Systematic Review and Meta-Analysis

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Prevalence and risk factors of hypertension among Hui population in China

A systematic review and meta-analysis based on 30,565 study participants

Yuanyuan Zhang, BS[a], Xiangping Fan, BS[b], Sijun Li, BS[a], Yutan Wang, BS[a], Sujie Shi, MS[a], Huilan Lu, MS[a], Fanghong Yan, MS[a], Yuxia Ma, MS[a,*]

Abstract

Background: Hypertension (HTN) has been considered as a health concern in developing countries. And Hui is a minority group with a large population in China. Its genetic background, inadequate access to health services, eating habits, religious belief, ethnic customs, and other factors differ from that of other ethnic groups, which may influence the prevalence of HTN. However, there is no current meta-analysis on the prevalence and risk factors of HTN among Hui population. Thus we conducted a systematic review aiming to estimate the pooled prevalence and risk factors of HTN among Hui population.

Methods: PubMed, The Cochrane library, Web of science, CINAHL Complete, Weipu Database (VIP), China Knowledge Resource Integrated Database (CNKI), Wanfang Database, and SinoMed were systematically searched from inception to February 28, 2020 with publication language restricted to English and Chinese. We included cross-sectional, case–control, or cohort studies that focused on prevalence and risk factors of HTN among Hui population. Two investigators independently assessed the risk of bias of the studies included in the review using tools developed by JBI. Meta-analysis was conducted using Stata 12.0 software package.

Results: Twenty-three studies were identified with a total of 30,565 study participants. The overall pooled prevalence of HTN was 28% (95% confidence interval [CI]: 24%–32%, $I^2 = 98.8\%$, $P < .001$). Stratified by gender, the pooled prevalence of HTN in Hui was 26% (95%CI: 20%–33%, $I^2 = 97.6\%$, $P < .001$) for males and 30% (95%CI: 23%–37%, $I^2 = 98.3\%$, $P < .001$) for females. Pooled prevalence of HTN in Hui was 2% (95%CI: 2%–6%, $I^2 = 70.6\%$, $P = .065$), 10% (95%CI: 3%–17%, $I^2 = 83.7\%$, $P < .001$), 22% (95% CI: 12%–32%, $I^2 = 87.9\%$, $P < .001$), 37% (95%CI: 20%–53%, $I^2 = 94.0\%$, $P < .001$), 39% (95%CI: 24%–54%, $I^2 = 97.7\%$, $P < .001$) and 42% (95%CI: 29%–56%, $I^2 = 95.6\%$, $P < .001$) for those aged 18 to 29, 30 to 39, 40 to 49, 50 to 59, 60 to 69, and ≥70 years, respectively. Pooled prevalence of HTN in Hui was 22% (95%CI: 14%–29%, $I^2 = 97.9\%$, $P < .001$) in urban areas and 23% (95%CI: 16%–30%, $I^2 = 95.8\%$, $P < .001$) in rural areas. Daily salt intake (odd ratio [OR] = 3.94, 95%CI: 3.03–5.13, $I^2 = 90.2\%$, $P < 001$), family history (OR = 3.50, 95%CI: 2.60–4.71, $I^2 = 95.3\%$, $P < .001$), smoking (OR = 1.84, 95%CI: 1.61–2.09, $I^2 = 59.6\%$, $P < .001$), drinking (OR = 1.74, 95%CI: 1.26–2.39, $I^2 = 95.3\%$, $P = .001$), weekly meat intake (OR = 1.92, 95%CI: 1.04–3.54, $I^2 = 96.5\%$, $P = .036$), body mass index (OR = 2.20, 95%CI: 1.81–2.66, $I^2 = 91.3\%$, $P < .001$), and areas (OR = 1.29, 95%CI: 1.10–1.51, $I^2 = 81.5\%$, $P = .001$) were risk factors of HTN in Hui, while physical exercise (OR = 0.76, 95%CI: 0.66–0.88, $I^2 = 62.7\%$, $P < .001$) was protective factor.

Conclusions: The pooled prevalence of HTN among Hui people was 28%, daily salt intake, family history, drinking, smoking, weekly meat intake, body mass index, areas, and physical exercise were all risk factors for HTN among Hui population. Early screening and treatment of HTN among Hui population should be given due attention.

Abbreviations: BMI = body mass index, CI = confidence interval, CNKI = China Knowledge Resource Integrated Database, CVD = Cardiovascular disease, DALYs = disability-adjusted life-years, HTN = hypertension, OR = odd ratio, SBP = systolic blood pressure, VIP = Weipu Database, WHO = World Health Organization.

Keywords: Hui population, hypertension, prevalence, risk factors

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

[a] Evidence-Based Nursing Center, School of Nursing, Lanzhou University, [b] Department of Nursing, the Third People's Hospital of Lanzhou, Lanzhou, China.

[*] Correspondence: Yuxia Ma, Evidence-Based Nursing Center, School of Nursing of Lanzhou University, Lanzhou, 730000, China (e-mail: yuxiama@lzu.edu.cn).

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1. Introduction

Hypertension (HTN) is the most common disease in primary care.[1] According to the World Health Organization (WHO) 2019 estimate, ~1.13 billion people worldwide are suffering from HTN.[2] In China, HTN accounts for 160 million people.[3] HTN is the greatest modifiable risk factor for cardiovascular disease (CVD), disability, and deaths worldwide.[4] The WHO estimates that 54% of strokes and 47% of ischemic heart disease cases are the direct result of HTN, which is still on the rise.[5,6] Moreover, as the largest contributor to global disability-adjusted life-years (DALYs), HTN accounted for 9.2% (95% uncertainty interval 8.3–10.2) of DALYs for men and 7.8% (6.9–8.7) of DALYs for women in 2015.[7] In China, there are 10,667 people who lose their healthy life due to HTN for every 100,000 people, which has caused a heavy burden on families and society.[8] In fact, HTN has been recognized as a "silent killer" due to its high mortality rates and lack of early symptoms.[9]

Hui is a minority with a large population in China. According to National Population Census of China in 2010, the Hui people has an estimated population of 10.59 million, which mainly spread in Ningxia, Gansu, Xinjiang, and Qinghai.[10] Hui people's genetic background, living environment, eating habits, religious belief, ethnic customs, and other factors are different from other population of China. And studies have shown that the polymorphism at the +2836 G>A site in the *apoE* gene is strongly correlated with the susceptibility to essential HTN in Hui people.[11] In addition, Hui people believe in Islam. Due to religious beliefs, they do not eat pork in their diet, mainly beef and mutton. What' s more, the men of Hui nationality are forbidden to smoke or drink alcohol.[12] These factors may cause the prevalence of HTN among Hui population to be different from that of Han nationality and other ethnic groups.

