High prevalence and low awareness of hyperuricemia in hypertensive patients among adults aged 50–79 years in Southwest China

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Abstract

Introduction: This study was aimed to assess the prevalence of hyperuricemia and its associated risk factors among hypertensive patients in Southwest China.

Methods: From September 2013 to March 2014, a multistage, stratified sampling was conducted on 3505 hypertensive people aged 50–79 years who lived in urban communities within Chengdu and Chongqing, using a questionnaire and performing physical and biochemical measurements.

Results: In the study population, approximately 18.2% of all hypertensive participants had hyperuricemia (638/3505), with a prevalence rate of 21.5% in men and 16.2% in women (p < 0.05). Multivariate logistic regression analysis showed that aging, without spouse, current drinking, preferring hotpot, hypertriglyceridemia, BMI ≥ 25 kg/m², and central obesity were all positively correlated with hyperuricemia, whereas female gender was negatively correlated with hyperuricemia. The prevalence of hyperuricemia among hypertensive patients in urban adults aged 50–79 years in southwestern China was high, while levels of awareness were extremely low.

Discussion: Improved hyperuricemia health knowledge should be delivered to improve public awareness of the disease and it may need aggressive strategies aiming at the prevention and treatment of hyperuricemia. It is may necessary to encourage people to check blood uric acid levels when they first time to be diagnosed with hypertension, especially in the elderly.

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national cross-sectional survey among Chinese adults in
2009–2010, the prevalence of hyperuricemia was 8.4%
[8]. One latest meta-analysis indicated that the pooled
prevalence of hyperuricemia was 13.3% in Mainland
China from 2000 to 2014 [7]. Hyperuricemia plays a role
in the development of hypertension [9, 10], and they
often occur together. For the largest developing country-
China, rapid ageing and urbanization are underway [11–
13]. Rapid city development in Chongqing and Chengdu,
their GDP grow up to 1774.1 billion and 1217 billion in
2016, compared to 390.7 billion and 275 billion in 2006
respectively, according to the data revealed in 2106 from
the national bureau of statistics. These are causing the
prevalence of hypertension and hyperuricemia increasing
at an alarming rate in China [7, 8, 14, 15]. Contrary to the
rapid increase in prevalence, the awareness of hyperten-
sion and hyperuricemia remained low. Hyperuricemia
is often asymptomatic and less than one in ten patients
with hyperuricemia presents with gout [7]. Most of
hypertensive patients are asymptomatic. A study investi-
gated urban adults in southwestern China in 2013–2014
showed that the prevalence of hypertension was 38.4%,
of which only 47.9% were aware of their hypertension,
40.1% were undergoing antihypertensive treatment, and
just 10.3% achieved BP control [16]. Both hypertension
and hyperuricemia are independent risk factors for car-
diovascular diseases, and when combined there was an
escalation of risk. China is the world’s largest developing
country, with a vast territory and many different ethnic
groups, the economic development varies greatly among
different regions. However, epidemiological investiga-
tions of the prevalence of hyperuricemia in hypertensive
patients in the southwestern region are lacking. In this
study, we aimed to assess the prevalence of hyperurice-
mia among hypertensive patients, aged 50–79 years, in
Southwest China and its associated risk factors.

Materials and methods
Study population
From September 2013 to March 2014, a multistage,
stratified sampling was conducted on 3505 people aged
50–79 years who lived in urban communities within
Chengdu and Chongqing, using a questionnaire and per-
forming physical and biochemical measurements. During
the first phase of this study, the Yubei and Jiangbei dis-
tricts were randomly selected for Chongqing, and the Jin-
jiang, Longquan and Chenghua districts were randomly
selected from the urban area of Chengdu. During the sec-
dond phase, a random subdistrict was selected from each
major district, and during the third stage, one commu-
nity was randomly selected from each subdistrict, result-
ing in a sample consisting of five random communities.

Inclusions and exclusions
Residents aged 50–79 years who had lived in the
selected communities for more than five years and
whose SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg, and/
or being diagnosed with hypertension and currently
under antihypertensive drug treatment, were included
in the study. People with a history of mental illness,
malignancies, renal failure requiring dialysis, or who
refused to participate in this inquiry were excluded.
From September 2013 to March 2014, 3505 patients
were included in the final analysis.

