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Prevalence and risk factors associated with prehypertension in Shunde District, southern China

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ABSTRACT

Objective: To explore the prevalence and combined cardiovascular risk factors of prehypertension in southern China.

Design: A retrospective study; the logistic regression model was used to find the risk factors of prehypertension.

Setting: The study was conducted in Shunde District, southern China, using the community-based health check-up information.

Participants: Participants aged ≥35 years with complete health check-up information data between January 2011 and December 2013 were enrolled and divided into hypertension, prehypertension and optimal blood pressure (BP) groups. Prehypertension was further divided into low-range (BP 120–129/80–84 mm Hg) and high-range (BP 130–139/85–89 mm Hg) subgroups.

Outcome measures: The prevalence of prehypertension and the combined cardiovascular risk factors within the prehypertensive subgroups.

Results: Of the 5362 initially reviewed cases (aged ≥35 years), 651 were excluded because of missing data. The proportions of optimal BP, prehypertension and hypertension were 39.1%, 38.6% and 22.3%, respectively. The average age, proportion of male sex, overweight, impaired fasting glucose (IFG), dyslipidaemia and hyperuricaemia were significantly higher in the prehypertension group than in the optimal BP group (all p <0.05). Compared with low-range prehypertension, the proportions of overweight, dyslipidaemia and IFG were higher in the high-range prehypertension group (all p<0.05). Multivariate logistic regression analysis showed that overweight (OR=2.84, 95% CI 1.55 to 5.20), male sex (OR=2.19, 95% CI 1.39 to 3.45), age (per 10 years, OR=1.21, 95% CI 1.02 to 1.44, p=0.03) and hyperuricaemia (OR=1.70, 95% CI 1.14 to 2.54) were independent risk factors of prehypertension.

Conclusions: Prehypertension is highly prevalent in southern China. Prehypertensive individuals presented with many other cardiovascular risk factors. There was heterogeneity of combined risk factors within the prehypertensive subgroups.

Strengths and limitations of this study

- This study shows that prehypertension is highly prevalent in the Shunde District, southern China.
- With the economic development and lifestyle changes in China, obesity/overweight has become a very important risk factor for increased blood pressure.
- This is the first study to show that there was a significant heterogeneity of combined risk factors within the prehypertensive subgroups.
- Some important confounding factors possibly associated with increased blood pressure were not evaluated in the present study.

INTRODUCTION

In 2003, the seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) proposed a new blood pressure (BP) category, including 120–139 mm Hg systolic BP (SBP) or 80–89 mm Hg diastolic BP (DBP), designated as 'prehypertension'.[1] The prevalence of prehypertension is up to 30–50% worldwide, as well as in many districts of China.[2–4] It is known that in China the prevalence of hypertension is significantly higher in the northern area than in the southern area because of the colder climate and high sodium intake.[5] Such regional factors may also affect the prevalence of prehypertension. However, the prevalence of prehypertension in Guangdong Province, southern China has been rarely reported.

Prehypertensive individuals are prone to progress into frank hypertension, and most of them present with clustering of other cardiovascular risk factors.[6–8] However, the use of the term 'prehypertension' is still controversial. Most of the arguments against using this term consist of the possible public anxiety and overtreatment it may cause. Further, there is a high heterogeneity within this category because the risk of progressing to hypertension and developing cardiovascular disease (CVD) is higher among people with BP 130–139/85–89 mm Hg than among those with BP 120–129/80–84 mm Hg.[6 9] Furthermore, the

question of whether the concurrent cardiovascular risk factors in subgroups of prehypertension are different remains unanswered.

Given these inconsistent results, we conducted a retrospective analysis to explore the prevalence of prehypertension, and the cardiovascular risk factors in the subgroups of prehypertension in Guangdong Province, southern China.

METHODS

Study participants

We performed a retrospective study in Shunde District, a traditional but economically developed district of Guangdong Province, in China, using the community-based health check-up information. Community-based health check-up information was collected in the Health Management Center of the First People's Hospital of Shunde. The centres provided data for participants who enrolled in their health check-up programmes conducted between January 2011 and December 2013. Participants aged ≥35 years with complete data for the following characteristics were included in this study: age, sex, smoking/drinking habits, history of chronic diseases and treatment, family history of hypertension, height, weight, BP, fasting plasma glucose (FPG), total cholesterol (TC), triglycerides (TG), low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C), serum creatinine (Scr), blood urea nitrogen and serum uric acid (UA).