Up-to-date, although there are several original studies that report the prevalence and risk factors of HTN among Hui people, the data are not homogenous between different studies. The prevalence of HTN varies from 8.46%[13] to 60.7%.[14] What's more, the risk factors included in the study were also slightly different. And as yet no systematic review has provided pooled prevalence and risk factors of HTN among Hui people in China, the present study aims to fill this gap. We aimed to present a pooled prevalence level and risk factors of HTN among Hui population in China, so as to provide theoretical basis for the prevention and management of HTN.

2. Methods and analysis

2.1. Literature search strategy

Comprehensive electronic searches of PubMed, The Cochrane library, Web of science, CINAHL Complete, VIP, CNKI, Wanfang, and SinoMed were conducted to identify relevant articles for epidemiologic studies, from inception to February 2020. Articles were identified with following search terms ("hypertension" OR "high blood pressure") AND ("prevalence" OR "epidemiologic studies") AND "Hui population." The relevant reference lists retrieved from databases also was searched to obtain full-scale studies. Two researchers were entrusted to screen the titles and abstracts and reviewed the full-text of the eligible articles. If there are different opinions, the third researcher makes final decisions. The search languages are English and Chinese.

2.2. Inclusion and exclusion criteria

Studies met the following inclusion criteria:

1. Observational studies (cross-sectional, case–control, or cohort studies) that were carried out among Hui people including more than 100 participants and reported prevalence and risk factors of HTN (or the data to calculate it).
2. Males or females of Hui people.
3. HTN has been diagnosed by systolic blood pressure/diastolic blood pressure (SBP/DBP) ≥140/90 in studies.
4. Ascertainment of HTN was decided mm Hg or kPa measured twice or the self-reported HTN and on antihypertensive medication as described by the seventh Joint National Committee.[15]

Studies were excluded if they:

1. were case series, reviews, policy reports, commentaries and editorials, and studies that did not provide data to estimate the prevalence and risk factors of HTN and
2. was non-essential HTN (renal HTN).

2.3. Data extraction

Two investigators independently screened the studies collected through the electronic searches for the present review extracted data, using a data extraction sheet prepared for the present study. The data extraction sheet was cross-checked and any disagreement was resolved by discussion for consensus. Information extracted included the followings: author information: first author's name and year of publication; study characteristics: study design (cross sectional, case–control, cohort), setting (urban and/or rural), sampling method (random vs non-random), data collection period, timing of data collection (prospectively vs retrospectively), response rate and methodological quality of the study; participants' characteristics: selection criteria, age, gender, HTN-related data; HTN characteristics: ascertainment of HTN, number of people with HTN, age and gender-specific data, and risk factors encountered.

2.4. Quality assessment

The included literature quality was assessed according to the criteria of observational studies recommended by JBI cross-sectional quality assessment tool.[16] The two reviewers independently evaluated the risk of bias, and quality disagreements were resolved by a third author.

2.5. Data analysis

The raw proportions of participants with HTN extracted from the included studies were recorded to perform pooled analyses. And random-effect model and fixed-effect model were used to calculate the prevalence and proportions. The prevalence from each study was expressed with exact 95%CI. In order to perform secondary analysis, subgroup analysis was employed. Subgroups were defined as differences in sex, age, and area differences (urban and rural).

In assessing the risk factors for the prevalence of HTN among Hui population, we extracted the OR and 95%CI from included studies, then summarized if data were available from two or more studies. We entered the ratio measures of the (adjusted) effect as a log OR and the standard error of the log OR using generic inverse-variance weighting method.

Statistical heterogeneity among studies was quantified using I^2 statistic with a cutoff of ≥50%. Besides, publication bias was assessed by testing for funnel plot asymmetry. Significance was set at a P value of <.1. All statistical analyses were performed using Excel 2010 and Stata 12.0 software package.

2.6. Ethical approval

This systematic review does not require ethical assessment because only indirect literature will be included and evaluated.

