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Abstract

Objectives—This study aims to analyze the status of hypertension in Chinese

nursing staff and the changes in prevalence, awareness, treatment and control rate of hypertension in Chinese nursing staffs based on the 2017 American College of Cardiology (ACC) /American Heart Association (AHA) High Blood Pressure Guideline and the 2010 Chinese guideline for the management of hypertension.

Design—cross-sectional study.

Setting—512 medical institutions in 13 cities in Hebei province.

Participants—The entire group of registered nurses from 512 medical institutions in 13 cities in Hebei province(n=143772)were invited to participate in the survey and and those who refused to participate were excluded.93603 incumbent nurses aged 18-65 years agreed to participate in the survey and submitted questionnaires online.A response rate of 65.11% was achieved. After excluding 788 individuals with missing or incomplete questionnaires,92815 participants were included in the final analyses.

Main outcome measures—The prevalence, awareness, treatment and control rate of hypertension.

Results—92815 participants were included in the final analyses,among which 3,677 men (3.96%) and 8,9138 women (96.04%). The mean age of participants was 31.65(SD=7.47)years.

There are 26,875 cases of hypertension in nursing staffs according to the 2017 ACC/AHA guideline, with 20,551 cases added to a previous number(6,324)according to the 2010 Chinese guideline. The prevalence of hypertension among nursing staffs was 28.96% in the context of the 2017 ACC/AHA guideline, 3.25 times higher than that (6.81%) evaluated by the criteria of the 2010 Chinese guideline .However, the awareness, treatment and control rate (13.50%,10.73%,0.81%) were 3.25, 3.22 and 17.48 times lower than those (57.37%,45.30%,14.97%) based on the 2010 Chinese guideline, respectively.

Conclusions—There is still much room for improvement in the awareness rate, drug treatment rate and control rate of hypertension among nurses. Meanwhile, according to the 2017 ACC/AHA guideline, the prevalence of hypertension in China will increase significantly, which poses a more severe challenge to the management of hypertension in China.

Strengths and limitations of this study

1.This study described the current status of the hypertension in nurses according to the 2010 Chinese guideline and the 2017 ACC/AHA guideline.

2. The large representative sample of individuals from 13 cities in Hebei province enhanced the generalizability of the findings.

3.The relationships between hypertension and specific factors identified in this study were not investigated.

Introduction

With the rapid development of society and economy, the changes of lifestyle and the aging of the population,hypertension has become one of the most important public health issues in the world.Its complications are associated with high morbidity and mortality, as well as high rate of consumption of medical resources [1].The direct economic burden caused by hypertension in China in 2013 amounted to 210.3 billion yuan, accounting for 6.61% of total expenditure on health of China[2-4].According to the China Health and Nutrition Survey(CHNS) data from 1991 to 2011, The adjusted prevalence rate of hypertension in Chinese over 18 years old increased from 15.6% to 20.9% , the prevalence rate of hypertension increased[5],meanwhile, the awareness, treatment and control rates were still low[6]. The level of the blood pressure among the nursing staff,(as a special class of professional groups),whose work is of high intensity and high stress level with frequent rotating shifts, should be paid more attention to.And the nursing staff, as a special class of professional groups, whose work is of high intensity, frequent rotating shift, and high stress level, blood pressure level should be paid more attention[7-8].

The 2017 American Heart Association/American College of Cardiology

(AHA/ACC) guideline for the prevention, detection, evaluation, and management of high blood pressure (BP) in adults was recently released. A significant transformation in the guideline is the shift in the definition of hypertension, from systolic blood pressure（SBP）≥ 140mm Hg or diastolic blood pressure (DBP) ≥ 90mm Hg to systolic blood pressure （SBP）≥ 130mm Hg or diastolic blood pressure(DBP) ≥ 80mm Hg. According to the 2017 AHA/ACC guideline,the prevalence rate of hypertension increased from 31.9% to 45.6% in the United States[9]。

The 2017 ACC/AHA guideline may have important effects on the hypertension status noted across the globe[10-13].However,it is not clear that the effect of the new guideline on the status of hypertension in different populations in China.The purpose of this study is to analyze the variation of prevalence, awareness, treatment and control rate of hypertension in Chinese nursing staffs based on the 2017 ACC/AHA guideline and the 2010 Chinese guideline.

METHODS

Participants and data collection

This cross-sectional study was conducted between October 2016 to February 2017,using general survey design.The entire group of registered nurses from 512 medical institutions in 13 cities in Hebei province(n=143772) were invited to

participate in the survey and those who refused to participate were excluded.93603 incumbent nurses aged 18-65 years agreed to participate in the survey and submitted questionnaires online.A response rate of 65.11% was achieved.After excluding 788 individuals with missing or incomplete questionnaires,92815 participants were included in the final analyses.

Electronic folders were distributed to the Nursing Quality Control Center(NQCC) of each city through NQCC of Hebei Province.The folder contained three documents:the link of electronic questionnaire(SO JUMP), a document on blood pressure measurement precautions,and a investigation notice.Upon receiving the folder,the contact person of each NQCC sent it to the nursing department of all medical institutions in the region.The nursing department would send it to the head managers of departments,who organized the nurses to fill in the questionnaire online.A researcher reported the response rate to the NQCC of each city every day.The questionnaire content mainly involves:(1)demographic characteristic: hospital name, hospital grade, department, name, age, gender, height, weight, etc.(2)systolic blood pressure, diastolic blood pressure.(3)The risk factors associated with hypertension: monthly night shift frequency, years of hyperlipidemia, years of diabetes, years of hypertension,educational status, marital status,menstruation condition, reproductive history, history of abortion,

whether received hormone replacement therapy, smoking habit,alcohol drinking,physical exercise, family history of hypertension,etc[14-17].

Ethical considerations

The study was reviewed and approved by the Research Ethics Committee of the Second Hospital of Hebei Medical University(No. 2016225). Consent was implied by completion of the questionnaire. All participants were voluntary and had every right to participate or refuse without any reason.To protect the privacy of respondents, electronic data were saved in secured computer of the hospital with restricted access.

Participants and public involvement

In this study, self-report was adopted, and all the participants were nurses who understand the effect of blood pressure measurement on themselves.After receiving the notification of the blood pressure survey, all participants filled in and submitted relevant data online, and those who did not agree could refuse to participate.Although the study participants or the public were not formally involved in the design and conduct of the study, the questionnaire used for data collection and the specific assessments conducted were developed based on previous experiences in other surveys and expert opinions.The findings will be disseminated to Municipal Nursing Quality and Control Center in Hebei

Province, but not to participating nurses directly.

Measurement

Blood pressure measurement and data reporting: the nursing staff measured blood pressure by themselves and reported data through the network.Although nurses master the blood pressure measurement method generally, the researchers standardized the method of blood pressure measurement and gave the relevant attention in order to reduce measurement bias as much as possible.

Blood pressure measurements:Chose a regular calibration of the mercury sphygmomanometer or validated electronic sphygmomanometer.Used the standard specification cuff with air bag length of 22cm and width of 12cm. The obese individuals or individuals with large arm circumference used a large size balloon cuff, and the upper arm was wrapped up at least 80% by air bag. Each participant was asked to take a rest at least for 5 minutes,any vigorous activity was avoided and cigarettes,beverage containing caffeine like tea and coffee were forbidden within 30 minutes, and empty the bladder before the blood pressure measurement. Blood pressure was measured on a sitting position, the right upper arm was measured without the cloth and with the cuff at the same level as heart. Each participant was measured three times with 1 min interval and the average of the last two readings was used for analysis.

Definitions

Hypertension was defined as systolic BP (SBP)≥140 mm Hg,or diastolic BP (DBP)≥90 mm Hg, and/or self-reported treatment of hypertension (medical records checked) with antihypertensive medication within 2 weeks prior to the interview in accordance with the 2010 Chinese guideline. The new classification designates SBP⩾130 mm Hg or DBP⩾80 mm Hg as hypertension according to the 2017 ACC/AHA guideline.

The ratio of hypertension to total population was the prevalence of hypertension.Awareness of hypertension was defined as any self-reported previous diagnosis of hypertension by a health care professional physician,treatment as self-reported use of a prescription medication for hypertension management within the 2 weeks at the time of the interview,control as pharmacologic treatment of hypertension associated with SBP <140 mm Hg and DBP <90 mm Hg during previous 2 weeks.

In addition, the study also estimated the prevalence (SBP⩾130 or DBP⩾80 mm Hg) and control rate (SBP<130 and DBP<80 mm Hg) of hypertension according to the 2017 ACC / AHA guideline.

Response rate was defined as the number of nurses responding to the questionnaire online divided by the total number of registered nurses in

Hebei Province.

Statistical analysis

Analyses were performed by using SPSS V.21.0 software.Continuous data were presented as mean±standard deviation,and categorical data were presented by the percentages description.Chi-square test was applied to compare the prevalence of hypertension among different groups.A two-sided P value<0.05 was considered statistically significant.

The study estimated the prevalence of hypertension among all participants, as well as awareness,treatment,and control rate of hypertension among hypertensive participants.

Results

Demographic characteristics

Totally, 93603 participants from 512 medical institutions in 13 cities were enrolled in this study,accounting for 65.11% of the total number of registered nurses in Hebei province.The main reason for non-response might be some invited nurses having retired but not logged out of the registration system，being on leave including maternity leave, study leave and other reasons during the period of data collection or refusing to participate.After excluding 788 individuals with missing or incomplete questionnaires(n=788),92815

participants were included in the final analyses,among which 3,677 men (3.96%) and 8,9138 women (96.04%). The mean age of participants was 31.65(SD=7.47) years (age range: 18–65 years). (Table 1).

Table 1 Characteristics of study participants（N=92815）

Variable	N	Percentage(%)	SBP($\bar{x}$ ±S)	DBP($\bar{x}$ ±S)
Overall	92815	100	111.95±12.69	71.32± 9.53
Gender				
Female	89138	96.04	111.43±12.48	70.98± 9.40
Male	3677	3.96	124.57±11.09	79.42± 8.71
Age,y*				
18-25	17289	18.63	110.22±10.59	70.49± 8.56
26-35	53799	57.96	110.81±11.85	70.34± 9.03
36-45	14989	16.15	114.10±14.39	72.97±10.37
46-55	6376	6.87	120.55±15.61	77.55±10.89
56-65	250	0.27	126.69±14.13	80.67± 9.73
Missing data	112	0.12	_	_
BMI,kg/m^2 *[a]				
Underweight	7037	7.58	105.46±11.22	67.36± 8.55
Normal	57077	61.50	110.10±11.72	70.12± 8.99
Overweight	22235	23.96	116.47±12.83	74.14± 9.67

Obese	6253	6.74	120.04±13.65	76.68±10.17
Missing data	213	0.23	_	_
Years of hyperlipidemia*				
0	86900	93.63	111.26±12.12	70.85± 9.18
~5	4837	5.21	121.58±15.79	77.82±11.56
~10	636	0.69	125.96±17.17	80.94±12.14
＞10	127	0.14	129.86±20.10	83.02±13.51
Missing data	315	0.34	_	_
Years of diabetes*				
0	91886	99.00	111.83±12.57	71.24± 9.46
~5	625	0.67	124.69±17.93	79.75±12.72
~10	164	0.18	123.59±16.43	79.13±12.22
＞10	56	0.06	129.73±18.05	81.80±13.04
Missing data	84	0.09	_	_
Smoking				
Never	91020	98.07	111.95±12.70	71.30± 9.54
＜10 cigarettes/day	1280	1.38	112.15±12.06	72.05± 9.07
10-20 cigarettes/day	419	0.45	112.27±13.38	72.34± 8.99
＞20 cigarettes/day	96	0.10	111.93±10.84	72.25± 8.46
Alcohol drinking				
Never	45984	49.54	111.92±12.65	71.29± 9.50
Occasionally	46263	49.84	111.97±12.73	71.34± 9.56

Often	568	0.61	112.23±12.68	72.07± 8.91
Family history of hypertension				
Yes	44451	47.89	111.93±12.66	71.29± 9.50
No	48364	52.11	111.97±12.71	71.34± 9.57

note：* with the missing data

[a] BMI was used to classify participants into categories of underweight (<18.5),normal weight (18.5 to <24), overweight (24 to <28) and obese (≥28).

2.2 Prevalence, awareness, treatment and control rate of hypertension in Chinese nurses according to the two edition of the guidelines

According to the 2017 ACC/AHA guideline, the prevalence of hypertension increased from 6.81% to 28.96%, and the prevalence rate was 3.25 times higher than that defined in the 2010 Chinese guideline. The prevalence of hypertension in female and male nurses increased by 3.36 and 2.35 times,respectively. The awareness rate of hypertension was 3.25 times lower than that according to the 2010 Chinese guideline, and the awareness rate of hypertension in female and male nurses decreased by 3.37 and 2.34 times,respectively. The rate of drug treatment decreased by 3.22 times. The drug treatment rate of female and male nurses decreased by 3.34 and 2.35 times,respectively.The control rate of hypertension was 17.48 times less than that according to the 2010 Chinese guideline. And the control rate of female and male nurses decreased by 17.51 and

24.24 times,respectively. (Table 2).

