

Risk factors related to hypertension in tuberculosis patients

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Abstract: Tuberculosis and high blood pressure are two major diseases that affect human health. According to the WHO survey, tuberculosis is the ninth cause of death in the global. Nearly a quarter of the world's population suffers from high blood pressure, and hypertension has become an independent factor in the death of certain diseases such as stroke and ischemic heart disease. This article mainly discusses the risk factors of hypertension in pulmonary tuberculosis patients, and provides a scientific basis for the early detection and prevention of hypertension in tuberculosis patients. A total of 100 patients with tuberculosis were enrolled in the study, 9 of them had hypertension. Patient data were collected by querying medical records and questionnaires. Logistic regression analysis was used to analyze the risk factors of pulmonary tuberculosis patients with hypertension. The distribution of Age and BMI in patients with hypertension and normal blood pressure was statistically significant. Univariate logistic regression analysis showed that age 50 years (OR (95% CI), 8.640(1.079-76.251)) and BMI 24 (OR (95% CI), 4.766(1.146-19.822)) were the risk factors for pulmonary tuberculosis with hypertension ($P < 0.05$), while Multivariate logistic regression analysis showed that only BMI 24 (OR (95% CI), 4.766(1.146-19.822)) was the risk factor for pulmonary tuberculosis with hypertension ($P < 0.05$). We found that the prevalence of hypertension in tuberculosis patients is higher, and the risk factors for hypertension are overweight/obese. Elderly age may also be the risk factor of hypertension in tuberculosis patients, which need a further study expanding the sample.

Keywords: Hypertension; tuberculosis; risk factor; logistic regression

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1. Introduction

There are more than a quarter of adults are hypertensive worldwide[1,2]. In 2008, there were almost 40% of adults had diagnosed with hypertension[3]. The prevalence is estimated to increase until 2025 in all regions and in 2010, hypertension had become the biggest single contributor to worldwide deaths, especially to stroke and ischemic heart disease[1,4,5]. Epidemic study showed that in the future two decades years from 2010, the trend of hypertension is not optimistic[6]. Most of this disease burden caused by high blood pressure is borne by middle-aged people, especially by people with prehypertension[5]. Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7), introduced the new category of "pre-hypertension"(high normal blood pressure), defined as systolic BP of 120 to 139 mmHg and/or diastolic BP of 80 to 89 mmHg[7]. According to the Guidelines for hypertension prevention and treatment in China, compared with people with 110/75 mmHg, the risk of occurrence of cardiovascular and cerebrovascular diseases in people with prehypertension after ten years were doubled[8].

Although the prevention and control effects of tuberculosis have been effective during the past decade, the incidence of tuberculosis in developing countries is still at a high level. According to the WHO survey, tuberculosis is the ninth cause of death in the global. In 2015, there were an estimated 10.4 million new incident TB cases worldwide. Six countries accounted for 60% of the new cases: India, Indonesia, China, Nigeria, Pakistan and South Africa.

Global progress depends on major advances in TB prevention and care in these countries. Worldwide, the rate of decline in TB incidence remained at only 1.5% from 2014 to 2015 and TB has become the ninth one of top 10 causes of death globally 2015[9]. In China, between 1990 and 2010, the prevalence of smear positive tuberculosis and tuberculosis-related mortality fell by 63% and 80%[10]. The regions with high prevalence of hypertension had high incidence of TB in general[11].

TB and its trigger of immunological responses can lead to the damage of endothelial function and lung tissue, which cause inflammation of vessels. Thereby, hypertension, especially pulmonary hypertension occurs[12-14]. Hypertension in patients with tuberculosis can also affects the treatment and prognosis of the disease and increases the risk of death. There was a significant difference of prevalence of hypertension between TB cohort (38.7%) and non-TB cohort (37.5%), all TB patients were newly diagnosed[15]. However, there are few studies on the influencing factors of pulmonary tuberculosis with hypertension. Therefore, our study mainly discusses the influencing factors of hypertension in tuberculosis patients, and provides a scientific basis for the early detection and prevention of hypertension in tuberculosis patients.

2. Material and Methods

2.1. Pulmonary tuberculosis patients

We conducted a cross-sectional study and the subjects involved 100 newly diagnosed and recurrent pulmonary tuberculosis (PTB) patients and 9 PTB

patients combined with hypertension from Qingdao Chest Hospital. After agreement of patients to participate, we collect patient medical records to obtain basic patient information and use face-to-face questionnaires to collect basic information and lifestyle of each patient, including age, gender, BMI, marital status, occupation, daily exercise time, smoking and drinking status.

We used SPSS 20.0 for statistical analysis. Mean \pm SD and t-test were used to describe and compare normally distributed data, median and interquartile range (IQR) and Wilcoxon test to skewed data. Chi-square test was used to compare categorical variables. Binary logistic regression analysis was used to determine risk factors of hypertension of tuberculosis patients. Variables with statistical significance in univariate analysis and variables without statistical significance but having effect for hypertension such as physical activity was included in multivariate analysis. The goodness of fit of the multivariate model was assessed using the Hosmer–Lemeshow test, and the fitness was good ($\chi^2 = 4.213$, $P = 0.755$).