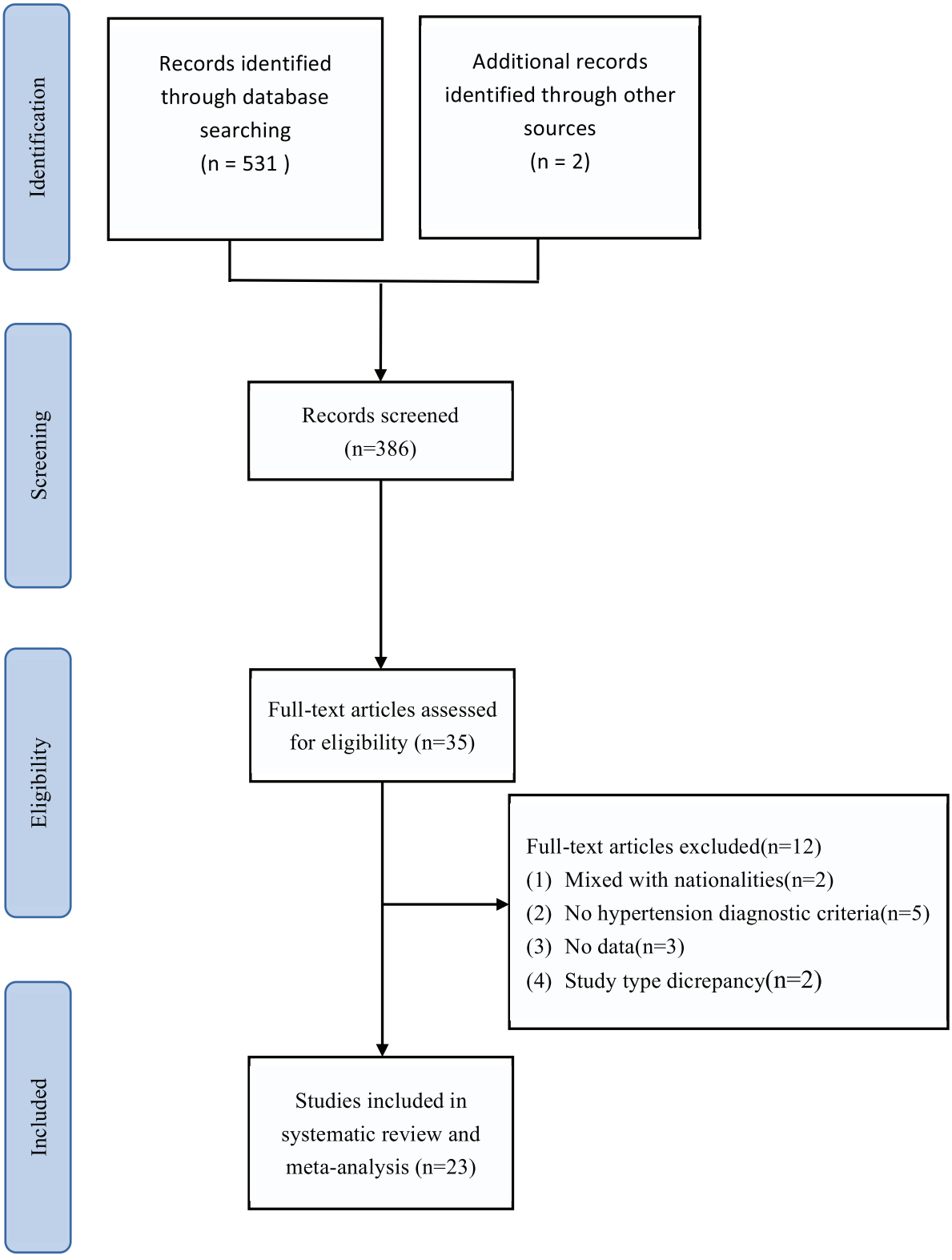

Figure 1. Flow diagram of the study selection process.

Table 1

The quality of included studies.

Study	Whether the sampling framework is suitable for the target population	Whether to take appropriate methods to extract research objects	Whether the sample size sufficient	Whether the object of study and the place of study are described in detail	Whether there is adequate coverage of the subjects for data analysis	Whether effective methods are used to identify disease or health problems	Whether to use standard and reliable methods to measure the subjects	Whether the data analysis method is appropriate	Whether the response rate is sufficient, if the response rate is low, whether to take appropriate treatment
Y Zhang(2005)	Yes	Unclear	Yes	No	Unclear	Yes	Unclear	Yes	Yes
J Y He(2010)	Yes	Yes	Yes	Unclear	Unclear	Yes	Unclear	Yes	Yes
H Liu(2010)	Yes	Yes	Yes	Yes	Unclear	Yes	Unclear	Yes	Yes
L Ma(2010)	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes
Y Z Xiao(2010)	Yes	Yes	Unclear	Unclear	Unclear	Yes	Unclear	Yes	Yes
L B Yu(2010)	Yes	Unclear	Unclear	Unclear	Unclear	Yes	Yes	Yes	Yes
Y Zhao(2010)	Yes	Yes	Unclear	Yes	Unclear	Yes	Yes	Yes	Yes
J Gong(2011)	Yes	Yes	Unclear	Yes	Unclear	Yes	Yes	Yes	Yes
L Ma(2011)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Y Zhang(2011)	Yes	Unclear	Unclear	No	No	Yes	Unclear	Yes	Yes
J Gong(2012)	Yes	Unclear	Yes	Yes	Yes	Yes	Unclear	Yes	Yes
H Y Liu(2012)	Yes	Unclear	Yes	Yes	Unclear	Yes	Yes	Yes	Yes
L Zhang(2012)	Yes	Unclear	Unclear	Yes	Unclear	Yes	Unclear	Yes	Yes
YP Zhang(2012)	Yes	Unclear	Yes	Unclear	Unclear	Yes	Unclear	Yes	Yes
J X Liu(2013)	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes
H GU(2015)	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes
L H Fang(2015)	Yes	Unclear	Yes	No	Unclear	Yes	Yes	Yes	Yes
G Q Zhao(2015)	Yes	Unclear	Unclear	Yes	Unclear	Yes	Unclear	Yes	Yes
W Liang(2017)	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes
F F Zhao(2017)	Yes	No	Unclear	Yes	Unclear	Yes	Unclear	Yes	Yes
XWZhang(2018)	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes
M Wang(2019)	Yes	Yes	Unclear	Yes	Unclear	Yes	Unclear	Yes	Yes
Q Zhang(2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

3. Results

3.1. Literature selection and methodological quality

The search of literature initially identified 386 potentially relevant references. The references included 131 English articles and 255 Chinese articles. According to inclusion and exclusion criteria, 23 studies (n = 30565) fulfilled the criteria for inclusion in a quantitative synthesis (meta-analysis)[13,14,17–37] (Fig. 1). The quality of the studies was evaluated by JBI cross-sectional quality assessment tool (Table 1).

3.2. Characteristics of the included studies

Of the remaining 23 articles we identified, included studies were published between May 2005 and April 2019. Descriptive data for the studies included in our analysis were summarized in Table 2. A total of 12 studies used random sampling methods,[14,19,21,22,27,28,31,32,34,35,36,37] 1 used stratified sampling methods,[32] 5 used cluster sampling methods[18,20,23,24,25,29] and the other studies didn't mentioned the sampling methods.[13,17,26,30] The sample size of included studies ranged from 102 to 4470. All the studies were conducted among participants over 12 years of age. And all the included studies made diagnosis of HTN by the 7th Joint National Committee criteria (SBP/DBP≥140/90 mm Hg).[15]

3.3. Meta-analysis

3.3.1. Prevalence of HTN. Overall prevalence of HTN from all 23 studies varies from 8.46%[13] to 60.7%.[14] The pooled prevalence of HTN among Hui people was 28% (95% CI: 24%–32%, I^2: 98.8%) (Fig. 2).

3.3.2. Gender-specific prevalence of HTN. Of all studies included in the current meta-analysis, 13 studies reported gender-specific data on prevalence of HTN among Hui people. As to male, the pooled prevalence was 26% (95% CI: 20%–33%, I^2: 97.6%). The pooled prevalence of HTN in female was 30% (95% CI: 23%–37%, I^2: 98.3%) (Fig. 3).

3.3.3. Age group-specific prevalence of HTN. Five studies provided data for the age group of 18 to 29 years, 30 to 39 years, 40 to 49 years, 50 to 59 years, 60 to 69 years, and ≧70 years. The overall prevalence of HTN in 18 to 29 years group was 2% (95% CI: 2%–6%, I^2: 70.6%), 30 to 39 years group was 10% (95% CI: 3%–17%, I^2: 83.7%), 40 to 49 years group was 22% (95% CI: 12%–32%, I^2: 87.9%), 50 to 59 years group was 37% (95% CI: 20%–53%, I^2: 94.0%), 60 to 69 years group was 39% (95% CI: 24%–54%, I^2: 97.7%), ≧70 years group was 42% (95% CI:29%–56%, I^2: 95.6%) (Fig. 4).