BP measurement

Although our data were based on retrospective analysis of community-based health check-up information, the protocol of BP measurement in our Health Management Center is carried out consistently since the foundation of the department. Participants were asked to avoid caffeinated beverages, smoking and exercise for at least 30 min, and BP measurements were taken after the participants were allowed to rest quietly for at least 5 min. Three BP measurements (2 min between each) were obtained for each individual by trained nurses, who were part of the Health Management Center, with a mercury sphygmomanometer. The first and fifth Korotkoff sounds were recorded as SBP and DBP, respectively. During the measurements, the participants were seated with the arm supported at the level of the heart. The mean of three BP measurements was calculated and recorded.

Definition of correlative risk factors

The correlative risk factors estimated in our study included the following: (1) BP classification was based on the recommendations from the JNC 7.[1] Optimal BP was defined as SBP <120 mm Hg and DBP <80 mm Hg. Hypertension was defined as SBP ≥140 mm Hg and/or DBP ≥90 mm Hg, or previously diagnosed as hypertension and currently undergoing antihypertensive treatment. Prehypertension was defined if individuals were not undergoing antihypertensive treatment and had an SBP of 120–139 mm Hg and/or DBP of 80–89 mm Hg. Prehypertension was further divided into low-range (SBP 120–129 and/or DBP 80–84 mm Hg) and high-range (SBP 130–139 mm Hg and/or DBP 85–89 mm Hg) subgroups. (2) Impaired glucose regulation was diagnosed based on FPG according to the American Diabetes Association criteria,[10] including diabetes mellitus (DM; FPG ≥7.0 mmol/L) and impaired fasting glucose (IFG, FPG 5.6–6.9 mmol/L). Dyslipidaemia was defined as with a history of receiving antidyslipidaemia agents or TC ≥5.18 mmol/L, LDL-C ≥3.37 mmol/L, HDL-C <1.04 mmol/L and/or TG ≥1.7 mmol/L, according to the 2007 Guidelines for Prevention and Treatment of Dyslipidemia in Adults in China.[11] Hyperuricaemia was defined as UA ≥416 µmol/L in men and 357 µmol/L in women. (3) Overweight and obesity were defined as body mass index (BMI) 24–27.9 kg/m^2 and BMI ≥28 kg/m^2 according to Chinese criteria.[12] (4) The estimated glomerular filtration rate (eGFR) of each participant was estimated using the modified Modification of Diet in Renal Disease equation adapted for the Chinese[13] as: $eGFR=186\times Scr^{-1.154}\times age^{-0.203}\times 0.742$ (female)×1.233 (Chinese).

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Science software release V.16.0 (SPSS Inc, Chicago, Illinois, USA). Continuous variables are presented as mean (SD) or median (IQR) as appropriate. Categorical variables are expressed as percentages. After testing for normality using the Kolmogorov-Smirnov test, continuous variables were compared using a t test or the Mann-Whitney U test, and categorical variables were compared by χ^2 test or Fisher's exact test as appropriate. Multiple logistic regression analysis was performed to evaluate predictive factors for prehypertension. Individuals with optimal BP were used as the reference group. Multicollinearity (strong correlations among independent variables) was examined by collinearity diagnostic statistics. Variance inflation factor values >2.5 or tolerance <0.4 may indicate concern for multicollinearity in logistic regression models.[14] A value of $p<0.05$ was considered statistically significant.

RESULTS

Prevalence of prehypertension

Of the 5362 cases (aged ≥35 years) initially reviewed, 651 were excluded because of missing data. Finally, 4711 cases (2674 men, 2037 women) were analysed. The proportions of optimal BP, prehypertension and hypertension were 39.1% (1842 cases), 38.6% (1819 cases) and 22.3% (1050 cases), respectively. The prevalence of prehypertension was higher in men than in women (43.5% vs 32.2%, $p<0.001$). There was an increasing trend of prehypertension prevalence associated with age (table 1).