Data collection
More than 30 investigators were trained for data col-
lection. All subjects filled out the same onsite ques-
tionnaire, according to the cardiovascular survey
methods set out by the World Health Organization,
which included demographic characteristics; lifestyle
risk factors; personal and family histories; height,
weight, WC, and blood pressure measurements [17].
The questionnaire also included the level of aware-
ness of hyperuricemia; and type of treatment. BMI was
calculated as weight (kg) divided by height (meters)
squared, and when measuring height and weight, sub-
jects were required to be barefoot and to be wearing
only lightweight clothing. Investigators measured the
minimum circumference between the inferior margin
of the ribcage and the crest of the iliac to obtain WC
measurements [18]. Patients should be seated comfort-
ably in a quiet environment for 15 min before begin-
ning BP measurements, subjects were told not to drink
coffee, tea, or alcohol and to refrain from smoking or
exercising. Two BP measurements were made on the
right arm with participants in a seated position by
using an automated BP monitoring device (Omron),
10 min apart, and additional measurements only if the
two readings differ by > 10 mmHg. BP is recorded as the
average of the two BP readings.

Blood sample collection and laboratory tests
Venous blood was drawn after 12 h of fasting. Blood
glucose, lipids, and uric acid (UA) levels were assessed
in all blood samples. Patients were tested using the oral
glucose tolerance test (OGTT), wherein 75 g of glucose
was dissolved in 300 ml of warm water and was admin-
istered orally within five minutes, and venous blood was
drawn two hours later. The total cholesterol (TC), tri-
glycerides (TG), and blood glucose levels were detected
by enzymatic methods. High-density lipoprotein choles-
terol (HDL-C), low-density lipoprotein cholesterol (LDL-
C) levels were measured using a homogeneous method.
Serum UA was measured by the phosphotungstic acid method.

**Diagnostic standards**

According to the recommendations from 2018 European Society of Cardiology (ESC) and the European Society of Hypertension (ESH) Guidelines, high blood pressure was defined as an SBP \( \geq 140 \) mm Hg and/or a DBP \( \geq 90 \) mm Hg and/or a diagnosis of hypertension currently treated by antihypertensive drugs [1]. Hyperuricemia was defined as serum level of uric acid > 420 μmol/L (7.0 mg/dL) for men and > 360 μmol/L (6.0 mg/dL) for women [19, 20]. DM was defined as a fasting plasma glucose (FPG) level \( \geq 7.0 \) mmol/L, 2-h postprandial glucose (2-hPG) level \( \geq 11.1 \) mmol/L, or a previous clinical diagnosis [21]. According to the criteria of the NCEP Adult Treatment Panel III report, hypertriglyceridemia was defined as a TG level \( \geq 1.7 \) mmol/L, high LDL-cholesterolemia was defined as a LDL-C level \( \geq 3.4 \) mmol/L, hypercholesterolemia was defined as a TC level \( \geq 5.2 \) mmol/L [22]. Overweight was defined as a BMI of 25.0–29.9 kg/m², and obesity was defined as a BMI of 30.0 kg/m² or more [23]. Central obesity was defined as a WC of 90 cm or more in men and of 80 cm or more in women [24]. A history of smoking was defined as smoking at least once per day for more than a year, and currently having smoked or quit smoking for less than 3 years. A history of drinking was defined as drinking at least once a week over a year, and currently having drunk or quit drinking for less than 3 years. The family history of hypertension was defined as immediate family members having hypertension. The family history of DM was defined as immediate family members having DM. Physical exercise was defined as having at least one exercise session per week.

**Statistical analysis**

EpiData 3.02 database software was used to record data from the questionnaires. Data input was completed by two researchers, who also performed data checking and correction, and data processing and analysis were carried out using the SAS 9.3 software (Institute Inc. SAS, Cary, NC, USA). Qualitative data were compared using Chi-square test. Quantitative data were compared using the t-test. The Chi-square linear trend test was used to detect the trend in the prevalence of hypertension with hyperuricemia in individuals in association with their age and BMI. Logistic regression was used to explore the potential risk factors for hypertension with hyperuricemia. A \( P < 0.05 \) was considered as significant.

**Results**

The basic characteristics of the study population are shown in Table 1. In this study, 3505 hypertensive patients aged 50–79 years in Southwest were included, among whom 1338 were men and 2167 were women, with a mean age of 62.8 ± 7.6 years, and the mean serum

