



Prevalence of cardiovascular disease in subjects hospitalized due to chronic obstructive pulmonary disease in Beijing from 2000 to 2010

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Abstract

Objectives To investigate the overall prevalence of cardiovascular disease (CVD) in subjects hospitalized for chronic obstructive pulmonary disease (COPD), and explore the prevalence of the major CVD complications and trends in patients with COPD over a 10-year period. **Methods** Medical records in the PLA General Hospital, Beijing Union Medical College Hospital, and Beijing Hospital from 2000/01/01 to 2010/03/03 were retrospectively reviewed. A total of 4960 patients with COPD were reviewed in the study (3570 males, mean age, 72.2 ± 10.5 years; 1390 females, mean age, 72.0 ± 10.4 years). **Results** The prevalence of CVD in COPD patients was 51.7%. The three most prevalent CVDs were ischemic heart disease (28.9%), heart failure (19.6%), and arrhythmia (12.6%). During the 10-year study period, the prevalence of various CVDs in COPD patients showed a gradual increasing trend with increasing age. There was higher morbidity due to ischemic heart disease ($P < 0.01$) in male COPD patients than in the female counterparts. However, heart failure ($P < 0.01$) and hypertension ($P < 0.01$) occurred less frequently in male COPD patients than in female COPD patients. Furthermore, the prevalence of ischemic heart disease decreased year by year. In addition to heart failure, various types of CVD complications in COPD patients tended to occur in younger subjects. The prevalence of all major types of CVD in women tended to increase year by year. **Conclusions** The prevalence of CVD in patients hospitalized for COPD in Beijing was high. Age, sex and CVD trends, as well as life style changes, should be considered when prevention and control strategies are formulated.

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Keywords: Prevalence; Cross-sectional investigation; Chronic obstructive pulmonary disease; Cardiovascular disease

1 Introduction

Several studies have confirmed that cardiovascular disease (CVD) is a major complication of chronic obstructive pulmonary disease (COPD), and COPD is an independent risk factor for CVD.^[1–3] However, studies focusing on the prevalence of CVD in patients with COPD are lacking. Our research investigated the overall prevalence of CVD in subjects hospitalized for COPD, and explored the prevalence of the major CVD complications in patients with COPD over a 10-year period.

COPD is, without a doubt, a disabling and fatal disease.

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It is estimated that the morbidity of COPD is more than 10% in the adult population.^[1] and approximately eight billion people worldwide suffer from moderate-to-severe COPD. Additionally, in China about five million people are disabled due to COPD and one million people die of COPD each year.

CVD is also a serious threat to personal health, to the extent that it has become a worldwide public-health problem.^[2] It has been confirmed that CVD is a major complication of COPD,^[3] and COPD is an independent risk factor for CVD.^[4] However, the incidence of CVD in patients with COPD is not known thereby affecting people's awareness of the dangers of COPD and prediction of the prognosis.

Focusing on hospitals in Beijing, China, we studied the prevalence of CVD in a substantial number of patients hospitalized due to COPD and examined the population distribution over a 10-year period. This was achieved by retrospectively examining the medical records of diagnosed patients.

2 Methods

2.1 Data source

COPD patients admitted to the three hospitals (People's Liberation Army General Hospital; Beijing Union Medical College Hospital and Beijing Hospital of Ministry of Health) from 2000/01/01 to 2010/03/03 were enrolled in the study. The three hospitals, which are managed by the government, registered 99% of the health data for people living in Beijing.

2.2 Study population

Selected patients had to meet the following criteria. First, the discharge diagnosis had to be in accordance with the 9/10th Revision of the International Classification of Diseases (ICD-9/10). Patients were diagnosed as having chronic bronchitis, emphysema or COPD. Secondly, patients should have a history of using anticholinergics and β -receptor agonists, or theophylline, either long-term or temporarily. Thirdly, patients had to be 40 years of age or older. Fourthly, the time-span from hospitalization to an outpatient (or the time-span for which hospital records were available) was more than six months. Lastly, the patients need to be Han Chinese.

A total of 4960 patients with a mean age of 72.2 ± 10.4 years and COPD were enrolled. There were 3570 males (mean age, 72.2 ± 10.5 years), and 1390 females (mean age, 72.0 ± 10.4 years), (Table 1).