Table 1 Prevalence of prehypertension and hypertension by sex and age group

Age (years)	n	Optimal BP (%)	Prehypertension (%)	Hypertension (%)
Male				
35–49	970	48.1	34.4	17.4
50–64	996	27.1	48.0	24.9
≥65	708	20.6	49.6	29.8
Total	2037	33.0	43.5	23.5
Female				
35–49	758	59.8	26.5	12.9
50–64	797	42.3	36.3	22.2
≥65	482	35.1	34.4	30.5
Total	2674	47.1	32.2	20.7
All				
35–49	1728	53.2	31.0	15.5
50–64	1793	33.9	42.8	23.7
≥65	1190	26.5	43.4	30.1
Total	4711	39.1	38.6	22.3

BP, blood pressure.

Risk factors clustering in different blood pressure statuses

The average age, proportion of male sex, family history of hypertension, overweight, IFG, dyslipidaemia, hyperuricaemia, levels of FPG, TC, TG, BMI and UA were significantly higher in the prehypertension and hypertension groups than in the optimal BP group (all p<0.05). The proportions of DM, obesity and level of LDL-C were also higher in the hypertension group than in the optimal BP group (all p<0.05); however, the differences were not significant in the prehypertension group compared with that in the optimal BP group (table 2).

Cardiovascular risk factors in different subranges of prehypertension

To explore the heterogeneity within the prehypertension category, patients with prehypertension were further classified into low-range and high-range subgroups. The proportions of male sex, overweight, IFG, BMI and levels of FPG were higher in the low-range prehypertension group than in the optimal BP group (all p<0.05), but there were no significant differences for other cardiovascular risk factors (all p>0.05). The proportions of male sex, overweight, obesity, dyslipidaemia, DM, IFG, hyperuricaemia and BMI, and levels of TC, LDL-C, TG, FPG and UA were higher in the high-range prehypertension group than in the optimal BP group (all p<0.05). Compared with low-range prehypertension, the proportions of overweight, dyslipidaemia and IFG were higher in the high-range prehypertension (all p<0.05; table 3).

Risk factors associated with prehypertension

The multivariable-adjusted risk factors associated with prehypertension are presented in table 4. High BMI (overweight/obesity) was the most important risk factor for prehypertension (OR=2.84, 95% CI 1.55 to 5.20, p<0.001). Age (per 10 years, OR=1.21, 95% CI 1.02 to 1.44, p=0.03), male sex (OR=2.19, 95% CI 1.39 to 3.45, p<0.001) and hyperuricaemia (OR=1.70, 95% CI 1.14 to 2.54, p=0.009) were also significantly associated with prehypertension. Furthermore, collinearity statistics were >0.4 for tolerance and <2.5 for the variance inflation factor, suggesting that multicollinearity was not a concern among the independent variables.

DISCUSSION

In this study, we found that prehypertension is highly prevalent in the Shunde District, Guangdong Province. Prehypertensive individuals presented with other risk factors associated with CVD, such as overweight, dyslipidaemia, impaired glucose and hyperuricaemia. Furthermore, combined cardiovascular risk factors were more significant in people with high-range prehypertension. To the best of our knowledge, this is the first study to show that there was a significant heterogeneity of combined risk factors within the prehypertensive subgroups.

Many epidemiological studies have demonstrated that prehypertension is an important public health problem. However, the prevalence of prehypertension in different countries and districts differs significantly, and may be influenced by different regional factors, such as climate and lifestyle, as well as ethnicity. At the beginning of this century (2000–2001), a cross-sectional survey found that the prevalence of prehypertension was 21.9% among Chinese participants aged between 35 and 74 years.[3] However, in other subsequent studies, the prevalence of prehypertension was significantly higher than this ratio. In rural northeastern China, the prevalence of prehypertension was 35.1% in men and 32.5% in women,[15] and up to 40% in the whole population from urban areas of northeastern China,[16] which may be associated with the cold climate and high sodium diet. In this study, we found that the prevalence of prehypertension in the Shunde District of Guangdong Province, a traditional but economically developed district of southern China, was up to 38.6%. It was very similar to that in the urban areas of northeastern China,[16] and significantly higher than that reported at the beginning of this century for the