Table 2 Prevalence, awareness, treatment and control rate of hypertension

Participants	Diagnostic criteria for hypertension	Prevalence(95%CI)	Awareness(95%CI)	Treatment(95%CI)	Control(95%CI)
Overall	≥140/90[a]	6.81(6.65- 6.97)	57.37(57.05-57.69)	45.30(44.98-45.62)	14.97(14.74-15.20)
(N=92815)	≥130/80[b]	28.96(28.67-29.25)	13.50(13.28-13.72)	10.73(10.53-10.93)	0.81(0.75- 0.87)
Female	≥140/90[a]	6.28(6.12- 6.44)	58.52(58.20-58.84)	46.74(46.41-47.07)	16.10(15.86-16.34)
(N=89138)	≥130/80[b]	27.41(27.12-27.70)	13.40(13.18-13.62)	10.77(10.57-10.97)	0.87(0.81- 0.93)
Male	≥140/90[a]	19.83(18.54-21.12)	48.56(46.94-50.18)	34.29(32.76-35.82)	6.31(5.52- 7.10)
(N=3677)	≥130/80[b]	66.41(64.88-67.94)	14.50(13.36-15.64)	10.28(09.30-11.26)	0.25(0.09- 0.41)

a According to the diagnostic criteria for hypertension in the 2010 Chinese guideline

b According to the diagnostic criteria for hypertension in the 2017 edition of the guideline

2.3 Multi-dimensional Comparative Analysis of hypertension prevalence among nursing staff

According to the 2017 ACC/AHA guideline, the number of people with high blood pressure in nursing staff rose from 6,324 to 26,875, with a total increase of 20551. (Table 3).The prevalence rate of hypertension has increased by 3.25 times,from 6.81% to 28.96%.The prevalence of hypertension in female and male nurses increased by 3.36 and 2.35 times,respectively.

The prevalence of hypertension stratified by age (18-25, 26-35, 36-45, 46-55,

and over 55 years) increased by 8.61, 4.97, 1.96, 1.04, and 1.03 times,respectively.

The prevalence of hypertension stratified by BMI (underweight, normal weight, overweight and obese) increased by 5.73, 4.42, 2.54 and 1.93 times,respectively.

According to the 2017 ACC/AHA guideline， the prevalence of hypertension among nurses without hyperlipidemia were 4.25 times higher than that according to the 2010 Chinese guideline, one time higher among nurses with hyperlipidemia for less than or equal to 5 years, and the increases in prevalence were 51% among nurses with hyperlipidemia for more than 5 years but less than or equal to 10 years，43% among nurses with hyperlipidemia for more than 10 years.

According to the 2017 ACC/AHA guideline，the prevalence of hypertension among nurses without diabetes were 3.42 times higher than that according to the 2010 Chinese guideline,the increases in prevalence were 58% among nurses with diabetes for less than or equal to 5 years, 46% among nurses with diabetes for more than 5 years but less than or equal to 10 years and 44% among nurses with diabetes for more than 10 years.

According to the 2017 ACC/AHA guideline， the prevalence of hypertension among nurses without history of smoking were 3.24 times higher than that

according to the 2010 Chinese guideline, 3.77 times higher among nurses who smoke cigarettes less than 10 a day, 3.34 times higher among nurses who smoke cigarettes 10-20 a day,and 5.20 times higher among nurses who smoke cigarettes more than 20 a day.

According to the 2017 ACC/AHA guideline,the prevalence of hypertension among nurses without the history of drinking, light drinker nurses and heavy drinker nurses were 3.29, 3.22 and 3.14 times higher than those according to the 2010 Chinese guideline, respectively.

According to the 2017 ACC/AHA guideline,the prevalence of hypertension among nurses with family history of hypertension and without family history of hypertension were 3.30 and 3.21 times higher than those defined by the 2010 Chinese guideline,respectively.

We assessed associations between variables and newly diagnosed hypertension according to the 2017 ACC/AHA guideline using $\chi 2$ tests and determined that gender,age,BMI,years of hyperlipidemia and years of diabetes were significantly associated with newly diagnosed hypertension.(table 4)

In table 5, the variables related to newly diagnosed hypertension, determined using a multiple logistic model, an OR and a 95% CI, are shown. Female are more likely to be newly diagnosed with hypertension than male according to the

2017 ACC/AHA guideline.Participants with no hyperlipidemia, no diabetes, lower age and lower BMI value are more likely to be newly diagnosed with hypertension.

Table 3 Comparison of hypertension prevalence among nursing staff

Variable	N	≥140/90[a]		≥130/80[b]		χ^2	*P*
		Hypertension	Prevalence	Hypertension	Prevalence	Value	Value
Gender							
Female	89138	5595	6.28(6.12- 6.44)	24433	27.41(27.12-27.70)	14211.74	＜0.001
Male	3677	729	19.83(18.54-21.12)	2442	66.41(64.88-67.94)	1626.88	＜0.001
Age,y							
18-25	17289	448	2.59(2.35- 2.83)	4303	24.89(24.25-25.53)	3626.22	＜0.001
26-35	53799	2263	4.21(4.04- 4.38)	13532	25.15(24.78-25.52)	9423.20	＜0.001
36-45	14989	1784	11.90(11.38-12.42)	5284	35.25(34.49-36.01)	2267.87	＜0.001
46-55	6376	1726	27.07(25.98-28.16)	3524	55.27(54.05-56.49)	1046.70	＜0.001
56-65	250	91	36.40(30.44-42.36)	185	74.00(68.56-79.44)	71.46	＜0.001
BMI,kg/m^2							
Underweight	7037	153	2.17(1.83- 2.51)	1028	14.61(13.78-15.44)	707.67	＜0.001
Normal	57077	2501	4.38(4.21- 4.55)	13552	23.74(23.39-24.09)	8852.47	＜0.001
Overweight	22235	2527	11.36(10.94-11.78)	8941	40.21(39.57-40.85)	4833.89	＜0.001
Obese	6253	1120	17.91(16.96-18.86)	3280	52.45(51.21-53.69)	1635.94	＜0.001
Years of							

hyperlipidemia							
0	86900	4473	5.15(5.00- 5.30)	23495	27.04(26.74-27.34)	15418.70	＜0.001
~5	4837	1431	34.74(33.29-36.19)	2712	65.84(64.39-67.29)	692.76	＜0.001
~10	636	292	25.82(23.27-28.37)	417	36.87(34.06-39.68)	49.79	＜0.001
＞10	127	61	17.43(13.46-21.40)	95	27.14(22.48-31.80)	19.21	＜0.001
Years of diabetes							
0	91886	5951	6.48(6.32- 6.64)	26285	28.61(28.32-28.90)	15554.93	＜0.001
~5	625	270	49.27(45.08-53.46)	413	75.36(71.75-78.97)	66.01	＜0.001
~10	164	64	33.51(26.82-40.20)	99	51.83(44.74-58.92)	14.94	＜0.001
＞10	56	30	28.30(19.72-36.88)	45	42.45(33.04-51.86)	9.08	0.003
Smoking							
Never	91020	6200	6.81(6.65- 6.97)	26290	28.88(28.59-29.17)	15121.35	＜0.001
＜10 cigarettes/day	1280	87	6.80(5.42- 8.18)	415	32.42(29.86-34.98)	266.59	＜0.001
10-20 cigarettes/day	419	32	7.64(5.10-10.18)	139	33.17(28.66-37.68)	84.12	＜0.001
＞20 cigarettes/day	96	5	5.21(0.76- 9.66)	31	32.29(22.94-41.64)	23.11	＜0.001
Alcohol drinking							
Never	45984	3085	6.71(6.48- 6.94)	13226	28.76(28.35-29.17)	7664.23	＜0.001
Occasionally	46263	3194	6.90(6.67- 7.13)	13463	29.10(28.69-29.51)	7720.74	＜0.001

Often	568	45	7.92(5.70-10.14)	186	32.75(28.89-36.61)	108.03	＜0.001
Family history of hypertension							
Yes	44451	2967	6.67(6.44- 6.90)	12743	28.67(28.25-29.09)	7389.14	＜0.001
No	48364	3357	6.94(6.71- 7.17)	14132	29.22(28.81-29.63)	8103.69	＜0.001

a According to the diagnostic criteria for hypertension in 2010 Chinese guideline

b According to the diagnostic criteria for hypertension in the 2017 edition of the guideline

c BMI was classified into underweight (<18.5),normal weight (18.5 to <24), overweight (24 to <28) and obese (≥28).

Table 4 Univariate analysis of factors associated with newly diagnosed hypertension

Variable	Hypertension according to the 2010 Chinese guideline（n=6324）	Newly diagnosed with hypertension according to the 2017 ACC/AHA guideline（n=20551）	χ^2	*P*
			Value	Value
Gender			59.65	＜0.001*
Female	5595	18838		
Male	729	1713		
Age,y			2403.69	＜0.001*
18-25	448	3855		
26-35	2263	11269		
36-45	1784	3500		
46-55	1726	1798		
56-65	91	94		
BMI,kg/m^2			553.79	＜0.001*

Underweight	153	875		
Normal	2501	11051		
Overweight	2527	6414		
Obese	1120	2160		
Years of hyperlipidemia			2146.97	＜0.001*
0	4473	19022		
~5	1431	1281		
~10	292	125		
＞10	61	34		
Years of diabetes			553.08	＜0.001*
0	5951	20334		
~5	270	143		
~10	64	35		
＞10	30	15		
Smoking			2.52	0.471
Never	6200	20090		
＜10 cigarettes/day	87	328		
10-20 cigarettes/day	32	107		
＞20 cigarettes/day	5	26		
Alcohol drinking			0.64	0.728
Never	3085	10141		

Occasionally	3194	10269		
Often	45	141		
Family history of hypertension			0.83	0.363
Yes	2967	9776		
No	3357	10775		

*P<0.10 was considered statistically significant.

Table 5 Multiple logistic regression of factors associated with newly diagnosed hypertension

Variables	OR	95% CI	P
Gender	0.647	0.585 to 0.716	<0.001
Age,y	0.538	0.520 to 0.557	<0.001
BMI,kg/m^2	0.760	0.729 to 0.791	<0.001
Years of hyperlipidemia	0.426	0.397 to 0.458	<0.001
Years of diabetes	0.597	0.517 to 0.690	<0.001

Discussion

According to the 2010 Chinese guideline , the prevalence rate of hypertension was 6.81% in this study.Li *et al*[18] investigated 4032 cardiovascular physicians from 386 hospitals in China. The results showed that the prevalence of hypertension among cardiovascular physicians was 13.1%. Liu *et al*[19] analyzed

the prevalence of hypertension among 1369 medical staff in a tertiary academic hospital in Zhengzhou, and the prevalence of hypertension was 18.33%. The prevalence of hypertension in this survey was lower than the above level, which may be related to the lower age and the greater proportion of women of nursing staff.According to the 2017 ACC/AHA guideline, the hypertension prevalence rate of nursing personnel in the survey increased to 28.96%, which increased 4.15 times among nurses under the 45 years old and 1.04 times among nurses of 45 years of age or older .The prevalence rate of the population with no hyperlipidemia, no diabetes, lower age and BMI value will increase,suggesting that more low-risk population will be diagnosed with hypertension.

The report of China Health and Family Planning Commission indicated that the awareness rate of hypertension among people over 18 years old in China was 46.5%, the drug treatment rate was 41.1%, and the control rate was 13.8% in 2012[20]. In addition, a survey[21] of 174,621 people aged 18 years or older in 31 provinces in China from 2013 to 2014 showed that the awareness, treatment and control rate were 31.9%, 26.4% and 9.7%,respectively.Lixin Jiang *et al*[22] made use of data generated in the China Patient-Centered Evaluative Assessment of Cardiac Events (PEACE) Million Persons Project from 2014 to 2017, a population-based screening project that enrolled around 1.7 million adults aged 35-75 years from all 31 provinces in mainland China. The age-standardised and

sex-standardised rates of hypertension prevalence, awareness, treatment, and control were 37.2%, 36.0% , 22.9% and 5.7% , respectively. In this survey, the awareness rate of hypertension in nursing staff was 57.37%, the rate of treatment was 45.30%, and the control rate was 14.7%, all higher than the above results. However, the control rate of hypertension among female nurses was 16.10%, and among male nursing staff was only 6.31%. The awareness rate and treatment rate of nursing staff were slightly higher than those of the above research results. As a medical worker, the awareness rate of hypertension and the rate of drug treatment should have been higher. The survey showed that there is still much room for improvement in the awareness rate of hypertension. According to the 2017 ACC/AHA guideline, the awareness rate, drug treatment rate and control rate of hypertension among Chinese nurses will be significantly reduced, and the number of people with normal blood pressure level will be greatly reduced.

