Prevalence, awareness, treatment, and control of hypertension in patients with type 2 diabetes: A cross-sectional survey among middle-aged people in China

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ABSTRACT

Objective: To assess the prevalence, awareness, treatment, and control of hypertension and their associated factors in patients with type 2 diabetes.

Methods: A cross-sectional survey across China, including 12,000 participants aged 35–64 years, was conducted in 2009–2010. Data were collected by using questionnaires, blood pressure (BP) measurement, and laboratory test. About 11,623 participants fitted the inclusion. Diabetes was defined as fasting glucose at least 7.0 mmol/L, and/or use of insulin, and/or oral antidiabetic drug. For diabetic participants, hypertension was considered to be controlled if the average BP was <130/80 mmHg.

Results: Overall, there were 1063 patients with diabetes (9.2%). The prevalence of hypertension among the patients with diabetes was 59.6%. Among the hypertensive patients (n = 633), 57.5% were aware of their condition, 41.7% received treatment, and only 3.8% had their BP adequately controlled. Age, region, body mass index (BMI), and family hypertension history were correlated with the prevalence, awareness, treatment, and control of hypertension among patients with diabetes.

Conclusion: The prevalence of hypertension among patients with diabetes was higher whereas the control was lower. Age, BMI, and family hypertension history were significantly associated with hypertension.

Key Words: Awareness, China, control, diabetes, hypertension, prevalence, risk factors, treatment

Introduction

Diabetes, as well as hypertension, is among the most common chronic diseases in developed and developing countries around the world. Both of them are harmful to our health.[1] The risk of cardiovascular disease (CVD) is higher in people with diabetes than nondiabetic population. In people with and without diabetes, the prevalence of stroke was 6.6% and 1.8%, respectively, and the prevalence of coronary heart disease was 9.1% and 2.1%, respectively.[2] Diabetes was significantly associated with increased CVD mortality (3.2 [1.4–7.1] in men; 8.5 [2.8–25.2] in women).[3] Meantime, annual deaths associated with hypertension were approximately 7.1 million, globally. The World Health Organization reported that 62% of cerebrovascular disease and 49% of ischemic heart disease are related to hypertension.[4] The risk of kidney failure and CVD increases in people with diabetes and hypertension simultaneously.[5,6]
The coexistence of diabetes and hypertension is common. A national health survey in Thailand showed that 49.0% of diabetic patients had hypertension. A research from Jordan reported that the prevalence of hypertension was 72.4%, factors positively associated with hypertension were age, body mass index (BMI), and duration of overt diabetes. A study of factors associated with hypertension among adults in the Southern China in 2010 showed that diabetes was a significant factor for the prevalence of hypertension; people who had diabetes had a higher risk of having hypertension (adjusted odds ratio [AOR] = 2.1) than those who did not; there was a significant difference in awareness and treatment of hypertension between patients with and without diabetes.

Existing literature suggested that certain characteristics of people who had diabetes might be associated with the prevalence and control of hypertension, while there were few domestic studies for prevalence, awareness, treatment, and control of hypertension and risk factors in diabetic patients. In order to improve the blood pressure (BP) control in diabetic population, and reduce the risk of CVDs, we undertook the study on prevalence, awareness, treatment, control of hypertension and associated factors in diabetic patients.

Methods

Subjects
A cross-sectional survey on risk factors for CVD across China was conducted in 2009–2010, based on the geographical location, socioeconomic level, and the previous study experience. Twelve research populations were selected from different parts of China delineated by the Southern and Northern (as delineated by the Yangtze River), urban and rural (based on administrative data). Random cluster samples of 1000 participants from each of the 12 populations, aged 35–64 years, half men and half women, were recruited. Totally, 12,000 potential subjects were selected, 11,815 persons completed the survey. Of them, 11,623 participants fit the inclusion criteria. The response rates were 85.5%. There were 1063 persons with diabetes (9.2%).

