Awareness, treatment and control of hypertension among hypertensive patients aged 18 to 59 years old in the northeast of China

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Hypertension not only has a high prevalence, but also brings disease burden to the affected patients. To assess the level of awareness, treatment and control of hypertension in the northeast of China, we investigated the rates of awareness, treatment and control of hypertension and identified its related factors among hypertensive patients aged 18 to 59 years old in Jilin, China. The data (n = 4632) for the present study were extracted from a cross-sectional study in Jilin. Among individuals with hypertension, the standardized rates of awareness, treatment and control of hypertension were 44.9%, 36.5%, 24.3%, respectively. The rates of awareness and treatment of hypertension among middle aged patients were higher than those among young patients. Compared to patients with normal Body Mass index (BMI), obese hypertensive patients had a higher rate of treatment (43.7% vs. 25.9%) and a lower rate of control (18.9% vs. 29.6%). Compared to patients with normal BMI, patients who were obese were more likely to take measures to treat hypertension (OR = 2.50, 95%CI: 2.05–3.05); but were less likely to have well-controlled blood pressure (OR = 0.55, 95%CI: 0.40–0.78). BMI is one of the influencing factors of hypertension awareness, treatment and control among patients 18 to 59 years old with hypertension.

Cardiovascular diseases (CVDs), a subtype of major non-communicable diseases, account for approximately one third of total global deaths12. It is predicted that CVD-related global deaths will climb to more than 23.3 million by 20308. Hypertension is a key risk factor for cardiovascular disease9. In 2008, approximately 40% of adults over 25 years of age had hypertension8. The prevalence of hypertension will be likely to increase 29% by 20255. Worldwide, there are 9.4 million hypertension-related deaths8. Hypertension is the cause of at least 45% of ischemic heart disease deaths, and 51% of stroke deaths7. In China, the prevalence of hypertension increased between 19598 and 20029 according to the National Nutrition and Health Survey (NNHS). It is estimated that 200 million people in China suffer from hypertension10. The prevalence of hypertension in north of China (including the northeast, middle north and northwest) is higher than that in south of China (including the east, middle south and southwest)11. The prevalence of hypertension in the Jilin province, which located in the northeast of China, was 37.3% in a reported study conducted in 201212.

Hypertension is one of the leading contributors to the global disease burden (7.0% of global disability-adjusted-life-years)6. It is estimated that 10% of healthcare spending is directly related to increased blood pressure and its complications13. Hypertension decreases the quality of life and increases the financial burden on health care systems14. Detecting hypertension early and taking measures to control it may be a cost-effective way to reduce the hypertension-related disease burden15. In China, the status of the awareness, treatment and control of hypertension has increased with time. From 1991 to 2011, the rate of awareness of hypertension increased from 33.7 to 54.9%, the rate of treatment increased from 19.9 to 45.9%, and the rate of control increased from 12.6 to 30.1% among hypertension patients14. However, the rates of awareness, treatment and control of hypertension are still lower than that of other countries15–18.

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Mean systolic blood pressure decreased in older adults, but increased in younger adults, during the 24 years from 1989 to 2013. Hypertension is increasingly affecting people younger than 50 years old, many of whom die prematurely. The rates of awareness, treatment and control of hypertension are at low levels among young and middle-aged hypertensive patients. Early intervention programs have impressive influence on the hypertension awareness, treatment and control. Accordingly, it is necessary to study the related factors of awareness, treatment and control among young and middle-aged hypertensive patients. Previous studies in Jilin province paid more attention to the prevalence and the risk factors of hypertension, but epidemiological investigation of the awareness, treatment and control among hypertensive patients is limited, especially research on young and middle-aged patients. This study investigated the rates of awareness, treatment and control status among hypertensive patients aged 18 to 59 years old and identified the related factors for hypertension awareness, treatment and control.

Results

Characteristics of hypertensive patients. As shown in Table 1, a total of 4632(2556 males and 2076 females) participants completed the questionnaire and all examinations. To make the sampling survey more representatively, we used complex weighted computation throughout the data analysis. The median age of the participants was 49 years old (interquartile range, 43–54 years old). The percent of participants in the young and middle-aged groups were 41.7% and 58.3%, respectively. There were more male patients than female patients in this study (61.5% vs. 38.5%). The median BMI of participants was 25.53 kg/m² (interquartile range, 23.39–28.07 kg/m²); 30.1% of the participants with normal BMI, 42.2% of the participants were overweight and 26.8% of the participants were obese.