| Table 1  | Baseline characteristics of the hypertensive population |
|----------|--------------------------------------------------------|
| **Groups** | **Overall** (n = 3505) | **Male** (n = 1338) | **Female** (n = 2167) | **P values** |
| Age, mean (SD) | 62.8 (7.6) | 63.7 (7.4) | 62.3 (7.8) | 0.000 |
| Current smoking (%) | 21.1 | 49.6 | 3.5 | 0.000 |
| Current drinking (%) | 17.0 | 37.9 | 4.0 | 0.000 |
| Education level high school or above (%) | 17.7 | 29.8 | 10.2 | 0.000 |
| Income 2000 Yuan/month or above (%) | 18.6 | 24.4 | 14.9 | 0.000 |
| Physical exercise (%) | 62.8 | 64.8 | 61.6 | 0.06 |
| Family history of hypertension (%) | 24.1 | 25.6 | 23.1 | 0.084 |
| Systolic pressure, mmHg, mean (SD) | 170 (21.3) | 171.3 (21.7) | 169.5 (21.1) | 0.102 |
| Diastolic pressure/mmHg, mean (SD) | 97.3 (18.6) | 100.3 (21.9) | 96 (16.7) | 0.000 |
| Heart rate/min, mean (SD) | 82.1 (31.4) | 81.8 (34.7) | 82.3 (29.2) | 0.639 |
| TC, mmol/L, mean (SD) | 4.7 (0.9) | 4.6 (0.9) | 4.9 (0.9) | 0.000 |
| HDL-C, mmol/L, mean (SD) | 1.4 (0.3) | 1.3 (0.3) | 1.4 (0.3) | 0.000 |
| LDL-C, mmol/L, mean (SD) | 2.6 (0.8) | 2.5 (0.8) | 2.7 (0.8) | 0.000 |
| TG, mmol/L, mean (SD) | 1.8 (1.4) | 1.7 (1.3) | 1.9 (1.5) | 0.000 |
| FPG, mmol/L, mean (SD) | 6 (2) | 5.9 (1.9) | 6.1 (2) | 0.022 |
| 2hPG, mmol/L, mean (SD) | 9 (4.1) | 8.7 (3.8) | 9.2 (4.2) | 0.001 |
| Uric acid, mmol/L, mean (SD) | 309.3 (84.4) | 352.4 (81.4) | 283.2 (75) | 0.000 |
| Waist circumference, cm, mean (SD) | 85.9 (27.8) | 87.8 (43.1) | 84.7 (9.9) | 0.009 |
| BMI, kg/m², mean (SD) | 25.1 (8.5) | 24.7 (7.5) | 25.3 (8.6) | 0.022 |
Uric acid (UA) were 309.3 ± 84.4 μmol/L. Compared to women, men had higher values of UA, age, WC, and DBP, had higher rates of drinking and smoking, and had higher personal monthly incomes and higher education levels (all \( p < 0.05 \)). However, women had higher BMI, TC, TG, HDL-C, LDL-C, FPG, 2-hPG (all \( p < 0.05 \)). There were no differences in SBP, heart rate, physical exercise and family history of hypertension (all \( p > 0.05 \)).

The characteristics of the prevalence of hyperuricemia among hypertensive patients are shown in Figs. 1, 2 and 3. As shown in Fig. 1, approximately 18.2% of all participants had hyperuricemia (638/3505), with a prevalence rate of 21.5% in men and 16.2% in women (\( p < 0.05 \)). As shown in Fig. 2, the prevalence of hyperuricemia increased significant with increasing age in women (\( p \) for trend < 0.05), but not in men. For women in the age ranges of 50–59, 60–69, 70–79, the prevalence of hyperuricemia in hypertensive patients were 12.9%, 16.9% and 21.3% (\( p \) for trend < 0.05), respectively. As shown in Fig. 3, the prevalence of hyperuricemia increased with BMI in both sexes (\( p \) for trend < 0.05). In the BMI ranges of < 25, 25–29.9, \( \geq 30 \text{ kg/m}^2 \), the prevalence of hyperuricemia in hypertensive patients were 19.9%, 24.7%, 29.9% in men, and 13.8%, 17.8%, 23.5% in women, respectively (\( p < 0.05 \)).

The awareness of hyperuricemia in different groups are shown in Table 2. Among the 638 (18.2%) hyperuricemia participants, 138 (3.9%) patients were previously diagnosed, and 500 (14.3%) were newly diagnosed. This means that 78.4% (500/638) of hyperuricemia patients didn’t aware of their illness. The unawareness rate was higher among women compared to men (81.4% versus 74.7%, \( p < 0.05 \)). The unawareness rate was 84.5% in 50–59 years subgroup, then the rate decreased. In 60–69 years subgroup the unawareness rate was 74.6%, and in 70–79 years subgroup it was 76.0%.