It has been reported that treatment of hypertension can reduce the risk of stroke and myocardial infarction by 30-43% and 15%, respectively, along with reducing the risk of a number of other chronic conditions[23-25].The entire population including nursing staff should pay more attention to the management of blood pressure.Improving the lifestyle and monitoring the blood pressure regularly are suggested to control the blood pressure in a reasonable range. In order to prevent and control the occurrence of hypertension and related diseases, drug treatment

should be carried out and therapeutic regimen should be adjusted in time if nessesary.

Limitation

At present, there are few studies on the current status of hypertension among nurses. This study is a cross-sectional survey based on a large sample of nursing staff. The large sample and high response rate make the data and results of this study better representative. However,some limitations should be considered when interpreting our data. First of all, this survey used the average blood pressure measured 3 times on the same day, that may have false positive diagnosis, resulting in overestimation of the prevalence rate. Secondly, the blood pressure was measured by nurses themselves rather than the staff trained unifiedly, but all nurses had received professional knowledge of blood pressure measurement. In addition, a unified description of the measurement methods and matters of attention were carried out in the study, which could ensure the reliability of the measurement results. Furthermore, because of the difference of blood pressure measuring instruments, it may have some effect on the data, but the sphygmomanometer had been tested and corrected. The blood pressure measurement in the survey was carried out according to international measurement and quality control regulations, which could guarantee the reliability of the measurement results. Finally, the generalizability of our results

may be restricted due to the participants being recruited from only one province in China. Future studies should be carried out to recruit participants from other cities in China .

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Contributors: WC conceived the study,WC, BZ, YMH and YJZ designed the study, drafted the manuscript, or critically revised the manuscript

for important intellectual content.J Li, FDL, XMC, XLY, AFZ, RFJ, RQZ, ALF, YW, MJY, LT, SLC, JC and MZZ conducted the research and collected data,J Liu, DF and MHX analyzed the data, WC, BZ, JLiu, YMH and DF wrote the this article.All authors gave final approval of the version to be published and are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. WC is the corresponding author and guarantor.

Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author). No financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other

relationships or activities that could appear to have influenced the submitted work.

Ethical approval:The protocol was reviewed and approved by the Research Ethics Committee of the Second Hospital of Hebei Medical University(No 2016225).

Transparency statement: The guarantor（BZ） affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Data sharing:No additional data available.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	the 1st segment of Page 4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 4 and Page 5
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	the 2nd segment and the 3rd segment of Page 6
Objectives	3	State specific objectives, including any prespecified hypotheses	the 1st segment of Page 7
Methods			
Study design	4	Present key elements of study design early in the paper	the 1st sentence in the last segment of Page 7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	the last segment of Page 7and the 1st segment of Page 8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	the last segment of Page 7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	the four segments of Page 11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	the two segments of Page 10
Bias	9	Describe any efforts to address potential sources of bias	the 2nd sentence in the 1st segment of Page 10
Study size	10	Explain how the study size was arrived at	the last segment of Page 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	the first two segments of Page 12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	the first two segments of Page 12
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	the 3rd sentence of Page 8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility,	N/A

		confirmed eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Table 2 and Table 3
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 2 and Table 3
		(*b*) Report category boundaries when continuous variables were categorized	Table 1 and Table 3
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Table 4 and Table 5
Discussion			
Key results	18	Summarise key results with reference to study objectives	the 1st sentence of Page 23 and the 2nd sentence of Page 24
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 26
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 23 and Page 24
Generalisability	21	Discuss the generalisability (external validity) of the study results	the last sentence of Page 26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	the 4th segment of Page 28

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

The prevalence of hypertension in 92815 nurses and its changes according to the 2017 ACC/AHA hypertension guideline: an observational cross-sectional study from China

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Primary Subject Heading:	Cardiovascular medicine
Secondary Subject Heading:	Epidemiology, Public health
Keywords:	Hypertension < CARDIOLOGY, nurses, prevalence, guideline

The prevalence of hypertension in 92815 nurses and its changes according to the 2017 ACC/AHA hypertension guideline: an observational cross-sectional study from China

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Abstract

Objectives—This study aims to analyze the status of hypertension in Chinese nursing staff and the changes in prevalence, awareness, treatment and control rate of hypertension in Chinese nursing staffs based on the 2017 American College of Cardiology (ACC) /American Heart Association (AHA) High Blood Pressure Guideline and the 2010 Chinese guideline for the management of hypertension.

Design—cross-sectional study.

Setting—512 medical institutions in 13 cities in Hebei province.

Participants—The entire group of registered nurses from 512 medical institutions in 13 cities in Hebei province (n=143772) were invited to participate in the survey and those who refused to participate were excluded. 93603 incumbent nurses aged 18-65 years agreed to participate in the survey and submitted questionnaires online. A response rate of 65.11% was achieved. After excluding 788 individuals with missing or incomplete questionnaires, 92815 participants were included in the final analyses.

Main outcome measures—The prevalence, awareness, treatment and control rates of hypertension.

Results—92815 participants were included in the final analyses, among which 3,677 men (3.96%) and 8,9138 women (96.04%). The

mean age of participants was 31.65 (SD=7.47) years.

There are 26,875 cases of hypertension in nursing staffs according to the 2017 ACC/AHA guideline, with 20,551 cases added to a previous number(6,324)according to the 2010 Chinese guideline. The prevalence of hypertension among nursing staffs was 28.96% in the context of the 2017 ACC/AHA guideline, 3.25 times higher than that (6.81%) evaluated by the criteria of the 2010 Chinese guideline .However, the awareness, treatment and control rate (13.50%,10.73%,0.81%) were 3.25, 3.22 and 17.48 times lower than those (57.37%,45.30%,14.97%) based on the 2010 Chinese guideline, respectively.

Conclusions—There is still much room for improvement in the awareness rate, drug treatment rate and control rate of hypertension among nurses. Meanwhile, according to the 2017 ACC/AHA guideline, the prevalence of hypertension in China will increase significantly, which poses a more severe challenge to the management of hypertension in China.

Strengths and limitations of this study

1.This study described the current status of the hypertension in nurses according to the 2010 Chinese guideline and the 2017 ACC/AHA guideline.

2. The large representative sample of individuals from 13 cities in

Hebei province enhanced the generalizability of the findings.

3.The relationships between hypertension and specific factors identified in this study were not all investigated.

Introduction

With the rapid development of society and economy, the changes of lifestyle and the aging of the population, hypertension has become one of the most important public health issues in the world. Its complications are associated with high morbidity and mortality, as well as high rate of consumption of medical resources [1]. The direct economic burden caused by hypertension in China in 2013 amounted to 210.3 billion yuan, accounting for 6.61% of total expenditure on health of China[2-4]. According to the China Health and Nutrition Survey(CHNS) data from 1991 to 2011, the adjusted prevalence rate of hypertension in Chinese over 18 years old increased from 15.6% to 20.9% , the prevalence rate of hypertension increased[5], meanwhile, the awareness, treatment and control rates were still low[6]. And the nursing staff, as a special class of professional groups, whose work is of high intensity, frequent rotating shift, and high stress level, blood pressure level should be paid more attention[7, 8].

The 2017 American Heart Association/American College of Cardiology (AHA/ACC) guideline for the prevention, detection,

evaluation, and management of high blood pressure (BP) in adults was recently released. A significant transformation in the guideline is the shift in the definition of hypertension, from systolic blood pressure（SBP）≥ 140 mm Hg or diastolic blood pressure (DBP) ≥ 90 mm Hg to systolic blood pressure（SBP）≥ 130 mm Hg or diastolic blood pressure(DBP) ≥ 80 mm Hg. According to the 2017 AHA/ACC guideline,the prevalence rate of hypertension increased from 31.9% to 45.6% in the United States[9].

The 2017 ACC/AHA guideline may have important effects on the hypertension status noted across the globe[10-13]. There have been some recent studies to explore the potential impacts of the updated guideline on Chinese population. A nationally representative cross sectional study examined the hypertension prevalence rate according to the new guideline and found an absolute increase of 17.0% among adults aged 45 to 75 years in China[14]. Additionally, a survey examined the effects of the new guideline in Southwest China and found the prevalence of hypertension was nearly twice the rate in the Chinese hypertension guideline[15]. However, it is unclear the impact of the new guideline on the hypertension status in different occupations in China. The purpose of this study is to analyze the variation of prevalence, awareness, treatment and control rates of hypertension in Chinese nursing staffs based on the 2017 ACC/AHA guideline and the 2010 Chinese guideline.

METHODS

Participants and data collection

This cross-sectional study was conducted between October 2016 to February 2017,using general survey design. The entire group of registered nurses from 512 medical institutions in 13 cities in Hebei province(n=143772) were invited to participate in the survey and those who refused to participate were excluded. 93,603 incumbent nurses aged 18-65 years agreed to participate in the survey and submitted questionnaires online. A response rate of 65.11% was achieved. After excluding 788 individuals with missing or incomplete questionnaires,92815 participants were included in the final analyses.

Electronic folders were distributed to the Nursing Quality Control Center (NQCC) of each city through NQCC of Hebei Province. The folder contained three documents: the link of electronic questionnaire(SO JUMP), a document on blood pressure measurement precautions, and an investigation notice.Upon receiving the folder, the contact person of each NQCC sent it to the nursing department of all medical institutions in the region. The nursing department would send it to the head managers of departments, who organized the nurses to fill in the questionnaire online. A researcher reported the response rate to the NQCC of each city every day. The questionnaire content mainly involves: (1) demographic

characteristic: hospital name, hospital grade, department, name, age, gender, height, weight, etc. (2) systolic blood pressure, diastolic blood pressure. (3) The risk factors associated with hypertension: monthly night shift frequency, years of hyperlipidemia, years of diabetes, years of hypertension,educational status, marital status,menstruation condition, reproductive history, history of abortion, whether received hormone replacement therapy, smoking habit, alcohol drinking, physical exercise, family history of hypertension, etc[16-19].

Ethical considerations

The study was reviewed and approved by the Research Ethics Committee of the Second Hospital of Hebei Medical University (No. 2016225). Consent was implied by completion of the questionnaire. All participants were voluntary and had every right to participate or refuse without any reason. To protect the privacy of respondents, electronic data were saved in secured computer of the hospital with restricted access.

Participants and public involvement

In this study, self-report was adopted, and all the participants were nurses who understand the effect of blood pressure measurement on themselves. After receiving the notification of the blood pressure survey, all participants filled in and submitted relevant data online, and those who did not agree could refuse to participate. Although the study participants

or the public were not formally involved in the design and conduct of the study, the questionnaire used for data collection and the specific assessments conducted were developed based on previous experiences in other surveys and expert opinions. The findings will be disseminated to Municipal Nursing Quality and Control Center in Hebei Province, but not to participating nurses directly.

Measurement

Blood pressure measurement and data reporting: the nursing staff measured blood pressure by themselves and reported data through the network. Although nurses master the blood pressure measurement method generally, the researchers standardized the method of blood pressure measurement and gave the relevant attention in order to reduce measurement bias as much as possible. In order to ensure the accuracy of the report and blood pressure data, a series of measures were adopted for quality controlling. Firstly,our research group established a 3-level supervision mechanism,which contained Nursing Quality Control Center, Nursing departments at all levels and head nurses. Each day during the investigations, research group members exported data from information platform to conduct data analysis, calculate the number of staffs who have finished the questionnaire in each hospital, then feed back it to their municipal quality control centers for controlling

researching progress. Additionally, each questionnaire was checked and verified by professional quality investigators. After that, the results of verified data were sent to municipal quality control centers for complementing the missing items and correcting mistakes. Finally, we also attached important cautions while releasing announcement of taking blood pressure.

Blood pressure measurements:Chose a regular calibration of the mercury sphygmomanometer or validated electronic sphygmomanometer. Used the standard specification cuff with air bag length of 22cm and width of 12cm. The obese individuals or individuals with large arm circumference used a large size balloon cuff, and the upper arm was wrapped up at least 80% by air bag. Each participant was asked to take a rest at least for 5 minutes, any vigorous activity was avoided and cigarettes, beverage containing caffeine like tea and coffee were forbidden within 30 minutes, and empty the bladder before the blood pressure measurement. Blood pressure was measured on a sitting position, the right upper arm was measured without the cloth and with the cuff at the same level as heart. Each participant was measured three times with 1 min interval and the average of the last two readings was used for analysis.