2.3 Validation of hospital discharge codes

We used the case management system based on the International Classification of Diseases (ICD) code in the three hospitals to search for the basic information on COPD patients. The tenth revision (ICD-10) was carried out by PUMC Hospital, Beijing and Hospital Ministry of Health. While the Chinese PLA General Hospital used the ninth revision (ICD-9) from January 2003 to July 2008. We then referred to the relevant content from their medical records. Differences in the ICD versions were corrected by referring to Tables ICD-9~ICD-10 from the Military Hospital Diagnosis Code. Disease codes were retrieved according to sub-orders (Table 2).

Table 1. Age and sex distribution of chronic obstructive pulmonary disease patients.

Age group (yr)	Males <i>n</i> (%)	Females <i>n</i> (%)	Total <i>n</i> (%)
< 50.0	141 (3.9)	59 (4.2)	200 (4.0)
50.0~59.9	324 (9.1)	108 (7.8)	432 (8.7)
60.0~69.9	758 (21.2)	304 (21.9)	1062 (21.4)
70.0~79.9	1508 (42.2)	602 (43.3)	2110 (42.5)
≥ 80.0	839 (23.6)	317 (22.8)	1156 (23.4)

Table 2. Codes of cardiovascular disease.

Diseases	ICD-9 code	ICD-10 code
Ischemic heart disease	410.x-414.x	I20.x-I25.x
Arrhythmia	427.x	I44.x-I49.x
Heart failure	428.x, 402.x	I50.x
Hypertension	401.9x, 402.901 or 403.907	I10.x-I15.x

ICD: international classification of diseases.

The prevalence of the target disease was defined as the percentage of patients with the target disease compared to all enrolled patients during the study period.

2.4 Statistical analyses

The continuous variables were tested for normal distribution by the Kolmogorov-Smirnov test. The normal distributed continuous variables were shown as mean \pm SD. The categorical variables were presented as frequencies (percentages). Comparisons of the groups for continuous variables were performed with the unpaired *t*-test. Comparisons of the groups for categorical variables were performed with Pearson chi-square test. *P* < 0.05 (two-sided) was considered significant. SPSS 18.0 statistical software (SPSS, Chicago, IL, USA) was used for data analysis in the study.

3 Results

3.1 Prevalence of CVD in COPD patients

The total prevalence of CVD in COPD patients was 51.7%, specifically 2562 cases out of all cases with COPD had CVD. The prevalence of ischemic heart disease among COPD patients was 28.9%, of heart failure was 19.6% and of arrhythmia was 12.6%.

3.2 Background of patients with COPD

A total of 96.7% of 4960 patients with COPD were from the Beijing district. Social and commercial insurance paid for the primary medical treatment in of 60.8% of patients. The professional background of the patients varied (Table 3).

3.3 Age prevalence of CVD in COPD patients

The prevalence of various types of CVD (ischemic heart disease, angina, acute myocardial infarction, arrhythmia, atrial fibrillation/atrial flutter, heart failure, hypertension) in COPD patients increased with age (Figure 1).

3.4 Sex prevalence of CVD in COPD patients

The prevalence of CVD complications in COPD patients differed according to sex. The prevalence of CVD was 49.3% in male COPD patients and 47.6% in female COPD

patients. In female COPD patients, the prevalence of heart failure and hypertension was higher than in male COPD patients ($P < 0.05$). The prevalence of ischemic heart disease and angina in male COPD patients was higher than in female ($P < 0.05$). There were no significant differences between male and female patients with respect to acute myocardial infarction and arrhythmia (Table 4).

Table 3. The distribution of sociological indicators of chronic obstructive pulmonary disease patients.

Project	n (%)
Professional	
Cadres	1048 (21.1)
Workers	332 (6.7)
Farmers	138 (2.8)
Soldiers	832 (16.8)
Unemployed	178 (3.6)
Other	1560 (31.5)
Unknown	872 (17.6)
Marital status	
Single	52 (1.0)
Married now	4417 (89.1)
Widowed	25 (0.5)
Other	466 (9.4)
Social security	
Public health care	342 (6.9)
Own expense	37 (0.7)
Serious co-ordination	252 (5.1)
Social basic medical insurance	2454 (49.5)
Commercial insurance	558 (11.3)
Other	1317 (26.6)
Areas	
Beijing City	4798 (96.7)
The county district of Beijing	162 (3.3)