2.2. Definitions and Diagnostic Criteria

According to WHO guidelines, the threshold for the diagnosis of hypertension is that systolic blood pressure (SBP) of at least 140 mm Hg and/or diastolic blood pressure (DBP) of at least 90 mm Hg[16]. Marital status was dichotomized as “married” and “not married” (widowed, separated and single). Smoking index were used to assess the smoking status of patients, it equals the number of cigarettes smoking per day multiplied by the years of smoking. Nonsmokers were considered as smoking index=0. In 2016 Chinese Dietary Guidelines, alcohol intake should not beyond 25g per day in men and 15 in

women, so alcohol intake beyond the threshold were considered as excess alcohol intake. Other employment status included students, medical staffs, officials, merchants, drivers and individuals jobless or retired.

3. Results

In this study, 100 patients with pulmonary tuberculosis were collected from the Qingdao Chest Hospital, of which 9 patients complicated with hypertension. By comparing the distribution of the age, gender, BMI, marital status, occupation, daily exercise time, smoking and drinking in patients with hypertension and normal blood pressure, we found that both age ($P=0.013$) and BMI ($P<0.001$) were statistically significant, (Table 1).

The explanation of the assignment of risk factors in logistic regression analysis was showed in Table 2. Univariate logistic regression analysis showed age ≥ 50 years (OR (95% CI), 8.640(1.079-76.251)), BMI ≥ 24 (OR (95% CI), 4.766 (1.146-19.822)) were risk factors for pulmonary tuberculosis with hypertension ($P < 0.05$) (Table 3).

Before continuing the multivariate conditional logistic regression analysis, variables with statistical significance in univariate analysis such as age, BMI and variables without statistical significance but having effect for hypertension such as physical activity, smoking and drinking, etc. were used for collinear diagnosis. The results show that there is no collinearity problem.

We further performed Multivariate logistic regression, the result revealed that elder age was not the risk factor for hypertension in tuberculosis patients but BMI ≥ 24 (OR (95% CI), 4.766(1.146-19.822)) was still the risk factor, ($P < 0.05$), (Table 4).

Table 1. Characteristics of tuberculosis patients with and without hypertension *

	Total	Hypertension	Normal	P
Total	100	9	91	-
Age (years)	40(17)	54 \pm 19	40(17)	0.013
Age (years)	-	-	-	0.046
10~	37(37.0)	1(11.1)	36(39.6)	-
30~	32(32.0)	2(22.2)	30(33.0)	-
50~	31(31.0)	6(66.7)	25(27.5)	-
Male	73(73.0)	6(66.7)	67(73.6)	0.458
BMI (kg/m ²)	21.4(3.2)	25.3(3.9)	21.1(2.9)	<0.001
BMI (kg/m ²)	-	-	-	0.022
<18.5	14(14.0)	4(15.4)	14(15.4)	-
18.5-23.9	65(65.0)	0(0.00)	61(67.0)	-
≥ 24	21(21.0)	5(55.6)	16(17.6)	-
Married ¹	66(66.0)	7(77.8)	59(64.8)	0.434

Employment status	-	-	-	0.701
Farmer	9(9.0)	1(11.1)	8(8.8)	-
Workers	35(35.0)	2(22.2)	33(36.3)	-
Others ²	56(56.0)	6(66.7)	50(54.9)	-
Exercise > 2h every day	28(28.0)	3(33.3)	25(27.5)	0.709
Smoking Index ³				
0	61(61.0)	6(66.7)	55(60.0)	0.388
0-400	15(15.0)	0(0.00)	15(16.5)	
>400	24(24.0)	3(33.3)	21(23.1)	
Excess alcohol intake ⁴	18(18.0)	2(22.2)	16(17.6)	0.509

*Mean ± SD were used to describe normally distributed data. Categorical data are given as n (%) which use valid percent.

¹Marital status was dichotomized as “married” and “not married” (widowed, divorced, separated and never married).

²“Other employment status” included students, medical staffs, officials, merchants, drivers and individuals jobless or retired.

³Smoking index equals the number of cigarettes smoking per day multiplied by the years of smoking. Nonsmokers were considered as smoking index=0.

⁴Alcohol intake exceed 25g per day in men and 15 in women were considered as “excess alcohol intake” according to 2016 Chinese Dietary Guidelines.

