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ORIGINAL

A comparative research on obesity hypertension by the comparisons and associations between waist circumference, body mass index with systolic and diastolic blood pressure, and the clinical laboratory data between four special Chinese adult groups

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ABSTRACT

Background: The obesity-hypertension pathogenesis is complex. From the phenotype to molecular mechanism, there is a long way to clarify the mechanism. To explore the association between obesity and hypertension, we correlate the phenotypes such as the waist circumference (WC), body mass index (BMI), systolic blood pressure (SB), and diastolic blood pressure (DB) with the clinical laboratory data between four specific Chinese adult physical examination groups (newly diagnosed untreated just-obesity group, newly diagnosed untreated obesity-hypertension group, newly diagnosed untreated just-hypertension group, and normal healthy group), and the results may show something. *Objective*: To explore the mechanisms from obesity to hypertension by analyzing the correlations and differences between WC, BMI, SB, DB, and other clinical laboratory data indices in four specific Chinese adult physical examination groups. *Methods*: This cross-sectional study was conducted from September 2012 to July 2014, and 153 adult subjects, 34 women and 119 men, from 21 to 69 years, were taken from four characteristic Chinese adult physical examination groups (newly diagnosed untreated just-obesity group, newly diagnosed untreated obesity-hypertension group, newly diagnosed untreated just-hypertension group, and normal healthy group). The study was approved by the ethics committee of Hangzhou Center for Disease Control and Prevention. WC, BMI, SB, DB, and other clinical laboratory data were collected and analyzed by SPSS. *Results*: Serum levels of albumin (ALB)□alanine aminotransferase (ALT), low density lipoprotein cholesterol (LDLC), triglyceride (TG), high density lipoprotein cholesterol (HDLC), alkaline phosphatase (ALP), uric acid (Ua), and TC/HDLC (odds ratio) were statistically significantly different between the four groups. WC statistically significantly positively correlated with BMI, ALT, Ua, and serum levels of glucose (GLU), and TC/HDLC, and negatively with ALB, HDLC, and serum levels of conjugated bilirubin (CB). BMI was statistically significantly positively related to ALT, Ua, LDLC, WC, and TC/HDLC, and negatively to ALB, HDLC, and CB. DB statistically significantly positively correlated with ALP, BMI, and WC. SB was statistically significantly positively related to LDLC, GLU, serum levels of fructosamine (FA), serum levels of the total protein (TC), BMI, and WC. *Conclusion*: The negative body effects of obesity are comprehensive. Obesity may lead to hypertension through multiple ways by different percents.

GGT, serum levels of gamma glutamyltransferase; ALB, serum levels of albumin; ALT, serum levels of alanine aminotransferase; LDLC, serum levels of low density lipoprotein cholesterol; TG, serum levels of triglyceride; HDLC, serum levels of high density lipoprotein cholesterol; FA, serum levels of fructosamine; S.C. R, serum levels of creatinine; IB, serum levels of indirect bilirubin; ALP, serum levels of alkaline phosphatase; CB, serum levels of conjugated bilirubin; UREA, Urea; Ua, serum levels of uric acid; GLU, serum levels of glucose; TC, serum levels of the total cholesterol; TB, serum levels of the total bilirubin; TP, serum levels of the total protein; TC/HDLC, TC/HDLC ratio.

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Introduction

Hypertension and obesity have become increasingly serious public health problems worldwide (1). The principle of obesity leading to hypertension, including function of adipose tissue derivatives (adipokines and cytokines), neurohumoral pathways, metabolic functions and modulation of pressor/depressor mechanisms, has been elaborated in many studies (2–5) However, the direct mechanisms of how obesity causes hypertension are still unknown (5). It is reported that central adiposity, measured as waist circumference (WC), is closely associated with cardiovascular disease (CVD), hypertension, diabetes, dyslipidemia, and the body

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mass index (BMI) represents general overweight/obesity (2,6). The associations between obesity and hypertension may vary with the diagnosed criteria changes of center or general obesity according to WC or BMI (7–9). Anthropometric indices vary among different ethnic groups (10,11). The criteria of overweight and obesity for Chinese people have been developed based on BMI and WC values (12), instead of the World Health Organization (WHO) criteria which are more fit for European descents (13). The data of the correlations of obesity and hypertension from Chinese populations have continued to be found.

