Prevalence, awareness, treatment and control of hypertension among Ngawa Tibetans in China: a cross-sectional study

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ABSTRACT

Objectives To explore the prevalence, awareness, treatment and control rate of hypertension and analyse the potential social environment factors among Ngawa Tibetans in China.

Design This was a cross-sectional observational study.

Setting The investigation based on a multistage stratified cluster sampling was conducted in the Ngawa area, Sichuan Province, Southwest China. Tibetan residents were selected by random sampling method from one city and six counties in Ngawa.

Methods Basic demographical information, physical activity and blood pressure were collected. In addition, the participants completed the questionnaire. A multivariate logistic regression analysis was used to examine the association between the prevalence, awareness, treatment and control rate of hypertension and the potential risk factors.

Participants The sample comprised 2228 Ngawa Tibetan residents (age 18–80 years) from September 2018 to June 2019.

Results The prevalence rate of hypertension was 24.6%. The control rate was 6.2%, while the awareness rate (32.3%) and treatment rate (21.7%) of hypertension had been significantly improved.

Conclusion The prevalence of hypertension among Ngawa Tibetans was high. The awareness and treatment were improved in recent years. But the control rate was low. The government needs to strengthen the basic medical care and health education for Ngawa Tibetans.

INTRODUCTION

High morbidity and mortality of cardiovascular disease are rapidly becoming the leading causes of death worldwide.1,2 Hypertension is a major risk factor for cardiovascular disease, affecting 26.4% of the world’s adult population (972 million), and is expected to increase to 29.2% (1.56 billion) by 2025.3–5 In China, the number of premature deaths caused by hypertension is ≥200 million, and the direct medical costs each year are at least ¥36.6 billion.6,7 As a result, poverty or return to poverty due to illness exists in economically underdeveloped areas.8

The existing data showed that the prevalence of hypertension varies considerably from one region to another and between rural and urban Tibetan populations (from 23.4% to 51.2%).9–13 This phenomenon could be attributed to the various branches of the Tibetan population, as well as the differences in living areas, altitudes, lifestyles, economic levels and genetic characteristics.14 15 Furthermore, the aetiology of hypertension involves the complex interplay of environmental and pathophysiological factors that affect multiple systems, as well as genetic predisposition.14 15 Thus, the impact of living environment and lifestyle changes on hypertension needs to be investigated.

The Ngawa Tibetan region is located in a transitional zone from the Qinghai–Tibetan plateau to the Sichuan basin. A significant proportion of the Tibetan population in Ngawa lives at a high altitude, low population density and economically less-developed areas. Also, the relative lack of medical resources contributes to a lack of health services provided in these areas. However, with the medical reform plans16 and poverty alleviation17 of the government, the socio-economic and primary healthcare in Ngawa has developed (online supplemental figure

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Strengths and limitations of this study

► To the best of our knowledge, this is one of the first investigations of hypertension among Ngawa Tibetans after the government’s poverty alleviation.

► This study, for the first time, reported the change in awareness, treatment and control rate of hypertension among Ngawa Tibetans.

► The multistage stratified cluster sampling was carried out in Ngawa Tibetan.

► This cross-sectional study was limited in determining the direction of the association.

► Self-filling the questionnaire might cause bias.

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was based on a multistage stratified cluster sampling in 13 counties. In this study, the cross-sectional investigation was conducted in the east, west, north and south corners of the Ngawa area. The main settlements of Ngawa Tibetans across 13 counties were included randomly. According to the population proportion, the cluster sampling method was used to randomly select the counties and towns located in the east, west, north and south corners and the central part to carry out the population survey. All subjects were selected by random sampling method from one city (Maerkang) and six counties (Rangtang, Jinchuan, Aba, Hongyuan, Xiaojin and Maoxian) over the altitude range of 1500–3700 m. Pregnant or lactating women, patients with mental disorders and those unable to complete the survey due to physiological diseases were excluded from this study. The institutional review boards of the participating institutes approved the study protocol, and informed consent was obtained from the participants.