3.3.4. Area-specific prevalence of HTN. Five studies reported area-specific prevalence of HTN in urban areas.[25,27–29,32] The pooled prevalence of HTN in the urban setting was 22% (95% CI: 14%–29%, I^2: 97.9%). Another five studies in the rural settings,[15,20–22,24] whose summary prevalence of HTN was 23% (95%CI: 16%–30%, I^2: 95.8%) (Fig. 5).

3.3.5. Risk factors. Risk factors pooling analysis suggests daily salt intake (OR = 3.94, 95%CI: 3.03–5.13, I^2 = 90.2%, $P < .001$),

Table 2

Baseline characteristics of the included studies.

	Study	Years	Study area	Type of study	Sampling method	Sample size (n)			Age	Prevalence of HTN (%)	Risk factors
						Total	Male	Female			
1	Y Zhang	2004.11	Xiji County	Cross-sectional	–	306	148	158	≥12	20.92	–
2	JY He	2007.04–2007.09	Midong district of urumqi	Cross-sectional	Stratified cluster	845	412	433	≥18	31.95	Age, Obesity, Daily salt intake, HTN Family history
3	H Liu	2008.08–2009.07	Guyuan, Zhongwei, Shizushan, Yinchuan and Wuzhong City	Cross-sectional	Stratified cluster random	4470	–	–	≥18	18.5	Age, Daily salt intake, Family history of vascular disease, Gender, Marital status, Education, Labor intensity, Smoking, drinking, Weekly meat intake, BMI and waist-to-hip ratio
4	L Ma	2009.03–2010.02	Yinchuan city	Cross-sectional	Stratified cluster	1902	1047	855	≥18	19.4	Age, Obesity, Daily salt intake, Family history, Education, Smoking, drinking, Weekly meat intake, BMI, Exercise, high-oil diet
5	YZ Xiao	2007	Yunnan Province	Cross-sectional	Random	172	74	98	15–69	34.3	–
6	LB Yu	2008.05–2008.07	Wulumuqi County	Cross-sectional	Stratified cluster random	128	48	80	≥35	28.1	–
7	Y Zhao	2008.05–2009.01	Guyuan and Wuzhong city	Cross-sectional	Stratified cluster	488	204	284	25–74	29.2	–
8	J Gong	2008–2009	Ningxia Rural	Cross-sectiona1	Cluster	2783	–	–	≥18	16.6	Gender, Age, Smoking, coronary heart disease, diabetes, family history
9	L Ma	–	Ningxia Hui Autonomous Region	Cross-sectiona1	Stratified cluster	1360	730	630	≥60	46	Age, Obesity, Daily salt intake, Family history, Education, drinking, Weekly meat intake, BMI, Exercise, high-oil diet, region
10	Y Zhang	2008.11	Xiji County	Xiji County	–	306	–	–	≥18	20.92	–
11	J Gong	2009.12–2010.10	Guyuan, Zhongwei, Shizushan, Yinchuan and Wuzhong City	Cross-sectiona1	Cross-sectiona1	1689	–	–	≥18	21.91	Age, HTN family history, diabetes, Education, Drinking, Smoking, BMI
12	HY Liu	2008.08–2009.07	Wuzhong City	Cross-sectiona1	Cluster random	3136	1384	1752	≥18	20.7	–
13	L Zhang	2009.06–2009.07	Yinchuan City	Cross-sectiona1	Cluster	102	–	–	≥60	55.9	Marital status, Education, Drinking, BMI and Exercise
14	YP Zhang	–	Haiyuan County in Ningxia	Cross-sectiona1	–	1818	–	–	≥35	13.97	–
15	JX Liu	2009.10–2011.06	Guyuan, Zhongwei, Shizushan, Yinchuan and Wuzhong City	Cross-sectiona1	Stratified random	1396	760	636	≥35	8.46	–
16	H Gu	2005–2007	Qinghai, Xinjiang and Inner Mongolia Yunnan	Cross-sectiona1	Random	1151	432	719	35–70	48	–
17	LH Fang	–	Guyuan city	Cross-sectiona1	Random	2200	1200	1000	35–78	15.18	–
18	GQ Zhao	–	Lanzhou city	Cross-sectiona1	Stratified	141	62	79	≥45	16.31	Gender, Age, Drinking, Smoking, Daily salt intake, Weekly meat intake, Exercise, Obesity, overweight, more vegetables, life pressure
19	W Liang	–	Gansu	Cross-sectiona1	Stratified cluster random	2790	1381	1409	≥45	37.31	Obesity, Daily salt intake, family history, Education, Drinking, Smoking, BMI, diabetes, Exercise, employment situation, high-oil diet
20	FF Zhao	2010–2015	Ningxia Hui Autonomous Region	Cross-sectiona1	–	145	0	145	60 ± 8	60.7	–
21	XW Zhang	2013.01–2014.03	Gansu	Cross-sectiona1	Stratified Random	390	–	–	>15	26.9	Age, Gender, Marital status, Education, employment situation, region
22	M Wang	2019.07–2019.09	Ningxia Hui Autonomous Region	Cross-sectiona1	Stratified Random	208	132	76	≥20	45.19	–
23	Q Zhang	2013.09–2014.12	Gansu	Cross-sectiona1	Stratified cluster random	1458	–	–	20–74	22.63	Age, Obesity, family history, Gender, Education, Drinking, BMI, diabetes, region

BMI = body mass index, HTN = hypertension.