In this study, the associations between WC, BMI, SB, DB, and other related clinical laboratory data among four Chinese adult physical examination groups were investigated, and the different expressions of these clinical laboratory indices between the four groups were also detected. And the four investigated groups were newly diagnosed untreated just-obesity (shorten for JO) group, newly diagnosed untreated obesity-hypertension (shorten for OH) group, newly diagnosed untreated just-hypertension (shorten for JH) group, and normal healthy group (shorten for NH).

Data and methods

Subjects and methods

The cross-sectional study was performed, including 153 adults (34 women and 119 men) from 21 to 69 years. The data were collected from September 2012 to July 2014. All the participants took annual routine physical examination in hospital during that time. They were divided into four characteristic groups as (1) newly diagnosed untreated just-obesity (55 subjects) group, (2) newly diagnosed untreated obesity-hypertension (41 subjects) group, (3) newly diagnosed untreated just-hypertension (31 subjects) group, and (4) normal healthy group (26 subjects) group. The study was approved by the ethics committee of Hangzhou Center for Disease Control and Prevention.

Firstly, the inclusion criteria of the subjects were set. The JO group definition is that the group people haven't been diagnosed for obesity and haven't been treated with any anti-obesity drugs till this annual physical examination. The JH group definition is that the group people haven't been diagnosed for hypertension and haven't been treated with any anti-hypertension drugs till this annual physical examination. The OH group definition is that the group people haven't been diagnosed for obesity or hypertension and haven't been treated with any anti-obesity or anti-hypertension drugs till this annual physical examination. The NH group definition is that the group people haven't been diagnosed for any clinical serious disease such as obesity, hypertension, etc. To minimize the possible influence by other diseases, some exclusion criteria were defined. Patients with diabetes mellitus, secondary hypertension, heart diseases, and acute inflammatory diseases (liver and kidney diseases) were excluded. Secondly, for the people referred to the physical examination center, after informed consent, they were selected according to inclusion criteria and assigned to the four groups. And the approximate matching of age and gender between the four groups and the suitable subject number for statistics were considered. And in the end, 55 subjects were selected for the JO group, 41 subjects for the OH group, 31 subjects for the JH group, and 26 subjects for the NH group.

And then subjects underwent the following procedure. The blood pressure (BP) (both systolic and diastolic) of all the participants was measured in the right arm by trained nurses according to a standard protocol (14). The average readings of the three BP measurements, with an interval of from 5 to 15 minutes between measurements, were regarded as the BP value for each subject. And the anthropometric measurements were taken after the subjects taking off their shoes and any heavy clothing or belts. The body weight and height were measured using an electronic scale. The WC was measured at the level midway between the lower rib margin and the iliac crest while the participants breathed out gently (11,15). And other routine clinical laboratory tests for subjects were taken about the blood sample and urine sample, etc.

Definition of obesity and hypertension

The BMI was defined as weight (kg)/height^2 (m^2), and the subjects' weights were classified according to the Chinese criteria raised by Chinese Obesity Working Group: BMI < 18.5: underweight; 18.5 ≤ BMI < 24: normal; 24 ≤ BMI < 28: overweight; and BMI ≥ 28: general obesity (12,16). A WC ≥ 85 and ≥80 m for males and females were identified as central obesity, respectively (12). An SBP ≥ 140 mmHg or/and a DBP ≥ 90 mmHg at each three separate appointments was defined as hypertension. All the patients were newly diagnosed. In this study, the general obesity was used to divide the subject groups.

Clinical laboratory data collection

Blood samples were obtained after a 12-hour diet. The baseline demographic and clinical laboratory data were obtained from hospital records and reviewed by experienced physicians. These data include the information of age, gender, serum levels of gamma glutamyltransferase (GGT),albumin(ALB), alanine aminotransferase(ALT), low density lipoprotein cholesterol (LDLC), triglyceride (TG), high density lipoprotein cholesterol (HDLC), fructosamine(FA), creatinine (S.C.R), indirect bilirubin (IB), alkaline phosphatase (ALP), conjugated bilirubin (CB), glucose (GLU), total cholesterol (TC), total bilirubin (TB), total protein (TP), uric acid (Ua), Urea (UREA), etc.

Statistical analysis

Descriptive analysis has been performed firstly. When the data were normally distributed and the equal variance test was satisfied, Pearson test was performed to analyze the statistical significance of the correlations between groups, respectively. And if the data were not normally distributed, the analyses were conducted using Mann–Whitney rank sum test and Spearman's correlation test. And partial correlations were also conducted. Clinical index difference between 4 group were analyzed by the least significant difference (LSD) method using the general linear models (GLM) procedure implemented in Statistical Package for the Social Sciences software (SPSS 16.0).ρ-Values less than 0.05 were considered statistically significant. All statistics were performed using SPSS (version 16.0 for Windows, SPSS Inc., Chicago, IL, USA).