Awareness, treatment and control of hypertension. Table 2 shows the rates of awareness, treatment and control of hypertension of patients in different categories. The rates of awareness, treatment and control of hypertension were 44.9%, 36.5% and 24.3%, respectively. Middle-aged hypertensive patients had higher rates of hypertensive awareness and treatment than young patients (54.2% vs 31.9%, \( P < 0.001 \)) and 45.3% vs 24.3%, \( P < 0.001 \), respectively). The incidence of awareness and treatment was lower in men than in women (38.4% vs 55.3%, \( P < 0.001 \) and 29.7% vs 47.5%, \( P < 0.001 \), respectively). Among the target population, different BMI groups had different levels of hypertension awareness, treatment and control status (\( P < 0.05 \)). Obese patients had higher rates of hypertension awareness (52.6% vs. 33.0%) and treatment (43.7% vs. 25.9%) than patients with normal BMI.

Factors associated with the awareness, treatment and control of hypertension. Table 3 shows the related factors associated with the awareness of hypertension. Middle-aged hypertensive patients were more likely to be aware of hypertension than young patients (OR = 2.07, 95% CI: 1.76–2.44). Male patients were less likely to be aware of hypertension than female (OR = 0.66, 95% CI: 0.54–0.80). Urban patients were less likely to be aware of hypertension than rural patients (OR = 0.73, 95% CI: 0.63–0.84). Single hypertensive patients were less likely to be aware of their blood pressure condition (OR = 0.40, 95% CI: 0.25–0.62) compared to patients who were married. Additionally, overweight patients (OR = 1.89, 95% CI: 1.60–2.24) and obesity patients (OR = 2.58, 95% CI: 2.13–3.12) were more likely to be aware of hypertension than those with normal BMI. Subjects who consumed alcohol products (OR = 0.64, 95% CI: 0.53–0.76) were less likely to be aware of hypertension than those who did not.

The results from the logistic regression model analyzing factors associated with hypertension treatment are shown in Table 4. The model showed that male patients (OR = 0.65, 95% CI: 0.54–0.79), urban patients (OR = 0.79, 95% CI: 0.68–0.92), single patients (OR = 0.43, 95% CI: 0.26–0.69) and individuals who consumed alcohol products (OR = 0.54, 95% CI: 0.45–0.65) were less likely to take measures to treat hypertension. It was noted that retired patients (OR = 1.35, 95% CI: 1.02–1.79) and patients who were overweight (OR = 1.84, 95% CI: 1.55–2.20) or obese (OR = 2.50, 95% CI: 2.05–3.05) were more likely to take measures to treat hypertension.

Table 5 shows that gender and urban-rural distribution were not influencing factors of blood pressure control among hypertensive patients. Middle-aged patients were less likely to have well-control BP (OR = 0.72, 95% CI: 0.54–0.95). Obesity (OR = 0.54, 95% CI: 0.39–0.76) was negatively associated with maintaining blood pressure in the appropriate range (BP < 140/90 mmHg).

Discussion

In this survey, there were 4632 respondents. Among 18–59 years old respondents with hypertension, 44.9% were aware of their condition; approximately 36.5% of participants used antihypertensive medication while 24.3% had their BP controlled well.

Age is one of the factors that affect the awareness, treatment and control of hypertension in hypertensive patients. In our study, the level of hypertensive awareness and treatment were significantly lower in younger patients than in middle-aged patients, but there was no significant difference in the level of hypertension control. This result was consistent with a previous study in Kazakhstan. It might be considered that young patients have more adverse life styles and habits than older patients. A study in Iran shows that the rates of awareness, treatment and control of hypertension increased with age, and a study in Senegal has similar results. Age is a powerful risk factor for the development of hypertension. Management of age-associated hypertension may be a key issue in the prevention of cardiovascular events. Gender differences have been shown in the management of hypertension. We found that gender is associated with hypertension awareness and treatment; men had larger hypertension prevalence than women among young and middle-aged hypertensive patients but had a lower incidence of awareness and treatment of hypertension than women. This result is similar to those reported in a study in north China, a study in Korea and a study in Malaysian. There are some researchers in China who...
Table 1. Characteristics of Hypertension patients (n = 4632) [M(Q25,Q75)/n(%)].