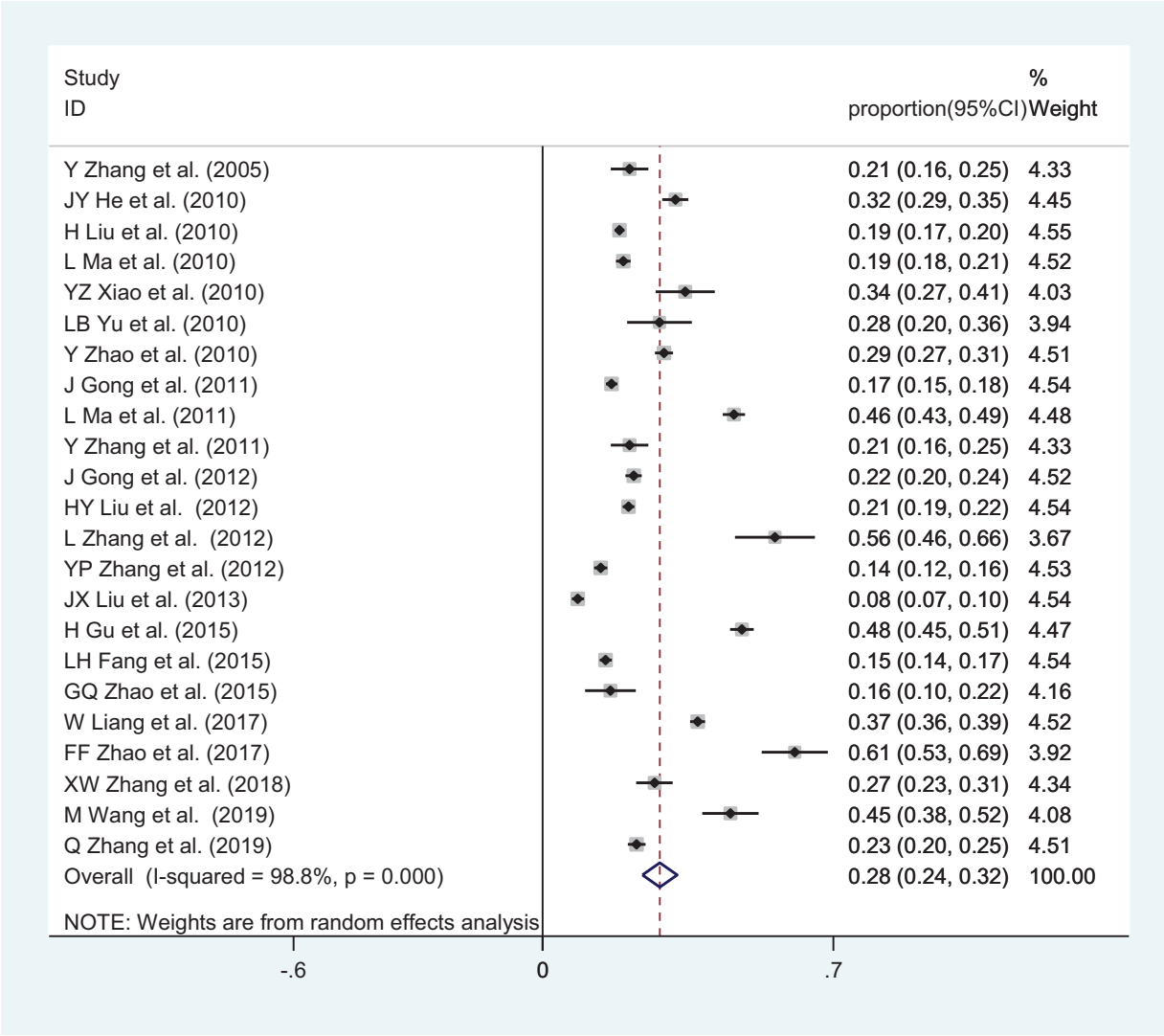

Figure 2. Forest plot of prevalence of hypertension.

family history (OR = 3.50, 95%CI: 2.60–4.71, $I^2 = 95.3\%$, $P < .001$), smoking (OR = 1.84, 95%CI: 1.61–2.09, $I^2 = 59.6\%$, $P < .001$), drinking (OR = 1.74, 95%CI: 1.26–2.39, $I^2 = 95.3\%$, $P = .001$), weekly meat intake (OR = 1.92, 95%CI: 1.04–3.54, $I^2 = 96.5\%$, $P = .036$), body mass index (BMI) (OR = 2.20, 95%CI: 1.81–2.66, $I^2 = 91.3\%$, $P < .001$) and areas (OR = 1.29, 95%CI: 1.10–1.51, $I^2 = 81.5\%$, $P = .001$) were risk factors for HTN, while physical exercise (OR = 0.76, 95%CI: 0.66–0.88, $I^2 = 62.7\%$, $P < .001$) was associated with a decreased risk of prevalence of HTN (Table 3).

3.4. Publication bias

Funnel plot and Begg's rank correlation were used to test the publication bias of the included literature. The results of funnel plot are shown in Figure 6, Begg's test, $Z = 1.93$, $P = .054$. The results showed no publication bias.

4. Discussion

Based on 23 studies included in the current meta-analysis, which involved a total of 30,565 patients, the estimated prevalence rate of HTN among Hui people was 28%. The assessment of potential risk factors associated with HTN indicated statistically significant correlation with eight factors: daily salt intake, family history, smoking, drinking, weekly meat intake, BMI, areas, and physical exercise.

The pooled prevalence of HTN among Hui people documented in the current meta-analysis appeared to be lower than Tibetan (40.68%) in China.[3] However, this rate was higher than that of National HTN (23.2%),[3] and it is also significantly higher than other ethnic minorities, such as Manchu (23.1%), Tujia (11.1%) and Miao (9.2%).[38] Tibetans usually live at higher altitudes than Hui. Studies have shown that increased sympathetic activity in high-altitude residents may lead to HTN.[39] In addition, hemoglobin, hematocrit, and white blood cells generally increased in plateau residents, which are related to the process of atherosclerosis and the occurrence and development of HTN.[40] It may be one of the reasons that the prevalence rate of HTN of Hui nationality is lower than that of Tibetan nationality. Different eating habits and genetic background may contribute to the higher prevalence of HTN among Hui people. Hui people believe in Islam, therefore pork is forbidden to eat in