Table 1. Demographic and clinical laboratory data of subjects.

Items	Mean (min–max)/number
Age, mean ± SD years	40.78 ± 11.77
Sex, male/female	119/34
SB	135.92(98–203)
DB	82.89(55–131)
BMI	27.25(18.9–36.6)
AC	94.21(69–125)
GGT (U/L)	34.72(6–202)
ALB (g/L)	46.69(40.9–52.3)
ALT (U/L)	33.13(4–341)
LDLC(mmol/L)	103.51(45–170)
TG (mg/dl)	168.58(42–998)
HDLC(mg/dl)	50.59(29–90)
FA(mmol/L)	1.57(1–3.2)
SCR (μmol/L)	83.8(55–106)
IB(μmol/L)	8.09(1.6–25.8)
ALP (U/L)	64.98(29–113)
CB(μmol/L)	3.84(1–11.5)
UREA(mmol/L)	5.05(2.88–9.36)
Ua(μmol/L)	344.53(161–585)
GLU (mmol/L)	5.28(4.02–14.13)
TC(mg/dl)	200.82(113–419)
TB(μmol/L)	11.93(3.6–37.3)
TP (g/L)	76.55(68.2–84)

Results

Demographic and clinical laboratory data of subjects

Demographic information and clinical laboratory data of the participants are shown in Table 1, including age, gender, serum levels of Gamma glutamyltransferase (GGT), Albumin (ALB), Alanine aminotransferase (ALT), Low density lipoprotein cholesterol (LDLC), Triglyceride (TG), High density lipoprotein cholesterol (HDLC), Fructosamine (FA), Creatinine (S.C.R) Indirect bilirubin(IB),Alkaline phosphatase(ALP),Conjugated bilirubin (CB),Glucose(GLU), Total cholesterol(TC), Total bilirubin(TB), Total protein(TP), Uric acid (Ua), Urea(UREA), etc.

Correlations between WC, BMI, and the clinical laboratory data

Correlation analysis (Table 2) and partial correlation analysis (Table 3) were both conducted in our study. A correlation between WC and BMI is statistically significantly positive ($r = 0.80$, $p < 0.001$). And DB and SB both statistically significantly positively related with BMI ($r = 0.249$, $p = 0.002$, $r = 0.303$, $p = 0.000$, respectively) and WC ($r = 0.279$, $p = 0.000$, $r = 0.307$, $p = 0.000$, respectively) .

And BMI is statistically significantly positively related to seven clininc laboratory indices, i.e., LDLC ($r = 0.224$, $p = 0.005$), TG ($r = 0.169$, $p = 0.036$), S.C.R ($r = 0.190$, $p = 0.018$), Ua ($r = 0.234$, $p = 0.004$), Glucose ($r = 0.162$, $p = 0.045$), ALT ($r = 0.252$, $p = 0.002$), TC/HDL odds ($r = 0.272$, $p = 0.001$), statistically significantly negatively correlating to HDLC ($r = -0.256$, $p = 0.001$), and ALB ($r = -0.166$, $p = 0.041$). And BMI also nearly statistically significantly positively correlates to three clinical laboratory indices, i.e., FA ($r = 0.143$, $p = 0.078$), TC ($r = 0.143$, $p = 0.078$), nearly statistically significantly negatively correlating with CB ($r = -0.148$, $p = 0.068$).

WC is statistically significantly positively correlated with ten clinical laboratory indices, i.e., GGT ($r = 0.179$, $p = 0.027$), FA ($r = 0.169$, $p = 0.037$), ALT ($r = 0.252$, $p = 0.002$), LDLC ($r = 0.182$, $p = 0.024$), S.C.R ($r = 0.303$, $p = 0.000$), ALP ($r = 0.179$, $p = 0.027$), UREA ($r = 0.169$, $p = 0.037$), Ua ($r = 0.337$, $p = 0.000$), GLU ($r = 0.239$, $p = 0.003$), TC/HDL ($r = 0.238$, $p = 0.003$), and nearly statistically significantly positively correlating to TG ($r = 0.155$, $p = 0.056$). And WC is statistically significantly negatively correlated with HDLC ($r = -0.277$, $p = 0.001$), nearly statistically significantly negatively correlating with Albumin ($r = -0.137$, $p = 0.090$).