Definitions

Hypertension was defined as systolic BP (SBP)≥140 mm Hg, or diastolic BP (DBP)≥90 mm Hg, and/or self-reported having an existing diagnosis of hypertension in accordance with the 2010 Chinese guideline. The new classification designates SBP ⩾ 130 mm Hg or DBP ⩾ 80 mm Hg and/or self-reported having an existing diagnosis of hypertension as hypertension according to the 2017 ACC/AHA guideline.

The ratio of hypertension to total population was the prevalence of hypertension. Awareness of hypertension was defined as any self-reported previous diagnosis of hypertension by a health care professional physician,treatment as self-reported use of a prescription medication for hypertension management within the 2 weeks at the time of the interview, control as pharmacologic treatment of hypertension associated with SBP <140 mm Hg and DBP <90 mm Hg during previous 2 weeks.

In addition, the study also estimated the prevalence (SBP⩾130 or DBP⩾80 mm Hg) and control rate (SBP<130 and DBP<80 mm Hg) of hypertension according to the 2017 ACC / AHA guideline.

Response rate was defined as the number of nurses responding to the questionnaire online divided by the total number of registered nurses in Hebei Province.

Statistical analysis

All variables were statistically described, the normality of the continuous variables was assessed, variables with a normal distribution were presented as mean±standard deviation, variables with a skewed distribution were reported with medians and interquartile ranges (IQRs), and categorical data were presented by the percentages description. The prevalence of hypertension as well as awareness, treatment, and control rates of hypertension among hypertensive participants were calculated according to the two guidelines. In addition, we reported the prevalence for each of the background characteristics of the study. Then we calculated the distribution of the population across 5 groups including those not having an existing diagnosis of hypertension with SBP/DBP <120/<80 mm Hg, 120 to 129/<80 mm Hg, 130 to139/80 to 89 mm Hg, and ⩾140/90 mm Hg, and those having an existing diagnosis of hypertension. To investigate the factors associated with newly diagnosed hypertension, the possible risk factors (gender, age, BMI, years of hyperlipidemia, years of diabetes, smoking, alcohol drinking, family history of hypertension) were incorporated into a multiple logistic regression analysis. Analyses were performed by using SPSS V.21.0 software. A two-sided P value<0.05 was considered statistically significant.

Results

Demographic characteristics

Totally, 93,603 participants from 512 medical institutions in 13 cities were enrolled in this study, accounting for 65.11% of the total number of registered nurses in Hebei province.The main reason for non-response might be some invited nurses having retired but not logged out of the registration system, being on leave including maternity leave, study leave and other reasons during the period of data collection or refusing to participate. After excluding 788 individuals with missing or incomplete questionnaires (n=788), 92,815 participants were included in the final analyses,among which 3,677 men (3.96%) and 89,138 women (96.04%). The mean age of participants was 31.65 (SD=7.47) years (age range: 18–65 years). (Table 1).

Table 1 Characteristics of study participants（N=92815）

Variable	N	Percentage (%)	SBP	DBP
Overall	92815	100	110.00(102.00-120.00)	70.00(64.00-80.00)
Gender				
Female	89138	96.04	110.00(101.00-120.00)	70.00(63.00-80.00)
Male	3677	3.96	123.00(120.00-130.00)	80.00(75.00-85.00)

Age,y*				
18-25	17289	18.63	110.00(102.00-120.00)	70.00(63.00-78.00)
26-35	53799	57.96	110.00(100.00-120.00)	70.00(62.00-78.00)
36-45	14989	16.15	110.00(105.00-120.00)	70.00(65.00-80.00)
46-55	6376	6.87	120.00(110.00-130.00)	80.00(70.00-85.00)
56-65	250	0.27	130.00(120.00-135.00)	80.00(75.00-86.13)
Missing data	112	0.12	-	-
BMI,kg/m^2 *[a]				
Underweight	7037	7.58	106.00(99.00-110.00)	68.00(60.00-70.00)
Normal	57077	61.50	110.00(100.00-120.00)	70.00(60.50-77.00)
Overweight	22235	23.96	118.00(110.00-123.00)	72.00(70.00-80.00)
Obese	6253	6.74	120.00(110.00-130.00)	79.00(70.00-80.00)
Missing data	213	0.23	-	-
Years of hyperlipidemia*				
0	86900	93.63	110.00(101.00-120.00)	70.00(63.00-80.00)
~5	4837	5.21	120.00(110.00-130.00)	80.00(70.00-85.00)
~10	636	0.69	125.50(110.00-140.00)	80.00(70.00-90.00)
＞10	127	0.14	128.00(120.00-140.00)	82.00(76.00-90.00)
Missing data	315	0.34	-	-
Years of diabetes*				
0	91886	99.00	110.00(102.00-120.00)	70.00(64.00-80.00)
~5	625	0.67	123.00(110.00-138.00)	80.00(70.00-90.00)
~10	164	0.18	120.00(110.00-130.00)	80.00(70.00-90.00)

＞10	56	0.06	129.73±18.05	80.00(75.25-90.00)
Missing data	84	0.09	-	-
Smoking				
Never	91020	98.07	110.00(102.00-120.00)	70.00(64.00-80.00)
＜10 cigarettes/day	1280	1.38	110.00(105.25-120.00)	70.00(66.00-80.00)
10-20 cigarettes/day	419	0.45	110.00(105.00-120.00)	70.00(68.00-80.00)
＞20 cigarettes/day	96	0.10	110.00(102.75-120.00)	70.00(70.00-80.00)
Alcohol drinking				
Never	45984	49.54	110.00(102.00-120.00)	70.00(64.00-80.00)
Occasionally	46263	49.84	110.00(102.00-120.00)	70.00(64.00-80.00)
Often	568	0.61	110.00(102.00-120.00)	70.00(69.25-80.00)
Family history of hypertension				
Yes	44451	47.89	110.00(102.00-120.00)	70.00(64.00-80.00)
No	48364	52.11	110.00(102.00-120.00)	70.00(64.00-80.00)

note：* with the missing data

[a] BMI was used to classify participants into categories of underweight (<18.5),normal weight (18.5 to <24), overweight (24 to <28) and obese (≥28).

BMI-body mass index,SBP-systolic blood pressure,DBP-diastolic blood pressure

2.2 Prevalence, awareness, treatment and control rate of hypertension in Chinese nurses according to the two edition of the guidelines

According to the 2017 ACC/AHA guideline, the prevalence of hypertension increased from 6.81% to 28.96%, and the prevalence rate

was 3.25 times higher than that defined in the 2010 Chinese guideline (female 3.36 times, male 2.35 times). However, the awareness rate of hypertension was 23.53% of that according to the 2010 Chinese guideline (female 22.90% , male 29.86%). The rate of drug treatment was 23.69% of that according to the 2010 Chinese guideline (female 23.04% , male 29.98%). The control rate of hypertension was 5.41% of that according to the 2010 Chinese guideline (female 5.40% , male 3.96%). (Table 2).

Table 2 Prevalence, awareness, treatment and control rate of hypertension

Participants	Diagnostic criteria for hypertension	Prevalence(95%CI)	Awareness(95%CI)	Treatment(95%CI)	Control(95%CI)
Overall	≥140/90[a]	6.81(6.65- 6.97)	57.37(57.05-57.69)	45.30(44.98-45.62)	14.97(14.74-15.20)
(N=92815)	≥130/80[b]	28.96(28.67-29.25)	13.50(13.28-13.72)	10.73(10.53-10.93)	0.81(0.75- 0.87)
Female	≥140/90[a]	6.28(6.12- 6.44)	58.52(58.20-58.84)	46.74(46.41-47.07)	16.10(15.86-16.34)
(N=89138)	≥130/80[b]	27.41(27.12-27.70)	13.40(13.18-13.62)	10.77(10.57-10.97)	0.87(0.81- 0.93)
Male	≥140/90[a]	19.83(18.54-21.12)	48.56(46.94-50.18)	34.29(32.76-35.82)	6.31(5.52- 7.10)
(N=3677)	≥130/80[b]	66.41(64.88-67.94)	14.50(13.36-15.64)	10.28(09.30-11.26)	0.25(0.09- 0.41)

a According to the diagnostic criteria for hypertension in the 2010 Chinese guideline

b According to the diagnostic criteria for hypertension in the 2017 edition of the guideline

CI-confidence interval

2.3 Multi-dimensional Comparative Analysis of hypertension prevalence among nursing staff

According to the 2017 ACC/AHA guideline, the number of people with high blood pressure in nursing staff rose from 6,324 to 26,875, with a total increase of 20,551. (Table 3). The prevalence rate of hypertension has increased by 3.25 times, from 6.81% to 28.96%. The prevalence of hypertension in female and male nurses increased by 3.36 and 2.35 times, respectively.

The prevalence of hypertension stratified by age (18-25, 26-35, 36-45, 46-55, and over 55 years) increased by 8.61, 4.97, 1.96, 1.04, and 1.03 times, respectively.

The prevalence of hypertension stratified by BMI (underweight, normal weight, overweight and obese) increased by 5.73, 4.42, 2.54 and 1.93 times, respectively.

The prevalence of hypertension stratified by years of hyperlipidemia(0,0~5,5~10,＞10) increased by 4.25, 0.90 ,0.43 and 0.56 times,respectively.

The prevalence of hypertension stratified by years of diabetes (0,0~5,5~10, ＞ 10) increased by 3.42, 0.53, 0.55 and 0.50 times, respectively.

The prevalence of hypertension stratified by the history of smoking(never, ＜ 10 cigarettes/day,10-20 cigarettes/day, ＞ 20 cigarettes/day) increased by3.24 ,3.77,3.34 and 5.20 times,respectively.

The prevalence of hypertension stratified by the history of drinking(never,occasionally,often) increased by 3.29, 3.22 and 3.14 times, respectively.

The prevalence of hypertension stratified by family history of hypertension(yes,no) inceased by 3.30 and 3.21 times ,respectively.

Table 4 shows that 60.68%, 10.36%, 22.14%, and 2.90% of nurses not having an existing diagnosis of hypertension had SBP/DBP levels of <120/80 mm Hg, 120 to 129/<80 mm Hg, 130 to 139/80 to 89 mm Hg, and ≥140/90 mm Hg, respectively. Additionally, 3.91% nurses were having an existing diagnosis of hypertension. Among nurses not having an existing diagnosis of hypertension, nurses with higher BP were older and were more likely to be men, be overweight or obese, having hyperlipidemia for less than 10 years, and have diabetes for less than 5 years.

Table 5 shows that gender (OR 0.647, 95% CI 0.585 to 0.716, p<0.001), age (OR 0.538, 95% CI 0.520 to 0.557, p<0.001), BMI (OR 0.760, 95% CI 0.729 to 0.791, p<0.001), years of hyperlipidemia (OR 0.426, 95% CI 0.397 to 0.458, p<0.001) and years of diabetes (OR 0.597, 95% CI 0.517 to 0.690, p<0.001) were factors significantly associated with newly diagnosed hypertension.

The female are more likely to be newly diagnosed with hypertension

than male according to the 2017 ACC/AHA guideline.Participants with no hyperlipidemia, no diabetes, lower age and lower BMI value are more likely to be newly diagnosed with hypertension.

