluation of health loss on atmosphere and water pollution in Xi'an is at an average of 2.28792-2.28792 billion per year from 1996 to 2003, account for 3.6% to 7%

of GDP (Xu Weiping & Wei Ningbo, 2007), which explains that environmental pollution has a significant impact on the residents' health. Haze appears in annual winter in Xi'an. However, most of people are not willing to wear gauze masks. Many people say that they do not adapt to wearing masks, so they go outside with no protection in bad weather. Furthermore, people are occupied with their work because of busy urban life and they have less opportunities to do sports. Day after day, they will be ill in the bad environment due to poor immunity. At present, the main pollutant are PM 2.5, PM 10, SO_2 and NO_2 (Xu Weiping & Wei Ningbo, 2007; Zhao Ke, Cao Jijun, Wen Xiangmin, 2011). A statistic shows that the mortality of respiratory system disease will go up to 8.32% when PM 2.5 increases 100 $\mu g/m^3$ in the air in which COPD occupies 7.25%.

There are some limitations in this study because of the limited time and the author's inexperience:

(1) Sampling range is not sufficiently extensive and questionnaires' results exist differences for different patients, some projects are blank and the data are missing, so the specificity of statistical results may not high; (2) There are some bugs during the preparation, which may influence this study's stringency.

Abbreviations

COPD	Chronic Obstructive Pulmonary Disease
AECOPD	acute exacerbation of chronic obstructive pulmonary disease
M	particulate matter
CI	confidence interval
PFT	pulmonary function test
SGRQ	St George's Respiratory Questions
FEV1	forced expiratory volume at 1st second
FVC	forced vital capacity
PARP	population attributable risk percent
GDP	gross domestic product

References

Chen Hong, Su Weiqiang and Chen Xiutao et al. (Oct. 2008). "The investigation of risk factors among COPD patients over the age of 40 in rural areas in Lianjiang, Guangdong", *Journal of Guangdong Medical College*, Vol. 28, No. 5, pp. 560-564.

Cheryl Pirozzi, Anne Sturrock and Patrick Carey et al. (2015). "Respiratory effects of particulate air pollution episodes in former smokers with and without chronic obstructive pulmonary disease: a panel study", *BioMed Central, COPD Research & Practice*, pp. 1-10.

Halbert R. J., Natoli J. L. and Gano A. et al. (2006). "Prevalance of chonic obstructive pulmonary disease in China: A large, population-based survey", *Eur. Respir J.*, Vol. 28, No. 3, pp. 523-532.

Hu Dajie (Jul. 2012). "Epidemiological survey of chronic obstructive pulmonary disease in Cixi city: 2009-2012", *China Modern Doctor*, Vol. 50, No. 19, pp. 9-13.

Landis S. H., Muellerova H. and Mannino D. M. et al. (2014). "Global burden of COPD international patient survey: Methods, COPD prevalance, and disease burden in 2012-2013", *Int. J. Chron Obstruct Pulmon Dis.*, Vol. 9, No. 1, pp. 597-611.

Li Qi, Liao xiuqing and Zhang Qiao et al. (Jan. 2009). "Epidemiological sampling survey on chronic obstructive pulmonary disease in urban area of Chongqing city", *China Journal of Critical Care Medicine*, Vol. 8, No. 1, pp. 12-15.

Li Chunyan, Zhou Liting, and Wang Shuyue et al. (Mar. 2016). "A Meta-analysis: The effect of air pollution on COPD inpatients", *Chinese Journal of Gerontology*, Vol. 36, No. 5, pp. 1141-1144.

Li Hang, Guo Weili, An Zhen and Zhai Chengkai et al. (Mar. 2016). "Research progress: the effect of $PM_{2.5}$ on chronic obstructive pulmonary disease", *Journal of Xinxiang Medical University*, Vol. 33, No. 3, pp. 234-238.

Ran Pixin (Feb. 2007). "Risk factors and prevention of chronic obstructive pulmonary disease", *Chinese Journal of Tuberculosis and Respiratory Diseases*, pp. 141-143.

Shan Shuxiang and Chen Baoyuan (Jul. 2007). "Epidemiology investigation of chronic obstructive pulmonary disease in city and country of Tianjin", *Tianjin Med. J.*, Vol. 35, No. 7, pp. 488-490.

Tang Wenfang, Liu Rihui, Yu Yaqin and Liu Jin et al. (Sep. 2015). "Prevalence of COPD among Chinese people aged 40 years and over from 2000 to 2014: A meta-analysis", *Journal of Jilin University (Medicine Edition)*, Vol. 41, No. 5, pp. 961-967.

Wang Wenqiao (May 2014). "The association analysis between chronic obstructive pulmonary disease and ambient air pollution", Shandong University.

Wu Yuetao and Zhong Weizhou (May 2015). "Urbanization and atmospheric pollution — Based on the empirical analysis of Xi'an City", *Modern Economic Science*, Vol. 37, No. 3, pp. 71-79.

Xu Weiping and Wei Ningbo (2007). "The research of economic loss of health damage of urban atmosphere and water pollution for the Xi'an City", *China Population Resources and Environment*, Vol. 17, No. 4, pp. 71-75.

Yao Weiqun, Dai Baizhang and He Fang et al. (2013). "The comparison and analysis: The morbidity of COPD patients between city residents and ground residents", *Chinese Community Doctors*, Vol. 15, No. 2, pp. 342-343.

Zeng Xuefeng, Wang Xiaoxia and Bao Yong et al. (Jan. 2011). "Epidemiological survey on chronic obstructive pulmonary disease in Chengdu communities", *China Journal of Critical Care Medicine*, Vol. 10, No. 1, pp. 30-32.

Zhang Longju, Liang Yi, Zhou Guang and Liu Wenting (Apr. 2015). "Meta analysis on risk factors of chronic obstructive pulmonary disease among Chinese people in mainland", *Chong Qing Medicine*, Vol. 44, No. 12, pp. 1655-1657.

Zhao Ke, Cao Jijun and Wen Xiangmin (Apr. 2011, "*Correlation between $PM_{2.5}$ pollution in air and mortality of residents in urban area, Xi'an*", *J. Prev. Med. Inf.*, Vol. 27, No. 4, pp. 257-262.

Zhong Nanshan (May 2011). "Chronic obstructive pulmonary disease in China", *Chinese Journal of Practical Internal Medicine*, Vol. 31, No. 5, pp. 321-322