Table 2 Cardiovascular risk factors in different blood pressure statuses

	Optimal BP (n=1842)	Prehypertension (n=1819)	Hypertension (n=1050)	p Value
Age (years)	48.8±10.5	52.1±11.3*	54.3±10.4*	0.008
Male (n (%))	829 (45.0)	1163 (63.9)*	628 (59.8)*†	<0.001
Smoking (n (%))	301 (16.3)	287 (15.8)	186 (17.7)	0.77
Alcoholic (n (%))	35 (1.9)	42 (2.3)	27 (2.6)	0.464
Family history of hypertension (n (%))	274 (14.9)	292 (16.1)*	203 (19.3)*†	0.007
Overweight (n (%))	236 (12.8)	395 (21.7)*	241 (23.0)*	<0.001
Obesity (n (%))	128 (6.9)	156 (8.6)	98 (9.3)*	0.019
BMI (kg/m^2)	21.6±3.2	24.9±3.5*	25.6±4.8*	0.001
Dyslipidaemia (n (%))	420 (22.8)	488 (26.8)*	312 (29.7)*†	<0.001
TC (mmol/L)	5.02±1.25	5.39±1.67*	5.64±1.59*†	0.01
LDL-C (mmol/L)	3.21±1.15	3.45±1.18	3.68±1.32*	0.03
HDL-C (mmol/L)	1.18±0.36	1.09±0.38	1.02±0.41	0.75
TG (mmol/L)	1.66±0.42	2.07±0.58*	2.09±0.63*	0.001
DM (n (%))	138 (7.5)	168 (9.2)	109 (10.4)*	0.002
IFG (n (%))	261 (14.2)	384 (21.1)*	275 (26.2)*†	<0.001
FPG (mmol/L)	5.14±1.96	5.79±2.03*	5.91±2.27*	0.003
Scr (mmol/L)	72.2±19.7	75.0±25.1	79.2±28.9	0.14
BUN (mmol/L)	5.34±1.71	6.01±1.87	6.25±1.99	0.35
eGFR (mL/min/1.73 m^2)	126.8±27.9	125.2±29.4	118.1±28.6	0.76
Hyperuricaemia (n (%))	233 (12.6)	302 (16.6)*	226 (21.5)*†	0.001
UA (mmol/L)	377.5±32.2	402.9±34.6*	428.1±33.8*†	0.007

*Versus optimal blood pressure p<0.05.
†Versus prehypertension p<0.05.
BMI, body mass index; BP, blood pressure; BUN, blood urea nitrogen; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; FPG, fasting plasma glucose; HDL-C, high-density lipoprotein-cholesterol; IFG, impaired fasting glucose; LDL-C, low-density lipoprotein-cholesterol; Scr, serum creatinine; TC, total cholesterol; TG, triglycerides; UA, serum uric acid.

entire country.[3] Further analysis showed that increased BMI was the most important risk factor for prehypertension in our study. Even among patients with low-range prehypertension, BMI was significantly increased compared with the optimal BP group. Therefore, our study suggests that although sodium intake is relatively low in the Guangdong Province in southern China,[17] the prevalence of prehypertension is almost as high as that in the northern area. With the economic development and lifestyle changes, obesity/overweight has become a very important risk factor for increased BP.

Although the proportions of IFG and dyslipidaemia were higher in the prehypertension group than in the optimal BP group, in multivariable analysis the associations of IFG and dyslipidaemia with prehypertension were not significant after adjustment for BMI. Many studies have documented that overweight/obesity can cause significant insulin resistance, which may play an important role in impaired glucose metabolism, dyslipidaemia and increased BP.[18 19] Clinical studies have shown that weight control can significantly lower BP.[20] These results indicated that lifestyle modifications, such as weight loss, are effective in the long-term primary prevention of hypertension. With the economic development and lifestyle changes, lifestyle modifications should be emphasised as a cornerstone in modern China.