Data collection
Demography, personal, and family history of CVD, and lifestyle (such as smoking, alcohol consumption, drinking tea, diet, and physical activity status) were collected by trained investigators using internationally standardized methods. Written informed consent for the survey was obtained from each participant prior to data collection. Institutional Review Board approval was obtained in the Fuwai Hospital Ethics Review Board and each participating center.

Physical examination
BP was measured three times with a conventional mercury sphygmomanometer after the participant sitting at rest for 5 min, with a rest of 30 s between each measurement. Systolic BP (SBP) based on the first Korotkoff phase and diastolic BP (DBP) on the fifth Korotkoff phase was recorded. The average of the three readings was used for analysis. Height was measured without shoes using a standard right angle device and a fixed measurement tape (to the nearest 0.5 cm), and waist circumference was measured, in a standing position, using a cloth tape directly on the participant’s skin (to the nearest 0.5 cm). Body weight without heavy clothing was measured using Omron body fat and weight measurement device (V-body HBF-359, Omron, Kyoto, Japan).

Laboratory measurements
Fasting bloods were carried out in the morning with subjects in a fasted state were collected. Glucose (Glu), serum total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and triglycerides (TG) were measured using enzymatic techniques using a Hitachi biochemical instrument (Hitachi, Japan). Low-density lipoprotein cholesterol (LDL-C) was calculated using the Friedewald formula when TG levels were <400 mg/dl: LDL-C = TC −HDL-C −TG/5.[12]

Diagnostic criteria
Hypertension was defined as SBP ≥140 mm Hg, and/or DBP ≥90 mm Hg, and/or under treatment. BMI was calculated as the ratio of weight to height squared (kg/m²). Overweight was defined as BMI ≥24 kg/m² and obesity as BMI ≥28 kg/m². Diabetes was defined as fasting Glu ≥7.0 mmol/L (126 mg/dl), or self-reported current treatment with insulin or oral hypoglycemic agents. Smoking was indicated when the person reported smoking more than one cigarette a day for at least 1 year; drinking was usually at least once a week. The patients who were diagnosed with high BP before the study were defined as being aware of hypertension. Receiving treatment was defined as patients who were aware of hypertension and used antihypertensive medications in the past 2 weeks. For diabetic participants, hypertension was considered to be controlled if the average BP was <130/80 mmHg. In addition, personal CVD history was defined as with the following condition: Hypertension, diabetes, coronary heart disease, and stroke; family history as CVD history for immediate family.

Statistical analysis
Continuous variables were given as the mean (standard deviation) and categorical variables as the percentage in each subgroup. The differences between different subgroups in
the categorical variables including prevalence, awareness, treatment, and control rates were compared using Chi-square test. Use the logistic model to analyze data and compute the AOR and its 95% confidence interval (CI) of risk factors associated with hypertension. Data were analyzed using SAS software (version 9.2, SAS Institute Inc., Cary, NC, USA). Statistical significance was considered as two-tailed \( P < 0.05 \).

**Results**

**Sociodemographic and clinical characteristics of patients with diabetes**

Table 1 shows the gender-wise and total distribution of characteristics of 1063 participants with diabetes. Of them, 51.2% were males, only 16.3% received high school education or more, 35.0% were in the South China. About 31.1% were obese (BMI ≥28), 32.1% were smokers, and 22.4% were drinkers. The percentages of smokers and drinkers in male were obviously higher than in female. Around 36.7% had a family history of hypertension. For all diabetic participants, 50.2% had BP under 140/90 mmHg.

**Prevalence of hypertension in diabetic population**

As shown in Table 2, 633 participants (59.6%) had hypertension, but no significant difference between men and women (59.6% vs. 59.5%, \( P > 0.05 \)). No matter men or women, the older, as well as those with high BMI, had a high prevalence of hypertension. Without considering gender, there was a significant difference in the prevalence of hypertension and diabetes between different subgroups of age factor, BMI, and smoking.

