Received: 9 October 2019 | Revised: 27 November 2019 | Accepted: 10 December 2019

DOI: 10.1111/jch.13820

ORIGINAL PAPER

WILEY

The impact of changes in population blood pressure on hypertension prevalence and control in China

Wei-guo Fan MD[1] | **Feng Xie MD**[1] | **Yi-rong Wan MD**[2] | **Norm R. C. Campbell MD**[3] | **Hai Su MD, PhD**[1]

[1]Department of Cardiovascular Medicine, The Second Affiliated Hospital of Nanchang University, Nanchang, China

[2]Dutou Hospital of Nanchang County, Jiangxi, China

[3]Libin Cardiovascular Institute of Alberta, University of Calgary, Calgary, AB, Canada

Correspondence
Hai Su, Department of Cardiovascular Medicine, The Second Affiliated Hospital of Nanchang University, Nanchang of Jiangxi, 330006, China.
Email: suyihappy@sohu.com

Norman R.C. Campbell, GE -86, Libin Cardiovascular Institute of Alberta, University of Calgary 3280 Hospital Drive NW Calgary Alberta, T2N 4Z6.
Email: ncampbel@ucalgary.ca

Abstract

In China, there are approximately 250 million adults who have hypertension with low rates of awareness, treatment and control. Changes in lifestyles at a population level have the potential to enhance or deteriorate the prevention and control of hypertension. We used data from a regional hypertension survey to examine the impact of 2/1 mm Hg decreases or increases in population blood pressure on hypertension prevalence, and rates of unawareness of the hypertension diagnosis, treatment, and control. The primary analysis was based on the average blood pressure of respondents from three visits and a diagnostic threshold of 140/90 mm Hg for hypertension. Secondary analyses examined average blood pressure from the first survey visit and also a diagnostic threshold of 130/80 mm Hg for hypertension. The baseline hypertension prevalence was 33.4%, and rates of unawareness of the hypertension diagnosis, treatment, and control were 74.2%, 25.8%, and 9.7%, respectively. Decreases or increases in blood pressure by 10/5 mm Hg resulted in changes in hypertension prevalence (22.1% vs 53.4%) and rates of unawareness of the diagnosis (60.9% vs 83.8%), treatment (39.1% vs 16.2%), and control (21.2% vs 3.6%), respectively. Similar trends were seen in the secondary analyses. Population changes in lifestyle could have a very large impact on the prevalence and control of hypertension in China. The results support implementation of programs to improve population lifestyles while implementing health services policies to enhance the clinical management of hypertension.

1 | INTRODUCTION

In China, there are approximately 250 million people with hypertension[1-3] and the Global Burden of Disease study attributes increased blood pressure to 24% of deaths and 14% of disability-adjusted life years (DALYs).[4] In fact, increased systolic blood pressure is the leading single modifiable risk for death in China.[4] Reducing blood pressure by population health interventions (eg, dietary salt reduction) or by enhancing hypertension control clinically on a population scale have been advocated.[1,5]

Population reductions in blood pressure can be a cost saving means to prevent and control hypertension. Interventions such as reducing dietary salt have been estimated to have a return on investment of up to $18 for every $1 invested and are considered by the World Health Organization to be a best buy.[6] China has initiated efforts to reduce dietary salt and to improve hypertension control clinically.[2,7] Other interventions, such as attaining and maintaining a healthy body weight, regular physical activity, a healthy diet, and low-risk alcohol consumption, are also effective in reducing blood pressure (Table1).[5,8-12]

In this study, we examine the potential impact of population interventions to reduce blood pressure on changes in prevalence and control of hypertension using data from a population-based survey from China. We have examined both increases and decreases in blood pressure within the range expected from various degrees of changes in lifestyles from randomized controlled trials (Table 1). We also examined the impact on the prevalence and hypertension control indicators using both a 140/90 mm Hg threshold and a 130/80 mm Hg threshold.

2 | METHOD AND SUBJECTS

This study was approved by the Ethics Committee of the Second Affiliated Hospital. The hypertension survey was conducted in the residents living in three villages of the countryside of Nanchang, Jiangxi, China from March 2017 to May of 2018. The initial survey results have been previously reported.[13] There were 2130 adult residents living in the three villages that were surveyed. All of the adults were asked to participate, with 1540 adult residents (72.3%) agreeing and having three BP measurements over 1 week. Therefore, 72.3% of adults in the surveyed villages were included in this study. In the survey, age, diagnosis of hypertension, and use of antihypertensive treatment were collected. The exclusion criteria were acute coronary syndrome, acute stroke, acute heart failure, and atrial fibrillation. Patients with known peripheral artery disease and walking disabilities were also excluded.