A multivariate logistic regression analysis was performed to identify significant determinants of hyperuricemia among hypertensive population, and the results are shown in Table 3. Multivariate logistic regression analysis showed that aging, without spouse, current drinking, like hotpot, hypertriglyceridemia, BMI \( \geq 25 \), and central obesity were all positively correlated with hyperuricemia, whereas female was negatively correlated with hyperuricemia.
The prevalence of hyperuricemia was lower than that among Chinese adults in 2009–2010, the prevalence of hyperuricemia was 18.2% among hypertensive patients. In a national cross-sectional survey of China from September 2013 to March 2014, the prevalence of hyperuricemia was 8.4% [8], and a latest meta-analysis indicated that the pooled prevalence of hyperuricemia was 13.3% in Mainland China from 2000 to 2014 [7].

The prevalence of hyperuricemia was lower than that in our study, which may be caused by factors like subjects included in this study were urban residents with hypertension and had higher mean age. Both hyperuricemia and hypertension have similar risk factors, such as age, obesity, hypertriglyceridemia and so on [8, 16]. Hence, hypertensive patients may be more likely to have hyperuricemia. Besides, as hyperuricemia was a positive risk factor for the development of hypertension [9, 10], perhaps the prevalence of hyperuricemia was higher in hypertensive patients than in the general population. Among the 638 (18.2%) hyperuricemia participants, only 138 (3.9%) patients were previously diagnosed, and 500 (14.3%) were newly diagnosed. That means 78.4% (500/638) of hyperuricemia patients had not been diagnosed and were not aware of the disease. The 78.4% unawareness rate means extremely low treatment and control rates. It is may necessary to encourage people to check blood uric acid levels when they first time to be diagnosed with hypertension, especially in the elderly.

In accordance with previous studies [5, 7], men had higher prevalence of hyperuricemia than women (21.5% vs 16.2%). Men had much higher rates of current drinking, which had already been identified as a risk factor for hyperuricemia [25, 26]. In our study, the odd ratio of current drinking was 1.34 (P < 0.05). In our study, female was a protective factor of hyperuricemia, this may be explained by the protective effect of estrogen [26]. In accordance with previous studies, age was confirmed as an independent risk factor for hyperuricemia in our study. However, the effect of advanced age on hyperuricemia was different between sexes. The prevalence of hyperuricemia increased significant with increasing age (p < 0.05) in women, but it was not observed in men. This disparity may be largely related to the loss of the uricosuric action of estrogen following menopause [26, 27]. The disparity of hyperuricemia prevalence between sexes seems to narrow with advanced age. But even so, hyperuricemia was still a male-dominant disease as indicated in our study.

Many studies have reported that hypertriglyceridemia, BMI ≥ 25, central obesity were independently risk factors for hyperuricemia [25, 26, 28–31]. In this study, multivariate logistic regression results have further confirmed the association between these metabolic abnormalities and hyperuricemia.

Hotpot is one of the representative cuisines in Chengdu and Chongqing, which is one kind of purine-rich diet, that may account for why it was an independent risk factor for hyperuricemia. The data disclosed that people without spouse was a risk factor for hyperuricemia in hypertensive patients. In geriatric patients with chronic illnesses, many studies stated that people with spouse could improve their medication compliance and quality of life [32–34]. These phenomena may explain that most of the elderly population who have a spouse eat more healthily and exercise more regularly.

Rapidly increasing prevalence in hyperuricemia, with an extremely low awareness and treatment rates, might lead to high incidences of renal failure, stroke and other cardiovascular diseases. It is may necessary to encourage people to check blood uric acid levels when they first time to be diagnosed with hypertension, especially in the elderly.

Several limitations remain. First, this is a cross-sectional study, the results cannot be used to establish a conclusive cause-and-effect relationship between risk factors and hyperuricemia in hypertensive patients. Second, the study was conducted in urban areas of Chongqing and Chengdu; hence, the results may not be representative of the prevalence of hyperuricemia in

### Table 3 Logistics regression for hyperuricemia among the hypertensive populations

| Variable                  | Odds ratios (95% CI) | P value |
|---------------------------|----------------------|---------|
| Gender (male)             | 0.756 (0.602,0.949)  | 0.016   |
| Female                    |                      |         |
| Age group (50–59)         |                      |         |
| 60–69                     | 1.122 (0.911,1.383)  | 0.278   |
| 70–79                     | 1.501 (1.185,1.901)  | 0.001   |
| Marriage                  |                      |         |
| Without spouse            | 1.789 (1.383,2.316)  | 0.000   |
| Drinking (no)             |                      |         |
| Yes                       | 1.342 (1.046,1.721)  | 0.021   |
| Preferring hotpot (no)    |                      |         |
| Yes                       | 1.375 (1.099,1.721)  | 0.005   |
| Hypertriglyceridemia (no) |                      |         |
| Yes                       | 1.732 (1.409,2.129)  | 0.000   |
| BMI ≥ 25 (no)             |                      |         |
| Yes                       | 1.243 (1.022,1.511)  | 0.029   |
| Center obesity (no)       |                      |         |
| Yes                       | 1.481 (1.162,1.888)  | 0.002   |

