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Association of obesity with glucose, blood pressure, and lipid goals attainment in patients with concomitant diabetes and hypertension

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Abstract

Objective: To investigate the associations between obesity and any significant improvements in glycemic control, blood pressure, and lipid targets in Chinese patients with concomitant T2DM and hypertension.

Methods and Results: A total of 3041 dyslipidemia patients with an average age of 65.7±10.53 years and comorbid conditions of T2DM and hypertension from the DYS lipidemia International Study (DYSIS)-China were included in the present subgroup analysis. Patients' demographic data, medication use, blood glucose, and lipid parameters were analyzed retrospectively. Body mass index (BMI), waist circumference (WC), and waist-to-height ratio (WtHR) differed significantly among participants according to the attainment of treatment targets. Among female patients, significant differences in the rate of target attainment were observed among different WC, WtHR, and BMI quartile groups, whereas no significant differences in goal attainment were found according to WC and WtHR quartiles in male patients. Among the female patients, the results of logistic regression supported a significant association of anthropometric indices and the achievement of targets.

Conclusion: A considerable proportion of dyslipidemia patients failed to achieve guideline-recommended targets in China, and this apparent treatment gap was more pronounced among women with central adiposity and patients with an elevated BMI. Based on the limitations of this cross-sectional study, further investigation of the mechanism at the molecular level is necessary.

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Conclusion: A considerable proportion of dyslipidemia patients failed to achieve guideline-recommended targets in China, and this apparent treatment gap was more pronounced among women with central adiposity and patients with an elevated BMI. Based on the limitations of this cross-sectional study, further investigation of the mechanism at the molecular level is necessary.

Short title: Obesity and cardiometabolic goal attainment

Introduction

Obesity affects almost 30% of the global population with a significantly increasing incidence. It is commonly associated with diabetes, hypertension, and dyslipidemia and is a known risk factor for cardiovascular disease. As obesity shares many common risk factors with diabetes, they are often concurrent in patients. Data from China indicated that more than 92.4 million adults (9.7%) aged over 20 years have diabetes[1], whereas a nationwide epidemiologic study demonstrated that the prevalence of hypertension in Chinese adults is 27.2%[2]. The Diabetes Control and Complications Trial (DCCT) [3] and the United Kingdom Prospective Diabetes Study (UKPDS) [4] showed that improved glycemic control is associated with reduced complications[5]. Subsequently, lowering blood pressure[6] and reducing cholesterol levels[7] can decrease the morbidity of cardiovascular diseases among patients with diabetes. Therefore, the achievement of therapeutic target levels for blood glucose, lipid, and blood pressure (BP) levels seems very important in these patients.

With regard to influencing factors, some studies have reported that women with type 2 diabetes mellitus (T2DM) are at a higher risk for poor glycemic control and abnormal lipid metabolism than men with T2DM[8, 9]. In addition, obesity appears to be an independent risk factor for the failure to attain targets for BP, dual BP, and low-density lipoprotein cholesterol (LDL-C) in patients with concomitant hypertension and dyslipidemia[10]. Therefore, any factor that can influence attainment of therapeutic targets should be identified.

Although total body fat and its distribution can be measured by sophisticated instruments, anthropometric measurements still play an important role in clinical and epidemiological

studies. Body mass index (BMI) is often used as an indicator of total body fat amount, whereas waist circumference (WC) and the waist-to-height ratio (WtHR) are used to represent intra-abdominal adiposity [11, 12]. These measures have been used as markers of metabolic diseases such as T2DM, hypertension, and dyslipidemia in adults and can be useful in the assessment of the treatment effectiveness. To our knowledge, few studies have investigated the usefulness of anthropometric indices in the achievement of treatment goals among T2DM and hypertension patients. Such important correlations may be helpful for achieving better metabolic control and reducing the incidence of related complications in clinical practice. In the present study, we aimed to explore the roles of BMI, WC, and WtHR as indicators in the attainment of guideline-recommended levels for glycemic control, BP, and lipid targets in patients of both genders. The results of our study may be beneficial to clinicians for the management of T2DM patients.