In the study, all participants had three visits where BP was measured within a week. Blood pressure (BP) was measured in the primary health center by doctors. The subjects were advised to avoid cigarette smoking and consumption of coffee, tea, and alcohol for at least 30 minutes before the BP measurement. In each visit, the BP of the right arm was measured using an oscillometric BP monitor (Omron HEM-7430) after a 5-minute rest period. Measurements were taken three times at 1-minute intervals, and the averages were recorded as the visit BP value.

Hypertension was defined as ≥140/90 mm Hg based on the definition used by many hypertension guidelines.[14-16] Hypertension was also defined as ≥130/80 mm Hg as recommended in the 2017 American College of Cardiology (ACC)/American Heart Association (AHA) High Blood Pressure Guideline[17]

Respondents were defined as having hypertension if their blood pressure met or exceeded the blood pressure threshold (140/90 or 130/ 80 mm Hg in different analyses) or they reported taking antihypertensive drugs within the last 2 weeks. Respondents were defined as having undiagnosed hypertension if they had blood pressure readings meeting the definition of hypertension but no history of a hypertension diagnosis and reported they were not taking antihypertensive drugs. Respondents were assessed as being treated for hypertension if they reported taking antihypertensive drugs within the last 2 weeks. Respondents were classified as having controlled hypertension if they reported taking antihypertensive medications within 2 weeks or had been diagnosed with hypertension and they had both systolic and diastolic blood pressure less than the respective threshold for defining hypertension.[18]

For the epidemiological definition, hypertension was based on the average of the first day BP values while the clinical definition of hypertension was based on the average of three visit BP readings.[15] The hypertension prevalence based on the epidemiological or the clinical criteria was calculated and expressed as a percent of the total surveyed population.

The percent of the survey respondents with hypertension were assessed at the threshold for hypertension of 140/90 and 130/ 80 mm Hg. The blood pressure of respondents was increased and decreased by 2/1 mm Hg to a change of 10/5 mm Hg, and the percent with hypertension as well as the rates of not being aware of having hypertension, treatment, and control were assessed. All data were recorded on an Excel 2003 spreadsheet. Statistical analysis was performed using the Statistical Package for Social Science software 23.0 (SPSS). Data are expressed as means and standard deviations. Dichotomous variables expressed as numbers and percentages, the rates of the trends over the changes in BP, were analyzed with the chi-square test; furthermore, Bonferroni method was used for pairwise comparison of the difference between the given changes BP and the BP threshold. A *P* value of <.05 was considered statistically.

3 | RESULTS

One thousand, five hundred forty adult residents (21-94 years, 62.8 ± 13.7 years) including 779 males and 761 females were included. There were 312 smokers, 8.6% were taking antihypertensive medications, and the mean blood pressure was 131.8/74.4 mm Hg. The characteristics of the respondents are in Table 2.

TABLE 1 Approximate changes in blood pressure with some lifestyle change

Lifestyle change	Expected change in blood pressure in persons with hypertension
Weight loss per 5 kg	6.3/3.4 mm Hg[8]
Sodium reduction per 4.4 g salt reduction	5.4/2.8 mm Hg[9]
Increase in physical activity	12.3/6.12 mm Hg[10]
Reduction in alcohol consumption from 2 or more drinks per day	5.5/4.0 mm Hg[11]
DASH type diet	5.2/2.6 mm Hg[5,12]

3.1 | 140/90 mm Hg hypertension threshold

Overall, the prevalence of hypertension using the clinical definition was 33.4% while the rates of not being aware of having hypertension were 74.2%, antihypertensive drug treatment was 25.8%, and control was 9.7% (Table 3).

The impact of interventions that would increase population blood pressure at 2/1 mm Hg intervals to 10/5 mm Hg are shown in Table 2. An increase in population blood pressure of 10/5 mm Hg would increase the prevalence of hypertension from 33.4% to 53.4% while reducing the hypertension control rate almost 2/3rds from 9.7% to 3.6%. The percent of those with hypertension treatment with a 10/5 mm Hg increase would be reduced from 25.8% to 16.2%.