**Awareness, treatment, and control of hypertension**

Overall, 57.5% of those with hypertension were aware of their conditions and 41.7% were treated [Table 3]. Only 3.8% (24/633) had their BP controlled according to the level of <130/80 mmHg, or 14.7% <140/90 mmHg. The awareness, as well as treatment, increased with age (\( P < 0.05 \)). More women were aware of their hypertension than men (63.4% vs. 51.9%, \( P < 0.01 \)), as well as treatment (50.2% vs. 33.6%, \( P < 0.01 \)). However, the control rate was no significant between men and women (4.0% vs. 3.6%, \( P > 0.05 \)).

**Factors associated with the awareness, treatment, and control of hypertension among diabetic patients**

When adjusted for all the other factors, those with an older age bracket, female, living in the South area, with higher BMI, and positive family history of hypertension were associated with a significantly higher rate of awareness and treatment than their counterparts [Table 4]. There were no significant differences in awareness and treatment between smoking and nonsmoking, as well as drinking and nondrinking. For control, there were not any differences except for region, those living in the South area had a higher control rate than in the North area (OR = 7.9, CI: 2.9, 21.6).
Discussion

This study demonstrated that while nearly 60% of the diabetic patients suffered from hypertension, only 57.5% of these hypertensive patients were aware of their condition, and 41.7% received treatment. Moreover, only 3.8% achieved the targeted SBP and DBP values according to the level of <130/80 mmHg, or 14.7% 140/90 mmHg. The awareness and treatment of hypertension were associated with age, gender, region, BMI, and family hypertension history, whereas the control rates were significant differences between regions.

Patients with type 2 diabetes mellitus had a higher risk of death from CVDs than those without diabetes.\[13\] Hypertension in patients with diabetes could cause a significant increase in the risk of vascular complications and predispose to chronic kidney disease.\[14,15\] Unfortunately, hypertension was a very common comorbidity among patients with type 2 diabetes. It was 72.4% in Jordan\[8\] and 73.0% in the UK.\[16\] Our study demonstrated that 59.6% of the diabetic population (1063) had hypertension. It was estimated that there were about 55 million hypertensive patients with diabetes based on the reported 92 million diabetic patients in China.\[17\] These findings indicate the alarming public health problem in China.

Our study showed the prevalence of hypertensive patients with diabetes was higher in the North area than that in the South area (61.7% vs. 55.7%). It may be due to different dietary habits and economic level. Meanwhile, both in North and South, the prevalence of hypertension

Table 3: Awareness, treatment and control of hypertension among patients with diabetes

| Variables | Awareness | Treatment | Control$^a$ | Control$^b$ |
|-----------|-----------|-----------|-------------|-------------|
|           | n   | %    | n   | %    | n   | %    | n   | %    |
| Total (n=633) | 364 | 57.5 | 264 | 41.7 | 24 | 3.8 | 93 | 14.7 |
| 35-44 | 32 | 48.5* | 14 | 21.2* | 2 | 3.0 | 9 | 13.6 |
| 45-54 | 112 | 52.1 | 78 | 36.3 | 8 | 3.7 | 32 | 14.9 |
| 55-64 | 220 | 62.5 | 172 | 48.9 | 14 | 4.0 | 52 | 14.8 |
| Male (n=324) | 168 | 51.9* | 109 | 33.6* | 13 | 4.0 | 46 | 14.2 |
| 35-44 | 19 | 45.2 | 8 | 19.1* | 1 | 2.4 | 3 | 7.1 |
| 45-54 | 61 | 48.8 | 37 | 29.6 | 6 | 4.8 | 20 | 16.0 |
| 55-64 | 88 | 56.1 | 64 | 40.8 | 6 | 3.8 | 23 | 14.6 |
| Female (n=309) | 196 | 63.4* | 155 | 50.2* | 11 | 3.6 | 47 | 15.2 |
| 35-44 | 13 | 54.2 | 6 | 25.0* | 1 | 4.2 | 6 | 25.0 |
| 45-54 | 51 | 56.7 | 41 | 45.6 | 2 | 2.2 | 12 | 13.3 |
| 55-64 | 132 | 67.7 | 108 | 55.4 | 8 | 4.1 | 29 | 14.9 |