Methods

Study design and population

The present study was an expanded investigation based on the DYSlipidemia International Study (DYSIS)-China, which consisted of a series of multicenter epidemiological cross-sectional studies. The DYSIS-China included 25,697 patients treated at 122 centers in China between April 2012 and October 2012. All patients provided informed consent before beginning the study, and the study protocol was approved by the Ethics Committee of each clinic center. The study design and methods of the DYSIS-China study as well as the baseline results have been reported in detail previously [13]. Among the 25,697 participants, 3,041 patients with dyslipidemia also had T2DM and hypertension with properly documented data

for their blood glucose, glycated hemoglobin A1C (HbA1C), and LDL-C levels as well as their BP for analysis in the present study.

Data collection

Clinical information for the study participants were collected during outpatient consultations by trained interviewers using a pretested questionnaire. A family history of premature cardiovascular disease (CVD) was defined as any immediate first-degree relative having experienced a fatal or nonfatal myocardial infarction (MI), stroke or sudden cardiac arrest, and the event was considered premature if it occurred before the ages of 55 and 65 years in male and female relatives, respectively. A patient's lifestyle was considered sedentary if the patient did not conduct regular physical activity (i.e., minimum of walking 20–30 min on 3–4 days a week or equivalent). Tobacco smoking was categorized into current, former, or never smoker groups, which corresponded to smoking now, having quit <1 year previously, and having never smoked, respectively. Alcoholism was defined by drinking ≥50 ml liquor per day, ≥150 ml red wine per day, or ≥500 ml beer per day. The cardiovascular history of the patients included coronary heart disease (CHD), ischemic cerebrovascular disease, peripheral arterial disease (PAD), and symptomatic chronic heart failure (New York Heart Association classes II-IV).

Anthropometry

Anthropometric measures were performed using standardized procedures by the trained staff in all associated study centers. Weight, height, and WC were measured using a calibrated scale, a rigid and portable stadiometer, and a measuring tape, respectively. BP was measured

with a calibrated sphygmomanometer after the patient had rested in the supine position for 10 min. The following obesity-related anthropometry indices were calculated: BMI (weight [kg]/height^2 [m^2]) and WtHR (WC [cm]/height [cm]). Patients were also divided into quartiles (Q) according to WC (men: Q1 <85.5 cm, Q2 = 85.5–92 cm, Q3 = 92–99 cm, Q4 ≥99cm; women: Q1 <80 cm, Q2 = 80 –86.6 cm, Q3 = 86.6–94 cm, Q4: ≥94 cm); to WtHR (men: Q1 <0.51, Q2 = 0.51–0.54, Q3 = 0.54–0.58, Q4 ≥0.58; women: Q1 <0.51, Q2 = 0.51–0.55, Q3 = 0.55–0.59, Q4: ≥0.59), and to BMI (men: Q1 <23.6 kg/m^2, Q2 = 23.6–25.4 kg/m^2, Q3 = 25.4–27.4 kg/m^2, Q4: ≥27.4 kg/m^2; women: Q1 <22.9 kg/m^2, Q2: 22.9–25.0 kg/m^2, Q3: 25.0–27.6 kg/m^2, Q4: ≥27.6 kg/m^2).

Definition of therapeutic goals

The defined therapeutic goals for HbA1c, BP, and LDL-C level were based on the 2010 Chinese guidelines for the management of T2DM [14]. The LDL-C treatment goals are <2.6 mmol/L (without a history of coronary heart disease) or 2.07 mmol/L (with a history of coronary heart disease). The HbA1c treatment goal was <7.0%, and that for BP treatment was <130/80 mmHg. In addition, we created four categories representing all possible combinations of target attainment: 1) no targets achieved; 2) only one target achieved; 3) only two targets achieved; 4) three targets achieved.

Statistical analysis

Statistical analyses were performed with SAS version 9.2 (Institute Inc., Cary, NC, USA). Data were expressed as mean ±standard deviation (SD) or percentage as suitable. Comparisons between groups were analyzed by t-tests and analysis of variance (ANOVA) for

measurement data, and chi-square test and Fisher exact test were applied for enumeration data. Logistic regression was used to determine the odds ratios (ORs) for the percentage of attainment of the targets stratified by WC, WtHR, and BMI, while adjusting for confounders, including age, alcohol consumption, and comorbidities. The percentage of patients who attained targets was used as the dependent variable, and the quartiles according to the WC, WtHR, and BMI categories were used as the independent variables. $p<0.05$ was defined as the threshold for statistical significance.