Decreases in population blood pressure would have the opposite effect on hypertension indicators (Table 3). The reduction in population blood pressure by 10/5 mm Hg would reduce the prevalence of hypertension by 1/3rd to 22.1% while the hypertension control rate would increase to 21.2% and the treatment rate to 39.1%.

The impact on hypertension prevalence and control indicators using an epidemiological definition of hypertension rather than a clinical definition is similar but the hypertension prevalence and rate of being unaware of the diagnosis is higher and hypertension treatment and control rates lower with the epidemiological definition (Table 3).

3.2 | 130/80 mm Hg hypertension threshold

Overall, the prevalence of hypertension using the clinical definition was 56.2% while the rate of not being aware of having hypertension was 84.6%, antihypertensive drug treatment 15.4%, and control 3.2% (Table 4).

The impact of interventions that would increase population blood pressure at 2/1 mm Hg intervals to 10/5 mm Hg are shown in Table 4. An increase in population blood pressure of 10/5 mm Hg would increase the prevalence of hypertension from 56.2% to 76.8% while reducing the hypertension control rate about 3/4ths from 3.2% to 0.8%. The percent of those with hypertension treated with a 10/5 mm Hg increase would be reduced from 15.4% to 11.2%.

Decreases in population blood pressure would have the opposite effect on hypertension indicators (Table 4). The reduction in population blood pressure by 10/5 mm Hg would reduce the prevalence of hypertension by 1/3rd to 36.4% while the hypertension control rate would more than double to 7.8% and the treatment rate increase almost 2/3rd to 23.7%.

The impact on hypertension prevalence and control indicators using an epidemiological definition of hypertension rather than a clinical definition is similar but the hypertension prevalence and rate of being unaware of the diagnosis is higher and hypertension treatment and control rates lower with the epidemiological definition (Table 4).

TABLE 2 Characteristics of the survey respondents

Respondent characteristics	Number ± SD (%)
Total	1540 (100)
Men	779 (50.6)
Women	761 (49.4)
Age (average)	62.8 ± 13.7 y
Body mass index (BMI)	22.7 ± 3.4 kg/m^2
Smoker (%)	312 (20.3)
Antihypertensive drug treatment	133 (8.6%)
Mean SBP (mm Hg)	131.8 ± 74.4
Mean DBP (mm Hg)	74.4 ± 9.9

4 | DISCUSSION

Changes in population blood pressure, in the range expected from substantive alterations in lifestyles that impact blood pressure, could have a major impact on the prevalence, awareness, treatment, and control rate of hypertension in China. The prevalence of hypertension, defined by a threshold of 140/90 mm Hg, varied from its current 33.4%-53.4% with a population increase in blood pressure of 10/5 mm Hg and was reduced to 22.1% with a population reduction in blood pressure of 10/5 mm Hg. Similarly, the hypertension control rate was reduced from 9.7% to 3.6% by a population blood pressure increase of 10/5 mm Hg and improved to 21.2% by a reduction in population blood pressure of 10/5 mm Hg. Consistent changes were seen when an epidemiological vs a clinical definition of hypertension was considered or if the hypertension threshold was 130/80 mm Hg.

Previously, Cook et al previously modeled the impact of a 2 mm Hg reduction in population blood pressure on hypertension and cardiovascular disease rates in United States. The impact on cardiovascular disease rate of the 2 mm Hg population reduction in diastolic blood pressure was greater than that expected from antihypertensive treatment of all people with a diastolic blood pressure of ≥95 mm Hg, and diastolic hypertension prevalence (diastolic blood pressure ≥ 90 mm Hg) was reduced by 17%.[19] Joffres et al[20] found that a population reduction in blood pressure of 5.06/2.7 mm Hg related to salt reduction in Canada would reduce the prevalence of hypertension by about 30% and almost double the hypertension control rate. In our analysis, a 4/2 mm Hg reduction in population blood pressure (using a similar epidemiological definition as Cook) was 16.6%. Differences in the "true" population distribution of blood pressure (hypertension prevalence 39.7% in our study vs 19.4% in Joffres) and different methodologies for assessing blood pressure are likely to explain the differences in our results vs those of Joffres et al Increases in blood pressure of 20/10 mm Hg have a linear doubling impact on cardiovascular disease; hence, changes in population blood pressure in the magnitude examined in this study would be expected to have a major impact on cardiovascular disease rates in China.[19-21] To our knowledge, ours is the only study to report