| Category                                    | Median (Interquartile range) | Estimated population |
|---------------------------------------------|------------------------------|----------------------|
| Systolic blood pressure (mmHg)              | 146 (140,158)               | 4059                 |
| Diastolic blood pressure (mmHg)             | 91 (85.97)                  | 4059                 |
| Age (years)                                 | 49 (43.54)                  | 4059                 |
| **Age group**                               |                              |                      |
| Young                                       | 1418 (41.7)                 | 1694                 |
| Middle-aged                                 | 3214 (58.3)                 | 2365                 |
| **Sex**                                     |                              |                      |
| Female                                      | 2076 (38.5)                 | 1561                 |
| Male                                        | 2556 (61.5)                 | 2498                 |
| **Region**                                  |                              |                      |
| Rural                                       | 2333 (45.9)                 | 1862                 |
| Urban                                       | 2299 (54.1)                 | 2197                 |
| **Education level**                         |                              |                      |
| Primary school or low (≤ 6 years)           | 1205 (22.0)                 | 894                  |
| Junior high school (7–9 years)              | 1390 (31.2)                 | 1267                 |
| Senior high school (10–12 years)            | 1416 (31.3)                 | 1270                 |
| University or above (>12 years)             | 621 (15.5)                  | 628                  |
| **Marital status**                          |                              |                      |
| Married                                     | 4209 (88.2)                 | 3580                 |
| Single                                      | 179 (6.9)                   | 282                  |
| Divorced or separated                       | 102 (2.4)                   | 96                   |
| widowed                                     | 142 (2.5)                   | 101                  |
| **Occupation**                              |                              |                      |
| Manual workers                              | 2807 (60.4)                 | 2448                 |
| Mental workers                              | 915 (21.4)                  | 870                  |
| Retired                                     | 342 (6.7)                   | 274                  |
| Others                                      | 568 (11.5)                  | 467                  |
| **Income (Yuan)**                           |                              |                      |
| <500                                        | 962 (16.8)                  | 685                  |
| 500–                                        | 940 (19.4)                  | 785                  |
| 1000–                                       | 1480 (33.0)                 | 1339                 |
| 2000–                                       | 823 (20.4)                  | 830                  |
| 3000–                                       | 427 (10.4)                  | 420                  |
| **Body Mass index (kg/m²)**                 | 25.55 (23.39, 28.07)        | 4059                 |
| **BMI group**                               |                              |                      |
| Normal                                      | 1411 (30.1)                 | 1223                 |
| Underweight                                 | 43 (0.9)                    | 38                   |
| Overweight                                  | 1984 (42.2)                 | 1713                 |
| Obesity                                     | 1194 (26.8)                 | 1085                 |
| **Family history of circulation system diseases** |                      |                      |
| No                                         | 1955 (41.9)                 | 1699                 |
| Yes                                        | 2677 (58.1)                 | 2360                 |
| **Smoking**                                 |                              |                      |
| Never                                       | 2553 (52.7)                 | 2139                 |
| Current                                     | 1655 (38.0)                 | 1544                 |
| Past                                        | 424 (9.3)                   | 376                  |
| **Consuming alcohol products**              |                              |                      |
| No                                         | 2744 (54.8)                 | 2224                 |
| Yes                                        | 1888 (45.2)                 | 1835                 |
| **Physical exercises**                      |                              |                      |
| Often                                       | 1340 (28.2)                 | 1143                 |
| Sometimes                                   | 1087 (25.6)                 | 1041                 |
| Never or rare                               | 2205 (46.2)                 | 1875                 |