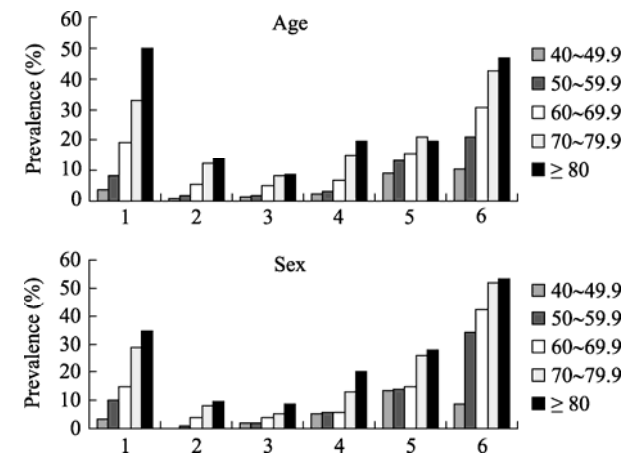


Figure 1. Prevalence of CVD in COPD patients according to age and sex. 1: ischemic heart disease; 2: angina; 3: acute myocardial infarction; 4: arrhythmia; 5: heart failure; 6: hypertension. CVD: cardiovascular disease; COPD: chronic obstructive pulmonary disease.

Table 4. Prevalence of CVD in COPD patients according to sex.

Complications	Male, n(%)	Female, n(%)	Total, n(%)	P
Ischemic heart disease	1096 (30.7)	341 (24.5)*	1433 (28.9)	< 0.001
Angina	457 (12.8)	93 (6.7)*	550 (11.1)	< 0.001
Acute myocardial infarction	57 (1.6)	33 (2.4)	89 (1.8)	0.075
Arrhythmia	457 (12.8)	168 (12.1)	625 (12.6)	0.505
Heart failure	657 (18.4)	313 (22.5)*	972 (19.6)	0.001
Hypertension	1346 (37.7)	650 (46.8)*	1999 (40.3)	< 0.001

* $P < 0.05$, female patients compared with male patients with COPD in prevalence of CVD. CVD: cardiovascular disease; COPD: chronic obstructive pulmonary disease.

3.5 Major trends of CVD in COPD patients (Table 5 and 6, Figure 2).

From 2000, the prevalence of heart failure in COPD patients ranged from 16.7% to 23.9%. From 2003 to 2004, it rose to 23.9%. From 2005, the prevalence gradually decreased. The prevalence of arrhythmia was 9.8% before 2003, but rose to 15.8% in 2004. From 2004 onwards, the prevalence decreased gradually. The prevalence of ischemic heart disease in COPD patients had a clear decreasing tendency from before 2003 to 2003~2004, declining from 43.9% to 27.6%. From 2004 onwards, the prevalence of ischemic heart disease in COPD patients was maintained at 22.4%~24.6%. COPD patients with heart failure, ischemic heart disease and arrhythmia tended to be younger and younger as the study progressed.

The prevalence of all major types of CVD in COPD declined in the males, but increased in the female counterparts. The prevalence of heart failure in male COPD patients declined, but increased in the females year on year. A similar trend was seen for arrhythmia. A break in this trend was seen for the period 2007 to 2008, where the prevalence in males increased while that of females decreased, but the original trend resumed after 2009. For ischemic heart disease, the prevalence in males decreased and that for females increased, and this trend was more prominent than for the other types of CVD.

Table 5. Age characteristics of COPD patients with CVD complications from 2000 to 2010.

Time	Heart failure		Arrhythmia		Ischemic heart disease	
	Prevalence (%)	Age (yr)	Prevalence (%)	Age (yr)	Prevalence (%)	Age (yr)
<2003	17.6	72.8±10.9	9.8	75.1±8.2	43.9	74.9±8.6
2003.1~2004.12	23.9*	74.6±8.6	15.8*	75.4±8.6	27.6*	74.6±8.9
2005.1~2006.12	20.6	73.9±8.5	13.6*	74.9±8.1	24.6*	74.7±8.5
2007.1~2008.12	16.7	74.8±9.1	11.8	74.7±9.1	22.8*	73.9±8.6
2009.1~2010.3	19.1	73.7±8.4	12.3	73.4±9.8	22.4*	73.3±8.8

* $P < 0.05$, annual differences compared with 2003. Data are presented as mean ± SE. CVD: cardiovascular disease; COPD: chronic obstructive pulmonary disease.