TABLE 3 The impact of increases and decreases in population blood pressure BP (at intervals of 2/1 mm Hg) on hypertension prevalence, and rates of "unawareness" of hypertension diagnosis, antihypertensive drug treatment, and control using a hypertension threshold of 140/90 mm Hg or greater from a population blood pressure survey (n = 1540)

	Epidemiological[a]				Clinical[a]			
BP change (mm Hg)	Prevalence n (%)	Unawareness[b] n (%)	Treated n (%)	Control n (%)	Prevalence n (%)	Unawareness[b] n (%)	Treated n (%)	Control n (%)
−10/5	390[c] (25.3)	257[c] (65.9)	133[c] (34.1)	67[c] (17.2)	340[c] (22.1)	207[c] (60.9)	133[c] (39.1)	72[c] (21.2)
−8/4	431[c] (28.0)	298 (69.1)	133 (30.9)	65[c] (15.1)	368[c] (23.9)	235 (63.9)	133 (36.1)	68[c] (18.5)
−6/3	461[c] (29.9)	328 (71.1)	133 (28.9)	54[c] (11.7)	399[c] (25.9)	266 (66.7)	133 (33.3)	63 (15.8)
−4/2	509[c] (33.1)	376 (73.9)	133 (26.1)	51 (10.0)	433 (28.1)	300 (69.3)	133 (30.7)	57 (13.2)
−2/1	555 (36.0)	422 (76.0)	133 (24.0)	50 (9.0)	466 (30.0)	333 (71.5)	133 (28.5)	54 (11.6)
0	611/1540 (39.7)	478/611 (78.2)	133/611 (21.8)	43/611 (7.0)	515/1540 (33.4)	382/515 (74.2)	133/515 (25.8)	50/515 (9.7)
2/1	679 (44.1)	546 (80.4)	133 (19.6)	36 (5.3)	574 (37.3)	441 (76.8)	133 (23.2)	43 (7.5)
4/2	743[c] (48.2)	610 (82.1)	133 (17.9)	35 (4.7)	637[c] (41.4)	504 (79.1)	133 (20.9)	43 (6.8)
6/3	817[c] (53.1)	684 (83.7)	133 (16.3)	32 (3.9)	688[c] (44.7)	555 (80.7)	133 (19.3)	41 (6.0)
8/4	865[c] (56.2)	732 (84.6)	133 (15.4)	31 (3.6)	770[c] (50.0)	637[c] (82.7)	133[c] (17.3)	34[c] (4.4)
10/5	917[c] (59.5)	784[c] (85.5)	133[c] (14.5)	26[c] (2.8)	823[c] (53.4)	690[c] (83.8)	133[c] (16.2)	30[c] (3.6)
P-value[d]	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001

[a]The epidemiological data are based on the average of three readings at a single visit. The clinical data are based on the average of three visits.
[b]Unawareness is defined as having high blood pressure but not having been diagnosed before the survey and not taking antihypertensive medication.
[c]$P < .05$, compared with the 140/90 mm Hg
[d]*P* value for trend in column.

the impact of increases in population BP on major hypertension indicators and to examine a multitude of blood pressure changes that are within the realm to those expected by major public health interventions.

Both increases and decreases in population blood pressure can occur with population changes in the major determinants of blood pressure (eg, diet, physical activity, obesity). Randomized controlled trials have confirmed lifestyle changes can significantly impact blood pressure (Table 1). In addition, several countries that have introduced substantive public health policy changes have subsequently observed significant changes in population blood pressure. For example, in Finland there were reductions in population diastolic blood pressure of over 8 mm Hg during the implementation of programs to reduce dietary salt, improve nutrition and physical activity, and enhance the clinical management of cardiovascular risks.[22] A salt reduction program in the United Kingdom also had a significant impact on salt consumption, blood pressure, and cardiovascular disease.[23] Major social change can also impact population blood pressure. Social upheaval in former Soviet Union countries following the breakup of the Soviet Union were marked by increases in blood pressure and cardiovascular disease with some countries subsequently improving and others continuing to have some of the world's highest rates of cardiovascular risks and disease.[24]