### Discussion

This study assessed the prevalence of and factors related to hyperuricemia among hypertensive population aged 50–79 years, who lived in urban Chengdu and Chongqing, from September 2013 to March 2014. Overall, the prevalence of hyperuricemia was 18.2% among hypertensive population. In a national cross-sectional survey among Chinese adults in 2009–2010, the prevalence of hyperuricemia was 8.4% [8], and a latest meta-analysis indicated that the pooled prevalence of hyperuricemia was 13.3% in Mainland China from 2000 to 2014 [7].

The prevalence of hyperuricemia was lower than that in our study, which may be caused by factors like subjects included in this study were urban residents with hypertension and had higher mean age. Both hyperuricemia and hypertension have similar risk factors, such as age, obesity, hypertriglyceridemia and so on [8, 16]. Hence, hypertensive patients may be more likely to have hyperuricemia. Besides, as hyperuricemia was a positive risk factor for the development of hypertension [9, 10], perhaps the prevalence of hyperuricemia was higher in hypertensive patients than in the general population. Among the 638 (18.2%) hyperuricemia participants, only 138 (3.9%) patients were previously diagnosed, and 500 (14.3%) were newly diagnosed. That means 78.4% (500/638) of hyperuricemia patients had not been diagnosed and were not aware of the disease. The 78.4% unawareness rate means extremely low treatment and control rates. It is may necessary to encourage people to check blood uric acid levels when they first time to be diagnosed with hypertension, especially in the elderly.

In accordance with previous studies [5, 7], men had higher prevalence of hyperuricemia than women (21.5% vs 16.2%). Men had much higher rates of current drinking, which had already been identified as a risk factor for hyperuricemia [25, 26]. In our study, the odd ratio of current drinking was 1.34 (P < 0.05). In our study, female was a protective factor of hyperuricemia, this may be explained by the protective effect of estrogen [26]. In accordance with previous studies, age was confirmed as an independent risk factor for hyperuricemia in our study. However, the effect of advanced age on hyperuricemia was different between sexes. The prevalence of hyperuricemia increased significant with increasing age (p < 0.05) in women, but it was not observed in men. This disparity may be largely related to the loss of the uricosuric action of estrogen following menopause [26, 27]. The disparity of hyperuricemia prevalence between sexes seems to narrow with advanced age. But even so, hyperuricemia was still a male-dominant disease as indicated in our study.

Many studies have reported that hypertriglyceridemia, BMI ≥ 25, central obesity were independently risk factors for hyperuricemia [25, 26, 28–31]. In this study, multivariate logistic regression results have further confirmed the association between these metabolic abnormalities and hyperuricemia.

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Rapidly increasing prevalence in hyperuricemia, with an extremely low awareness and treatment rates, might lead to high incidences of renal failure, stroke and other cardiovascular diseases. It is may necessary to encourage people to check blood uric acid levels when they first time to be diagnosed with hypertension, especially in the elderly.

Several limitations remain. First, this is a cross-sectional study, the results cannot be used to establish a conclusive cause-and-effect relationship between risk factors and hyperuricemia in hypertensive patients. Second, the study was conducted in urban areas of Chongqing and Chengdu; hence, the results may not be representative of the prevalence of hyperuricemia in
hypertensive patients among rural residents in southwestern China.

Conclusion
The high prevalence of hyperuricemia among hypertensive patients in urban adults aged 50–79 years in southwestern China, but low levels of awareness. Strengthen the public’s understanding of the harm of high uric acid and it is may necessary encourage people to check blood uric acid levels when they first time to be diagnosed hypertension, especially in the elderly. To prevention hyperuricemia, life style should be changed, such as limiting intake purine-rich diet, taking regular physical exercise, limiting alcohol and weight loss.

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Authors contributions
ZY, FQN and XBH collected the raw data, WWT, RH, WQZ, JXL, RHX performed the data analysis, LY, DW, TZW and XF design the study, LY and WD provided the logistic support for this study. All authors read and approved the final manuscript.

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Not available.

Availability of data and materials
The datasets generated and/or analysed during the current study are not publicly available due to the general data accuracy control, but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The observational study involving human subjects was in accord with the Helsinki Declaration. And all investigations in this study were approved by the ethics committee of Second People’s Hospital of Chengdu, China (No. 2013015).

Consent for publication
The informed consents were obtained from all subjects.

Competing interests
The authors have no conflicts of interest to declare.

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