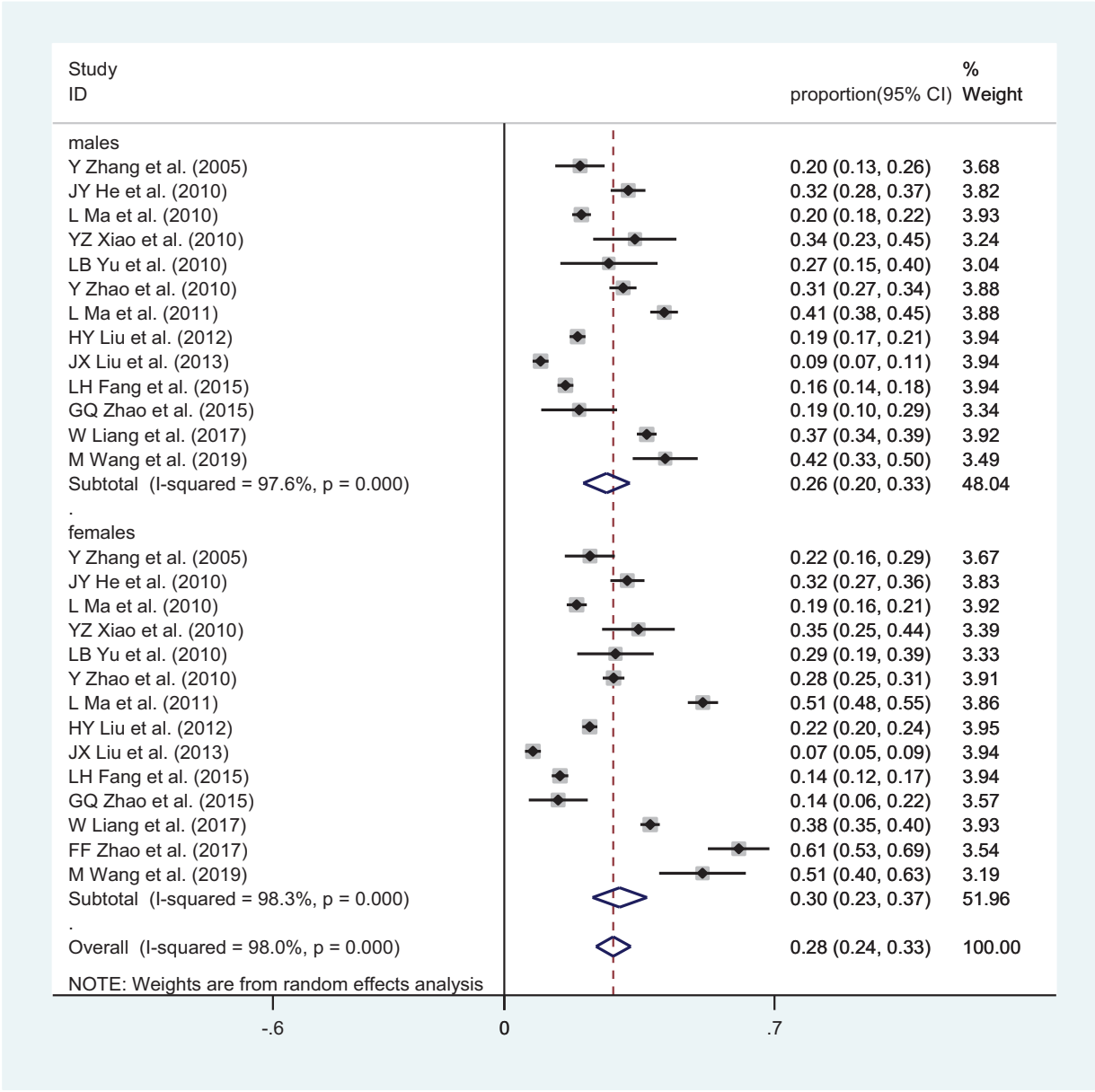

Figure 3. Forest plot of tratified prevalence of hypertension according to gender.

Hui diet, and they especially like to eat beef and mutton, which have high cholesterol and fat content. Our meta-analysis results also showed that BMI and weekly meat intake were risk factors for Hui nationality. Study have shown that the relative risk of HTN in people with BMI ≥ 24 was 2.93.[41] And eating meat more than 5 times a week can affect blood lipid levels, which can affect blood pressure levels.[25] Foreign studies also have shown that obesity is highly correlated with chronic diseases such as HTN and CVD, especially the excessive distribution of visceral fat, which can change the levels of hormones, inflammation and endothelial cells. These variations cause changes in the sympathetic nervous system, renal function, and microvascular levels, which contribute to HTN.[42,43] Therefore, it is necessary to advocate early weight control, and guide overweight and obese people to reduce weight. What's more, genome-based study showed that the Hui and Han ethnic groups showed significant genetic heterogeneity in the size, number and size range of alleles.[44] And Islamic laws forbid Hui people from marrying non-Muslim people, gradually forming a genetic "segregation group." Therefore, genetic heterogeneity between Han and ethnic minorities may also lead to variability in prevalence.

The present meta-analysis has demonstrated that prevalence of HTN differs between genders. Previous studies have shown that the incidence of HTN is higher in females than in males, which is different from the results of ordinary research.[45,46] On one hand, it may be because some of the women in the study went through menopause. Study has shown that estrogen has a protective effect on the cardiovascular system in women, and premenopausal women have a lower cardiovascular risk than men, but estrogen levels drop significantly after menopause, the