In addition to the traditional risk factors, previous studies have found that serum UA levels were significantly associated with prehypertension.[21 22] The mechanisms may be associated with inhibition of the nitric oxide pathway and activation of the renin-angiotensin system. Further, UA can cause a proliferation of vascular smooth muscle cells and renal microvascular damage because of local inflammation and oxidative stress, finally leading to high BP.[23 24] In our study, we found that the level of UA tended to increase in the low-range prehypertension group (p=0.07), and the difference was significant between high-range prehypertension and the optimal BP groups. These results indicate that the effect of UA on BP may be increased throughout the entire prehypertension range.

In a recent randomised controlled trial, prehypertensive obese adolescents aged 11–17 years were enrolled and randomised to a urate-lowering therapy (including allopurinol or probenecid) or placebo. Participants treated with a urate-lowering therapy experienced a highly significant reduction in BP (SBP 10.2 mm Hg and DBP 9.0 mm Hg, respectively). Systemic vascular resistance was also reduced in the urate-lowering therapy group.[25] These findings strongly supported the synergistic pathogenic role of UA and obesity in hypertension. Genes and diet are important factors affecting the levels of UA; therefore, we emphasise the importance of lifestyle modification interventions for people with prehypertension.

It was interesting that there was significant 'heterogeneity' of combined cardiovascular risk factors within the prehypertensive subgroups in our study. Compared with optimal BP, BMI and FPG were increased in the low-

Table 3 Cardiovascular risk factors in different subranges of prehypertension

	Low-range prehypertension (n=925)	High-range prehypertension (n=894)	p Value
Age (years)	50.6±11.2	53.7±12.4*	0.08
Male (n (%))	584 (63.1)*	579 (64.8)*	0.47
Smoking (n (%))	149 (16.1)	138 (15.4)	0.69
Alcoholic (n (%))	20 (1.9)	22 (2.7)	0.29
Family history of hypertension (n (%))	153 (16.5)	139 (15.5)	0.56
Overweight (n (%))	183 (19.8)*	212 (23.7)*	0.04
Obesity (n (%))	75 (8.1)	81 (9.1)†	0.47
BMI (kg/m^2)	23.7±3.3†	26.1±3.9*	<0.001
Dyslipidaemia (n (%))	227 (24.5)	261 (29.2)*	0.025
TC (mmol/L)	5.25±1.38	5.53±1.70*	0.04
LDL-C (mmol/L)	3.33±1.08	3.58±1.19†	0.10
HDL-C (mmol/L)	1.14±0.35	1.03±0.37	0.69
TG (mmol/L)	1.81±0.56	2.34±0.67†	0.12
DM (n (%))	78 (8.4)	90 (10.1)†	0.23
IFG (n (%))	171 (18.5)*	213 (23.8)*	0.005
FPG (mmol/L)	5.52±1.91†	6.07±2.05*	0.002
Scr (mmol/L)	76.1±29.4	73.8±27.0	0.18
BUN (mmol/L)	5.98±2.02	6.04±1.79	0.37
eGFR (mL/min/1.73 m^2)	128.7±30.6	121.6±28.4	0.29
Hyperuricaemia (n (%))	140 (15.1)	162 (18.1)*	0.09
UA (mmol/L)	392.5±40.2	411.8±37.9*	0.08

*Versus optimal blood pressure p<0.01.
†Versus optimal blood pressure p<0.05.
BMI, body mass index; BUN, blood urea nitrogen; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; FPG, fasting plasma glucose; HDL-C, high-density lipoprotein cholesterol; IFG, impaired fasting glucose; LDL-C, low-density lipoprotein cholesterol; Scr, serum creatinine; TC, total cholesterol; TG, triglycerides; UA, serum uric acid.