Data collection procedure
A standard structured questionnaire (online supplemental file 2) was prepared, which included demographic data such as age, gender, place of residence and education status. The history of hypertension and obesity were recorded by a team of doctors. First, height and weight were measured in light indoor clothes without shoes. The body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared (kg/m²). In addition, the blood pressure (BP) of each subject was measured twice on the right upper arm after at least 5 min of rest in a seated position using an automatic digital sphygmomanometer (Omron HBP-9020, Kyoto, Japan), following the American National Management Centre of Sichuan Provincial People’s Hospital. Patients were not involved in the recruitment to and conduct of the study. The research results would be reported to study participants in future popular science lectures. This is not randomised controlled trials, and the burden of the investigation costs was assessed by the project funding. We are grateful to all study participants and advisers for their active cooperation in the project funding. We are grateful to all study participants and advisers for their active cooperation in the project funding.

METHODS

Design
Cross-sectional observational study.

Patient and public involvement
The study protocol including the survey content was developed and designed with representatives from health management centre of Sichuan Provincial People’s Hospital. Patients were not involved in the recruitment to and conduct of the study. The research results would be reported to study participants in future popular science lectures. This is not randomised controlled trials, and the burden of the investigation costs was assessed by the project funding. We are grateful to all study participants and advisers for their active cooperation in the acknowledgements.

Participants
Ngawa Tibetan Autonomous Prefecture is located in the northwest of Sichuan province of China and consists of 13 counties. In this study, the cross-sectional investigation was based on a multistage stratified cluster sampling in the Ngawa area. The main settlements of Ngawa Tibetans across 13 counties were included randomly. According to the population proportion, the cluster sampling method was used to randomly select the counties and towns located in the east, west, north and south corners and the central part to carry out the population survey. All subjects were selected by random sampling method from one city (Maerkang) and six counties (Rangtang, Jinchuan, Aba, Hongyuan, Xiaojin and Maoxian) over the altitude range of 1500–3700 m. Pregnant or lactating women, patients with mental disorders and those unable to complete the survey due to physiological diseases were excluded from this study. The institutional review boards of the participating institutes approved the study protocol, and informed consent was obtained from the participants.

Data analysis
Quantitative data were expressed as mean±SD and qualitative data as percentages. T-test and χ² test were used to examine the differences in continuous and categorical variables, respectively. Multivariate logistic regression models were used to explore the correlation between baseline features and prevalence, awareness and control rate of hypertension. The data were entered (double entry) using EpiData V.3.0, and statistical analyses were performed using IBM SPSS Statistics V.19.0. The reported probabilities were two-sided, and p value <0.05 indicated statistical significance.
RESULTS

Participant characteristics
A total of 2680 participants were invited to the survey. However, 239 subjects refused to participate. Finally, 2228 participants, aged 45.00±14.01 years, completed the investigation. The response rate was 83.1%. The participant flowchart is shown in figure 1. The education level was low (about 40% of subjects had elementary school or lower education), and 63% of subjects reported being able to undergo regular physical examinations. Table 1 shows the demographical characteristics across gender.

Prevalence, awareness, treatment and control of hypertension and demographical characteristics
Based on the measurement values obtained at the interview, the mean SBP and DBP were 128.23±14.06 and 79.08±10.89 mm Hg. Among all the subjects, 548 subjects were diagnosed to be hypertensive; 177/548 were patients with hypertension who have been diagnosed or had taken medication, and 371/548 were newly diagnosed with high blood pressure (HBP), that is, 16.7% of the population. The prevalence rate was 24.6%, which was significantly higher in men (30.0%) than in women (p<0.0001). With

