Letter to the Editor

Analysis of Cardiovascular Risk Factors in Newly Defined Stage 1 Hypertension among Chinese on the Basis of the 2017 ACC/AHA Hypertension Guidelines*

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In 2017, American College of Cardiology (ACC)/American Heart Association (AHA) et al. jointly released the latest guidelines for adult hypertension, exactly including prevention, diagnosis, assess and treatment, in which blood pressure levels greater than 130/80 mmHg were defined as hypertension[1]. Based on these modified guidelines, the morbidity of hypertension in US increased from 32% to 46%. In addition, the latest guidelines cancelled the previous definition of prehypertension (120−129/80−89 mmHg) and redefined that blood pressure levels 120−129/< 80 mmHg as elevated blood pressure, 130−139/80−89 mmHg as stage 1 hypertension, and > 140/90 mmHg as stage 2 hypertension. The 2017 ACC/AHA Hypertension Guidelines emphasized the importance of early intervention to prevent the development of cardiovascular and cerebrovascular diseases. However, the new definition of adult hypertension posed a new challenge for the prevention and treatment of hypertension, which include patient's mentality, government public policy-making, health economy, and health education. Moreover, there is a need to prove that it is proper to popularize this new definition of hypertension in other countries. Unlike the 2017 ACC/AHA guidelines, the 2018 ESC-ESH guidelines for the management of arterial hypertension still adhere to the use of more than 140/90 mmHg as the standard for hypertension[2]. The revision of the Chinese guidelines for the prevention and treatment of hypertension in 2018 also does not adopt the new American hypertension standards.

In China, about 32.5% of Chinese adults are hypertensive, which is similar to the prevalence in the United States[3]. Based on the 2017 ACC/AHA guidelines, the morbidity of hypertension in the Chinese population has significantly increased. However, no study assessing whether the new American hypertension standards fit the Chinese setting has been conducted to date. Thus, we conducted an epidemiological investigation on middle-aged and elderly residents of community in 2012 and compared the differences in cardiovascular risk factors between stage 1 hypertension and elevated blood pressure on the basis of the 2017 ACC/AHA guidelines to discuss the feasibility of the new hypertension standards for Chinese adults.

This study randomly recruited 10,028 subjects (40 years of age and older) from Shandong Province from January to April 2012, which was one part of the baseline survey of the reaction study[4,5]. The following exclusion criteria were implemented: (1) previously diagnosed hypertension; (2) systolic pressure ≤ 90 mmHg or diastolic pressure ≤ 60 mmHg; (3) previously diagnosed kidney disease, including autoimmune or drug-induced kidney disease, nephritis, renal fibrosis or renal failure; (4) previously diagnosed hepatic disease, including fatty liver, liver cirrhosis and autoimmune hepatitis; and (5) any malignant disease. Ultimately, 6,863 subjects (4,581 women) were eligible for analysis. The institutional review board at Department of Endocrinology and Metabolic Disease, Ruijin Hospital, Shanghai Jiaotong University School of Medicine approved the study protocol. All the subjects provided their informed consent. Trained interviewers conducted in-person surveys when the participants attended a health examination at community health care settings. After at least 10 h of overnight fasting, venous blood samples were

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collected for measurements of fasting blood glucose (FBG), triglyceride (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and creatinine. Two-hour plasma glucose (2-h PG) levels were measured after subjects had completed a 75-g oral glucose tolerance test (OGTT). Hemoglobin A1c (HbA1c) was measured *via* high-performance liquid chromatography (VARIANT II and D-10 Systems, BIO-RAD, USA). Metabolic abnormalities were defined according to the standard of care for type 2 diabetes in China. Chronic kidney disease (CKD) was defined as eGFR < 60 mL/(min·1.73 m^2), which was calculated from the creatinine levels using the CKD-EPI formula.

All of the data were analyzed using SPSS 16.0 (SPSS Inc., Chicago, IL, USA). Continuous variables displaying a normal distribution were expressed as the means ± SD, and variables displaying a non-normal distribution were presented as medians (interquartile range). Categorical variables were presented as percentages (%). Differences among groups were detected *via* one-way ANOVA (LSD) (continuous variables displaying a normal distribution), the Kruskal-Wallis *H* test (skewed continuous variables), or the chi-square test (categorical variables). The association between BP and metabolic abnormalities were analyzed using multiple logistic regression. Differences displaying $P < 0.05$ were considered statistically significant.