range prehypertension group and were increased even further in the high-range prehypertension group. Furthermore, the proportions of overweight, dyslipidaemia and IFG were higher in those in the high-range prehypertension group than in those in the low-range prehypertension group. These findings confirmed the importance of the definition of prehypertension, as well as the inhomogeneity of the prehypertension subcategories. Our prior meta-analysis also found that prehypertension was associated with increased risks of CVD[26] and end-stage renal disease.[27] However, owing to limit prospective, randomised trials examining the effects of antihypertensive therapy on reducing target organ damage specifically in prehypertension, professional societies do not currently recommend pharmacotherapy for prehypertension, even in individuals with high-range prehypertension.[28 29] This is a great gap to be covered between epidemiological studies and randomised controlled studies in prehypertension. Prehypertensive individuals are at high risk to progress to sustained hypertension, as well as CVD and renal damage. So periodic screening is important. For therapeutic

Table 4 Multivariate logistic regression analysis for risk factors of prehypertension

Risk factors	OR	95% CI	p Value
Age (per 10 years)	1.21	1.02 to 1.44	0.03
Sex (men vs women)	2.19	1.39 to 3.45	<0.001
Smoking (yes vs no)	0.97	0.70 to 1.34	0.85
Alcoholic (yes vs no)	1.12	0.89 to 1.41	0.33
Family history of hypertension (yes vs no)	1.29	0.88 to 1.89	0.19
Overweight/obesity (yes vs no)	2.84	1.55 to 5.20	<0.001
Dyslipidaemia (yes vs no)	1.58	0.92 to 2.71	0.09
Impaired glucose regulation (yes vs no)	1.64	0.96 to 2.81	0.07
Hyperuricaemia (yes vs no)	1.70	1.14 to 2.54	0.009

Prehypertension was defined if individuals were not undergoing antihypertensive treatment and had a systolic blood pressure (SBP) of 120–139 mm Hg and/or diastolic blood pressure (DBP) of 80–89 mm Hg. Individuals with optimal blood pressure (SBP <120 mm Hg and DBP <80 mm Hg) were used as the reference group.

implications, we consider that healthcare professionals should recommend lifestyle changes to participants with prehypertension. Furthermore, high-risk subpopulations with prehypertension, especially those with high-range prehypertension, should be selected for future controlled trials to evaluate the effects of pharmacological treatment on this population.

Several limitations of this study must be considered. First, our data were based on community-based health check-up information, and not from a multistage stratified clustering sample. This may cause a bias in the prevalence of prehypertension. Second, some important confounding factors possibly associated with increased BP, such as diet, physical activity and socioeconomic factors, were not evaluated in the present study. Third, follow-up data of individuals with prehypertension are lacking and further studies are needed on the matter.

CONCLUSION

This study showed that along with the economic development and lifestyle changes, prehypertension is highly prevalent in the Shunde District, southern China. Many other cardiovascular risk factors were present in individuals with prehypertension, especially in those with high-range prehypertension. Periodic screening and lifestyle changes should be recommended to participants with prehypertension for prevention of hypertension, as well as those with CVD.

Contributors YHua, YHu and DX conceptualised the study and designed the protocol. YHua, WQ and XC analysed the data and drafted the manuscript. CL, DZ and JH collected the data. YW, YHu and DX revised the manuscript. YHu and DX participated in administrative and technical support.