Our study has several limitations. The analyses assume instantaneous changes in population blood pressure with no changes in clinical management of hypertension. In addition, the analyses using a 130/80 mm Hg threshold may also have limited face validity for clinicians in China given the national guidance is to use 140/90 mm Hg as the diagnostic threshold. Hence, the findings need to be viewed from a theoretical perspective rather than the likely results that could occur with the implementation of major public policies that would occur over years and be likely to impact clinical practice. The survey was also conducted in a single region of China and is not directly generalizable to all of China. The prevalence of hypertension in provinces of China ranges from 18% to 37%, while the prevalence of hypertension was 39.7% in our study.[1] Hypertension indicators (rates of awareness, treatment

TABLE 4 The impact of increases and decreases in population blood pressure BP (at intervals of 2/1 mm Hg) on hypertension prevalence, and rates of "unawareness" of hypertension diagnosis, antihypertensive drug treatment, and control using a hypertension threshold of 130/80 mm Hg or greater from a population blood pressure survey (n = 1540)

	Epidemiological[a]				Clinical[a]			
BP change (mm Hg)	Prevalence (%)	Unawareness[b] (%)	Treated (%)	Control (%)	Prevalence (%)	Unawareness[b] (%)	Treated (%)	Control (%)
−10/5	670[c] (43.5)	537[c] (80.1)	133[c] (19.9)	41[c] (6.1)	561[c] (36.4)	428[c] (76.3)	133[c] (23.7)	44[c] (7.8)
−8/4	736[c] (47.8)	603 (81.9)	133 (18.1)	34 (4.6)	632[c] (41.0)	499 (79.0)	133 (21.0)	40 (6.3)
−6/3	801[c] (52.0)	668 (83.4)	133 (16.6)	33 (4.1)	686[c] (44.5)	553 (80.6)	133 (19.4)	40 (5.8)
−4/2	867[c] (56.3)	734 (84.7)	133 (15.3)	32 (3.7)	743[c] (48.2)	610 (82.1)	133 (17.9)	38 (5.1)
−2/1	913 (59.3)	780 (85.4)	133 (14.6)	30 (3.3)	820 (53.2)	687 (83.8)	133 (16.2)	30 (3.7)
0	979 (63.6)	846 (86.4)	133/979 (13.6)	25/979 (2.6)	866 (56.2)	733 (84.6)	133/866 (15.4)	28/866 (3.2)
2/1	1037 (67.3)	904 (87.2)	133 (12.8)	22 (2.1)	954 (61.9)	821 (86.1)	133 (13.9)	22 (2.3)
4/2	1079 (70.1)	946 (87.7)	133 (12.3)	18 (1.7)	10 163 (66.0)	883 (86.9)	133 (13.1)	17 (1.7)
6/3	11 213 (72.8)	988 (88.1)	133 (11.9)	9 (0.8)	10 733 (69.7)	940 (87.6)	133 (12.4)	13 (1.2)
8/4	11 803 (76.6)	1047 (88.7)	133 (11.3)	7[c] (0.6)	11 293 (73.3)	996 (88.2)	133 (11.8)	11[c] (1.0)
10/5	12 263 (79.6)	1093 (89.2)	133 (10.8)	6[c] (0.5)	11 833 (76.8)	1050 (88.8)	133 (11.2)	9[c] (0.8)
P-value[d]	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001

[a]The epidemiological data are based on the average of three readings at a single visit. The clinical data are based on the average reading from three visits over 1 wk.

[b]Unawareness is defined as having high blood pressure but not having been diagnosed before the survey and not taking antihypertensive medication.

[c]$P < .05$, compared with the 140/90 mm Hg

[d]*P* value for trend in column.

and control) also have regional variations within China.[1] The ability to generalize the findings may also be limited when applying the analysis to other countries. Nevertheless, many countries will have similar blood pressure distributions, and most low-/middle-income countries have similar rates of hypertension prevalence, awareness, treatment, and control and will have relatively similar impacts of shifts in population distribution of blood pressure.[25-27] The study findings are also impacted by the number of visits used to assess blood pressure. Hence, in this analysis we examined the impact of using average blood pressures from a single visit or three visits to define hypertension. Nearly all population surveys assess blood pressure at a single visit which inflates the prevalence of hypertension compared to the average blood pressure of three visits (Table 3). The data using the epidemiological definition therefore will be more representative of results from blood pressure surveys that assess single visit blood pressure following an intervention that changes population blood pressure. The average of three visits used for the clinical definition in this study will be more representative of the usual basil blood pressure of the population, and therefore, the true impact of interventions that change population blood pressure. We also used both an older and more conventional threshold for defining hypertension (140/90 mm Hg) and the newer threshold (130/80 mm Hg) for hypertension to allow interpretation of the data with both thresholds.