Results

Characteristics of study participants

A total of 3014 dyslipidemia patients with comorbid conditions of T2DM and hypertension from the DYSIS-China study were included in the present analysis. The mean patient age was 65.7±10.53 years, and 50.2% (1526/3014) of patients were male. As compared with female patients, male patients had a significantly lower mean age, WtHR, and rate of dyslipidemia as well as a significantly higher WC and greater likelihood of a history of cerebrovascular disease. In addition, significantly higher percentages of male patients had a sedentary lifestyle, were current smokers, and were current alcohol drinkers than among females. BMI, a family history of premature CVD, the prevalence of major comorbidities, and treatment rates of T2DM and hypertension were similar between the genders.

Individual levels of BP, lipid, and glucose profiles

The levels of individual components of BP, lipid levels, and glucose profiles are listed in Table 2. Systolic BP and blood glucose profiles (both fasting plasma glucose and HbA1c)

were comparable between male and female patients. The LDL-C and high-density lipoprotein cholesterol (HDL-C) levels were higher in female patients than in male patients, whereas the diastolic BP was lower in female patients than in male patients. Only 6.2% of men and 6.8% of women had achieved all three therapeutic targets. Moreover, 30.5% of men and 25.7% of women achieved two of the three targets; 38.3% of men and 39.8% of women achieved one of the three targets; and 25.0% of men and 27.7% of women did not achieve any targets.

Therapeutic goal attainment stratified by WC, WtHR, and BMI

The patients' combined BP, glucose and lipid therapeutic goal attainment were assessed according to four quartiles of WC, WtHR, and BMI (Figure 1A-C), respectively. In all eligible patients, with increasing WC, WtHR, and BMI, the percentage of patients that achieved combined goal attainment decreased. Similar results were observed in the female group, whereas no similar trend was observed in the male group. Furthermore, Figure 2A-C shows the frequency of BP, glucose, and lipid abnormalities stratified by WC, WtHR, and BMI. In both male and female patients, a lower percentage of abnormalities were observed among patients in the lower quartile WC, WtHR, and BMI groups, compared to that among patients in the higher WC, WtHR, and BMI quartile group.

Associations of anthropometric indices and blood pressure, blood glucose, and lipid level goal attainment

The associations of BMI, WC, and WtHR with attainments of glycemic, BP, and lipids targets were analyzed by logistic regression analysis. As shown in Table 3-4, only male patients who achieved at least two targets were less likely, overall, for WC values above 99

cm group compared to below 99 cm group (p=0.0251). No significant association was found between WC and the achievement of one or more targets in male patients. Likewise, men with a WtHR greater than 0.58 were significantly less likely to reach two targets (p=0.0292), and those with a WtHR between 0.54 and 0.58 were significantly less likely to reach one target (p=0.0403) after the model had been adjusted for age, current drinking, and antihypertensive treatment. For men who achieved at least two targets, the ORs (95% CIs) for the third and fourth quartiles of BMI were lower than those of patients in the first BMI quartile; however, this association was significant after relevant adjustments. For women who achieved at least one or two targets, the ORs (95% CIs) for the second, third, and fourth quartiles of WC were lower than that of patients in the first WC quartile (reference). After adjustment for glucose-lowering treatment, family history of premature CVD, CHD, and cerebrovascular disease, this association was not changed. For those who achieved three targets, WC values above 94 cm were associated with a decreased likelihood of target attainment (p<0.05). Among the patients who achieved at least one or two targets, the ORs (95% CIs) for the third and fourth quartiles of WtHR were not differ from that for the patients in the first WtHR quartile (reference). However, after adjustment for confounders, this association remained significant. For patients with WtHR values greater than 0.59, the likelihood of attaining three targets was lower (p<0.005). Concurrently, similar results were observed among patients who achieved one or two targets according to the quartiles for BMI. For those who achieved three targets, the ORs (95% CI) for the second and fourth quartiles of BMI lower than that for patients in the first BMI quartile (reference).

Discussion

Obesity, hyperglycemia/insulin resistance, hypertension, and hyperlipidemia are all related at the molecular level in metabolic syndrome [15]. Therefore, attaining the relevant therapeutic target for any aspect could have a synergetic effect on attaining other targets. The management guidelines for the individual targets vary depending on geography and race, especially for Asians [16][16]. We selected the management criteria recommended by the Working Group on Obesity in China, which is closely aligned with the World Health Organization and American guidelines[17-20] [17-20].