*Control of blood pressure level as <130/80mmHg; *Difference between age groups within awareness, treatment, or control group, significant at $P<0.05$. *Difference between genders within awareness, treatment, or control group, significant at $P<0.05$

Table 4: Factors associated with the awareness, treatment and control of hypertension from multivariate logistic regression models

| Variables | Awareness | Treatment | Control |
|-----------|-----------|-----------|---------|
|           | COR | AOR | COR | AOR | COR | AOR |
| Age groups |       |     |       |    |       |    |
| 35-44* | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| 45-54 | 1.2 (0.7-2.0) | 1.1 (0.6-2.0) | 2.1 (1.1-4.1) | 2.1 (1.1-4.3) | 1.2 (0.3-6.0) | 0.9 (0.2-5.0) |
| 55-64 | 1.8 (1.0-3.0) | 1.7 (1.0-3.3) | 3.5 (1.9-6.6) | 3.6 (1.9-7.1) | 1.3 (0.3-6.0) | 1.0 (2-4.8) |
| Gender |       |     |       |    |       |    |
| Male* | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Female | 1.6 (1.2-2.2) | 1.8 (1.2-2.7) | 2.0 (1.4-2.7) | 1.8 (1.2-2.8) | 0.9 (0.4-2.0) | 1.0 (2-3.2) |
| Region |       |     |       |    |       |    |
| North* | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| South | 0.6 (0.4-0.9) | 1.9 (1.3-2.8) | 1.6 (1.2-2.3) | 1.7 (1.1-2.5) | 6.7 (2.6-17.1) | 7.9 (2.9-21.6) |
| BMI, kg/m$^2$ |       |     |       |    |       |    |
| <24* | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| 24-28 | 1.1 (0.7-1.7) | 1.1 (0.7-1.7) | 1.5 (0.9-2.3) | 1.5 (0.9-2.4) | 0.4 (0.2-1.1) | 0.4 (0.1-1.1) |
| ≥28 | 1.7 (1.1-2.5) | 1.7 (1.1-2.7) | 2.1 (1.4-3.3) | 2.4 (1.5-3.8) | 0.6 (0.2-1.5) | 0.7 (0.2-1.9) |
| Family history of hypertension |       |     |       |    |       |    |
| No* | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 3.2 (2.3-4.5) | 3.0 (2.1-4.3) | 3.1 (2.2-4.3) | 3.0 (2.1-4.3) | 1.2 (0.5-2.6) | 0.9 (0.4-2.3) |
| Smoking |       |     |       |    |       |    |
| Yes | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| No* | 0.9 (0.7-1.4) | 0.7 (0.5-1.1) | 1.2 (0.8-1.6) | 0.7 (0.4-1.1) | 0.6 (0.2-1.3) | 0.4 (0.1-1.2) |
| Drinking |       |     |       |    |       |    |
| Yes | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| No* | 1.0 (0.7-1.5) | 0.9 (0.6-1.5) | 1.6 (1.1-2.3) | 1.5 (0.9-2.5) | 0.9 (0.4-2.4) | 2.5 (0.8-8.0) |

Data are presented as OR (95% confidence interval), the reference group as ‘1’. BMI - Body mass index, GLU - Glucose, COR - Crude OR, AOR - Adjusted OR, adjusted for all other variables in the tables. *Indicated as reference group.
was higher among diabetic population than among general population, for example, it was 39.1% in the Northeast China and 22.59% in the Southern China. It indicated that diabetes would accelerate hypertension. In order to reduce the risk of vascular complications and hypertension which increased the risk of comorbidities, diabetic individuals should pay special attention to control diabetes. Moreover, we should strengthen related educational guide in the intervention programs.