concluded that the rates of awareness, treatment and control of hypertension in women were higher than that in men.14,15,35,36 However, Ursua, R. et al. found that the rates of awareness, treatment and control of hypertension were not significantly distinct between the sexes. The impact of sex on hypertension and antihypertensive therapy remains unclear. It has been estimated that the overall life expectancy for 50-year-old individuals is 4.9 years shorter for hypertensive women and 5.1 years shorter for hypertensive men compared to normotensive individuals of the same age.37 Blood pressure management in male hypertensive patients should be strengthened. Location and marital status are associated with hypertension awareness and treatment. Previous studies have found that patients who lived in urban areas had more opportunities to be aware of their blood pressure level than those who lived in rural areas.38,39 Interestingly, our study shows a completely opposite result. In our study, we found that patients who came from urban areas might be less likely to be aware of their blood pressure condition and take measures to treat hypertension than those came from rural areas. The reason for this phenomenon was that there were a larger proportion of rural subjects in our research. A previous study indicated that marital status was associated with hypertension awareness and control.40 We found that single hypertensive patients were less likely to be aware of their blood pressure condition and be on treatment than patients who were married. Different BMI groups are associated with hypertension awareness and treatment; obesity is negatively associated with hypertension control. From our research, we found that individuals who were overweight or obese were more likely to be aware of their conditions and be on treatment than those with normal BMI. Pereira, M. et al.25 also suggest that awareness of hypertension is directly associated with BMI in both males and females; participants who are overweight or obese are more likely to be aware of hypertension and take hypertension medication. Supiyev, A. et al.25 and Evelyn, P. et al.41 found that obese patients are more likely to be aware of their hypertension. Lei, W. et al. reported that a higher BMI was significantly associated with hypertension awareness and treatment in both 2001 and 2010 among an urban elderly population. Moreover, patients who were obese may not decrease their BP below 140/90 mmHg compared to those with normal BMI. Work by Pereira, M. et al.42 also suggested that BMI is associated with a lower likelihood of blood pressure control. Hu, M. et al.44 have different views about the relationship between obesity and blood pressure control; they suggest that it is easier for obese patients to have well-control blood pressure. The prevalence of hypertension increases with increasing BMI. The current study found that BMI was a more reliable predictor of hypertension for middle-aged patients. Obesity increases the risk of treatment-resistant arterial hypertension.46 Thus, obese patients with hypertension should pay more attention to the control of their hypertension. Clinical trials have demonstrated that weight loss of approximately 10% of a patient's original body weight, by calorie restriction and/or increased activity, is an effective means to achieve clinically meaningful reductions in blood pressure and mortality from cardiovascular disease.47 Reductions in BMI are associated with decreases in carotid intima media thickness and improvements in the cardiovascular risk-factor profile, suggesting that weight loss is worthwhile because it might result in long-term benefit.48 Alcohol consumption is related to hypertension awareness, treatment and control. Individuals who consumed alcohol products could be more likely to ignore hypertension awareness and treatment than those who do not consumed alcohol. Yang, L. et al. concluded that abstaining from alcohol is associated with hypertension treatment and affects the control of hypertension. However, Hu, M. et al. have a different perspective and report that alcohol consumption is associated with a higher rate of hypertension awareness.49

The sample for this study was extracted from a complex sampling scheme, and the sample size was large. However, there are still some limitations to our study. The definitions of hypertension awareness and anti-hypertensive treatments were all acquired from self-reported questionnaires, which can cause reporting bias. The life styles (smoking, consuming alcohol products, physical exercises) were also self-reported and provided from memory, which may cause some recall bias.

In conclusion, the rates of awareness and treatment of hypertension among middle aged patients were higher than that in young patients. The condition of awareness and treatment among male hypertensive patients were poor. Obese hypertensive patients may be less likely to maintain blood pressure within the normal range. Young hypertensive patients, male hypertensive patients and obese hypertensive patients may benefit from improved hypertension management.