Optimal control of glycemia, BP, and lipid levels has been shown to decrease complications in several randomized controlled trials[5]. Previous studies have shown that a high BMI is associated with lower attainment of glycemic[8, 21, 22], BP[10, 22, 23], and lipid targets[10, 24]. However, other studies demonstrated a relationship between high BMI and LDL targets[23, 25] and those obese patients, who are often resistant to therapy and require a combined drug treatment and lifelong intervention, encounter difficulty in the attainment of proper targets. In the present study, women had a significantly higher WC as well as an increased rate of failure to achieve the therapeutic targets, consistent with the findings in a previous study[24]. Disappointingly, only 6.2% of male patients and 6.8% of female patients attained the three guideline-recommended targets in the present study, and these percentages seemed lower than those in a study of American patients (from 7.0%–14.3%) conducted from 1999–2010 [23]. The underlying reasons are likely multifactorial. We found that patients who did not attain any targets had a significantly higher BMI, WC, and WtHR, whereas those who attached all three goals had a significantly lower BMI, WC, and WtHR in both genders. These results suggest that obesity may be an important factor associated with the deregulation of blood glucose, BP, and blood lipids.

We also observed the percentages of patients who attained different numbers of targets stratified by quartiles based on WC, WtHR, and BMI. Significant differences in the rate of target attainment were observed among the different WC or WtHR quartile groups only in women. A significantly higher percentage of women with first quartile of WC (Q1) attained the three targets, whereas a significantly lower percentage of these women attained no targets compared with the percentages in all other quartiles. Similar results were observed for the WtHR. Interestingly, a significantly higher percentage of patients in the lowest quartile of BMI (Q1) attained all three targets, and a significantly lower percentage of these women attained no targets compared to these percentages among women in the third and fourth quartiles (Q2-Q3, ≥Q3). Furthermore, we found a strong association between WC and target attainment, with women who had a WtHR greater than 0.55 or BMI greater than 25 kg/m^2 being less likely to achieve one or two targets upon, and women with a WC greater than 94 cm, WtHR greater than 0.59, or BMI greater than 27.6 kg/m^2 being less likely to achieve all three targets. In contrast, only men with a WC greater than 99 cm, WtHR greater than 0.59, or BMI greater than 25.4 kg/m^2 were less likely to achieve two targets, and men with a WtHR between 0.55 and 0.59 were less likely to achieve one target. These results reflected a gender difference in the likelihood of target attainment: women were less likely to meet guideline-recommended targets than men with a high WC or WtHR. This is partly consistent with the findings of several previous studies [9, 23, 26, 27], which reported that a higher proportion men achieved targets than women. However, these previous studies did not report that women with abdominal obesity were less likely to achieve targets. As WC and WtHR are used to evaluate abdominal obesity and BMI is a marker for general obesity, our findings show that women with central obesity and all patients with general obesity are less likely to achieve

targets, highlighting the importance of maintaining normal WC and body weight in achieving goals for glycemic control, BP, and lipid levels among T2DM patients.

Furthermore, female diabetes patients have a poorer prognosis after myocardial infarction and a greater risk of death overall from cardiovascular diseases than male diabetes patients[28, 29], and the disparity of goal attainment may be one reason contributing to these worse outcomes in female T2DM patients. The sex disparities seem to represent innate differences in sexual motivation and characteristics [25, 30, 31], carbohydrate metabolism [32], pharmacodynamics and pharmacokinetics of the drugs[33], and adherence to treatments. However, a detailed investigation is required to explore such differences at the molecular level.

The present study is, to our knowledge, one of very few detailed investigations of the associations of WC and WtHR with the attainment of the glycemic, BP, and lipids targets in Chinese patients. Furthermore, our study employed a large number of patients with diabetes in a developing country. In addition, abdominal obesity as indicated by WC or WtHR seemed to influence the likelihood of T2DM patients attaining the treatment targets, although we still have not fully explored the underlying mechanism. Obese patients would have an increased level of visceral body fat, and it has been demonstrated that excess abdominal visceral fat and a larger WC have strong correlations with metabolic abnormalities and cardiovascular disease[34-37]. Visceral fat may stimulate the secretion of adipokines such as adiponectin, leptin, resistin, visfatin, etc., for participation in inflammation, lipid metabolism, insulin sensitivity, and atherogenesis[38].