Table 3 Comparison of hypertension prevalence among nursing staff

Variable	N	≥140/90[a]		≥130/80[b]		χ^2	*P*
		Hypertension	Prevalence	Hypertension	Prevalence	Value	Value
Gender							
Female	89138	5595	6.28(6.12- 6.44)	24433	27.41(27.12-27.70)	14211.74	＜0.001
Male	3677	729	19.83(18.54-21.12)	2442	66.41(64.88-67.94)	1626.88	＜0.001
Age,y*							
18-25	17289	448	2.59(2.35- 2.83)	4303	24.89(24.25-25.53)	3626.22	＜0.001
26-35	53799	2263	4.21(4.04- 4.38)	13532	25.15(24.78-25.52)	9423.20	＜0.001
36-45	14989	1784	11.90(11.38-12.42)	5284	35.25(34.49-36.01)	2267.87	＜0.001
46-55	6376	1726	27.07(25.98-28.16)	3524	55.27(54.05-56.49)	1046.70	＜0.001
56-65	250	91	36.40(30.44-42.36)	185	74.00(68.56-79.44)	71.46	＜0.001
BMI,kg/m^2 [C*]							
Underweight	7037	153	2.17(1.83- 2.51)	1028	14.61(13.78-15.44)	707.67	＜0.001
Normal	57077	2501	4.38(4.21- 4.55)	13552	23.74(23.39-24.09)	8852.47	＜0.001
Overweight	22235	2527	11.36(10.94-11.78)	8941	40.21(39.57-40.85)	4833.89	＜0.001
Obese	6253	1120	17.91(16.96-18.86)	3280	52.45(51.21-53.69)	1635.94	＜0.001
Years of hyperlipidemia*							
0	86900	4473	5.15(5.00- 5.30)	23495	27.04(26.74-27.34)	15418.70	＜0.001

~5	4837	1431	29.58(28.29-30.87)	2712	56.07(54.67-57.47)	692.76	＜0.001
~10	636	292	45.91(42.04-49.78)	417	65.57(61.88-69.26)	49.79	＜0.001
＞10	127	61	48.03(39.34-56.72)	95	74.80(67.25-82.35)	19.21	＜0.001
Years of diabetes*							
0	91886	5951	6.48(6.32- 6.64)	26285	28.61(28.32-28.90)	15554.93	＜0.001
~5	625	270	43.20(39.32-47.08)	413	66.08(62.37-69.79)	66.01	＜0.001
~10	164	64	39.02(31.55-46.49)	99	60.37(52.88-67.86)	14.94	＜0.001
＞10	56	30	53.57(40.51-66.63)	45	80.36(69.95-90.77)	9.08	0.003
Smoking							
Never	91020	6200	6.81(6.65- 6.97)	26290	28.88(28.59-29.17)	15121.35	＜0.001
＜10 cigarettes/day	1280	87	6.80(5.42- 8.18)	415	32.42(29.86-34.98)	266.59	＜0.001
10-20 cigarettes/day	419	32	7.64(5.10-10.18)	139	33.17(28.66-37.68)	84.12	＜0.001
＞20 cigarettes/day	96	5	5.21(0.76- 9.66)	31	32.29(22.94-41.64)	23.11	＜0.001
Alcohol drinking							
Never	45984	3085	6.71(6.48- 6.94)	13226	28.76(28.35-29.17)	7664.23	＜0.001
Occasionally	46263	3194	6.90(6.67- 7.13)	13463	29.10(28.69-29.51)	7720.74	＜0.001
Often	568	45	7.92(5.70-10.14)	186	32.75(28.89-36.61)	108.03	＜0.001
Family history of hypertension							
Yes	44451	2967	6.67(6.44- 6.90)	12743	28.67(28.25-29.09)	7389.14	＜0.001
No	48364	3357	6.94(6.71- 7.17)	14132	29.22(28.81-29.63)	8103.69	＜0.001

* with the missing data

a According to the diagnostic criteria for hypertension in 2010 Chinese guideline

b According to the diagnostic criteria for hypertension in the 2017 edition of the guideline

c BMI was classified into underweight (<18.5),normal weight (18.5 to <24), overweight (24 to <28) and obese (≥28).

BMI-body mass index

Table 4 Characteristics of study participants by blood pressure levels （N=92815）

Variable	Nurses not having an existing diagnosis of hypertension				having an existing diagnosis of hypertension
	＜120/80 (n=56320)	120-129/＜80(n=9620)	130-139/80-89 (n=20551)	≥140/90 （n=2696）	(n=3628)
Percentage of study participants	60.68 （60.28-61.08）	10.36 （9.75-10.97）	22.14 （21.57-22.71）	2.90 （2.27-3.53）	3.91 （3.28-4.54）
Gender					
Female	55669(98.84)	9036(93.93)	18838(91.66)	2321(86.09)	3274(90.24)
Male	651(1.16)	584(6.07)	1713(8.34)	375(13.91)	354(9.76)
Age,y*	29.00(26.00-34.00)	30.00(27.00-35.00)	30.00(26.00-36.00)	31.00(27.00-40.00)	43.00(35.00-49.00)
BMI*[a]					
Underweight	5587(9.92)	422(4.39)	875(4.26)	109(4.04)	44(1.21)
Normal	38076(67.61)	5449(56.64)	11051(53.77)	1220(45.25)	1281(35.31)
Overweight	10363(18.40)	2931(30.47)	6414(31.21)	926(34.35)	1601(44.13)
Obese	2176(3.86)	797(8.28)	2160(10.51)	428(15.88)	692(19.07)
Missing data	118(0.21)	21(0.22)	51(0.25)	13(0.48)	10(0.28)
Years of hyperlipidemia*					

0	54352(96.51)	9053(94.11)	19022(92.56)	2373(88.02)	2100(57.88)
~5	1652(2.93)	473(4.92)	1281(6.23)	251(9.31)	1180(32.52)
~10	167(0.30)	52(0.54)	125(0.61)	39(1.45)	253(6.97)
＞10	26(0.05)	6(0.06)	34(0.17)	1(0.04)	60(1.65)
Missing data	123(0.22)	36(0.37)	89(0.43)	32(1.19)	35(0.96)
Years of diabetes*					
0	56053(99.53)	9548(99.25)	20334(98.94)	2649(98.26)	3302(91.01)
~5	167(0.30)	45(0.47)	143(0.70）	31(1.15)	239(6.59)
~10	47(0.08)	18(0.19)	35(0.17)	10(0.37)	54(1.49)
＞10	10(0.02)	1(0.01)	15(0.07)	1(0.04)	29(0.80)
Missing data	43(0.08)	8(0.08)	24(0.12)	5(0.19)	4(0.11)
Smoking					
Never	55276(98.15)	9454(98.27)	20090(97.76)	2644(98.07)	3556(98.02)
＜10 cigarettes/day	740(1.31)	125(1.30)	328(1.60)	37(1.37)	50(1.38)
10-20 cigarettes/day	251(0.45)	29(0.30)	107(0.52)	12(0.45)	20(0.55)
＞20 cigarettes/day	53(0.09)	12(0.12)	26(0.13)	3(0.11)	2(0.06)
Alcohol drinking					
Never	27936(49.60)	4822(50.12)	10141(49.35)	1280(47.48)	1805(49.75)
Occasionally	28056(49.82)	4744(49.31)	10269(49.97)	1402(52.00)	1792(49.39)
Often	328(0.58)	54(0.56)	141(0.69)	14(0.52)	31(0.85)
Family history of hypertension					
Yes	27017(47.97)	4691(48.76)	9776(47.57)	1259(46.70)	1708(47.08)
No	29303(52.03)	4929(51.24)	10775(52.43)	1437(53.30)	1920(52.92)

SBP, mm Hg	108.00(100.00-110.00)	120.00(120.00-123.00)	120.00(120.00-125.00)	130.00(120.00-140.00)	140.00(130.00-145.00)
DBP, mm Hg	68.00(60.00-70.00)	70.00(70.00-75.00)	80.00(80.00-80.00)	90.00(90.00-90.00)	90.00(85.00-95.00)

Participants were grouped into the higher category of SBP and DBP.For example, if a person had SBP of 142 mm Hg and DBP of 88 mm Hg, she/he was grouped into the ≥140/90 mm Hg category.

* with the missing data

[a] BMI was used to classify participants into categories of underweight (<18.5),normal weight (18.5 to <24), overweight (24 to <28) and obese (≥28).

BMI-body mass index; SBP-systolic blood pressure; DBP-diastolic blood pressure

Table 5 Multiple logistic regression of factors associated with newly diagnosed hypertension

Variables	OR	95% CI	P
Gender	0.647	0.585 to 0.716	＜0.001
Age,y	0.538	0.520 to 0.557	＜0.001
BMI,kg/m^2	0.760	0.729 to 0.791	＜0.001
Years of hyperlipidemia	0.426	0.397 to 0.458	＜0.001
Years of diabetes	0.597	0.517 to 0.690	＜0.001
Smoking	1.070	0.921 to 1.243	0.379
Alcohol drinking	0.962	0.906 to 1.022	0.210

Family history of hypertension	0.946	0.890 to 1.006	0.077

BMI-body mass index,OR-odds ratio,CI-confidence interval

Discussion

At present, there are few studies on the current status of hypertension among nurses. This study is a cross-sectional survey based on a large sample of nursing staff. The final analyses included 92815 participants, who were from 512 medical institutions in 13 cities in Hebei province. According to the 2010 Chinese guideline, the prevalence rate of hypertension was 6.81% in this study. Therefore, we should pay more attention to the health condition of nurses. Li *et al*[20] investigated 4032 cardiovascular physicians from 386 hospitals in China. The results showed that the prevalence of hypertension among cardiovascular physicians was 13.1%. Liu *et al*[21] analyzed the prevalence of hypertension among 1369 medical staff in a tertiary academic hospital in Zhengzhou, and the prevalence of hypertension was 18.33%. The prevalence of hypertension in this survey was lower than the above level, which may be related to the lower age and the greater proportion of women of nursing staff. The report of China Health and Family Planning Commission indicated that the awareness rate of hypertension among people over 18 years old in China was 46.5%, the drug treatment rate was 41.1%, and the control rate was 13.8% in 2012[22]. In addition, a survey[23]

of 174,621 people aged 18 years or older in 31 provinces in China from 2013 to 2014 showed that the awareness, treatment and control rate were 31.9%, 26.4% and 9.7%,respectively. Lixin Jiang *et al*[24] made use of data generated in the China Patient-Centered Evaluative Assessment of Cardiac Events (PEACE) Million Persons Project from 2014 to 2017, a population-based screening project that enrolled around 1.7 million adults aged 35-75 years from all 31 provinces in mainland China. The age-standardised and sex-standardised rates of hypertension prevalence, awareness, treatment, and control were 37.2%, 36.0% , 22.9% and 5.7% , respectively. In this survey, the awareness rate of hypertension in nursing staff was 57.37%, the rate of treatment was 45.30%, and the control rate was 14.7%, all higher than the above results. However, the control rate of hypertension among female nurses was 16.10%, and among male nursing staff was only 6.31%. The awareness rate and treatment rate of nursing staff were slightly higher than those of the above research results. As a medical worker, the awareness rate of hypertension and the rate of drug treatment should have been higher. The survey showed that there is still much room for improvement in the awareness rate of hypertension.

In this study, we sought to assess the potential impact of the new hypertension guidelines on the status of blood pressure in clinical nurses. According to the 2017 ACC/AHA guideline, the hypertension prevalence rate of nursing personnel in the survey increased to 28.96%, which

increased 4.15 times among nurses under the 45 years old and 1.04 times among nurses of 45 years of age or older. The prevalence rate of the population with no hyperlipidemia, no diabetes, lower age and BMI value will increase, suggesting that more low-risk population will be diagnosed with hypertension. Meanwhile, the awareness rate, drug treatment rate and control rate of hypertension among Chinese nurses decreased from 57.37%, 45.30% and 14.97% to 13.50%, 10.73% and 0.81%, respectively.

A study from South Korea showed that in the cross-sectional study with 15,784 adults， the prevalence of hypertension was estimated to be 49.2% based on the BP criteria suggested by the 2017 ACC/AHA guidelines, which was a signifcant increase compared to the 30.4% prevalence rate based on the previous defnitions,the control rate decreased from 59.5 to 16.1[25]. And a study from Nepal found that if the ACC/AHA guideline was used, the overall prevalence of hypertension in Nepal would approximately double (from 21.2% to 44.2%)[26]. According to the standards of the new guidelines, the prevalence of hypertension among nurses in China is lower than the above two studies, which may be related to the fact that nurses are more female, lower in age level, and have more medical knowledge and resources. In addition, the difference could be due to several factors, including Nepal's predominantly rural population, relatively young population structure, and low income.

However, it is worth noting that the hypertension control rate among nurses according to the new standard is very low, only 0.81. Nurses as health care workers, they tend to own relatively adequate medical knowledge, and they are supposed to be more familiar with the medical environment and medical resources, but there still is a situation that a number of the nursing personnel neglecting their own blood pressure condition, consequently, it is urgent to enhance their awareness of health management and blood pressure monitoring. Our task is endeavor to achieve the target of early diagnosis, early treatment and early control of high blood pressure so that high blood pressure and related diseases can be effectively prevented and controlled. It has been reported that treatment of hypertension can reduce the risk of stroke and myocardial infarction by 30-43% and 15%, respectively, along with reducing the risk of a number of other chronic conditions[27-29]. The entire population including nursing staff should pay more attention to the management of blood pressure.Improving the lifestyle and monitoring the blood pressure regularly are suggested to control the blood pressure in a reasonable range. In order to prevent and control the occurrence of hypertension and related diseases, drug treatment should be carried out and therapeutic regimen should be adjusted in time if nessesary.

The guidelines recommend that antihypertensive drugs be considered in patients with coronary heart disease and stroke, or 10 years of

atherosclerotic cardiovascular disease risk 10% and blood pressure 130/80mmhg. If there is no coronary heart disease and stroke, and the 10-year risk of atherosclerotic cardiovascular disease is less than 10%, the starting standard is 140/90mmhg. Therefore, it can be speculated that according to the new guidelines, the number of nursing staff requiring medication will increase, but not all of them need medication, and they need to make a reasonable judgment based on their own conditions and medical history.