Table 2. Bivariate analysis on the relationship of WC and BMI to the clinical laboratory data(only indices with the analysis results of *p*-value less than or nearly less than 0.05 being listed below).

	WC		BMI	
Correlates	*r*	*p*-Value	*r*	*p*-Value
HDLC(mg/dl)	−0.277	0.001	−0.256	0.001
ALB (g/L)	−0.137	0.090	−0.166	0.041
CB(μmol/L)	−0.118	0.147	−0.148	0.068
TC(mg/dl)	0.099	0.221	0.143	0.078
TG (mg/dl)	0.155	0.056	0.169	0.036
FA(mmol/L)	0.169	0.037	0.143	0.078
UREA(mmol/L)	0.169	0.037	0.055	0.503
GGT (U/L)	0.179	0.027	0.129	0.113
ALP (U/L)	0.179	0.027	0.119	0.143
LDLC(mmol/L)	0.182	0.024	0.224	0.005
TC/HDLC	0.238	0.003	0.272	0.001
GLU (mmol/L)	0.239	0.003	0.162	0.045
ALT (U/L)	0.252	0.002	0.252	0.002
DB	0.303	0.000	0.249	0.002
SCR (μmol/L)	0.303	0.000	0.190	0.018
SB	0.307	0.000	0.279	0.000
Ua(μmol/L)	0.337	0.000	0.234	0.004
BMI	0.800	0.000	1.000	0.800
AC	1.000	0.000	0.800	0.000

Table 3. Statistically significantly Partial correlations between WC, BMI and the clinical laboratory data controlled by age and gender.

	WC		BMI	
Correlates	*r*	*p*-Value	*r*	*p*-Value
ALB (g/L)	−0.217	0.007	−0.212	0.009
ALT (U/L)	0.227	0.005	0.242	0.003
LDLC(mmol/L)	0.103	0.21	0.189	0.02
HDLC(mg/dl)	−0.23	0.004	−0.235	0.004
CB(μmol/L)	−0.161	0.049	−0.167	0.041
Ua(μmol/L)	0.215	0.008	0.182	0.025
GLU (mmol/L)	0.216	0.008	0.149	0.067
BMI	0.806	0	1	0
AC	1	0	0.806	0
TC/HDLC (odds ratio)	0.165	0.043	0.241	0.003

But, when the age and gender conditions were controlled, the associations had some changes. WC was statistically significantly positively correlated to some clinical laboratory indices, i.e., ALT ($r = 0.227$, $p = 0.005$),Ua($r = 0.215$, $p = 0.008$),GLU ($r = 0.216$, $p = 0.008$),BMI($r = 0.806$, $p = 0.000$), and TC/HDLC($r = 0.165$, $p = 0.043$), statistically significantly negatively correlating with ALB ($r = -0.217$, $p = 0.007$), HDLC($r = -0.23$,$p = 0.004$), and CB($r = -0.161$, $p = 0.049$).

For BMI, the statistically significantly positively related clinical laboratory indices were ALT ($r = 0.242$, $p = 0.003$),LDLC ($r = 0.189$,$p = 0.02$),Ua($r = 0.182$, $p = 0.025$),WC($r = 0.806$, $p = 0.000$), and TC/HDLC($r = 0.241$, $p = 0.003$), and the negatively related ones were ALB (($r = -0.212$, $p = 0.009$), HDLC($r = -0.235$, $p = 0.004$), and CB($r = -0.167$, $p = 0.041$)

Correlations between DB, SB, and the clinical laboratory data

Correlation analysis (Table 4) and partial correlation analysis (Table 5) were both conducted. In our study, correlationship

Table 4. Bivariate analysis on the relationship of DB and SB to the clinical laboratory data(only indices with the analysis results of *p*-value less than or nearly less than 0.05 being listed below).

	DB		SB	
Correlates	*r*	*p*-Value	*r*	*p*-Value
ALB (g/L)	−0.052	0.527	−0.203	0.012
TC(mg/dl)	0.054	0.504	0.210	0.009
FA(mmol/L)	0.106	0.192	0.315	0.000
LDLC(mmol/L)	0.117	0.148	0.195	0.016
GLU (mmol/L)	0.138	0.088	0.309	0.000
GGT (U/L)	0.146	0.071	0.028	0.728
UREA(mmol/L)	0.176	0.029	0.164	0.043
Ua(μmol/L)	0.196	0.015	0.082	0.311
ALP (U/L)	0.248	0.002	0.185	0.022
BMI	0.249	0.002	0.279	0.000
AC	0.303	0.000	0.307	0.000
SB	0.705	0.000	1.000	
DB	1.000		0.705	0.000

Table 5. Statistically significantly partial correlations between DB,SB and the clinical laboratory data controlled by age and gender.