Table 2. The explanation of the assignment of risk factors in logistic regression analysis

Variables	Assignment
Hypertension	No=0; Yes=1
Age	Age: 10~30=1; Age: 30~50=1; Age ≥50=3
Gender	Female=1; Male=2
BMI	BMI <18.5=1; BMI: 18.5~24=2; BMI ≥24=3
Marital status	Single/separated/widowed =1; Married =2
Occupations	Others=0; Farmer=1; Worker=2
Exercise time > 2h	No=0; Yes=1
Smoking Index	0=0; 0~400=1; ≥400=2
Excess alcohol intake	No=0; Yes=1

Table 3. Univariate logistic regression analysis of hypertension in tuberculosis patients and its risk factors

Factors	OR (95%CI)	P
Age(years)	-	-
10~(reference)	-	-
30~	2.400(0.207-27.781)	0.483
50~	8.640(1.079-76.251)	0.050
Male	0.716(0.166-3.092)	0.655
BMI (kg/m2)	-	-
18.5-23.9(reference)	-	-
≥24	4.766(1.146-19.822)	0.032
Married	1.898(0.372-9.682)	0.441
Occupations	-	-
Others(reference)	-	-
Farmer	1.042(0.110-9.831)	0.972
Worker	0.505(0.096-2.655)	0.420

Exercise time > 2h	1.320(0.306-5.686)	0.709
Smoking Index	-	-
0 (reference)	-	-
> 400	1.310(0.300-5.720)	0.720
Excess alcohol intake	1.339(0.254-7.055)	0.730

Table 4. Multivariate logistic regression analysis of hypertension in tuberculosis patients and its risk factors

Factors	OR (95%CI)	P
Age(years)	-	-
10~(reference)	-	-
30~	5.419(0.170-17.782)	0.339
50~	15.753(0.572-43.925)	0.103
Male	0.874(0.135-5.662)	0.887
BMI (kg/m2)	-	-
18.5-23.9(reference)	-	-
≥24	4.766(1.146-19.822)	0.032
Married	0.179(0.010-3.042)	0.234
Exercise time > 2h	0.798(0.131-4.847)	0.806
Smoking Index	-	-
0 (reference)	-	-
> 400	0.987(0.105-9.278)	0.991
Excess alcohol intake	1.025(0.099-10.640)	0.983

4. Discussion

Pulmonary tuberculosis (PTB) and high blood pressure (HBP) are chronic diseases that seriously damage human life and health.

Tuberculosis is a chronic disease caused by *M. tuberculosis* infection, which is mainly transmitted through the respiratory tract. Although the global incidence of tuberculosis has been well controlled, the rise in resistance rates and the risk of comorbidities can lead to worse disease prognosis, which still poses a serious challenge to global public health[17,18]. A survey of global human immunodeficiency virus (HIV)-negative populations[19] showed that incident number of all types of tuberculosis in 2013 was 7.1 million (6.9 million to 7.3 million), and the prevalence number was 11.2 million (10.80 million to 11.6 million), the death number was 1.3 million (1.2 million to 1.4 million). There are about 500 million people infected with *Mycobacterium tuberculosis* in China, 4.5 million tuberculosis patients, and about 1.5 million new cases each year. The characteristics of tuberculosis in China are high infection rate, high prevalence rate and high drug resistance rate[20]. In

China, the imbalance in the distribution of tuberculosis areas highlights the importance of geographical location in the prevention and control of tuberculosis. According to the results of the fifth national tuberculosis survey in 2010[21].

Since the 21st century, the number and proportion of older people aged 60 and over in the world are at a rapid growth stage, and this trend will continue in the coming decades. According to the results of the 2015 World Ageing Population Report, it is estimated that between 2015 and 2030, the number of elderly people aged 60 and over will increase from 900 million to 1.4 billion, an increase of 56%. By 2050, the elderly population will reach 2.1 billion[22].

A study on the economic burden of obesity shows that the economic burden on direct and indirect diseases caused by obesity and related diseases cost about 117 billion dollars per year in the United States[23]. Obesity is also associated with other cardiovascular diseases such as high blood pressure. The results of our country's research show that cardiovascular disease caused by high blood pressure was the first in the disease burden and cause of death

of urban and rural residents in China[24]. The number of deaths from cardiovascular disease patients caused by hypertension in 2005 was approximately 2.33 million, of which 1.27 million patients with cardiovascular disease died prematurely[25]. chronic diseases caused by other cardiovascular diseases such as hypertension are given to individuals and families. And the society has brought a heavy economic burden, which has seriously eroded the health stock of middle-aged and elderly people.

Our study found that age and BMI were statistically significant between patients with and without hypertension, patients with high blood pressure had older and more overweight individuals than patients without hypertension. Overweight/obesity ($BMI \geq 24$) was the risk factors for hypertension in tuberculosis patients. Clinical treatment should focus on obese patients to prevent or control the occurrence and prognosis of hypertension.

5. Conclusion

The distribution of the age and BMI were statistically significant between patients with and without hypertension, patients with high blood pressure were older and have more overweight/obesity individuals than patients with normal blood pressure. Overweight/obesity ($BMI \geq 24$) was the risk factors for hypertension in tuberculosis patients.

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