Meanwhile, the ACC/AHA guidelines would require expansion of the public health infrastructure necessary to manage the substantial increase in the public health burden of hypertension in China. Different countries have different epidemiological characteristics, genetic background, disease control and economic levels. More evidence-based medical evidence is needed to confirm whether the new guidelines are applicable to China, how to determine the boundary value of hypertension, and whether lowering blood pressure to 130/80mmhg can improve the prognosis. The number of hypertension patients in China is huge and the medical resources are relatively insufficient.The report of Chinese Center for Disease Control and Prevention in 2013 pointed out that the number of hypertension in China had risen to 330 million in 2010, and the direct economic burden caused by hypertension reached 210.3 billion yuan in 2013, accounting for 6.61% of the total health cost in China. The number

of people with high blood pressure in China will rise by a large margin according to the new guidelines, posing more severe challenges to medical and health resources.

Limitation

The large sample and high response rate make the data and results of this study better representative. However,some limitations should be considered when interpreting our data. First of all, this survey used the average blood pressure measured 2 times on the same day, that may have false positive diagnosis, resulting in overestimation of the prevalence rate. Secondly, the blood pressure was measured by nurses themselves rather than the staff trained unifiedly, but all nurses had received professional knowledge of blood pressure measurement. In addition, a unified description of the measurement methods and matters of attention were carried out in the study, which could ensure the reliability of the measurement results. Thirdly, because of the difference of blood pressure measuring instruments, it may have some effect on the data, but the sphygmomanometer had been tested and corrected. The blood pressure measurement in the survey was carried out according to international measurement and quality control regulations, which could guarantee the reliability of the measurement results. Furthermore, the small proportion of men and nurses over 55 years old in this study may have some influence on the study results. Finally, the generalizability of our results

may be restricted due to the participants being recruited from only one province in China. Future studies should be carried out to recruit participants from other cities in China.

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Contributors: WC conceived the study,WC, BZ, YMH and YJZ designed the study, drafted the manuscript, or critically revised the manuscript for important intellectual content.J Li, XMC, XLY, AFZ, RFJ, RQZ, ALF, YW, MJY, LT, SLC, JC and MZZ conducted the research and collected data,J Liu, DF and MHX analyzed the data, WC, BZ, JLiu, YMH and DF wrote the this article.All authors gave final approval of the version to be published and are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. WC is the corresponding author and guarantor.

Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author). No financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear

to have influenced the submitted work.

Ethical approval:The protocol was reviewed and approved by the Research Ethics Committee of the Second Hospital of Hebei Medical University(No 2016225).

Transparency statement: The guarantor (BZ) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Data sharing:No additional data available.

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Contribution, v) the inclusion of electronic links from the Contribution to third party material where-ever it may be located; and, vi) licence any third party to do any or all of the above.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Title and the 2st segment of Page 4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 4 and Page 5
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	the 2nd segment and the 3rd segment of Page 6
Objectives	3	State specific objectives, including any prespecified hypotheses	the 1st segment of Page 7
Methods			
Study design	4	Present key elements of study design early in the paper	Page 7 and page 8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 7 and Page 8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 9
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 12
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 8 and page 10
Bias	9	Describe any efforts to address potential sources of bias	Page 10 and page 11
Study size	10	Explain how the study size was arrived at	Page 8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	the first two segments of Page 13
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 13
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	the 3rd sentence of Page 8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive	14*	(a) Give characteristics of study participants (eg demographic,	Table 1

data		clinical, social) and information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Table 2 and Table 3
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 2 and Table 3
		(*b*) Report category boundaries when continuous variables were categorized	Table 1 、Table 3、Table4
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Table 5
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 25 and Page 26
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 30
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 25 and Page 26
Generalisability	21	Discuss the generalisability (external validity) of the study results	the last sentence of Page 30
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 32

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

The hypertension prevalence alteration in 92815 nurses based on the new standard by 2017 ACC/AHA hypertension guideline: an observational cross-sectional study from China

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The hypertension prevalence alteration in 92815 nurses based on the new standard by 2017 ACC/AHA hypertension guideline: an observational cross-sectional study from China

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Abstract

Objectives—This study aims to elucidate the status of hypertension and analyze the hypertension changes in prevalence, awareness, treatment and control rate among the portion of Chinese nursing staffs based on the

2017 American College of Cardiology (ACC) /American Heart Association (AHA) High Blood Pressure Guideline and the 2010 Chinese guideline for the management of hypertension.

Design—cross-sectional study.

Setting—512 medical institutions in 13 cities in Hebei province.

Participants—The candidate of registered nurses from 512 medical institutions in 13 cities in Hebei province (n=143772) were invited to participate in the survey and few of them who refused to participate were excluded from the research group. Based on the reasons that 93603 incumbent nurses at the age of 18-65 accepted to the survey and submitted questionnaires online. Undoubtedly, a response rate of 65.11% was achieved. After excluding 788 individuals with incomplete information in the questionnaires, 92815 participants were included in the final analysis.

Main outcome measures—The prevalence, awareness, treatment and control rates of hypertension.

Results—92815 participants were included in the final analysis, among which consisted of 3,677 men (3.96%) and 8,9138 women (96.04%). The mean age of participants was 31.65 (SD=7.47) years.

We demonstrated that 26,875 nursing staffs were diagnosed as hypertension according to the new standard by 2017 ACC/AHA guideline,

more than 20,551 cases compared with the previous threshold upon the 2010 Chinese guideline. The prevalence of hypertension among nursing staffs was 28.96% in the context of the 2017 ACC/AHA guideline, 3.25 times higher than that (6.81%) evaluated by the criteria of the 2010 Chinese guideline. However, the awareness, treatment and control rate (13.50%, 10.73%, 0.81%) were 3.25, 3.22 and 17.48 times lower than those (57.37%, 45.30%, 14.97%) based on the 2010 Chinese guideline, respectively.

Conclusions—This research illustrated that it was crucial for the improvement in the awareness rate, drug treatment rate and control rate of hypertension among nurses. Meanwhile, according to the 2017 ACC/AHA guideline, the prevalence of hypertension in China will increase significantly, which poses a more severe challenge to the management of hypertension in China.

Strengths and limitations of this study

1.This study described the current status of the hypertension in nurses according to the 2010 Chinese guideline and the 2017 ACC/AHA guideline.

2.This study had a large sample size, covering 13 regions, and described the prevalence and distribution of hypertension in different population groups.

3.Not all the relationships between hypertension and specific factors

identified in this study were investigated.

Introduction

With the rapid development of society and economy, the changes of lifestyle and the aging of the population, hypertension has become one of the most important public health issues in the world. Its complications are associated with high morbidity and mortality, as well as high rate of consumption of medical resources [1]. The direct economic burden caused by hypertension in China in 2013 amounted to 210.3 billion yuan, accounting for 6.61% of total expenditure on health of China[2-4]. According to the China Health and Nutrition Survey (CHNS) data from 1991 to 2011, the adjusted prevalence rate of hypertension in Chinese over 18 years old increased from 15.6% to 20.9% , the prevalence rate of hypertension increased[5], however, the awareness, treatment and control rates were still low[6].

The 2017 American Heart Association/American College of Cardiology (AHA/ACC) guideline for the prevention, detection, evaluation, and management of high blood pressure (BP) in adults has been recently released. A significant transformation in the guideline is the shift in the definition of hypertension, from systolic blood pressure（SBP）≥ 140 mm Hg or diastolic blood pressure (DBP) ≥ 90 mm Hg to systolic blood pressure（SBP）≥ 130 mm Hg or diastolic blood pressure(DBP) ≥ 80 mm Hg. According to the 2017 AHA/ACC guideline, the prevalence

rate of hypertension increased from 31.9% to 45.6% in the United States[7].

The 2017 ACC/AHA guideline may bring critical effects on the hypertension status in different regions worldwide[8-11]. Recently, more and more researchers focused on the issues about the potential impacts of the updated guideline on Chinese population. A nationally representative cross sectional study examined the hypertension prevalence rate according to the new guideline and found an absolute increase of 17.0% among adults aged 45 to 75 years in China[12]. Additionally, a survey examined the effects of the new guideline in Southwest China and found the prevalence of hypertension was nearly twice than the Chinese hypertension guideline[13]. Findings from previous studies were mainly focused on the increase in the prevalence of hypertension in Chinese general population under the new guideline, but it was still largely unclear that how the new guideline exerted influence on the hypertension status in different social communities in China. And the nursing staff, as a specially class of professional group, whose work was of high intensity, characterized with high stress level and requires frequent rotating shifts, their blood pressure level should be paid more attention to[14, 15].This study was a cross-sectional survey based on a large number of nursing staffs. The purpose was to analyze the alteration of prevalence, awareness, treatment and control rates of hypertension in

Chinese nursing staffs based on the 2017 ACC/AHA guideline and the 2010 Chinese guideline, as well as the characteristics of the newly diagnosed hypertension population.

METHODS

Participants and data collection

This cross-sectional study was conducted from October 2016 to February 2017, using general survey design. The candidate of registered nurses from 512 medical institutions in 13 cities in Hebei province(n=143772) were invited to participate in the survey and few of them who refused to participate were excluded from the research group. Based on the reasons that who accepted to the survey and submitted questionnaires online, we collected 93,603 incumbent nurses at the age of 18-65. Undoubtedly a response rate of 65.11% was achieved. After excluding 788 individuals with incomplete information in the questionnaires, 92815 participants were included in the final analysis.

Electronic folders were distributed to the Nursing Quality Control Center (NQCC) of each city through NQCC of Hebei Province. The folder contained three documents: the link of electronic questionnaire(SO JUMP), a document on blood pressure measurement precautions and an investigation notice.Upon receiving the folder, the contact person of each NQCC sent it to the nursing department of all medical institutions in the different cities Then the nursing department sent it to the head managers

of departments, who organized the nurses to fill in the questionnaire online. A researcher was arranged to report the response rate to the NQCC of each city every day. The questionnaire content mainly involves: (1) Demographic characteristic: hospital name, hospital grade, department, name, age, gender, height, weight, etc. (2) Systolic blood pressure, diastolic blood pressure. (3) The risk factors associated with hypertension: monthly night shift frequency, years of hyperlipidemia, years of diabetes, years of hypertension,educational status, marital status,menstruation condition, reproductive history, history of abortion, whether received hormone replacement therapy, smoking habit, alcohol drinking, physical exercise, family history of hypertension, etc[16-19].

Ethical considerations

The study was reviewed and approved by the Research Ethics Committee of the Second Hospital of Hebei Medical University (No. 2016225). Consent was implied by completion of the questionnaire. All participants were voluntary and had right to participate or refuse without any reason. To protect the privacy of respondents, electronic data were saved in secured computer of the hospital with restricted access.

Participants and public involvement

In this study, self-report was adopted, and all the participants were nurses who understood the effect of blood pressure measurement by themselves.

After receiving the notification of the blood pressure survey, all participants filled in and submitted relevant data online, and those who did not accept could refuse to participate. Although the participants or the public were not formally involved in the design and conduct of the study, the questionnaire used for data collection and the specific assessments conduction were developed based on previous experiences in other surveys and expert opinions. The research data would be sent to Municipal Nursing Quality and Control Center in Hebei Province.

Measurement

Blood pressure measurement and data reporting: the nursing staff measured blood pressure by themselves and reported data through the network. Although nurses mastered the blood pressure measurement method generally, the researchers standardized the method of blood pressure measurement and gave the relevant attention in order to reduce measurement bias as much as possible. In order to ensure the accuracy of the report and blood pressure data, a series of measures were adopted for quality controlling. Firstly,our research group established a 3-level supervision mechanism which contained Nursing Quality Control Center, nursing departments and head nurses of hospitals at all levels. Each day during the investigations, research group members exported data from information platform to conduct data analysis, calculated the number of staffs who had finished the questionnaire in each hospital, then feed it

back it to their municipal quality control centers for controlling researching progress. Additionally, each questionnaire was checked and verified by professional quality investigators. After that, the results of verified data were sent to municipal quality control centers for complementing the missing items and correcting mistakes. What is more, we also attached important cautions while releasing announcement of taking blood pressure.

Blood pressure measurements:Chose a regular calibration of the mercury sphygmomanometer or validated electronic sphygmomanometer. Used the standard specification cuff with air bag which is 22cm in length and 12cm in width. The obese individuals or individuals with large arm circumference used a large size balloon cuff, and the upper arm was wrapped up at least 80% by air bag. Each participant was asked to take a rest at least for 5 minutes, any vigorous activity was avoided and cigarettes, beverage containing caffeine like tea and coffee were forbidden within 30 minutes, and empty the bladder before the blood pressure measurement. Blood pressure was measured in a sitting position, the right upper arm should be exposed and the cuff should be kept at the same level as heart. Each participant was measured three times with an interval time of 1 min interval and the average of the last two readings was used for analysis.