Table 6. Sex differences of COPD patients with CVD complications from 2000 to 2010.

Time	Heart failure		Arrhythmia		Ischemic heart failure	
	M (%)	F (%)	M (%)	F (%)	M (%)	F (%)
<2003	75.3	24.7	78.6	21.4	83.4	16.6
2003.1~ 2004.12	67.3	32.7	62.2*	37.8	59.6*	40.4
2005.1~ 2006.12	65.7	34.3	63.0*	37.0	55.8*	44.2
2007.1~ 2008.12	62.2*	37.8	67.8	32.2	55.8*	44.2
2009.1~ 2010.5	58.6*	41.4	64.4*	35.6	50.8*	49.2

* $P < 0.05$, annual differences compared with 2003. CVD: cardiovascular disease; COPD: chronic obstructive pulmonary disease. M: male; F: female.

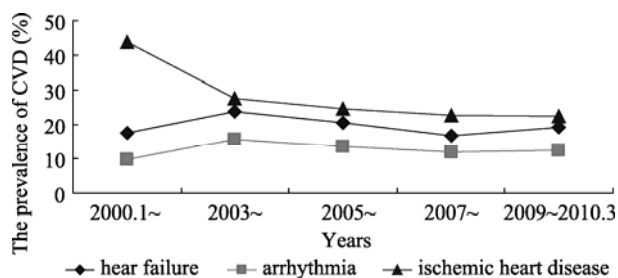


Figure 2. The prevalent of CVD in COPD patients in the past ten years. CVD: cardiovascular disease; COPD: chronic obstructive pulmonary disease.

4 Discussion

It has been confirmed that CVD is a major complication of COPD and COPD is an independent risk factor for CVD. COPD is characterized by systemic inflammation and airflow obstruction. Hypoxia, systemic inflammation, and oxidative stress affect blood vessels, the heart, and the lungs, leading to early subclinical CVD in COPD patients.^[5,6] However, investigation of the exact incidence of CVD in patients with COPD has been lacking.

In the present study, 4960 subjects aged more than 40 years old hospitalized for COPD were retrospectively analyzed using data from three general hospitals in Beijing. The number of COPD patients with CVD was 2562 (51.7%), and the prevalence gradually increased with age. The prevalence of ischemic heart disease was higher in male COPD patients than in female patients. The prevalence of heart failure and hypertension were lower in male COPD patients than in female patients. The prevalence of ischemic heart disease in COPD patients decreased year on year. COPD patients with heart failure, ischemic heart disease and arrhythmia tended to be younger as the study progressed. More females with COPD and major CVD were observed year on year as the study progressed.

The present study showed the prevalence of ischemic heart disease in subjects hospitalized for COPD decreased year on year. The age of new patients with COPD tended to decrease as the study progressed. The proportion of male patients declined, whereas the proportion of female patients increased as the study progressed.

COPD patients tend to be younger due to the extensive development of the economy, which has led to air pollution and an increasing population of smokers.^[7,8] Several studies have found that the older the patient with COPD, the higher is the prevalence of CVD. Hence, aging itself may be a common risk factor in the increased prevalence of CVD complications in patients with COPD. The trends of CVD occurring in younger subjects may be due to the changes in lifestyle and diet as more Chinese adults relocate to cities, as well as the higher morbidity associated with hypertension, hyperlipidemia and diabetes.^[9,10] Consequently, over the last decade, the mean age of COPD patients with CVD has declined as the result of several factors.

A retrospective investigation of the prevalence of complications in COPD patients showed that the diagnosis of various complications differed according to sex.^[11] More female subjects with COPD tend to have osteoporosis, non-psychotic mental disorders or depression, whereas more men tend to have the complications of ischemic heart disease, diabetes and lung cancer.^[12] The present study showed there were more male COPD patients with ischemic heart disease than female COPD patients ($P < 0.05$), which was in accordance with the results of similar studies.^[11,12] Basili *et al.*^[13] showed an increased risk of cardiovascular events in COPD patients could not be simply attributed to metabolic disorders in induced atherosclerosis. The difference between smoking and the protective effect of estrogen may explain (at least in part) the different types and proportions of CVD complications between men and women,^[14] but further studies are needed.