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REFERENCES

1. Chobanian AV, Bakris GL, Black HR, *et al*. The seventh report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. *JAMA* 2003;289:2560–72.
2. Sun Z, Zheng L, Xu C, *et al*. Prevalence of prehypertension, hypertension and, associated risk factors in Mongolian and Han Chinese populations in Northeast China. *Int J Cardiol* 2008;128:250–4.
3. Yu D, Huang J, Hu D, *et al*. Prevalence and risk factors of prehypertension among Chinese adults. *J Cardiovasc Pharmacol* 2008;52:363–8.
4. Sun Z, Zheng L, Wei Y, *et al*. Prevalence and risk factors of the rural adult people prehypertension status in Liaoning Province of China. *Circ J* 2007;71:550–3.
5. Liu LS. [2010 Chinese guidelines for the management of hypertension]. *Zhonghua Xin Xue Guan Bing Za Zhi* 2011;39:579–615.
6. Elliott WJ, Black HR. Prehypertension. *Nat Clin Pract Cardiovasc Med* 2007;4:538–48.
7. Egan BM, Lackland DT, Jones DW. Prehypertension: an opportunity for a new public health paradigm. *Cardiol Clin* 2010;28:561–9.
8. Pimenta E, Oparil S. Prehypertension: epidemiology, consequences and treatment. *Nat Rev Nephrol* 2010;6:21–30.
9. Gupta P, Nagaraju SP, Gupta A, *et al*. Prehypertension—time to act. *Saudi J Kidney Dis Transpl* 2012;23:223–3.
10. Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Report of the expert committee on the diagnosis and classification of diabetes mellitus. *Diabetes Care* 2003;26(suppl 1): S5–20.
11. Joint Committee for Developing Chinese guidelines on Prevention and Treatment of Dyslipidemia in Adults. [Chinese guidelines on prevention and treatment of dyslipidemia in adults]. *Zhonghua Xin Xue Guan Bing Za Zhi* 2007;35:390–419.
12. Zhou B. [Predictive values of body mass index and waist circumference to risk factors of related diseases in Chinese adult population]. *Zhonghua Liu Xing Bing Xue Za Zhi* 2002;23:5–10.
13. Ma YC, Zuo L, Chen JH, *et al*. Modified glomerular filtration rate estimating equation for Chinese patients with chronic kidney disease. *J Am Soc Nephrol* 2006;17:2937–44.
14. Pallant J. *SPSS survival manual: a step by step guide to data analysis using SPSS for windows (version 10)*. Open University Press, 2001.
15. Li Z, Guo X, Zheng L, *et al*. Prehypertension in rural northeastern china: results from the northeast china rural cardiovascular health study. *J Clin Hypertens (Greenwich)* 2014;16:664–70.
16. Dong GH, Wang D, Liu MM, *et al*. Sex difference of the prevalence and risk factors associated with prehypertension among urban Chinese adults from 33 communities of China: the CHPSNE study. *J Hypertens* 2012;30:485–91.
17. Cheng TO. Systolic and diastolic blood pressures and urinary sodium excretion in mainland China. *QJM* 2000;93:557–8.
18. Tobias DK, Pan A, Jackson CL, *et al*. Body-mass index and mortality among adults with incident type 2 diabetes. *N Engl J Med* 2014;370:233–44.
19. Gillman MW, Ludwig DS. How early should obesity prevention start? *N Engl J Med* 2013;369:2173–5.
20. Tyson CC, Appel LJ, Vollmer WM, *et al*. Impact of 5-year weight change on blood pressure: results from the Weight Loss Maintenance trial. *J Clin Hypertens* 2013;15:458–64.
21. Liang J, Xue Y, Zou C, *et al*. Serum uric acid and prehypertension among Chinese adults. *J Hypertens* 2009;27:1761–5.
22. Kawamoto R, Tabara Y, Kohara K, *et al*. Interaction between serum uric acid and triglycerides in relation to prehypertension in community-dwelling Japanese adults. *Clin Exp Hypertens* 2014;36:64–9.
23. Soltani Z, Rasheed K, Kapusta DR, *et al*. Potential role of uric acid in metabolic syndrome, hypertension, kidney injury, and cardiovascular diseases: is it time for reappraisal? *Curr Hypertens Rep* 2013;15:175–81.
24. Reynolds TM. Serum uric acid and new-onset hypertension: a possible therapeutic avenue? *J Hum Hypertens* 2014;28:519–20.
25. Soletsky B, Feig DI. Uric acid reduction rectifies prehypertension in obese adolescents. *Hypertension* 2012;60:1148–56.
26. Huang Y, Wang S, Cai X, *et al*. Prehypertension and incidence of cardiovascular disease: a meta analysis. *BMC Med* 2013;11:177.
27. Huang Y, Cai X, Zhang J, *et al*. Prehypertension and incidence of ESRD: a systematic review and meta analysis. *Am J Kidney Dis* 2014;63:76–83.
28. James PA, Oparil S, Carter BL, *et al*. 2014 Evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8)[J]. *JAMA* 2014;311:507–20.
29. Mancia G, Fagard R, Narkiewicz K, *et al*. 2013 ESH/ESC guidelines for the management of arterial hypertension: the Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *Eur Heart J* 2013;34:2159–219.