Table 1 Characteristics of the sample

| Variable               | Man (n=1310), n (%) | Woman (n=918), n (%) | Total (n=2228), n (%) |
|------------------------|---------------------|----------------------|-----------------------|
| Age(years)             | 47.15±14.29         | 41.93±13.02          | 45.00±14.01           |
| BMI (kg/m²)            | 24.45±2.53          | 22.25±2.81           | 23.55±2.86            |
| Education level        |                     |                      |                       |
| Elementary school or lower | 506 (42.6)          | 325 (36.5)           | 831 (40.0)            |
| Middle school          | 214 (18.0)          | 141 (15.8)           | 355 (17.1)            |
| High school or above   | 467 (39.3)          | 424 (47.6)           | 891 (42.9)            |
| Altitude (m)           |                     |                      |                       |
| 1500–2500              | 346 (26.4)          | 142 (15.5)           | 488 (21.9)            |
| 2500–3500              | 772 (58.9)          | 596 (64.9)           | 1368 (61.4)           |
| ≥3500                  | 192 (14.7)          | 192 (14.7)           | 372 (16.7)            |
| Region                 |                     |                      |                       |
| City                   | 624 (47.6)          | 484 (52.7)           | 1108 (49.7)           |
| County                 | 686 (52.4)          | 434 (47.3)           | 1120 (50.3)           |
| Medical check-up regularly |               |                      |                       |
| Yes                    | 802 (61.2)          | 602 (65.6)           | 1404 (63.0)           |
| No                     | 508 (38.8)          | 316 (34.4)           | 824 (37.0)            |

BMI, body mass index.
the increasing age, the prevalence rate also showed a significant increase (5.9% vs 29.6% vs 52.9%, p<0.0001). The awareness rate was 32.3%. Both the awareness and treatment rates in the 40–59 age group were highest among the three age groups. However, the treatment and control rates in our study were low (21.7% and 6.2%, respectively). Among the 177 participants who were aware of their hypertension, 56 (31.64%) did not receive medical treatment, while five had blood pressure under control in this measurement. The analysis of the questionnaire information revealed that only 304 (16.0%) subjects understood hypertension diagnosis standards correctly. While discussing the detrimental effects of hypertension on health, 1188 (53.3%) subjects filled in ‘not clear’. The prevalence, awareness, treatment and control of hypertension are shown in table 2 and figure 2.

Multivariate analyses about prevalence, awareness and treatment of hypertension

The prevalence, awareness and treatment rate of hypertension were correlated with gender, age, place of residence, altitude, family history of hypertension, weight, education level and regular medical check-up. The control rate of hypertension in this population was low (6.2%), which was insufficient for further analysis. As a result, multivariate attributive analysis was performed on the prevalence, awareness and treatment rate of hypertension, which showed statistically significant differences (table 2). Figure 3 shows the results of the risk factors of prevalence, awareness, and treatment related to demographic characteristics.

DISCUSSION

The prevalence of hypertension in many studies among the Tibetan population in the highland areas is different (23.4%–51.2%). Ngawa is located in the northwest of Sichuan province, a plateau area adjacent to Ganzi, where >536,000 Tibetans resided. Ngawa Tibetan had the oldest altitude ancestry and living environment as other Tibetans: thin air, low oxygen partial pressure, salty meat and lesser intakes of fruits and vegetables. With the implementation of the government’s poverty alleviation plan, the change in the socioeconomic and medical resources affected their lifestyle and the incidence of hypertension. To the best of our knowledge, this is the first study of hypertension in Ngawa, which provides the baseline survey data for future research and fills in the gap in this field.

The prevalence rate of hypertension among Ngawa Tibetan was 24.6%, which was lower than that in Ganzi Tibetan, but consistent with the result among the Chinese population (23.2%). About 33% of the Ngawa Tibetan (32.2%) were aware of their hypertension. Although the awareness rate is still lower than the average level of other regions in China (40.7%), compared with the previous surveys from Ganzi Tibetans (7.5%), it had increased significantly in recent years, while the treatment and the control rates were still low (21.7% and 6.2%, respectively). Moreover, the awareness, treatment and control rates of hypertension varied greatly even for the same race from different areas as China is a vast country. Also, hypertension was newly detected during the survey in about 16.7% of the population studied, which has major implications for public health measures towards diagnosis and treatment of hypertension. Although epidemiological studies relying on single-session measurements overdiagnose hypertension by 20%–25%, it is becoming one of the primary public health problems in Sichuan Tibetan areas. The government should undertake measurements for the prevention and control of hypertension in these regions.