Our study suggested that hypertension among type 2 diabetics appeared to be age-related. The age-specific prevalence of hypertension in our study was similar to that reported in a study of a Jordanian population, whose prevalence was 45.6%, 69.7%, and 84.3% among different age groups (<50, 50–59, ≥60), a little higher than our study. However, it is worth noting that the prevalence also reached 51.6% even in 35–44 age groups. It implied that there were more hypertensive patients in early stage of diabetes history. Our study also found that hypertension was BMI-related, the higher the BMI level, and higher the rate of hypertension. Effective management strategies for hypertension must focus on patients, family education, counseling, and behavioral interventions designed to modify lifestyle such as doing more exercise and having a balanced diet.

Low hypertension awareness, treatment, and control rates were always a highlight problem in China. In a study of general urban adults from 33 Chinese communities, the rates of awareness, treatment, and control among hypertensive patients were found to be 42.9%, 28.2%, and 3.7%; meanwhile, it was 80.6%, 73.7%, and 30.3% in a study from the USA. It was commonly observed, both in the developed countries or in the developing countries, women had a higher hypertension awareness and treatment than men. Compared to men, women often visited the doctor, had longer consultations, and tended to see their physician earlier in the course of their illness. This may be a reason for women's high hypertension awareness and treatment. In theory, diabetic patients should pay more attention to their condition and have more chance to make physical examinations, which is helpful to screen hypertension and to modify the treatment. However, in fact, the situation was nonideal. In our study, awareness and treatment rates were 57.5% and 41.7%. As for control rate, only 3.8% hypertensive patients had their BP controlled. Even according to the level of <140/90 mmHg, the control rate was only 14.7%, which was slightly higher than that in non-diabetic population (12.4%). Increasing the awareness, treatment, and control of hypertension would reduce morbidity and mortality of CVDs. Therefore, a national HBP education program should be established in China to improve the situation. Both of patients and medical workers should receive education for prevention and treatment of hypertension. Physicians should regularly check their patients’ BP and reach the BP control goals aggressively, especially for diabetic population.

Multivariate logistic regression analysis revealed that age, gender, region, BMI, and family hypertension history were significantly associated with the awareness and treatment of hypertension, whereas only regions were significantly associated with the control rate of hypertension. As known, the elders, as well as females, those with a positive family history of hypertension, have higher control rates because they normally pay more attention to the disease, especially for the hypertensive patients with diabetes, they had seen doctors more often. One of the possible reasons could be that those factors have no positive effects on the control may be that the patients did not think highly of the damage, so they are not aware of controlling it actively; second, they thought diabetes is more important than hypertension, they place emphasis on diabetes rather than hypertension; more possibility is the assumption that BP is difficult to control for the patient with diabetes, the positive effects of the factors, such as family history of hypertension, were offset. Hence, we should pay more attention to the management of hypertension among old age patients with diabetes, improve health education program in order to let more patients concern their condition, and must stress to deal with diabetes and hypertension simultaneously. The control rate was better in the South area than in the North area, which may be because the Southern China had a higher level of economic development and educational level. It indicates economic and affordability should also be taken into consideration.

Some limitations of the present study should be noted. First, because this was a cross-sectional study, the findings cannot be used to establish as conclusive cause-and-effect relationship between factors, such as BMI and the prevalence of hypertension. Second, the treatment of hypertension may have been underestimated or overestimated because these definitions do not include adults who have been told they have high BP but are controlling it through therapeutic lifestyle changes alone. Third, the white-coat effect or white-coat hypertension may contribute to overestimates of the true prevalence of hypertension. Finally, the order of suffering from hypertension or diabetes could not be confirmed.
Conclusion

More than half patients with type 2 diabetes had hypertension in middle-aged Chinese. In the meantime, the rates of awareness, treatment, and control of hypertension were unsatisfactory. In addition, age, region, family history of hypertension, and obesity were the main factors that affected the awareness, treatment, and control of hypertension. These results emphasized the urgent need to develop a hypertension education program, especially for diabetic individuals, they should pay more attention to protect themselves from hypertension.

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Conflicts of interest

There are no conflicts of interest.

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