The present study was a cross-sectional study, and therefore, temporal and causal relationships between anthropometric indices and the attainment of the glycemic, BP, and lipid targets could not be established. Furthermore, patient exclusion based on self-reported personal medical history may have caused selection bias, and lipid parameters were not measured in a central core laboratory. Therefore, our results may only support the hypothesis that obesity affects the treatment outcomes of T2DM, and further detailed investigations may be needed for verification of these findings at the molecular level.

In summary, the results of the present study support that obesity as indicated by a high WC and WtHR is associated with treatment target attainment in female T2DM patients, and high values of BMI are associated with target attainment among both male and female T2DM patients. More longitudinal studies should be conducted to elucidate the possible mechanism underlying these associations. These results imply that maintaining a normal body weight should be a priority in T2DM patients attempting to achieve treatment targets for glycemic control, BP, and lipid levels.

Transparency

Declaration of funding:

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Declaration of financial/other relationships:

Jihu Li is an employee of MSD China. All other Authors declare no conflict of interest. All authors contributed to the intellectual development of this paper. CMRO Peer Reviewers on this manuscript have no relevant financial relationships to disclose.

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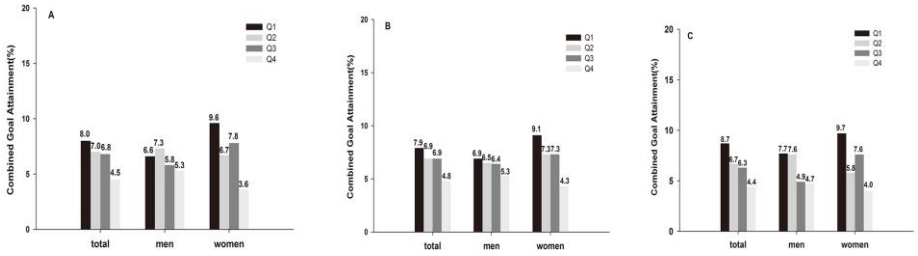

Figure 1. Combined BP, glucose, and lipid therapeutic goal attainment. (A) Stratified by WC; (B) stratified by WtHR; (C) stratified by BMI.

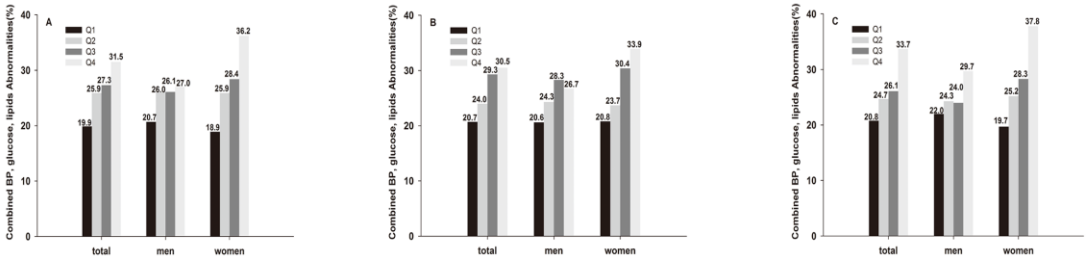

Figure 2. Combined BP, glucose, and lipid abnormalities. (A) Stratified by WC; (B) stratified by WtHR; (C) stratified by BMI.

Table 1 Patient characteristics

Variable	All patients (n=3014)	Male patients (n=1526)	Female patients (n=1515)	*p*
Age (years, mean±SD)	65.7±10.53	64.7±11.52	66.7±9.31	<0.0001
≥65 (n,%)	1621(53.3%)	732(48.0%)	889(58.7%)	<0.0001
<65 (n, %)	1420(46.7%)	794(52.0%)	626(41.3%)	
Height (cm, mean±SD)	164.1±8.33	170.3±5.74	157.8±5.33	<0.0001
Weight (kg, mean±SD)	68.8±11.88	74.3±10.79	63.3±10.27	<0.0001
WC (cm, mean±SD)	89.8±11.02	92.2±10.87	87.4±10.63	<0.0001
BMI (kg/m^2, mean±SD)	25.5±3.49	25.6±3.18	25.4±3.78	0.1123
WtHR (mean±SD)	0.55±0.066	0.54±0.063	0.55±0.068	<0.0001
Family history of premature CVD (n, %)	303(10.0%)	162(10.6%)	141(9.3%)	0.2500
Current smoker (n, %)	396(13.0%)	366(24.0%)	30(2.0%)	<0.0001
Alcohol consumption (n, %)	319(10.5%)	312(20.4%)	7(0.5%)	<0.0001