Methods
Population sample. This study is based on the 2012 Survey on Chronic Diseases in Jilin, China.49,50 The survey data were collected from a multistage stratified cluster sample. The sample size has been estimated according to the prevalence of chronic disease in Jilin province. The sampling process included five stages. In the first stage, 9 cities (Changchun, Jilin, Siping, Liaoyuan, Tonghua, Baishan, Songyuan, Baicheng and Yanbian) were chosen from 32 districts/counties for inclusion in the study; they were identified by the proportion of the population, the location of the whole province and the race of their residents. In the second stage, towns were selected by stratified random sampling based on the size of the district. In the third stage, three committees which were near each selected towns were chosen by stratified random sampling. In the fourth stage, one village which was close to the selected committee was chosen by simple random sampling. In the fifth stage, individuals were chosen by cluster random sampling. Finally, 23050 subjects from 32 districts/counties were enrolled, and 21435 participants completed the survey (response rate: 84.9%).49 The survey included three aspects: a face-to-face questionnaire interview by trained investigators, a physical examination (measurement of height, weight and blood pressure) and a laboratory examination. The study was performed in accordance with the principles of the Declaration of Helsinki. Data in this study came from the epidemiologic investigation of the project (Survey on Chronic Diseases in Jilin, China, 2012), specifically from the part which contained information on participants with hypertension that were 18 to 59 years old. Ultimately, 4632 participants were included in the present study. The flowchart of the participants included in or excluded from the present study is shown in Fig. 1.
| Category               | Subcategory                  | Awareness n (%) | Estimated population n | Treatment n (%) | Estimated population | Control among treated |
|------------------------|------------------------------|----------------|------------------------|-----------------|----------------------|------------------------|
| Age group              | Young                        | 469(31.9)      | 541                    | 1282            | 412                  | 92(27.5)               |
|                        | Middle-aged                  | 1758(54.2)     | 1471(45.3)             | 1071            | 328                  | 323(32.1)              |
| Sex                    | Female                       | 1198(55.3)     | 1028(47.5)             | 742             | 225                  | 230(26.4)              |
|                        | Male                         | 1029(38.4)     | 804(29.7)              | 741             | 165                  | 165(22.2)              |
| Region                 | Rural                        | 1211(48.0)     | 990(38.5)              | 718             | 199                  | 171(22.4)              |
|                        | Urban                        | 1016(42.3)     | 842(34.8)              | 765             | 201                  | 188(24.6)              |
| Education level        | Primary school or low (< 6 years) | 668(52.9) | 552(43.0)             | 385             | 125                  | 99(25.7)               |
|                        | Junior high school(7-9 years) | 620(41.2) | 511(33.9)              | 429             | 135                  | 120(28.0)              |
|                        | Senior high school(10-12 years) | 667(45.8) | 552(37.5)              | 476             | 119                  | 107(22.4)              |
|                        | University or above (>12 years) | 272(39.2) | 217(30.7)             | 193             | 41                   | 35(17.9)               |
| Marital status         | Married                      | 2049(46.6)     | 1684(38.0)             | 1360            | 387                  | 335(24.6)              |
|                        | Single                       | 396(16.3)      | 32(12.4)               | 35              | 8                    | 8(22.2)                |
|                        | Divorced or separated        | 499(49.0)      | 41(38.3)               | 37              | 10                   | 9(24.0)                |
|                        | Widowed                       | 90(60.1)       | 75(50.5)               | 51              | 15                   | 9(17.8)                |
| Occupation             | Manual workers               | 1276(41.7)     | 1029(33.4)             | 817             | 235                  | 197(24.2)              |
|                        | Mental workers               | 420(43.8)      | 334(34.2)              | 298             | 67                   | 61(20.3)               |
|                        | Retired                      | 206(60.2)      | 187(54.9)              | 151             | 49                   | 43(28.5)               |
|                        | Others                       | 325(54.6)      | 282(46.5)              | 217             | 69                   | 60(27.5)               |
| Income(Yuan)           | <500                         | 526(51.6)      | 441(42.8)              | 293             | 97                   | 70(23.7)               |
|                        | 500-                          | 484(50.1)      | 400(41.2)              | 324             | 86                   | 81(25.1)               |
|                        | 1000-                         | 677(42.7)      | 553(34.6)              | 463             | 138                  | 114(24.7)              |
|                        | 2000-                         | 331(37.3)      | 268(30.2)              | 250             | 61                   | 65(25.8)               |
|                        | 3000-                         | 209(46.2)      | 170(36.3)              | 153             | 38                   | 31(20.3)               |
| Body Mass index(kg/m²) | Normal                       | 518(33.0)      | 401(25.9)              | 317             | 109                  | 94(29.6)               |
|                        | Underweight                  | 17(35.4)       | 13(27.0)               | 10              | 5                    | 5(45.7)                |
|                        | Overweight                   | 1015(45.8)     | 842(35.8)              | 682             | 197                  | 172(25.3)              |
|                        | Obesity                      | 677(52.6)      | 576(43.7)              | 474             | 109                  | 70(18.9)               |
| Family history of circulation system diseases | No | 757(35.1) | 600(27.6) | 470 | 147 | 122 | 122(26.0) |
|                        | Yes                          | 1470(52.0)     | 1232(42.9)             | 1013            | 273                  | 239(23.5)              |
| Smoking                | Never                        | 1297(47.4)     | 1090(39.5)             | 845             | 251                  | 210(24.9)              |
|                        | Current                      | 700(39.8)      | 554(31.1)              | 480             | 127                  | 114(23.8)              |
|                        | Past                         | 230(51.6)      | 188(42.1)              | 158             | 42                   | 37(23.0)               |
| Consuming alcohol products | No | 1523(52.5) | 1308(45.1) | 1004 | 320 | 260 | 259(25.9) |
|                        | Yes                          | 764(35.7)      | 524(26.1)              | 479             | 100                  | 101(21.0)              |
Definition. Hypertension was defined as any blood pressure where the mean systolic blood pressure was equal to or higher than 140 mmHg and/or the mean diastolic blood pressure was higher than 90 mmHg, and/or the self-reported use of antihypertensive medication in the past two weeks after having had a diagnosis of hypertension by a physician at the county-level or above. After at least 5 minutes rest first, blood pressure was measured two times by an electric sphygmomanometer (HEM-7200, OMRON, Dalian, China) on the arm in the sitting position; the final blood pressure was the average of the two measurement results.