Definitions

Hypertension was defined as systolic BP (SBP)≥140 mm Hg, or diastolic BP (DBP)≥90 mm Hg, and/or self-reported having an existing diagnosis of hypertension in accordance with the 2010 Chinese guideline. The new classification designates SBP≥130 mm Hg or DBP≥80 mm Hg and/or self-reported having an existing diagnosis of hypertension as hypertension according to the 2017 ACC/AHA guideline.

The ratio of hypertension to total population was the prevalence of hypertension. Awareness of hypertension was defined as any self-reported previous diagnosis of hypertension by a health care professional physician,treatment was self-reported use of a prescription medication for hypertension management within the 2 weeks at the time of the interview, control referred to pharmacologic treatment of hypertension associated with SBP <140 mm Hg and DBP <90 mm Hg during the past 2 weeks.

In addition, the study also estimated the prevalence (SBP≥130 or DBP≥80 mm Hg) and control rate (SBP<130 and DBP<80 mm Hg) of hypertension according to the 2017 ACC / AHA guideline.

Response rate was defined as the number of nurses responding to the questionnaire online divided by the total number of registered nurses in Hebei Province.

Statistical analysis

All variables were statistically described, the normality of the

continuous variables was assessed, variables with a normal distribution were presented as mean±standard deviation, variables with a skewed distribution were reported with medians and interquartile ranges (IQRs), and categorical data was presented by the percentages description. The prevalence of hypertension as well as awareness, treatment, and control rates of hypertension among hypertensive participants were calculated according to the two guidelines. In addition, we reported the prevalence for each of the background characteristics of the study. Then we calculated the distribution of the population across 5 groups including those who didn't have an existing diagnosis of hypertension with SBP/DBP <120/<80 mm Hg, 120 to 129/<80 mm Hg, 130 to139/80 to 89 mm Hg, and≥140/90 mm Hg, and those who had an existing diagnosis of hypertension. To investigate the factors associated with newly diagnosed hypertension, the possible risk factors (gender, age, BMI, years of hyperlipidemia, years of diabetes, smoking, alcohol drinking, family history of hypertension) were incorporated into a multiple logistic regression analysis. Analyses were performed by using SPSS V.21.0 software. A two-sided P value<0.05 was considered statistically significant.

Results

Demographic characteristics

Totally, 93,603 participants from 512 medical institutions in 13 cities were enrolled in this study, accounting for 65.11% of the total number of registered nurses in Hebei province.The main reason for non-response might be that some invited nurses have retired but have not logged out of the registration system, being on leave including maternity leave, study leave and other reasons during the period of data collection or refusing to participate.

After excluding 788 individuals with incomplete questionnaires, information in the 92,815 participants were included in the final analysis, among which consisted of 3,677 men (3.96%) and 89,138 women (96.04%). The median (IQR) age of participants was 30 (26-35) years (age range: 18–65 years). Our sample contained more people aged 35 years and younger (76.59%; table 1). Hypertension levels in different groups were shown in Table 1.With the increase of BMI, years of diabetes and years of hyperlipidemia, the blood pressure presented increasing trend.

Table 1 Characteristics of study participants（N=92815）

Variable	N	Percentage (%)	SBP Median(IQR)/mean±SD	DBP Median(IQR)
Overall	92815	100	110(102-120)	70(64-80)
Gender				
Female	89138	96.04	110(101-120)	70(63-80)
Male	3677	3.96	123(120-130)	80(75-85)
Age,y*				

18-25	17289	18.63	110(102-120)	70(63-78)
26-35	53799	57.96	110(100-120)	70(62-78)
36-45	14989	16.15	110(105-120)	70(65-80)
46-55	6376	6.87	120(110-130)	80(70-85)
56-65	250	0.27	130(120-135)	80(75-86)
Missing data	112	0.12	-	-
BMI,kg/m^2 *[a]				
Underweight	7037	7.58	106(99-110)	68(60-70)
Normal	57077	61.50	110(100-120)	70(61-77)
Overweight	22235	23.96	118.(110-123)	72(70-80)
Obese	6253	6.74	120(110-130)	79(70-80)
Missing data	213	0.23	-	-
Years of hyperlipidemia*				
0	86900	93.63	110(101-120)	70(63-80)
~5	4837	5.21	120.(110-130)	80(70-85)
~10	636	0.69	125(110-140)	80(70-90)
＞10	127	0.14	128(120-140)	82(76-90)
Missing data	315	0.34	-	-
Years of diabetes*				
0	91886	99.00	110(102-120)	70(64-80)
~5	625	0.67	123(110-138)	80(70-90)
~10	164	0.18	120(110-130)	80(70-90)
＞10	56	0.06	130±18	80(75-90)
Missing data	84	0.09	-	-
Smoking				
Never	91020	98.07	110(102-120)	70(64-80)
＜10 cigarettes/day	1280	1.38	110(105-120)	70(66-80)
10-20 cigarettes/day	419	0.45	110(105-120)	70(68-80)

＞20 cigarettes/day	96	0.10	110(103-120)	70(70-80)
Alcohol drinking				
Never	45984	49.54	110(102-120)	70(64-80)
Occasionally	46263	49.84	110(102-120)	70(64-80)
Often	568	0.61	110(102-120)	70(69-80)
Family history of hypertension				
Yes	44451	47.89	110(102-120)	70(64-80)
No	48364	52.11	110(102-120)	70(64-80)

note：* with the missing data

[a] BMI was used to classify participants into categories of underweight (<18.5),normal weight (18.5 to <24), overweight (24 to <28) and obese (≥28).

BMI-body mass index,SBP-systolic blood pressure,DBP-diastolic blood pressure

2.2 Prevalence, awareness, treatment and control rate of hypertension in Chinese nurses according to the two edition of the guidelines

According to the 2017 ACC/AHA guideline, the prevalence of hypertension increased from 6.81% to 28.96%, and the prevalence rate was 3.25 times higher than that defined in the 2010 Chinese guideline. The awareness rate, drug treatment rate and control rate of hypertension according to two guidelines were shown in Table 2.

Table 2 Prevalence, awareness, treatment and control rate of hypertension

Participants	Diagnostic criteria for hypertension	Prevalence(95%CI)	Awareness(95%CI)	Treatment(95%CI)	Control(95%CI)
Overall	≥140/90[a]	6.81(6.65- 6.97)	57.37(57.05-57.69)	45.30(44.98-45.62)	14.97(14.74-15.20)

(N=92815)	≥130/80[b]	28.96(28.67-29.25)	13.50(13.28-13.72)	10.73(10.53-10.93)	0.81(0.75- 0.87)
Female	≥140/90[a]	6.28(6.12- 6.44)	58.52(58.20-58.84)	46.74(46.41-47.07)	16.10(15.86-16.34)
(N=89138)	≥130/80[b]	27.41(27.12-27.70)	13.40(13.18-13.62)	10.77(10.57-10.97)	0.87(0.81- 0.93)
Male	≥140/90[a]	19.83(18.54-21.12)	48.56(46.94-50.18)	34.29(32.76-35.82)	6.31(5.52- 7.10)
(N=3677)	≥130/80[b]	66.41(64.88-67.94)	14.50(13.36-15.64)	10.28(09.30-11.26)	0.25(0.09- 0.41)

a According to the diagnostic criteria for hypertension in the 2010 Chinese guideline

b According to the diagnostic criteria for hypertension in the 2017 edition of the guideline

CI-confidence interval

2.3 Multi-dimensional Comparative Analysis of hypertension prevalence among nursing staff

According to the 2017 ACC/AHA guideline, the number of people with high blood pressure in nursing staff rose from 6,324 to 26,875, with a total increase of 20,551. The times of increase of hypertension prevalence in different groups according to the new guideline were shown in Table 3 .

Table 4 showed that 60.68%, 10.36%, 22.14%, and 2.90% of nurses not having an existing diagnosis of hypertension had SBP/DBP levels of <120/80 mm Hg, 120 to 129/<80 mm Hg, 130 to 139/80 to 89 mm Hg, and ≥140/90 mm Hg, respectively. Additionally, 3.91% nurses were having an existing diagnosis of hypertension. Among the nurses who didn't have an existing diagnosis of hypertension, nurses with higher BP were older and more likely to be men, overweight or obese, and tended to

have hyperlipidemia for less than 10 years or diabetes for less than 5 years.

Table 5 showed that gender (OR 0.647, 95% CI 0.585 to 0.716, p<0.001), age (OR 0.538, 95% CI 0.520 to 0.557, p<0.001), BMI (OR 0.760, 95% CI 0.729 to 0.791, p<0.001), years of hyperlipidemia (OR 0.426, 95% CI 0.397 to 0.458, p<0.001) and years of diabetes (OR 0.597, 95% CI 0.517 to 0.690, p<0.001) were factors significantly associated with newly diagnosed hypertension.

The female were more likely to be newly diagnosed with hypertension than male according to the 2017 ACC/AHA guideline. Besides, Participants with no hyperlipidemia, no diabetes, lower age and lower BMI value were more likely to be newly diagnosed with hypertension.

Table 3 Comparison of hypertension prevalence among nursing staff

Variable	N	≥140/90[a]		≥130/80[b]		Times of increase
		Hypertension	Prevalence (95%CI)	Hypertension	Prevalence (95%CI)	
Gender						
Female	89138	5595	6.28(6.12-6.44)	24433	27.41(27.12-27.70)	3.36
Male	3677	729	19.83(18.54-21.12)	2442	66.41(64.88-67.94)	2.35
Age,y*						
18-25	17289	448	2.59(2.35-2.83)	4303	24.89(24.25-25.53)	8.61
26-35	53799	2263	4.21(4.04-	13532	25.15(24.78-25.52)	4.97

			4.38)			
36-45	14989	1784	11.90(11.38-12.42)	5284	35.25(34.49-36.01)	1.96
46-55	6376	1726	27.07(25.98-28.16)	3524	55.27(54.05-56.49)	1.04
56-65	250	91	36.40(30.44-42.36)	185	74.00(68.56-79.44)	1.03
BMI,kg/m^2 c*						
Underweight	7037	153	2.17(1.83-2.51)	1028	14.61(13.78-15.44)	5.73
Normal	57077	2501	4.38(4.21-4.55)	13552	23.74(23.39-24.09)	4.42
Overweight	22235	2527	11.36(10.94-11.78)	8941	40.21(39.57-40.85)	2.54
Obese	6253	1120	17.91(16.96-18.86)	3280	52.45(51.21-53.69)	1.93
Years of hyperlipidemia*						
0	86900	4473	5.15(5.00-5.30)	23495	27.04(26.74-27.34)	4.25
~5	4837	1431	29.58(28.29-30.87)	2712	56.07(54.67-57.47)	0.90
~10	636	292	45.91(42.04-49.78)	417	65.57(61.88-69.26)	0.43
＞10	127	61	48.03(39.34-56.72)	95	74.80(67.25-82.35)	0.56

Years of diabetes*						
0	91886	5951	6.48(6.32-6.64)	26285	28.61(28.32-28.90)	3.42
~5	625	270	43.20(39.32-47.08)	413	66.08(62.37-69.79)	0.53
~10	164	64	39.02(31.55-46.49)	99	60.37(52.88-67.86)	0.55
＞10	56	30	53.57(40.51-66.63)	45	80.36(69.95-90.77)	0.50
Smoking						
Never	91020	6200	6.81(6.65-6.97)	26290	28.88(28.59-29.17)	3.24
＜10 cigarettes/day	1280	87	6.80(5.42-8.18)	415	32.42(29.86-34.98)	3.77
10-20 cigarettes/day	419	32	7.64(5.10-10.18)	139	33.17(28.66-37.68)	3.34
＞20 cigarettes/day	96	5	5.21(0.76-9.66)	31	32.29(22.94-41.64)	5.20
Alcohol drinking						
Never	45984	3085	6.71(6.48-6.94)	13226	28.76(28.35-29.17)	3.29
Occasionally	46263	3194	6.90(6.67-7.13)	13463	29.10(28.69-29.51)	3.22

Often	568	45	7.92(5.70-10. 14)	186	32.75(28.89-36.61)	3.14
Family history of hypertension						
Yes	44451	2967	6.67(6.44-6.90)	12743	28.67(28.25-29.09)	3.30
No	48364	3357	6.94(6.71-7.17)	14132	29.22(28.81-29.63)	3.21

* with the missing data

a According to the diagnostic criteria for hypertension in 2010 Chinese guideline

b According to the diagnostic criteria for hypertension in the 2017 edition of the guideline

c BMI was classified into underweight (<18.5),normal weight (18.5 to <24), overweight (24 to <28) and obese (≥28).