As shown in Table 1, the respective percentages of stage 1 hypertension and stage 2 hypertension were 28.0% and 52.9% in males, and 27.7% and 43.0% in females. Only 8.2% of the males and 15.3% of the females showed normal BP. Table 2 showed that the stage 1 hypertension group had a higher proportion of abdominal obesity, hyperglycemia, high TG, high TC, and high LDL-C compared to the elevated BP group. Furthermore, the stage 2 hypertension group showed the most remarkable metabolic abnormality. There was no significant difference between the normal and elevated groups in metabolic abnormality after adjusting for age and gender. However, the stage 1 hypertension group showed an increase in *OR*s for abdominal obesity (*OR* = 1.274, *P* = 0.004), hyperglycemia (*OR* = 1.246, *P* = 0.015), and elevated TG (*OR* = 1.261, *P* = 0.014), TC (*OR* = 1.256, *P* = 0.006), and LDL-C (*OR* = 1.235, *P* = 0.018) levels compared to the elevated BP group even after adjusting for age and gender. As expected, the stage 2 hypertension groups also presented significantly higher *OR*s for abdominal obesity (*OR* = 1.959, *P* < 0.001), hyperglycemia (*OR* = 1.758, *P* < 0.001), and elevated TG (*OR* = 1.832, *P* < 0.001), TC (*OR* = 1.421, *P* < 0.001), and LDL-C (*OR* = 1.525, *P* < 0.001) levels compared to the elevated BP group after adjusting for age and gender. In addition, the risks of low HDL-C and CKD did not differ among the four groups (Table 3).

Our study would provide new evidence on the new hypertension standard of the 2017 ACC/AHA guidelines in the application of community residents

Table 1. Distribution of BP in study participants, *n* (%)

Age group	Normal BP	Elevated BP	Hypertension (stage 1)	Hypertension (stage 2)
Males (years)				
40–50	66 (16.1)	45 (10.9)	144 (35.0)	156 (38.0)
51–60	58 (8.0)	85 (11.7)	222 (30.5)	363 (49.8)
61–70	42 (5.5)	78 (10.3)	192 (25.3)	447 (58.9)
> 70	21 (5.5)	41 (10.7)	81 (21.1)	241 (62.7)
Total	187 (8.2)	249 (10.9)	639 (28.0)	1,207 (52.9)
Females (years)				
40–50	288 (25.1)	206 (17.9)	360 (31.3)	296 (25.7)
51–60	277 (16.6)	243 (14.5)	481 (28.7)	674 (40.2)
61–70	108 (8.6)	149 (11.8)	332 (26.2)	676 (53.4)
> 70	30 (6.1)	43 (8.8)	95 (19.3)	323 (65.8)
Total	703 (15.3)	641 (14.0)	1,268 (27.7)	1,969 (43.0)

Note. Data are expressed as numbers (%).

in China. The China Kadoorie Biobank Study[3] revealed that about 32.5% of Chinese adults had hypertension, which was defined as SBP ≥ 140 mmHg or DBP ≥ 90 mmHg. Undoubtedly, the new standards of hypertension were bound to significantly increase the prevalence of hypertension. A study[6] comparing the hypertension profiles of China and the United States showed that hypertension was more common in the United States, but blood pressure levels were higher in China, which may be responsible for the observed high stroke prevalence in Chinese adults. Meanwhile, the levels of treatment and control in hypertension were significantly lower in China, and clustering of hypertension with other cardiovascular risk factors was more common in China. Therefore, early intervention may be helpful in changing this situation.

The adoption of the 2017 ACC/AHA hypertension guidelines will markedly increase the number of people with hypertension and thus requiring treatment, which was based on evidence-based evidence of cardiovascular risk reduction but had also faced controversy. Patients marked with stage 1 hypertension may have adverse psychological effects, and not every patient diagnosed with stage 1 hypertension benefits from