	DB		SB	
Correlates	*r*	*p*-Value	*r*	*p*-Value
LDLC(mmol/L)	0.066	0.423	0.174	0.033
FA(mmol/L)	0.025	0.762	0.225	0.005
ALP (U/L)	0.205	0.011	0.139	0.089
GLU (mmol/L)	0.079	0.337	0.231	0.004
TC(mg/dl)	0.003	0.974	0.174	0.032
BMI	0.205	0.012	0.248	0.002
AC	0.206	0.011	0.227	0.005

between DB and SB is statistically significantly positive ($r = 0.705$, $p = 0.00$). DB statistically significantly positively correlated to three clinical laboratory indices, i.e., ALP ($r = 0.248$, $p = 0.002$), UREA ($r = 0.176$, $p = 0.029$), GLU ($r = 0.138$, $p = 0.088$), and nearly positively correlated with GGT($r = 0.146$, $p = 0.071$).

For SB, the statistically significantly positively related clinical laboratory indices were LDLC ($r = 0.195$, $p = 0.016$), FA ($r = 0.315$, $p = 0.000$), UREA($r = 0.164$, $p = 0.043$),GLU ($r = 0.164$, $p = 0.043$), and TC($r = 0.210$, $p = 0.009$), and the negatively related one was ALB($r = -0.203$, $p = 0.012$),

But, when the age and gender conditions were controlled, the correlations changed to some extent. DB statistically significantly positively correlated with three clinical laboratory indices, i.e., ALP ($r = 0.205$, $p = 0.011$), BMI ($r = 0.205$, $p = 0.012$), and WC($r = 0.206$, $p = 0.011$).

For SB, the statistically significantly positively related clinical laboratory indices were LDLC ($r = 0.174$, $p = 0.033$), FA ($r = 0.225$, $p = 0.005$), GLU($r = 0.231$, $p = 0.004$), TC ($r = 0.174$, $p = 0.032$), BMI ($r = 0.248$, $p = 0.002$), and WC ($r = 0.227$, $p = 0.005$).

Comparisons of the clinical laboratory data between four groups

When the age and gender conditions were controlled, clinical laboratory indices having statistical differences between the four groups were as the followings (Table 6): ALB of NH was statistically significantly higher than JO, OH, JH groups, ALT of JO was statistically significantly higher than NH and JH groups. LDLC of OH was statistically significantly higher than NH group. TG of JH was statistically significantly higher than NH group. HDLC of JO was statistically significantly lower than JO and NH groups. ALP of NH was statistically significantly lower than JH and OH groups. Ua of NH was statistically significantly lower than JO and OH groups. TC/HDLC (odds ratio) of JO were statistically significantly higher than JH and NH groups.

Table 6. Clinical laboratory indices comparisons between four groups (only indices with the analysis results of *p*-value less than 0.05 being listed below).

item	Rank ($p < 0.05$)
ALB	NC > JO,OH,JH
ALT	JO > NC
LDLC	OH > NC
TG	JH > NC
HDLC	JO < JH,NC
ALP	NC < JH,OH
Ua	NC < JO,OH
TC/HDLC	JO > JH,NC

Discussion

Obesity, hypertension, high blood sugar, high blood fat are recognized as the metabolic disorders, whose pathogenesis underlie with Insulin resistance (17). And the disorders infect each other. The mechanisms between the obesity and the hypertension are complicated. The mechanisms, by which obesity can induce the hypertension, include the mediators of abnormal kidney function, enhanced noxious influence of inflammation on the vasculature, sympathetic nervous system activation, increased visceral adiposity, renin-angiotensin-aldosterone system activation, etc. (1,5,18,19). Some research shows that in Chinese people, the prevalence of general and central obesity is strongly related to high blood pressure, and men with obese BMI but normal WC may be at increased risk of high blood pressure (18). Association information between obesity and hypertension among Chinese specific populations has being obtained.

To explore the relationships between the obesity and the hypertension step by step, the 17 lab indices were analyzed by correlating with WC, BMI, SB, and DB among the subjects, and were compared between the 4 groups of NH, JO, OH, and JH.

The results showed that WC and BMI both statistically significantly positively correlated with SB and DB. It is speculated that the obesity correlates with hypertension and may spawn it. This result may back on it at some extent.