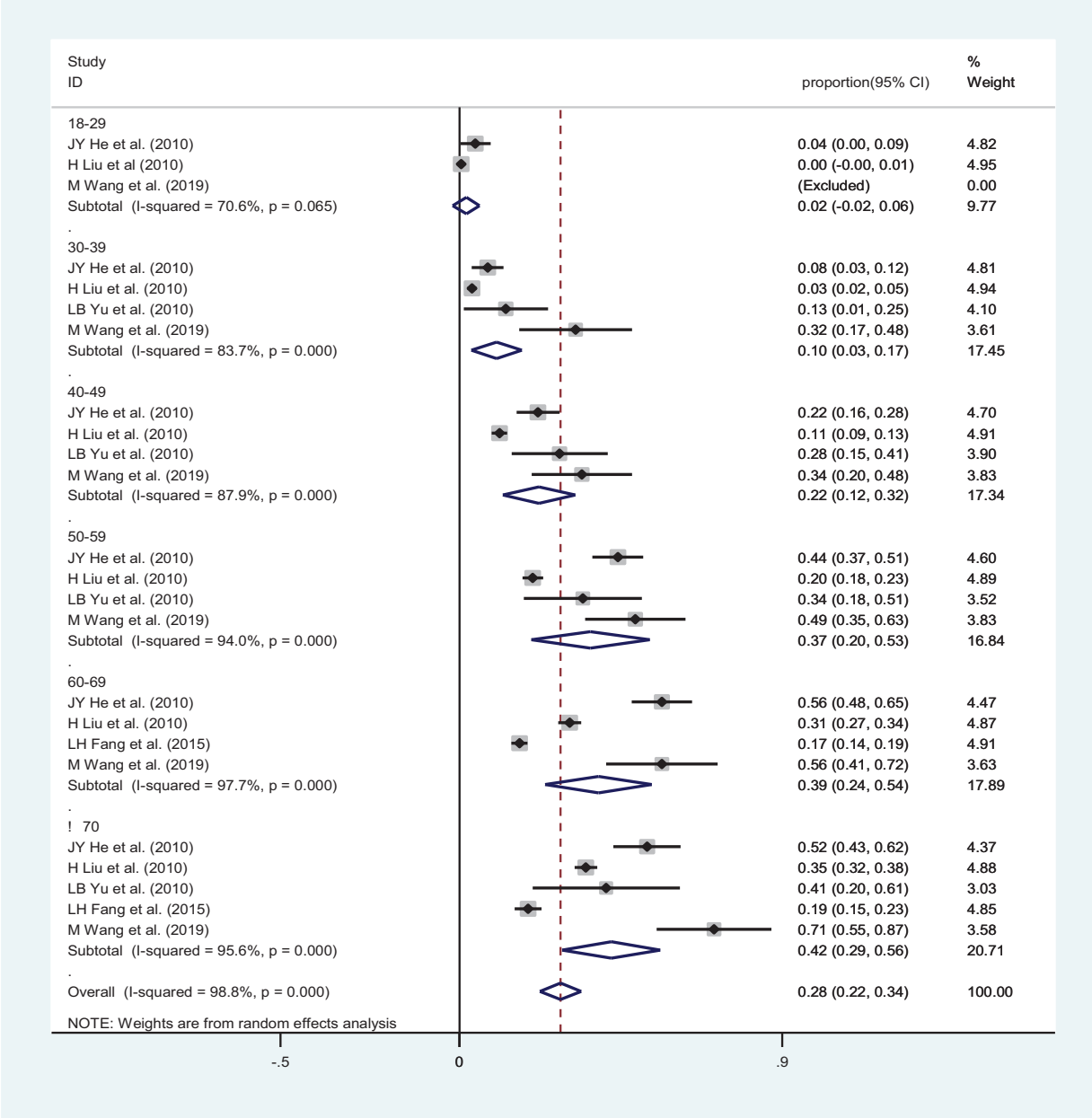

Figure 4. Forest plot of tratified prevalence of hypertension according to age.

incidence of HTN and CVDs, such as coronary heart disease and stroke, increase significantly in women.[47] On the other hand, most Hui women married early and often had many children in the traditional concept of Hui nationality. Their main duty was to take care of their husbands and children at home. And compared with the Han nationality, Hui women are under the bondage of dual culture. Life-style and pressure are associated with HTN.[48,49] While the results of this study also show that the prevalence of HTN in rural areas is higher than that in urban areas, which may be due to the relatively insufficient publicity and education of HTN prevention and control to cause poor medical care delivery and poor behavior in seeking medical care in rural areas.[31,37] But Some studies have pointed out that with the acceleration of urbanization in China, the difference between urban and rural HTN prevalence rates in developed areas will narrow.[50] Therefore, it is necessary to further study the regional differences in the prevalence of HTN among Hui people in the future.

The age-stratified analysis indicated that the prevalence of HTN in Hui nationality increased with age. The prevalence of HTN increased with age was found in the current meta-analysis as well as in other studies for general population in China.[9] China's 2018 HTN guidelines point out that age is one of the risk factors for HTN, and the prevalence of HTN in China is still on the rise.[51] Older patients with HTN have a higher risk of CVD and stroke than younger patients with HTN. What's more, HTN is the leading cause of death and disability in the elderly. This may be related to changes in cardiovascular function with age. It has

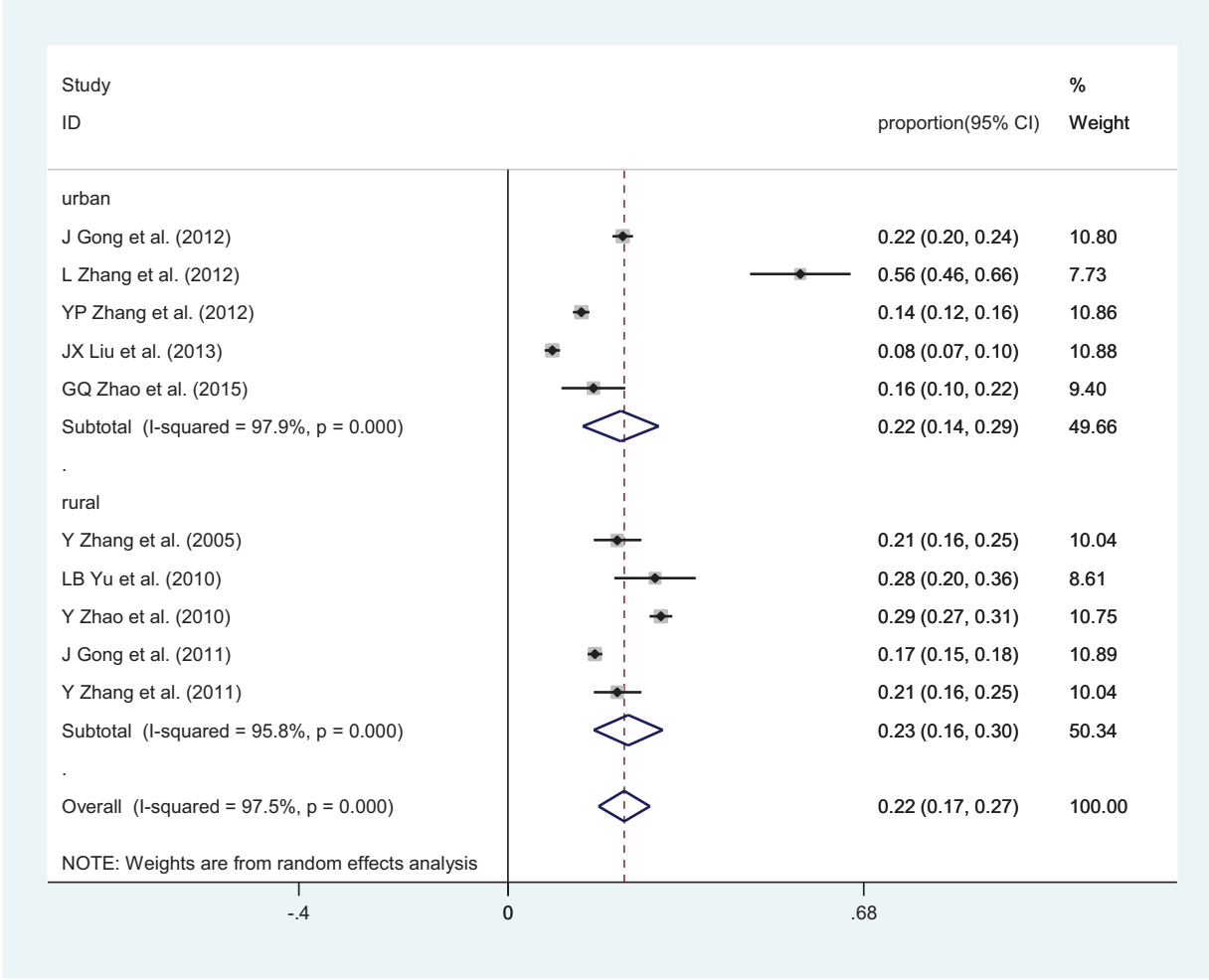

Figure 5. Forest plot of tratified prevalence of hypertension according to area.

been proved that, in the prime of life, the diastolic function of resistance vessels first decreases, which reduces the body's ability to regulate blood pressure, and eventually leads to the occurrence of HTN.[35]

Our findings also suggest that daily salt intake, physical exercise, smoking and drinking are fairly important factors of HTN among Hui people. Hui people put salt in rice and porridge, and they also like to eat pickles and fried food.[18] This leads to high salt intake in the hui population. Research shows that high salt diet is an important cause of HTN, taking salt intake ≥6 g/day was 4.604 times that of taking salt intake <6 g/day about the risk of HTN.[18] And this study also noted that physical exercise are

Table 3

Risk factors of hypertension among Hui people.