Table 2. Characteristics of the study participants based on BP

Characteristics	Normal BP (*N* = 890)	Elevated BP (*N* = 890)	Hypertension (stage 1) (*N* = 1,907)	Hypertension (stage 2) (*N* = 3,176)
Female, *n* (%)	703 (79.0)	641 (72.0)^{a}	1,268 (66.5)^{ab}	1,969 (62.0)^{abc}
Age, y	53.18 ± 9.12	56.05 ± 9.62^{a}	56.40 ± 9.35^{a}	60.22 ± 9.45^{abc}
BMI, kg/m^2	24.55 ± 3.12	25.21 ± 3.21^{a}	27.79 ± 3.30^{ab}	26.75 ± 3.44^{abc}
WC, cm	81.83 ± 9.26	83.45 ± 9.60^{a}	85.47 ± 9.66^{ab}	88.45 ± 9.66^{abc}
SBP, mmHg	109.79 ± 6.81	123.59 ± 3.06^{a}	129.29 ± 7.77^{ab}	152.71 ± 14.97^{abc}
DBP, mmHg	68.78 ± 5.22	71.59 ± 4.88^{a}	78.46 ± 5.95^{ab}	85.36 ± 10.73^{abc}
FPG, mmol/L	5.66 ± 1.57	5.80 ± 1.61	5.95 ± 1.65^{ab}	6.32 ± 2.05^{abc}
2hPG, mmol/L	5.54 (4.76–6.62)	5.67 (4.81–1.10)^{a}	5.97 (4.90–1.58)^{ab}	6.35 (5.08–9.00)^{abc}
HbA1c, %	5.95 ± 1.13	6.06 ± 1.11^{a}	6.09 ± 1.01^{a}	6.33 ± 1.28^{abc}
TG, mmol/L	1.09 (0.80–1.56)	1.16 (0.86–1.63)^{a}	1.26 (0.90–1.81)^{ab}	1.41 (1.02–2.02)^{abc}
TC, mmol/L	5.11 ± 1.02	5.23 ± 0.98^{a}	5.33 ± 1.01^{ab}	5.47 ± 1.02^{abc}
HDL-C, mmol/L	1.57 ± 0.38	1.56 ± 0.38	1.52 ± 0.35	1.49 ± 0.35^{abc}
LDL-C, mmol/L	3.00 ± 0.82	3.06 ± 0.83	3.13 ± 0.84^{ab}	3.24 ± 0.84^{abc}
eGFR, mL/(min·1.73 m^2)	89.65 ± 9.99	87.78 ± 10.68^{a}	87.09 ± 10.42^{a}	83.37 ± 11.21^{abc}
Abdominal obesity, *n* (%)	293 (32.9)	348 (39.1)^{a}	865 (45.4)^{ab}	1,858 (58.5)^{abc}
Hyperglycemia, *n* (%)	203 (22.8)	251 (28.2)^{a}	635 (33.3)^{ab}	1,425 (44.9)^{abc}
High TG, *n* (%)	169 (19.0)	209 (23.5)^{a}	532 (27.9)^{ab}	1,161 (36.6)^{abc}
High TC, *n* (%)	395 (44.4)	430 (48.3)^{a}	1,019 (53.4)^{ab}	1,868 (58.8)^{abc}
Low HDL-C, *n* (%)	34 (3.8)	43 (4.8)	100 (5.2)	186 (5.9)^{a}
High LDL-C, *n* (%)	248 (27.9)	260 (29.2)	639 (33.5)^{ab}	1,283 (40.4)^{abc}
CKD, *n* (%)	12 (1.3)	17 (1.9)	36 (1.9)	113 (3.6)^{abc}

Note. Data are expressed as the mean ± SD, median (interquartile range) or numbers (%). BP, blood pressure; BMI, body mass index; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; FPG, fasting plasma glucose; 2hPG, 2-h plasma glucose; TG, triglyceride; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease. $^{a}P < 0.05$ compared with normal group; $^{b}P < 0.05$ compared with elevated group; $^{c}P < 0.05$ compared with hypertension (Stage 1) group.

treatment. Moreover, whether stage 1 hypertension is related to cardiovascular disease or even cardiovascular mortality requires further investigation, particularly in the Chinese population. To this end, we have explored the differences in cardiovascular risk factors between stage 1 hypertension and elevated BP, which were considered as the same group in the past guide, including obesity, hyperglycemia, dyslipidemia, and CKD. We found that the detection rate of abdominal obesity, hyperglycemia, and dyslipidemia among adults with stage 1 hypertension significantly increased compared to the elevated BP group. In this perspective, the new version of the American guidelines for hypertension seems to be supported in the Chinese population.

Cardiovascular disease risks are the main basis for the determination of antihypertensive treatment strategies. A large number of studies have reported a gradient of progressively higher CVD risk going from normal BP to elevated BP and stage 1 hypertension, however, this does not mean that all stage 1 hypertension should be treated with antihypertensive drugs[7]. SPRINT studies have shown that SBP could only benefit when the SBP is reduced to approximately 130 mmHg, but the majority of hypertensive patients included in this study had an SBP ≥ 140 mmHg[8]. A subgroup analysis of the HOPE-3 study showed that patients with SBP > 143.5 mmHg benefited from antihypertensive therapy[9]. A meta-analysis showed that antihypertensive treatment was not associated with mortality and major cardiovascular events but might offer additional protection in patients with CHD if baseline SBP is below 140 mmHg[10]. Therefore, in the new guidelines, stage 1 hypertension should be coupled with individualized treatment plans.