Sedentary lifestyle (n, %)	746(24.5%)	427(28.0%)	319(21.1%)	<0.0001
Comorbidities				
CHD (n, %)	1065(35.0%)	548(35.9%)	517(34.1%)	0.3021
Ischemic cerebrovascular disease (n, %)	559(18.4%)	325(21.3%	234(15.4%)	<0.0001
PAD (n, %)	60(2.0%)	36(2.4%)	24(1.6%)	0.1244
Heart failure (n, %)	137(4.5%)	61(4.0%)	76(5.0%)	0.1755
Anti-hypertensive treatment (n, %)	2829(93.0%)	1412(92.5%)	1417(93.5%)	0.2862
Anti-diabetic treatment (n, %)	2854(93.9%)	1426(93.4%)	1428(94.3%)	0.3657
Aspirin (n, %)	2121(69.7%)	1100(72.1%)	1021(67.4%)	0.0051

SD, standard deviation; BMI, body mass index; WC, waist circumference; WtHR, waist-to-height ratio; CVD, cardiovascular disease; CHD, coronary heart disease; PAD, peripheral artery disease.

Data are listed as n (%) for dichotomous variables and were tested using chi-square tests. Data are listed as mean ± standard deviation (SD) for continuous variables, and differences between the two groups were tested using t-tests.

Table 2 Individual blood pressure, lipid, and glucose levels

Variable	All patients (n=3014)	Male patients (n=1526)	Female patients (n=1515)	*p*
SBP (mmHg, mean±SD)	135.7±16.76	135.4±16.33	136.0±17.17	0.3547
DBP (mmHg, mean±SD)	78.9±10.52	80.0±10.65	77.9±10.28	<0.0001
TC (mmol/L, mean±SD)	4.5±1.22	4.3±1.19	4.7±1.22	<0.0001
TG (mmol/L, mean±SD)	2.1±1.81	2.0±1.97	2.1±1.64	0.6063
LDL-C (mmol/L, mean±SD)	2.6±0.96	2.5±0.92	2.7±0.98	<0.0001
HDL-C (mmol/L, mean±SD)	1.2±0.34	1.1±0.30	1.3±0.37	<0.0001
FPG (mmol/L, mean±SD)	7.8±3.02	7.9±3.090	7.8±2.94	0.4283
HbA1c (%, mean±SD)	7.4±1.78	7.4±1.75	7.5±1.81	0.7862

SD, standard deviation; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; TG, triglycerides; LDL-C, low density lipoprotein cholesterol; HDL-C, high density lipoprotein cholesterol; FPG, fasting plasma glucose; HbA1c, hemoglobin A1c.

Data are listed as mean±SD for continuous variables, and differences between the two groups were tested using t-tests.

Table 3 Odds ratios for attainment of different numbers of targets according to the quartiles of WC, WtHR, and BMI in male patients

Item	WC	OR (95% CI)	*p*	WtHR	OR (95% CI)	*p*	BMI	OR (95% CI)	*p*
At least 1 target achieved	Q1	1.00		Q1	1.00		Q1	1.00	
	Q2	0.75(0.54,1.06)	0.1054	Q2	0.83(0.58,1.19)	0.3106	Q2	0.95(0.67,1.33)	0.7542
	Q3	0.80(0.56,1.13)	0.2012	Q3	0.70(0.50,0.98)	0.0403	Q3	1.03(0.73,1.45)	0.8798
	Q4	0.77(0.55,1.08)	0.1303	Q4	0.74(0.53,1.03)	0.0778	Q4	0.77(0.55,1.08)	0.1260
At least 2 targets achieved	Q1	1.00		Q1	1.00		Q1	1.00	
	Q2	0.82(0.61,1.10)	0.1808	Q2	0.83(0.61,1.12)	0.2148	Q2	0.86(0.64,1.15)	0.3005
	Q3	0.83(0.61,1.12)	0.2175	Q3	0.76(0.57,1.03)	0.0742	Q3	0.69(0.51,0.93)	0.0154
	Q4	0.71(0.53,0.96)	0.0251	Q4	0.72(0.54,0.97)	0.0292	Q4	0.66(0.49,0.90)	0.0088
3 targets achieved	Q1	1.00		Q1	1.00		Q1	1.00	
	Q2	1.09(0.62,1.91)	0.7613	Q2	0.90(0.50,1.63)	0.7376	Q2	0.99(0.57,1.69)	0.9593
	Q3	0.84(0.46,1.53)	0.5598	Q3	0.91(0.51,1.62)	0.7460	Q3	0.59(0.32,1.09)	0.0935
	Q4	0.78(0.42,1.42)	0.4109	Q4	0.74(0.41,1.34)	0.3234	Q4	0.57(0.30,1.06)	0.0752