Large changes in the prevalence of hypertension and its clinical indicators can be seen with changes in lifestyles that could be attained with public health policies. Many of the policies are outlined by the World Health Organization and are either highly cost-effective or cost saving.[6] Policies to reduce dietary salt have a return on investment of 13-19$ for every dollar invested and are particularly relevant in China where the salt intake is very high.[28-30] Policies to reduce population blood pressure do not compete with health services policies to clinically improve blood pressure treatment and control but as our study indicates reducing population blood pressure will significantly enhance the awareness, treatment, and control rates reducing the clinical burden of disease.[31,32] Although our data are from China, the concepts are broadly applicable to other countries and especially those with a high prevalence rate and low rates of treatment and control. Our analysis of the impact of increases in blood pressure should concern policy makers in countries where there is a lack of political will to prevent deterioration in population diet, activity, obesity, and alcohol consumption and support policy change where there is political will to introduce healthy public policies.

CONFLICT OF INTEREST

NRCC was a paid consultant to the Novartis Foundation (2016-2017) to support their program to improve hypertension control in low- to middle-income countries which includes travel support for site visits and a contract to develop a survey. NRCC has provided paid consultative advice on accurate blood pressure assessment to Midway Corporation (2017) and is an unpaid member of World Action on Salt and Health (WASH). The other authors have no conflicts of interest to declare.

AUTHOR CONTRIBUTIONS

Wei-guo Fan, Feng Xie, and Yi-rong Wan: Conducted the survey and data analysis, reviewed and approved the final manuscript. Norm RC Campbell: Developed the concept, drafted and revised the manuscript and approved the final version. Hai Su: Oversaw the survey and data analysis, assisted in the analysis design and writing of the manuscript and approved the final version.

ORCID

Feng Xie https://orcid.org/0000-0002-9853-7396
Norm R. C. Campbell https://orcid.org/0000-0002-1093-4742