This study was a cross-sectional observational

Table 3. Multiple logistic regression analysis of the association between BP and metabolic abnormality

Groups	Normal BP *OR* (95% *CI*)	*P*-value	Elevated BP (reference)	Hypertension (stage 1) *OR* (95% *CI*)	*P*-value	Hypertension (stage 2) *OR* (95% *CI*)	*P*-value
Abdominal obesity							
Model 1	0.764 (0.630–0.928)	0.007	1	1.293 (1.100–1.520)	0.002	2.196 (1.886–2.556)	< 0.001
Model 2	0.854 (0.699–1.042)	0.119	1	1.274 (1.082–1.500)	0.004	1.959 (1.678–2.287)	< 0.001
Hyperglycemia							
Model 1	0.752 (0.607–0.932)	0.009	1	1.271 (1.068–1.513)	0.007	2.072 (1.762–2.436)	< 0.001
Model 2	0.874 (0.700–1.091)	0.234	1	1.246 (1.044–1.488)	0.015	1.758 (1.490–2.075)	< 0.001
High TG							
Model 1	0.764 (0.608–0.960)	0.021	1	1.261 (1.048–1.516)	0.014	1.877 (1.582–2.227)	< 0.001
Model 2	0.812 (0.644–1.023)	0.077	1	1.261 (1.048–1.517)	0.014	1.832 (1.541–2.178)	< 0.001
High TC							
Model 1	0.854 (0.708–1.029)	0.096	1	1.228 (1.047–1.440)	0.012	1.528 (1.316–1.774)	< 0.001
Model 2	0.928 (0.763–1.128)	0.453	1	1.256 (1.068–1.477)	0.006	1.421 (1.218–1.657)	< 0.001
Low HDL-C							
Model 1	0.782 (0.494–1.239)	0.295	1	1.090 (0.756–1.573)	0.645	1.225 (0.872–1.722)	0.242
Model 2	0.926 (0.577–1.486)	0.752	1	1.011 (0.698–1.465)	0.952	1.078 (0.762–1.525)	0.672
High LDL-C							
Model 1	0.936 (0.762–1.150)	0.529	1	1.221 (1.027–1.452)	0.024	1.642 (1.398–1.929)	< 0.001
Model 2	1.028 (0.830–1.274)	0.797	1	1.235 (1.037–1.471)	0.018	1.525 (1.294–1.798)	< 0.001
CKD							
Model 1	0.702 (0.333–1.478)	0.352	1	0.988 (0.552–1.769)	0.968	1.895 (1.132–3.172)	0.015
Model 2	1.030 (0.470–2.255)	0.942	1	0.965 (0.530–1.759)	0.908	1.166 (0.684–1.990)	0.572

Note. Model 1: not adjusted; Model 2: adjusted for age and gender. TG, triglyceride; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; CKD, chronic kidney disease.

study that validates the feasibility of the 2017 ACC/AHA hypertension guidelines in the Chinese population in the context of the association of hypertension with other metabolic diseases. However, there is still a lack of prospective follow-up studies to determine whether the Chinese population should accept this more stringent diagnostic and therapeutic criteria for hypertension.

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REFERENCES

1. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCN A Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults. Hypertension, 2018; 71, 1269−324.
2. Bryan W, Giuseppe M, Wilko S, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. European Heart J, 2018; 39, 3021−104.
3. Lewington S, Lacey B, Clarke R, et al. The burden of hypertension and associated risk for cardiovascular mortality in China. JAMA Intern Med, 2016; 176, 524.
4. Ning G. Reaction Study Group. Risk evaluation of cAncers in Chinese diabeTic individuals: a lONgitudinal (REACTION) study. J Diabetes, 2012; 4, 172−3.
5. Liang K, Sun Y, Li W J, et al. Diagnostic efficiency of hemoglobin A1c for newly diagnosed diabetes and prediabetes in community-based Chinese adults aged 40 years or older. Diabetes Technol Ther, 2014; 16, 853−7.
6. Lu Y, Wang P, Zhou T, et al. Comparison of prevalence, awareness, treatment, and control of cardiovascular risk factors in china and the United States. JAMA, 2018; 7, e007462.
7. Sheppard JP, Stevens S, Stevens R, et al. Benefits and harms of antihypertensive treatment in low-risk patients with mild hypertension. JAMA Intern Med, 2018; 178, 1626−34.
8. Group S, Jr W J, Williamson JD, et al. A randomized trial of intensive versus standard blood-pressure control. N Engl J Med, 2015; 373, 2103−16.
9. Lonn EM, Bosch J, Lopez-Jaramillo P, et al. Blood-pressure lowering in intermediate-risk persons without cardiovascular disease. N Engl J Med, 2016; 374, 2009−20.
10. Brunström M, Carlberg B. Association of blood pressure lowering with mortality and cardiovascular disease across blood pressure levels: a systematic review and meta-analysis. JAMA Intern Med, 2018; 178, 28−36.