OR, odds ratio; WC, waist circumference; WtHR, waist-to-height ratio; BMI, body mass index; Q1, first quartile; Q2, second quartile; Q3, third quartile; Q4, fourth quartile.

Range for WC: (Q1:<85.5 cm; Q2: 85.5–92 cm; Q3: 92–99 cm; Q4: >99 cm).

Range for WtHR: (Q1: <0.51; Q2: 0.51–0.55; Q3: 0.55–0.59; Q4: >0.59).

Range for BMI: (Q1 <23.6 kg/m^2; Q2: 23.6–25.4 kg/m^2; Q3: 25.4–27.4 kg/m^2; Q4: >27.4 kg/m^2).

Factors including age, alcohol consumption, and anti-hypertensive treatment were adjusted for male patients in the regression model.

Table 4 Odds ratios for attainment of different numbers of targets according to quartiles of WC, WtHR, and BMI in female patients

Item	WC	OR (95% CI)	*p*	WtHR	OR (95% CI)	*p*	BMI	OR (95% CI)	*p*
At least 1 target achieved	Q1	1.00		Q1	1.00		Q1	1.00	
	Q2	0.67(0.48,0.98)	0.0389	Q2	0.86(0.60,1.24)	0.4210	Q2	0.72(0.51,1.02)	0.0631
	Q3	0.62(0.43,0.89)	0.0091	Q3	0.63(0.44,0.88)	0.0079	Q3	0.63(0.45,0.88)	0.0069
	Q4	0.44(0.31,0.63)	<0.0001	Q4	0.54(0.39,0.76)	0.0003	Q4	0.41(0.29,0.57)	<0.0001
At least 2 targets achieved	Q1	1.00		Q1	1.00		Q1	1.00	
	Q2	0.70(0.51,0.94)	0.0186	Q2	0.86(0.63,1.18)	0.3469	Q2	0.77(0.57,1.03)	0.0790
	Q3	0.66(0.48,0.90)	0.0090	Q3	0.67 (0.48,0.91)	0.0116	Q3	0.54(0.40,0.74)	0.0001
	Q4	0.51(0.37,0.70)	<0.0001	Q4	0.61(0.45,0.83)	0.0017	Q4	0.47(0.35,0.65)	<0.0001
3 targets achieved	Q1	1.00		Q1	1.00		Q1	1.00	
	Q2	0.68(0.40,1.16)	0.1574	Q2	0.78(0.45,1.34)	0.3640	Q2	0.57(0.33,0.99)	0.0447
	Q3	0.82(0.48,1.39)	0.4549	Q3	0.80(0.46,1.37)	0.4166	Q3	0.76(0.46,1.28)	0.3034
	Q4	0.38(0.20,0.74)	0.0040	Q4	0.47(0.26,0.85)	0.0129	Q4	0.39(0.21,0.72)	0.0027

OR, odds ratio; WC, waist circumference; WtHR, waist-to-height ratio; BMI, body mass index; Q1, first quartile; Q2, second quartile; Q3, third quartile; Q4, fourth quartile.

Range for WC: (Q1:<80 cm; Q2: 80–86.6 cm; Q3: 86.6–94 cm; Q4: >94 cm).

Range for WtHR: (Q1: <0.51; Q2: 0.51–0.55; Q3: 0.55–0.59; Q4: >0.59).

Range for BMI: (Q1: <22.9 kg/m^2; Q2: 22.9–25.0 kg/m^2; Q3: 25.0–27.6 kg/m^2; Q4: >27.6 kg/m^2).

Factors including anti-diabetic treatment, family history of premature CVD, CHD, and ischemic cerebrovascular disease were adjusted for female patients in the regression model.