Awareness of hypertension was defined as a self-reported diagnosis of hypertension by physicians. Individuals who had used anti-hypertension medications in the past 2 weeks prior to the interview were classified as being on treatment. Control was defined as systolic blood pressure lower than 140 mm Hg and diastolic blood pressure lower than 90 mm Hg among hypertensive patients who were being treated.

Subjects aged 18–44 years old were defined as the young group and subjects aged 45–59 years old were defined as the middle-aged group. Education levels were divided into four groups: primary school or lower (including

| Category | Subcategory | Awareness | Treatment | Control among treated |
|----------|-------------|-----------|-----------|----------------------|
|          | n (%)       | Estimated population | n (%) | Estimated population | n (%) | Estimated population |
|          | χ²          | P          | χ²        | P          | χ²        | P          |
| Physical exercises | Often | 748 (52.6) | 601 | 646(45.5) | 520 | 155(25.0) | 130 |
|          | Sometimes | 469(39.4) | 411 | 377(30.7) | 319 | 88(23.9) | 76 |
|          | Never or rare | 1010(43.2) | 811 | 809(34.3) | 644 | 177(24.0) | 155 |
|          | χ² | 47.870 | <0.001 | 66.987 | <0.001 | 0.261 | 0.909 |
|          | P | <0.001 | <0.001 | 0.059 | 0.059 | 0.969 | 0.969 |

Table 2. Comparison of awareness, treatment and control of hypertension between various factors.

| Category | Subcategory | Awareness | OR | 95.0% CI | P   |
|----------|-------------|-----------|----|----------|-----|
| Age group | Young | 1 | | | |
|          | Middle-aged | 2.07 | 1.76–2.44 | <0.001 |
| Sex | Female | 1 | | | |
|          | Male | 0.66 | 0.54–0.80 | <0.001 |
| Region | Rural | 1 | | | |
|          | Urban | 0.73 | 0.63–0.84 | <0.001 |
| Marital status | Married | 1 | | | |
|          | Single | 0.40 | 0.25–0.62 | <0.001 |
|          | Divorced or separated | 1.23 | 0.79–2.04 | 0.333 |
|          | Widowed | 1.33 | 0.88–2.21 | 0.184 |
| Occupation | Manual workers | 1 | | | |
|          | Mental workers | 1.25 | 1.04–1.50 | 0.018 |
|          | Retired | 1.23 | 0.93–1.64 | 0.144 |
|          | Others | 1.41 | 1.11–1.79 | 0.004 |
| Body Mass index(kg/m²) | Normal | 1 | | | |
|          | Underweight | 1.40 | 0.70–2.77 | 0.342 |
|          | Overweight | 1.89 | 1.60–2.24 | <0.001 |
|          | Obesity | 2.58 | 2.13–3.12 | <0.001 |
| Family history of circulation system diseases | No | 1 | | | |
|          | Yes | 2.02 | 1.76–2.33 | <0.001 |
| Smoking | Never | 1 | | | |
|          | Current | 1.44 | 1.20–1.72 | <0.001 |
|          | Past | 1.61 | 1.25–2.08 | <0.001 |
| Consuming alcohol products | No | 1 | | | |
|          | Yes | 0.64 | 0.53–0.76 | <0.001 |
| Physical exercises | Often | 1 | | | |
|          | Sometimes | 0.75 | 0.62–0.91 | 0.004 |
|          | Never or rare | 0.73 | 0.62–0.86 | <0.001 |