REFERENCES

1. Li Y, Wang L, Feng X, et al. Geographical variations in hypertension prevalence, awareness, treatment and control in China: findings from a nationwide and provincially representative survey. *J Hypertens*. 2018;36(1):178-187.
2. Hu S, Gao R, Liu L, et al. Summary of the 2018 report on cardiovascular diseases in China. *Chin Circulation J*. 2019;34:209.
3. Li Y, Yang L, Wang L, et al. Burden of hypertension in China: a nationally representative survey of 174,621 adults. *Int J Cardiol*. 2017;227:516-523.
4. Global Burden of Disease Website. Institute for health metrics and evaluation. http://vizhub.healthdata.org/gbd-compare/. Accessed July 13, 2019.
5. Institute of Medicine of the National Academies. *A Population-Based Policy and Systems Change Approach to Prevent and Control Hypertension-Brief Report*. Washington, D.C.: National Academy Press; 2010.
6. World Economic Forum and the Harvard School of Public Health, World Health Organization. *From Burden to "Best Buys": Reducing the Economic Impact of Non-Communicable Diseases in Low- and Middle-Income Countries*. Geneva, Switzerland: World Economic Forum; 2011.
7. Xi B, Hao Y, Liu F. Salt reduction strategies in China. *Lancet*. 2014;383(9923):1128.
8. Horvath K, Jeitler K, Siering U, et al. Long-term effects of weight-reducing interventions in hypertensive patients: systematic review and meta-analysis. *Arch Intern Med*. 2008;168(6):571-580.
9. He FJ, Li J, MacGregor GA. Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomised trials. *BMJ*. 2013;346:f1325.
10. Cao L, Li X, Yan P, et al. The effectiveness of aerobic exercise for hypertensive population: a systematic review and meta-analysis. *J Clin Hypertens*. 2019;21(7):868-876.
11. Roerecke M, Kaczorowski J, Tobe SW, Gmel G, Hasan OSM, Rehm J. The effect of a reduction in alcohol consumption on blood pressure: a systematic review and meta-analysis. *Lancet Public Health*. 2017;2(2):e108-e120.
12. Chiavaroli L, Viguiliouk E, Nishi SK, et al. DASH dietary pattern and cardiometabolic outcomes: an umbrella review of systematic reviews and meta-analyses. *Nutrients*. 2019;11(2):338.
13. Lai M, Tong H, Wan Y, Wang W, Su H. The variance of hypertension prevalence detected by epidemiological survey against clinical practice: data from a rural population in South China. *J Am Soc Hypertens*. 2018;12(12):e103-e106.
14. Chobanian AV, Bakris GL, Black HR, et al. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. The JNC 7 report. *JAMA*. 2003;289(19):2560-2572.
15. WgoCGfrmoh LLS. 2018 Chinese guidelines for the management of hypertension. *Chin J Cardiovasc Med*. 2019;24:1-46.
16. Williams B, Mancia G, Spiering W, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. *Eur Heart J*. 2018;39(33):3021-3104.
17. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American college of cardiology/American heart association task force on clinical practice guidelines. *Hypertension*. 2017;71:e13-e115.
18. Campbell NRC, Ordunez P, DiPette DJ, et al. Monitoring and evaluation framework for hypertension programs. A collaboration between the Pan American Health Organization and World Hypertension League. *J Clin Hypertens*. 2018;20(6):984-990.
19. Cook NR, Cohen J, Hebert P, Taylor JO, Hennekens CH. Implications of small reductions in diastolic blood pressure for primary prevention. *Arch Intern Med*. 1995;155(7):701-709.
20. Joffres M, Campbell NR, Manns B, Tu K. Estimate of the benefits of a population-based reduction in dietary sodium additives on hypertension and its related health care costs in Canada. *Can J Cardiol*. 2007;23(6):437-443.
21. Giles TD. Assessment of global risk: a foundation for a new, better definition of hypertension. *J Clin Hypertens*. 2006;8(s8):5-14.
22. Karppanen H, Mervaala E. Sodium intake and hypertension. *Prog Cardiovasc Dis*. 2006;49(2):59-75.
23. He FJ, Pombo-Rodrigues S, MacGregor GA. Salt reduction in England from 2003 to 2011: its relationship to blood pressure, stroke and ischaemic heart disease mortality. *BMJ Open*. 2014;4(4):e004549.
24. Murphy A, Johnson CO, Roth GA, et al. Ischaemic heart disease in the former Soviet Union 1990–2015 according to the Global Burden of Disease 2015 Study. *Heart*. 2018;104(1):58-66.
25. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19.1 million participants. *Lancet*. 2017;389(10064):37-55.
26. Forouzanfar MH, Liu P, Roth GA, et al. Global burden of hypertension and systolic blood pressure of at least 110 to 115 mm Hg, 1990–2015. *JAMA*. 2017;317(2):165-182.
27. Mills KT, Bundy JD, Kelly TN, et al. Global disparities of hypertension prevalence and control: a systematic analysis of population-based studies from 90 countries. *Circulation*. 2016;134(6):441-450.
28. Nugent R. *Benefits and Costs of the Non-Communicable Disease Targets for the Post-2015 Development Agenda*. Copenhagen, Denmark: Consensus Center; 2015;I-II:1-25.
29. World Health Organization. *Saving Lives, Spending Less: A Strategic Response to Noncommunicable Diseases*. Geneva, Switzerland:

World Health Organization; 2018 (WHO/NMH/NVI/18.8). Licence: CC BY-NC-SA 3.0 IGO.
30. Powles J, Fahimi S, Micha R, et al. Global, regional and national sodium intakes in 1990 and 2010: a systematic analysis of 24 h urinary sodium excretion and dietary surveys worldwide. *BMJ Open*. 2013;3(12):e003733.
31. World Health Organization. *A Global Brief on Hypertension: Silent Killer, Global Public Health Crisis. World Health Day 2013*. Geneva, Switzerland: World Health Organization; 2013.
32. Campbell NR, Lackland DT, Niebylski ML; World Hypertension L, International Society of Hypertension Executive C. High blood pressure: why prevention and control are urgent and important-A 2014 fact sheet from the world hypertension league and the international society of hypertension. *J Clin Hypertens*. 2014;16(8):551-553.

How to cite this article: Fan W-G, Xie F, Wan Y-R, Campbell NRC, Su H. The impact of changes in population blood pressure on hypertension prevalence and control in China. *J Clin Hypertens*. 2020;22:150–156. https://doi.org/10.1111/jch.13820