The survey found greater awareness and treatment rates of hypertension compared with the data from rural areas in Sichuan in 2015 (24.7% and 14.7%, respectively). The prevalence of hypertension in the county was higher than that in the city, while the awareness and treatment rates in the county were significantly lower. After adjusting the multivariate regression model, no significant independent influence was noted on the prevalence (figure 3A). However, the urban–rural difference was the independent risk factor of awareness and the treatment of hypertension (figure 3B and C). Although this study did not find any significant difference in the prevalence and treatment of hypertension among people with or without regular physical examinations, the awareness rate was significantly higher among people undergoing regular physical examinations. Also, the higher the education of Tibetan residents, the lower the awareness rate and the higher the awareness rate (figure 3A and B). Thus, we speculated that improving basic medical security and enhancing universal health education are effective in preventing and controlling hypertension.

Furthermore, an age-related increase was detected in the prevalence irrespective of gender; this finding was consistent with previous studies. The decreased vascular patency and the deterioration of vascular elasticity in the aged might be one of the reasons for prevalence. In addition, the high prevalence of hypertension in young Tibetans should be noted, especially in men aged 18–30 years old. Based on their income increases, the lifestyle and living standards of the Ngawa Tibetan had changed. Fast food with high calories becomes readily available as the number of income-wealthy consumers grows, which is an increasing source of food. Reduced physical activity and high-calorie foods are the major contributing factors to the rise in body overweight and obesity. Some Ngawa Tibetans have abandoned husbandry and are pursuing a living in the urban environment, while some have retained pastoral lives, either by owning livestock under the care of others or by moving intermittently between urban and pastoral settings. Thus, the current urban food environment and lifestyle could effectuate changes in health among the population, especially young people. Thus, the health-related behaviours in young people, such as smoking, alcoholism and eating habits, should be under intensive focus.
Some investigators have assessed the impact of altitude on blood pressure. The studies suggested that chronic exposure to a hypoxic environment at high altitudes (≥3500 m) caused increased sympathetic and parasympathetic activities, which in turn raised the blood pressure. Research across the Tibetan regions indicated a significant correlation between altitudes (3000–4300 m) and the prevalence of hypertension among Tibetans. However, another survey in Ladakh and Northern India reported that the prevalence of hypertension in Tibetan nomads living at higher altitudes (4000–4900 m) was relatively low (19.7%). Some studies contributed to the