Table 3. Factors associated with awareness of hypertension among hypertensive patients. * Adjusted for gender, age and region (rural or urban).
those who never attended school and those who only finished elementary school, years of education ≤6), junior high school (6 < years of education ≤9), senior high school (including those who attended senior high school and those who attended secondary vocational education, 9 < years of education ≤12) and university or above (including undergraduate and graduate levels of education, years of education >12). Occupation status was

| Category                  | Subcategory                  | Treatment          | OR    | 95.0% CI    | P    |
|---------------------------|------------------------------|--------------------|-------|-------------|------|
| Age group                 | Young                        |                    | 1     |             |      |
|                           | Middle-aged                  |                    | 2.03  | 1.71–2.41   | <0.001 |
| Sex                       | Female                       |                    | 1     |             |      |
|                           | Male                         |                    | 0.65  | 0.54–0.79   | <0.001 |
| Region                    | Rural                        |                    | 1     |             |      |
|                           | Urban                        |                    | 0.79  | 0.68–0.92   | 0.002 |
| Marital status            | Married                      |                    | 1     |             |      |
|                           | Single                       |                    | 0.43  | 0.26–0.69   | 0.001 |
|                           | Divorced or separated        |                    | 1.22  | 0.74–2.01   | 0.429 |
|                           | Widowed                      |                    | 1.21  | 0.80–1.84   | 0.374 |
| Occupation                | Manual workers               |                    | 1     |             |      |
|                           | Mental workers               |                    | 1.18  | 0.98–1.43   | 0.084 |
|                           | Retired                      |                    | 1.35  | 1.02–1.79   | 0.035 |
|                           | Others                       |                    | 1.39  | 1.09–1.76   | 0.007 |
| Body Mass index (kg/m²)   | Normal                       |                    | 1     |             |      |
|                           | Underweight                  |                    | 1.28  | 0.62–2.65   | 0.498 |
|                           | Overweight                   |                    | 1.84  | 1.55–2.20   | <0.001 |
|                           | Obesity                      |                    | 2.50  | 2.05–3.05   | <0.001 |
| Family history of circulation system diseases | No | 1 | 4.83 | 0.64–4.72 | 0.283 |
|                           | Yes                          |                    | 1.97  | 1.70–2.27   | <0.001 |
| Smoking                   | Never                        |                    | 1     |             |      |
|                           | Current                      |                    | 1.45  | 1.20–1.75   | <0.001 |
|                           | Past                         |                    | 1.59  | 1.23–2.06   | <0.001 |
| Consuming alcohol products | No                          |                    | 1     |             |      |
|                           | Yes                          |                    | 0.54  | 0.45–0.65   | <0.001 |
| Physical exercises        | Often                        |                    | 1     |             |      |
|                           | Sometimes                    |                    | 0.68  | 0.56–0.83   | <0.001 |
|                           | Never or rare                |                    | 0.66  | 0.56–0.79   | <0.001 |

Table 4. Factors associated with treatment of hypertension among hypertensive patients. *Adjusted for gender, age and region (rural or urban).