Risk factors	OR	95%CI	I^2 (%)	P
Family history	3.5	2.60–4.71	95.30	<.001
Smoking	1.84	1.61–2.09	59.60	<.001
Drinking	1.74	1.26–2.39	95.30	.001
Weekly meat intake (<5 times vs ≧5 times)	1.92	1.04–3.54	96.50	.036
Gender	1.02	0.84–1.25	92.80	.827
Areas (rural vs urban)	1.29	1.10–1.51	81.50	.001
Physical exercise	0.76	0.66–0.88	62.70	<.001
Employment situation	1.88	0.71–5.00	96.90	.203
BMI (≦24 vs ≧24)	2.2	1.81–2.66	91.30	<.001
Daily salt intake (<15 g vs ≧15 g)	3.94	3.03–5.13	90.20	<.001

BMI = body mass index, CI = confidence interval, OR = odd ratio.

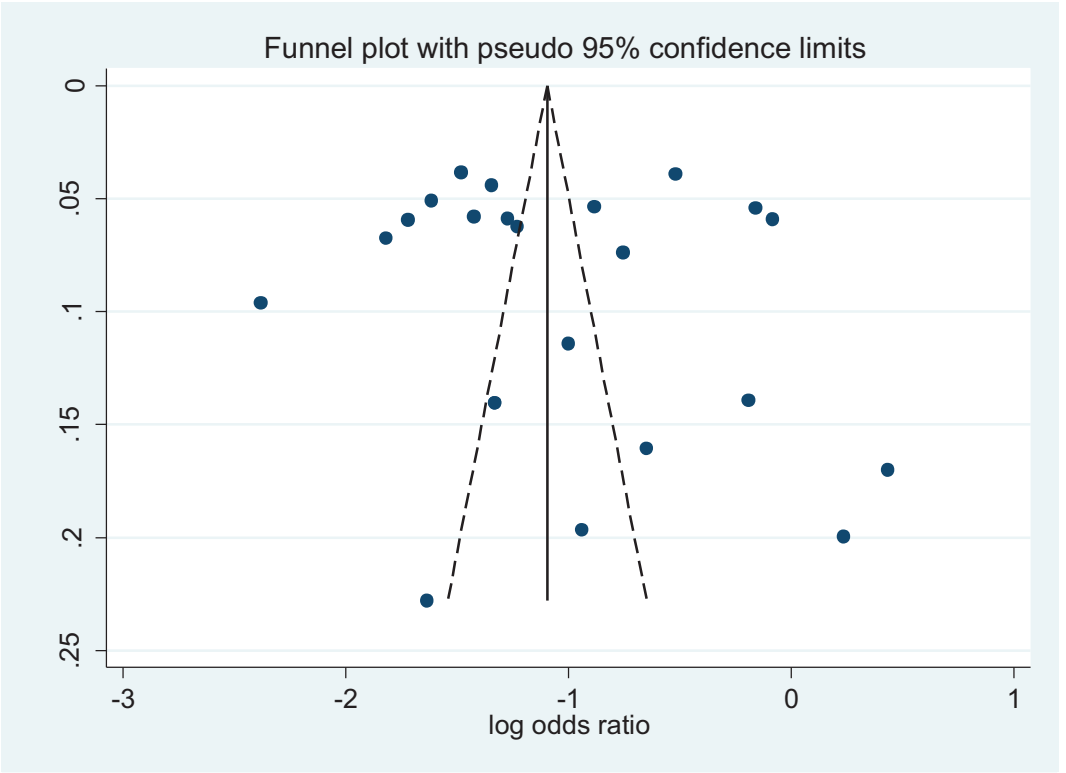

Figure 6. Results of publication bias funnel plot analysis.

protective factors for HTN. Long-term physical exercise can reduce blood pressure, prevention and treatment of CVD has been widely recognized.[25] In addition, there is an interesting result that drinking alcohol and smoking are risk factors of HTN among Hui population. As is well known, Hui Muslims believe in Islam. And Quran rules that Hui people are forbidden to drink alcohol and smoking. The reason is that the study population included in our study are located in non-Hui cluster areas. Therefore, whether drinking alcohol and smoking are risk factors for HTN in Hui population should be further discussed in future studies. To this end, while respecting religious beliefs, knowledge popularization is carried out to encourage them to develop healthy lifestyle and dietary habits, so as to truly achieve primary prevention. At the same time, necessary intervention and health education should be carried out for high-risk groups to reduce the risk of HTN.

5. Strengths and limitations

A principal strength of the current is the employment of robust methodology. The comprehensive literature search was conducted in 8 electronic databases. To the best of our knowledge, the present study is the first to provide an assessment of the prevalence of HTN and related risk factors among Hui people in China. However, the potential limitations of the present study should be noted. First, all the included literatures are cross-sectional studies, which may have some limitations due to the influence of research design. Secondly, the languages of the included studies were limited to English and Chinese, excluded studies in other languages, which limited the comprehensiveness of the included literature. Future studies will be needed to overcome this limitation and interrogate the risk factors of HTN in a more comprehensive manner.

6. Conclusion

In conclusion, this systematic review found that the pooled prevalence of HTN among Hui population was 28%. Daily salt intake, family history, smoking, drinking, weekly meat intake, BMI and areas were risk factors for HTN, while physical exercise was associated with a decreased risk of prevalence of HTN. These evidence-based data will facilitate further research in this area and contribute to better prevention and treatment HTN among Hui population. What's more, it is of great significance for the national government and medical institutions to formulate corresponding policies and measures as well as capital and personnel allocation. Therefore, it is suggested that the medical and health departments at all levels strengthen publicity, active prevention, early diagnosis and treatment, so as to reduce the related medical expenses and save the limited health resources.

Author contributions

Conceptualization: Fanghong Yan, Yuxia Ma.
Data curation: Xiangping Fan.
Formal analysis: Yuanyuan Zhang, Yutan Wang.
Methodology: Yuanyuan Zhang, Sijun Li, Huilan Lu.
Software: Sijun Li, Sujie Shi, Fanghong Yan.
Visualization: Yutan Wang.
Writing – original draft: Yuanyuan Zhang, Xiangping Fan.

Writing – review & editing: Yuxia Ma.
Appendix 1.docx, http://links.lww.com/MD2/A56

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