The present study demonstrated a gradual declining trend in the prevalence of ischemic heart disease in COPD patients in the decade. It has been showed that the tobacco-control programs contributed to the decreased mortality in CVD in the USA from 1955 and 2007.^[15,16] From 2000 to 2010, the decreased prevalence of ischemic heart disease in COPD patients may be firstly due to the gradually enhanced tobacco-control programs of the government and increasing awareness of tobacco health affects and control in Chinese society. Secondly, the declining trend may also be related to the promotion of primary prevention of CVD among physicians. For example, the use of statins has prompted the rapid progress in the prevention and treatment for ischemic

heart disease. Lastly, the early diagnosis and standardized treatment for COPD patients made a positive impact on the prevention and control of ischemic heart disease.

In addition, exposure to tobacco smoke, occupational dust and air pollution are common risk factors for CVD and COPD.^[17,18] Exposure to such risk factors in females in China, because of their increased social status, may have led to the gradual increase in the proportion of women with COPD and CVD in the recent decade.

The prevalence of arrhythmias was relatively stable except for a rise in 2003~2004. The number of males with arrhythmia, as a complication, decreased year on year, with a slight increase in the number of women with arrhythmias. The prevalence of arrhythmias in COPD patients also increased with increasing age. One important factor is that smoking and aging may be interrelated because they cause cell damage, which may increase the risk of complications in COPD.^[7,8]

Arrhythmia, often accompanied COPD or CVD, was not determined to be an independent disorder. It is associated with the instability of myocardial cells, damage to cardiac conduction fibers, or changes in the environment of cells. In addition to chronic hypoxia, oxidative effects, and inflammation in COPD patients, the occurrence of ischemic heart disease, heart failure and/or hypertension would give rise to different types of arrhythmia.^[19] Therefore, arrhythmias are closely related to the development of COPD and CVD.

A higher incidence of arrhythmias has been reported in COPD patients. Hypoxemia, infection, heart failure, acid-base imbalance and electrolyte disturbances induce and aggravate arrhythmia. The prevalence of arrhythmias in COPD patients increased with age, aggravation of heart dysfunction, and coronary heart disease. It has been suggested that respiratory failure, cardiac dysfunction, coronary heart disease, hypokalemia, and old age are important factors for arrhythmia in COPD patients. Arrhythmia is also closely related to the prognosis of COPD.^[20]

According to worldwide data, the prevalence of heart failure for the general population is 1.5%~2%, but for those aged ≥ 65 years, it is 6%~10%. The prevalence of adults with heart failure was 0.9%. In males it was 0.7% and in females it was 1%. In the past 40 years, the prevalence of deaths caused by heart failure has increased sixfold. Heart failure has become an important public health issue in the 21st century.^[21]

In Western countries, the prevalence of heart failure in COPD patients is about 20%. The prevalence of COPD in heart failure patients can be as high as 20%~30%, similar to the values of the present study.^[22] In hospitalized patients, heart failure in elderly patients with COPD is associated

with a greater risk of death compared with age-matched patients with heart failure alone or patients with COPD.^[23] The study showed that the older the patient, the higher was the prevalence of heart failure in COPD patients. This was similar to the prevalence of other types of CVD, and the number of female patients with heart failure was higher than the number of males with heart failure ($P < 0.05$). The ECCO study showed that heart failure, osteoporosis, edema, hypertension and diabetes without complications were higher in female COPD patients than in male COPD patients.^[11]

The prevalence of heart failure was in a downward trend over the decade with a break in the trend in 2003~2004. The reasons included poor awareness of patients; a low detection rate before 2003; extremely rapid economic development; active and passive smoking in 2003~2004; and because awareness of universal healthcare and social security increased after 2005. The prevalence in males over 10 years tended to decrease, whereas in women it increased. In addition to the prevalence of sex-based differences, the level of medical technology increased, exposure to passive smoking and occupational exposure for women increased, social and psychological stress increased, and the gradual loss of estrogen-protective factors were all associated with the increase in the proportion of women with COPD who had heart failure.^[25]

5 Study limitations

The patients involved in the present study were urban residents. As a retrospective investigation, the study did not investigate treatment or smoking status that could affect the prevalence of CVD.

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