When the age and gender conditions were controlled (the following is the same), in the study, ALB、ALT、LDLC、; TG、HDLC、HDLC、ALP、;Ua、and TC/HDLC were significantly different between the four groups.

ALP was found in NH statistically significantly to be lower than JH and OH groups. The role of inflammation on the rising risk of hypertension has been speculated. And it also may be considered benign that inflammation and immune activation lead to modest elevations of blood pressure (20–22). ALP was considered as a Marker of Inflammation in CKD Patients or a protector against renal inflammation, paradoxically (23). Also, ALP may play a special role in hypertension and contribute to higher BP. ALP was also positively correlate with WC, and obesity may contribute to more ALP.

ALT in JO group was found to be statistically significantly higher than that in NH group. Elevated ALT is recognized to be associated with a worse cardiac risk profile and metabolic syndrome (24). And ALT in this study statistically significantly

positively correlated with WC and BMI. From the data, it is speculated that obesity may contribute to higher ALT .

And only LDLC in the OH group was statistically significantly higher than that in NH group. LDLC is considered to be bad cholesterol, leading to plaque, a thick, hard deposit and less flexible arteries and clogs. In the study, LDLC were statistically significantly positively associated with WC□BMI, and SB. So, may be, elevated LDLC have influence with both obesity and hypertension (25).

In our study, HDLC was found in the JO group to be statistically significantly lower than in JH or NH group. And HDLC statistically significantly negatively correlated with WC and BMI, but had no correlations with SB and DB. And GLU had statistically significantly positive correlation with SB and DB. It is said that high HDLC helps to reduce the risk of heart disease. Also, Fats and cholesterol can be dislodged from cells by high density lipoprotein cholesterol particles. But, in this study, HDLC was not directly associated with hypertension. These data indicate there are a lot of factors those can influence BP, and HDLC may just a intermediate linking factor.

ALB was found in the NH group to be statistically significantly higher than in the JH group, in the OH group or in the JO group. And ALB statistically significantly negatively correlated with BMI, WC, and SB. Obesity may lead to more microalbuminuria or frank proteinuria and low serum albumin by the physical compression to the kidneys by fat in and around kidneys (21). This result had no insistence with the study by Cho et al. (26), in which, increased serum levels of albumin were found to be related with higher prevalence of metabolic syndrome. And the difference need more research.

TG in JH group was found to be statistically significantly higher than in NH group. And TG may statistically significantly positively correlate with BMI. But this association may be influenced by age and gender. TG is said to be an independent risk factor for hypertension□and low HDLC and high triglyceride levels were more prevalent with the existence of hypertension and obesity (19,20).

In our study, Ua of NH group was found to be statistically significantly lower than that of JO group or of OH group. And Ua statistically significantly positively correlated with WC and BMI. Also it statistically positively correlated with DB, but this association may be influenced by age and gender. And it is said that enhanced serum uric acid, recognized as a predictor of BP elevation and obesity, correlated with Angiotensinogen in obese patients with untreated hypertension (27). Also, there are associations between Ua and inflammation biomarkers, endothelial dysfunction and carotid atherosclerosis (28). Maybe, the obesity contributes to more uric acid compared with normal population and then the more Angiotensinogen. And in the end, this can do some contribution for the happening of hypertension.

From the results, it can be speculated that obesity's negative body effects are comprehensive. And obesity can lead to hypertension through multiple ways. ALP and ALT may be at the way of "inflammation on the vasculature", and LDLC, HDLC and TG may be at the way of "increased visceral adiposity", and ALB may be at the way of "the mediators of abnormal kidney function," and Ua may be at the way of "renin-angiotensin-aldosterone system activation".

In summary, mechanisms between the obesity and hypertension are complex. In this study, the criteria of obesity developed for Chinese people were used, and some statistically significant differences of some clinical laboratory indices were found among four special Chinese population, i.e., the newly diagnosed untreated just-obesity group, newly diagnosed untreated obesity-hypertension group, newly diagnosed untreated just-hypertension group, and normal Chinese population group. The data are precious and may clarify some relationships between the obesity and hypertension. Most results in this study were consistent with previous researches' findings. But conflicting results were found about serum levels of ALB between our study and other one research. Maybe, different mechanisms about obesity's leading to hypertension are all working, but for various individuals, the different mechanisms account for different percents.

And the continual studies will be done by our research team to further touch the related mechanisms between obesity and hypertension.

Declaration of interest

The authors declare no conflict of interest.

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