| Category                  | Subcategory                  | Control among treated | OR    | 95.0% CI    | P    |
|---------------------------|------------------------------|-----------------------|-------|-------------|------|
| Age group                 | Young                        |                       | 1     |             |      |
|                           | Middle-aged                  | 0.72                  | 0.54–0.95 | 0.022 |
| Sex                       | Female                       | 1                     |       |             |      |
|                           | Male                         | 0.82                  | 0.64–1.05 | 0.120 |
| Region                    | Rural                        | 1                     |       |             |      |
|                           | Urban                        | 1.19                  | 0.90–1.56 | 0.220 |
| Education level           | Primary school or low(≤6 years) |                       | 1     |             |      |
|                           | Junior high school(7–9 years) | 1.064                 | 0.78–1.46 | 0.698 |
|                           | Senior high school(10–12 years) | 0.79                  | 0.56–1.11 | 0.172 |
|                           | University or above(>12 years) | 0.58                  | 0.35–0.95 | 0.030 |
| Body Mass index (kg/m²)   | Normal                       | 1                     |       |             |      |
|                           | Underweight                  | 1.73                  | 0.64–4.72 | 0.283 |
|                           | Overweight                   | 0.82                  | 0.61–1.10 | 0.180 |
|                           | Obesity                      | 0.54                  | 0.39–0.76 | <0.001 |

Table 5. Factors associated with control of hypertension among hypertensive patients. *Adjusted for gender, age and region (rural or urban).
classified into four groups: manual workers (including farmers, factory workers, and service workers), mental workers (including teachers, researchers, office assistants, and others technical staff), retirees and other kinds of workers (including students and unemployed persons).

Body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared; BMI was classified into four groups according to the Chinese BMI classification criteria: underweight (BMI < 18.5 kg/m$^2$), normal (18.5 ≤ BMI < 24 kg/m$^2$), overweight (24 ≤ BMI < 28 kg/m$^2$), and obese (BMI ≥ 28 kg/m$^2$)52. Smoking status included three groups: Never, Current, and Past. Never smokers were individuals who reported never having smoked up to 100 cigarettes. Current smokers were individuals who consumed any kind of tobacco products per day in the past 30 days. Past smokers were individuals who had smoked before but had quit at least three months prior53. Participants who consumed any kind of alcoholic beverage during the past year before the interview were defined as current drinkers. Physical exercise (excluding regular activity associated with daily life) status was divided into three levels: the ‘Never or rare’ group included individuals who never or seldom exercised; the ‘Exercise sometimes’ group included individuals who exercised one or two times per week; the ‘Often exercise’ group included individuals who exercised more than three times per week54.

Ethics. The Health Bureau of Jilin province approved this project. The School of Public Health, Jilin University, organized the investigation. Each participant in the research signed written informed consent.

Statistical analysis. The analysis of this study was conducted using SPSS version 22.0 statistical software (IBM Corp, Armonk, NY, USA). We used a weighted approach throughout the data analysis. An all-data weighted statistical analysis was implemented using the complex sample function in SPSS. The data was weighted by age, sex, and region (urban or rural) according to the demographic data of the statistical bureau of Jilin province to make more it representative of the 18~59 years old hypertensive patients in that province. The characteristics of participants were described by frequency and percentage. Descriptive analyses for non-normally distributed of quantitative data were described by median and interquartile range. The standardized rates of awareness, treatment and control of hypertension were weighted by age, sex, and region (urban or rural) in Jilin Province of China. The comparison of the prevalence of awareness, treatment and control among hypertensive patients in different categories were conducted by Rao-Scott Chi-square tests for complex samples. The regression analysis was first carried out by univariate regression analysis first. Factors that had a significant $P$ value in the univariate regression were brought into the multivariable regression analysis. The multivariable logistic regression analysis was mandatorily adjusted for age, gender and region (urban or rural). Binary logistic regression analyses (Method: Forward: LR) were performed to identify potential independent factors associated with the awareness, treatment and control of hypertension. The significance threshold was 0.05.

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Acknowledgements
The data used for the current research is from the 2012 Survey on Chronic Diseases in Jilin, China. This Survey was funded by the Scientific Research Foundation of the Health Bureau of Jilin Province, China (Grant Number: 2011Z116). The study was performed in accordance with the principles of the Declaration of Helsinki.

Author Contributions
X.L., H.N., Y.Q., M.L., L.L., X.M., S.J., C.G., R.W., and B.L. designed the study. X.L., H.N. and Y.Q. performed the study. X.L. analysed the data and drafted the manuscript. X.L., H.N., Y.Q., M.L. and L.L. participated in amending the manuscript. All authors approved the final version of the manuscript.

Additional Information
Competing Interests: The authors declare no competing interests.

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