BMI-body mass index

Table 4 Characteristics of study participants by blood pressure levels （N=92815）

Variable	Nurses not having an existing diagnosis of hypertension				having an existing diagnosis of hypertension,n(%) (n=3628)
	＜120/80,n(%) (n=56320)	120-129/＜80,n(%) (n=9620)	130-139/80-89,n(%) (n=20551)	≥140/90,n(%) （n=2696）	
Percentage of study participants	60.68 （60.28-61.08）	10.36 （9.75-10.97）	22.14 （21.57-22.71）	2.90 （2.27-3.53）	3.91 （3.28-4.54）
Gender					
Female	55669(98.84)	9036(93.93)	18838(91.66)	2321(86.09)	3274(90.24)
Male	651(1.16)	584(6.07)	1713(8.34)	375(13.91)	354(9.76)
Age,y*	29(26-34)	30(27-35)	30(26-36)	31(27-40)	43(35-49)
BMI*[a]					

Underweight	5587(9.92)	422(4.39)	875(4.26)	109(4.04)	44(1.21)
Normal	38076(67.61)	5449(56.64)	11051(53.77)	1220(45.25)	1281(35.31)
Overweight	10363(18.40)	2931(30.47)	6414(31.21)	926(34.35)	1601(44.13)
Obese	2176(3.86)	797(8.28)	2160(10.51)	428(15.88)	692(19.07)
Missing data	118(0.21)	21(0.22)	51(0.25)	13(0.48)	10(0.28)
Years of hyperlipidemia*					
0	54352(96.51)	9053(94.11)	19022(92.56)	2373(88.02)	2100(57.88)
~5	1652(2.93)	473(4.92)	1281(6.23)	251(9.31)	1180(32.52)
~10	167(0.30)	52(0.54)	125(0.61)	39(1.45)	253(6.97)
＞10	26(0.05)	6(0.06)	34(0.17)	1(0.04)	60(1.65)
Missing data	123(0.22)	36(0.37)	89(0.43)	32(1.19)	35(0.96)
Years of diabetes*					
0	56053(99.53)	9548(99.25)	20334(98.94)	2649(98.26)	3302(91.01)
~5	167(0.30)	45(0.47)	143(0.70）	31(1.15)	239(6.59)
~10	47(0.08)	18(0.19)	35(0.17)	10(0.37)	54(1.49)
＞10	10(0.02)	1(0.01)	15(0.07)	1(0.04)	29(0.80)
Missing data	43(0.08)	8(0.08)	24(0.12)	5(0.19)	4(0.11)
Smoking					
Never	55276(98.15)	9454(98.27)	20090(97.76)	2644(98.07)	3556(98.02)
＜10 cigarettes/day	740(1.31)	125(1.30)	328(1.60)	37(1.37)	50(1.38)
10-20 cigarettes/day	251(0.45)	29(0.30)	107(0.52)	12(0.45)	20(0.55)
＞20 cigarettes/day	53(0.09)	12(0.12)	26(0.13)	3(0.11)	2(0.06)
Alcohol drinking					
Never	27936(49.60)	4822(50.12)	10141(49.35)	1280(47.48)	1805(49.75)
Occasionally	28056(49.82)	4744(49.31)	10269(49.97)	1402(52.00)	1792(49.39)
Often	328(0.58)	54(0.56)	141(0.69)	14(0.52)	31(0.85)

Family history of hypertension					
Yes	27017(47.97)	4691(48.76)	9776(47.57)	1259(46.70)	1708(47.08)
No	29303(52.03)	4929(51.24)	10775(52.43)	1437(53.30)	1920(52.92)
SBP median (IQR), mm Hg	108(100-110)	120(120-123)	120(120-125)	130(120-140)	140(130-145)
DBP median(IQR), mm Hg	68(60-70)	70(70-75)	80(80-80)	90(90-90)	90(85-95)

Participants were grouped into the higher category of SBP and DBP.For example, if a person had SBP of 142 mm Hg and DBP of 88 mm Hg, she/he was grouped into the ≥140/90 mm Hg category.

* with the missing data

[a] BMI was used to classify participants into categories of underweight (<18.5),normal weight (18.5 to <24), overweight (24 to <28) and obese (≥28).

BMI-body mass index; SBP-systolic blood pressure; DBP-diastolic blood pressure

Table 5 Multiple logistic regression of factors associated with newly diagnosed hypertension

Variables	OR	95% CI	P
Gender	0.647	0.585 to 0.716	＜0.001
Age,y	0.538	0.520 to 0.557	＜0.001
BMI,kg/m^2	0.760	0.729 to 0.791	＜0.001
Years of hyperlipidemia	0.426	0.397 to 0.458	＜0.001
Years of diabetes	0.597	0.517 to 0.690	＜0.001
Smoking	1.070	0.921 to 1.243	0.379

Alcohol drinking	0.962	0.906 to 1.022	0.210
Family history of hypertension	0.946	0.890 to 1.006	0.077

BMI-body mass index,OR-odds ratio,CI-confidence interval

Discussion

At present, there were few studies on the current status of hypertension among nurses. This study was a cross-sectional survey based on a large sample of nursing staff. The final analysis included 92815 participants from 512 medical institutions in 13 cities in Hebei province. According to the 2010 Chinese guideline, the prevalence rate of hypertension was 6.81% in this study. Li *et al*[20] investigated 4032 cardiovascular physicians from 386 hospitals in China and found that the prevalence of hypertension among them was 13.1%. Liu *et al*[21] analyzed the prevalence of hypertension among 1369 medical staffs in a tertiary academic hospital in Zhengzhou, and the prevalence of hypertension was 18.33%. The prevalence of hypertension in this survey was lower than the above results, which may be related to the lower age and the greater proportion of women of nursing staffs. The report of China Health and Family Planning Commission indicated that the awareness rate of hypertension among people over 18 years old in China was 46.5%, the drug treatment rate was 41.1%, and the control rate was 13.8% in 2012[22]. In addition, a survey[23] of 174,621 people aged 18 years or older in 31

provinces in China from 2013 to 2014 showed that the awareness, treatment and control rate were 31.9%, 26.4% and 9.7%,respectively. Lixin Jiang *et al*[24] organized a population-based screening hypertension project enrolling around 1.7 million adults aged 35-75 years from all 31 provinces in mainland China. The rates of hypertension prevalence, awareness, treatment, and control were 37.2%, 36.0% , 22.9% and 5.7% , respectively. In this survey, the awareness rate of hypertension in nursing staff was 57.37%, the rate of treatment was 45.30%, and the control rate was 14.97%, which were all higher than the above results. However, the control rate of hypertension among female nurses was 16.10%, and among male nursing staff was only 6.31%. For medical workers, the awareness rate and drug treatment rate of hypertension should have been higher. There was still large space for improvement in the awareness rate of hypertension.

In this study, we sought to assess the potential impact of the new hypertension guideline on the status of blood pressure in clinical nurses. According to the 2017 ACC/AHA guideline, the hypertension prevalence rate of nursing personnel in the survey increased to 28.96%, which increased 4.15 times among nurses under the 45 years old and 1.04 times among nurses of 45 years of age or older. The prevalence rate of the population with no hyperlipidemia, no diabetes, lower age and BMI value increased, suggested that more low-risk population would be diagnosed

with hypertension. Meanwhile, the awareness rate, drug treatment rate and control rate of hypertension among Chinese nurses decreased from 57.37%, 45.30% and 14.97% to 13.50%, 10.73% and 0.81%, respectively.

A study from South Korea showed that the prevalence of hypertension was 49.2% based on the 2017 ACC/AHA guideline, while the number was 30.4% based on the previous guideline, the control rate decreased from 59.5% to 16.1%[25]. Additionally, a study from Nepal found that if the ACC/AHA guideline was applied, the overall prevalence of hypertension in Nepal would be approximately double (from 21.2% to 44.2%)[26]. According to the standards of the new guideline, the prevalence of hypertension among nurses in China was lower than the above two studies, which might be related to the fact that most of the nurses were female, lower in age level, and had more medical knowledge and resources. In addition, the difference could be due to several factors, including Nepal's predominantly rural population and low income. However, it is worth noting that the hypertension control rate among nurses according to the new standard is very low, only 0.81%. It had been reported that treatment of hypertension could reduce the risk of stroke and myocardial infarction by 30-43% and 15%, respectively, along with reducing the risk of a number of other chronic conditions[27-29]. Consequently, the nursing staff should pay more attention to the

management of blood pressure. Improving the lifestyle and monitoring the blood pressure regularly were suggested to control the blood pressure in a reasonable range.

The new guideline generally recommends using of BP-lowering medications for secondary prevention of CVD in patients with clinical CVD (CHD, HF, and stroke) and an average BP ≥130/80 mm Hg and for primary prevention of CVD in adults with an estimated 10-year ASCVD risk of ≥10% and an average SBP ≥130 mm Hg or an average DBP ≥80 mm Hg. Despite the fact that the number of nursing staff who need the medication treatment is speculated to increase according to the new guideline, they should take both their own conditions and medical history into consideration to make a a reasonable judgment on whether it is necessary and proper for them to take the medicine.

Meanwhile, the ACC/AHA guideline would require expansion of the necessary public health infrastructure to manage the substantial increase in the public health burden of hypertension in China. Different countries have different epidemiological characteristics, genetic background, disease control and economic levels. More facts founded on evidence-based medicine is needed to confirm whether the new guideline is applicable to China, how to determine the boundary value of hypertension, and whether lowering hypertension diagnosis standard to 130/80mmhg can improve the prognosis. The number of hypertension

patients in China is huge and the medical resources are relatively insufficient.The report of Chinese Center for Disease Control and Prevention in 2013 pointed out that the number of hypertension in China had risen to 330 million in 2010, and the direct economic burden caused by hypertension reached 210.3 billion yuan in 2013, accounting for 6.61% of the total health cost in China. The number of people with high blood pressure in China will rise by a large margin according to the new guidelines, which poses more severe challenges to medical and health resources.

Limitation

Some limitations should be considered when interpreting our data. First of all, this survey used the average blood pressure measured 2 times on the same day, which may lead to false positive diagnosis, resulting in overestimation of the prevalence rate. Secondly, the blood pressure was measured by nurses themselves rather than the staff trained unifiedly, but all nurses had received professional knowledge of blood pressure measurement. In addition, a unified description of the measurement methods and matters of attention were carried out in the study, which could ensure the reliability of the measurement results. Thirdly, because of the difference of blood pressure measuring instruments, it may have some effect on the data, but the sphygmomanometer had been tested and corrected. The blood pressure measurement in the survey was carried out

according to international measurement and quality control regulations, which could guarantee the reliability of the measurement results. Furthermore, the small proportion of men and nurses over 55 years old in this study may have some influence on the study results. Finally, the generalizability of our results may be restricted because the participants being recruited were from only one province in China. Future studies should be carried out to recruit participants from other cities in China.

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Contributors: WC conceived the study,WC, BZ, YMH and YJZ designed the study, drafted the manuscript, or critically revised the manuscript for important intellectual content.J Li, XMC, XLY, AFZ, RFJ, RQZ, ALF, YW, MJY, LT, SLC, JC and MZZ conducted the research and collected data,J Liu, DF and MHX analyzed the data, WC, BZ, JLiu, YMH and DF wrote the this article.All authors gave final approval of the version to be published and are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. WC is the corresponding author and guarantor.

Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf (available on

request from the corresponding author). No financial relationships with any organizations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval:The protocol was reviewed and approved by the Research Ethics Committee of the Second Hospital of Hebei Medical University(No 2016225).

Transparency statement: The guarantor (BZ) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Data sharing:No additional data available.

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abstracts of the Contribution, iii) create any other derivative work(s) based on the Contribution, iv) to exploit all subsidiary rights in the Contribution, v) the inclusion of electronic links from the Contribution to third party material where-ever it may be located; and, vi) licence any third party to do any or all of the above.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Title and the 2nd segment of Page 4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page3, Page 4 and Page 5
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 6
Objectives	3	State specific objectives, including any prespecified hypotheses	the 2nd segment of Page 7
Methods			
Study design	4	Present key elements of study design early in the paper	page 8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 9 and Page10
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 12
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 8 and page 10
Bias	9	Describe any efforts to address potential sources of bias	Page 10 and page 11
Study size	10	Explain how the study size was arrived at	Page 8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 12
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	the 2nd sentence of Page 8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive	14*	(a) Give characteristics of study participants (eg demographic,	Table 1

data		clinical, social) and information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Table 2 and Table 3
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 2 and Table 3
		(*b*) Report category boundaries when continuous variables were categorized	Table 1 、Table 3、Table4
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Table 5
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 22, Page 23 and Page 24
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 26 and Page 27
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 25 and Page 26
Generalisability	21	Discuss the generalisability (external validity) of the study results	the last sentence of Page 26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 28

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.