| Characteristics | N  | Prevalence, N1 (%)* | Awareness, N2 (%)† | Treatment, N3 (%)‡ | Control, N4 (%)§ |
|-----------------|----|---------------------|-------------------|--------------------|-----------------|
| Subjects        | 2228 | 548 (24.6)        | 177 (32.3)        | 119 (21.7)         | 34 (6.2)        |
| Gender          |     |                    |                   |                    |                 |
| Male            | 1310 | 393 (30.0)         | 142 (36.1)        | 95 (24.2)          | 26 (6.6)        |
| Female          | 918  | 155 (16.9)         | 35 (22.6)         | 24 (15.5)          | 8 (5.2)         |
| P value         |     | <0.0001¶          | 0.002¶            | 0.026¶             | 0.525           |
| Age (years)     |     |                    |                   |                    |                 |
| 18–39           | 876  | 52 (5.9)           | 5 (9.6)           | 2 (3.8)            | 1 (1.9)         |
| 40–59           | 942  | 279 (29.6)         | 116 (41.6)        | 78 (28.0)          | 22 (7.9)        |
| 60–80           | 410  | 217 (52.9)         | 56 (25.8)         | 39 (18.0)          | 11 (5.1)        |
| P value         |     | <0.0001¶          | <0.0001¶          | <0.0001¶           | 0.18            |
| Education level |     |                    |                   |                    |                 |
| Elementary school or lower | 831 | 325 (39.1)        | 79 (24.3)         | 57 (17.5)          | 12 (3.7)        |
| Middle school   | 355  | 65 (18.3)          | 25 (38.5)         | 19 (29.2)          | 6 (9.2)         |
| High school or above | 891 | 118 (13.2)        | 50 (42.4)         | 29 (24.6)          | 12 (10.2)       |
| P value         |     | <0.0001¶          | <0.0001¶          | <0.0001¶           | 0.051           |
| Family history  |     |                    |                   |                    |                 |
| Yes             | 182  | 98 (53.8)          | 62 (63.5)         | 55 (43.9)          | 9 (9.2)         |
| No              | 2046 | 450 (22.0)         | 115 (25.6)        | 76 (16.9)          | 25 (5.6)        |
| P value         |     | <0.0001¶          | <0.0001¶          | <0.0001¶           | 0.18            |
| Altitude (m)    |     |                    |                   |                    |                 |
| 1500–2500       | 488  | 168 (34.4)         | 72 (42.9)         | 40 (23.8)          | 16 (9.5)        |
| 2500–3500       | 1368 | 252 (18.4)         | 82 (32.5)         | 58 (23.0)          | 15 (6.0)        |
| ≥3500           | 372  | 128 (34.4)         | 23 (18.0)         | 21 (16.4)          | 3 (2.3)         |
| P value         |     | <0.0001¶          | <0.0001¶          | 0.25               | 0.039¶          |
| Region          |     |                    |                   |                    |                 |
| City            | 1108 | 196 (17.7)         | 75 (38.3)         | 55 (28.1)          | 15 (7.7)        |
| County          | 1120 | 352 (31.4)         | 102 (29.0)        | 64 (18.2)          | 19 (5.4)        |
| P value         |     | <0.0001¶          | 0.026¶            | 0.007¶             | 0.29            |
| BMI (kg/m²)     |     |                    |                   |                    |                 |
| <24             | 1292 | 218 (16.9)         | 66 (30.3)         | 57 (26.1)          | 17 (7.8)        |
| 24–28 (overweight) | 794 | 259 (32.6)        | 69 (26.6)         | 48 (18.5)          | 13 (6.0)        |
| ≥28 (obesity)   | 136  | 71 (52.2)          | 42 (59.2)         | 14 (19.7)          | 2 (2.8)         |
| P value         |     | <0.0001¶          | <0.0001¶          | 0.021              | 0.22            |
| Medical check-up regularly |     |                    |                   |                    |                 |
| Yes             | 1404 | 268 (19.9)         | 99 (38.7)         | 73 (28.5)          | 17 (6.6)        |
| No              | 824  | 280 (34.0)         | 78 (26.7)         | 46 (15.8)          | 17 (5.8)        |
| P value         |     | <0.0001¶          | 0.003¶            | <0.0001¶           | 0.69            |

*N1/N1*100%.
†N2/N1*100%.
‡N3/N1*100%.
§N4/N1*100%.
¶P<0.05 was considered statistically significant.
BMI, body mass index.
Moreover, the control rate of hypertension in the city and county was low (7.7% and 5.4%, respectively). No significant difference was observed in the gender, age and weight groups (table 2 and figure 3C). The higher the altitude and/or the lower the education level, the lower the control rate. This might prompt the government to improve primary care in high-altitude and low-education level areas in the control rate of hypertension.

Other risk factors correlated with the prevalence of hypertension collected in this survey mainly include the family history of hypertension, overweight and obesity (figure 3A). Obese and overweight patients have a higher prevalence and awareness of hypertension but a lower control rate. This phenomenon was consistent with that described previously.21 28 Hypertension is hereditary and related to family genes, living habits, eating habits and other factors. Subjects with a family history of hypertension had a 3.86-fold higher risk of hypertension. However, their awareness and treatment rate were also higher. Thus, the high risk of the disease might gain their attention and prompt them to be proactive in the treatment. Limited by funding and other objective conditions, the sample size collected in this survey was small, and we had not obtained blood glucose, blood lipids, diet and physical activity levels. Therefore, in the future, large-scale epidemiological investigations are required among the population in the specific region.

Among the 177 participants who are aware of their HBP, 56 subjects did not receive medical treatment (31.64%), while five subjects had normal blood pressure in this measurement. This might be because they changed their lifestyles after the diagnosis,25 or it may be that these individuals have reported that they had hypertension without clearly understanding the disease being referred to. The existing data cannot further analyse the reasons. In future surveys, for self-reported patients with hypertension, if participants could provide any documented evidence to prove the diagnosis of hypertension or inspection of the actual medications being taken, the analysis data would be more accurate. In the questionnaire, we can add ‘whether lifestyle intervention has been done’ to assist in the analysis.

Nevertheless, the present study has several limitations that should be considered while interpreting the findings. First, it was a cross-sectional study and, hence, limited in determining the direction of the association, as the exposure and the outcomes are simultaneously assessed. Thus, prospective studies are required for further investigation of these findings. However, this is the first survey on the hypertension of Ngawa Tibetan after the government’s poverty alleviation, which could provide evidence-based data for future research. Second, it was difficult to exclude the possibility of bias in self-reporting because some participants could not tell whether they had HBP or what medicine they were taking. Although investigators had tried their best to assist in the diagnosis by asking for details of the disease and promoting the name of the drug that may be taken, the error in the hypertension figures may be

Figure 2  The prevalence, awareness and treatment rate of hypertension. (A) Hypertension in woman. (B) Hypertension in man. *Prevalence was defined as subjects had an average SBP≥ 140 mmHg, and/or average DBP≥ 90 mmHg, and/or were diagnosed as being hypertensive in the past, and/or reported current treatment with anti-hypertensive medications among the population. Awareness was defined as self-reporting any prior diagnosis of hypertension by health care professionals among the population who were defined as being hypertensive. Treatment was defined as the use of an anti-hypertensive medication at the time of the interview or during the previous year for hypertension among the population who were defined as being hypertensive.
Figure 3  The OR and 95% CI from multiple logistic regression. (A) The prevalence rate of hypertension. (B) The awareness rate of hypertension. (C) The treatment rate of hypertension. *P<0.05 was considered statistically significant.

due to inaccuracy or omission. Third, limited by objective conditions, such as funding, the sample size of this survey was small; no random sampling of the population was stratified by age; and no blood index, diet, exercise and other data were collected. Some of the selected residents, especially those aged >70 years old, were reluctant for a check-up and to fill out the questionnaire, which might lead to missing data for older people and bias the results.

Fourth, the prevalence of hypertension was based on the measurements of BP on a single day. The possibility of white-coat hypertension in some of these subjects (especially newly diagnosed) could not be excluded. Finally, a lack of information on comorbidities, such as diabetes, hyperlipidaemia, renal disease and lifestyle factors, such as diet and physical activities, limited further interpretation of the data. Therefore, additional epidemiological
studies are needed to obtain comprehensive information and data to develop appropriate prevention strategies and controls.

CONCLUSIONS
The prevalence of hypertension among Ngawa Tibetan was high. The awareness and treatment rates were improved in recent years, while the control rate needed to be improved. This study, for the first time, analysed the hypertension data and potential social environment factors among Ngawa Tibetans, which provided evidence-based data on hypertension for future research. The government needs to strengthen the construction of basic medical care and health education for residents in Ngawa to develop population-based hypertension detection and control strategies. These could include increasing clinics, providing local medical staff with the diagnosis and treatment capabilities, enhancing education on the adverse outcomes of hypertension and encouraging medical follow-up for monitoring the BP in those already diagnosed with hypertension.

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