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Gender differences in associations of serum ferritin and diabetes, metabolic syndrome, and obesity in the China Health and Nutrition Survey

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Abstract

Scope: This study examines gender differences in associations of serum ferritin and diabetes, metabolic syndrome (MetS), and obesity in Chinese.

Methods and results: Based on a nationwide, population-based China Health and Nutrition Survey this study included 8564 men and women aged 18 years or older. Anthropometric and fasting blood glucose, insulin, lipids, ferritin, and transferrin data were collected. Ferritin concentrations were higher in men than women (201.55 ± 3.6 versus 80.46 ± 1.64 ng/mL, $p < 0.0001$). The prevalences of MetS, diabetes, obesity, and overweight were 8.05, 8.97, 4.67, 25.88% among men and 14.23, 6.58, 5.81, 26.82% among women, respectively. Elevated ferritin concentrations were associated with higher body mass index, waist circumference, lipids, insulin, glucose (all $p < 0.0001$). Serum ferritin concentrations increased gradually with aging among women. The inverted U-shaped association between serum ferritin and age was observed among men. Elevated concentration of ferritins were significantly related with higher risk of MetS ($p < 0.0001$), obesity ($p = 0.010$), overweight ($p < 0.0001$), and diabetes ($p < 0.0001$) among men, but not among women.

Conclusion: There was a gender difference in associations between ferritin and MetS, obesity, and diabetes in Chinese adults. Further evaluations of the variation in gender on these associations are warranted to understand the mechanisms behind gender differences.

Keywords

China Health and Nutrition Survey; Ferritin; Metabolic syndrome; Obesity

1 Introduction

Large growing evidence demonstrated that moderately elevated body iron stores are associated with adverse health outcomes. Elevated ferritin levels have been demonstrated to

be associated with hypertension [1], dyslipidemia [2], elevated fasting insulin, and blood glucose [3], and can independently predict incident type 2 diabetes in prospective studies [4, 5]. EPIC-Norfolk prospective study demonstrated that serum ferritin is an important and independent predictor of the development of diabetes [6]. Elevated iron stores are also positively associated with the prevalence of the metabolic syndrome (MetS) and with insulin resistance in US adults [7], and with waist/hip ratio, body fat distribution, and obesity in Mexican American men aged 20–49 years [8]. Elevated iron stores may interfere with hepatic insulin extraction leading to peripheral hyperinsulinemia [9]. Study showed that iron modulates insulin action in healthy individuals and in patients with type 2 diabetes [10], furthermore, iron depletion has been demonstrated to be beneficial in endothelial dysfunction, insulin secretion, insulin action, and metabolic control in type 2 diabetes [10].

A few studies explored the associations between elevated iron stores and metabolic disorders in Chinese populations [11–13]. Shi and colleagues reported that iron status and iron intake was independently associated with risk of diabetes in Chinese women but not in men [11]. It has been reported that the influence of gender on metabolic disorders prevalences varies between populations [14]. Women are distinctly different to men with regard to the actions of insulin, the susceptibility to develop insulin resistance, and the response to stimuli that are known to enhance or impair sensitivity to the effects of insulin. Females are intrinsically more insulin resistant than males. Sex hormones, environmental and life-style factors augment or improve the female “genetic” disadvantage, in ways that are possibly also genetically predetermined [15]. Furthermore, elevated circulating ferritin concentrations were associated with higher risk of type 2 diabetes and MetS in middle-aged and elderly Chinese [12], and with higher risk of diabetes in north Chinese adults [13]. However, to date, no data reported the relationship between circulating ferritin levels and obesity in Chinese. Furthermore, although serum ferritin levels differ widely between men and women and has different association with diabetes among Chinese women and men [11], whether there is an effect modification by sex in the associations between circulating ferritin and metabolic disorders has not been investigated in detail, especially in Chinese population, whose dietary habits and iron intake are very different. For example, the prevalence of iron deficiency anemia was thus low: 6.3% among women and 0.7% among men [16].

We hypothesize that the associations of serum ferritin with metabolic disorders is different among men and women. To test this hypothesis, we conducted a cross-sectional analysis using representative data from the China Health and Nutrition Survey (CHNS).

2 Methods

2.1 Study population

The goal of the CHNS was to develop a multipurpose longitudinal survey that would allow the group to examine a series of economic, sociological, demographic, and health questions [17]. The CHNS collected health data in 228 communities in nine diverse provinces (Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong) throughout China from 1989 to 2009 in eight rounds of surveys. The 2009 survey included fasting blood collection for the first time. The sampling methods were described in previous study [18]. Total 8654 subjects aged 18 years or older were included in the present study.

The study was approved by the Institutional Review Boards at the University of North Carolina at Chapel Hill, the China-Japan Friendship Hospital, Ministry of Health, and the Institute of Nutrition and Food Safety, China Centers for Disease Control. Individuals gave written informed consent for participation.

2.2 Dependent variables

After an overnight fast, blood was collected by venipuncture (12 mL). Whole blood was immediately centrifuged and the serum was tested for related measurements. All samples were analyzed in a national central lab in Beijing (medical laboratory accreditation certificate ISO 15189:2007) with strict quality control. Glucose was measured with a Hitachi 7600 analyzer using a glucose oxidase phenol 4-aminoantipyrine peroxidase kit (GOD-PAP; Randox, Crumlin, UK). Total cholesterol (TC), HDL cholesterol and LDL cholesterol (HDL-c and LDL-c) were measured using glycerol-phosphate oxidase method, and the PEG-modified enzyme method, respectively, by determiner reagents (Kyowa Medex Co., Ltd., Tokyo, Japan) and triglycerides (TG) using glycerol-phosphate oxidase method and the PEG-modified enzyme method, respectively, by determiner reagents (Kyowa Medex Co., Ltd.). All lipid measures were on the Hitachi 7600 automated analyzer (Hitachi Inc., Tokyo, Japan); inflammation (high-sensitivity C-reactive protein) via the immunoturbidimetric method with Denka Seiken, Japan reagents (Hitachi 7600 automated analyzer, Hitachi Inc.). Self-report questionnaires were used to elicit information regarding medical history and current medication use.

2.3 Definition of diseases

Diabetes was defined according to the WHO 2006 guidelines as having fasting blood glucose measurement ≥ 7.0 mmol/L or having been diagnosed by a physician. The MetS was defined according to the National Cholesterol Education Program Expert Panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III; ATP III) [19, 20] criteria that presented three or more of the following risk factors: waist circumference (WC) greater than 102 cm in men or greater than 88 cm in women; serum TG concentration of ≥ 1.7 mmol/L or greater; HDL-c concentration of less than 1.0 mmol/L in men or less than 1.3 mmol/L in women; blood pressure $\geq 130/85$ mm Hg or greater; or serum glucose concentration of ≥ 6.1 mmol/L or greater [21]. BMI was calculated as weight in kilograms divided by the square of height in meters. Obesity was defined as a BMI of ≥ 29 kg/m² or greater. Overweight was defined as a BMI of ≥ 25.0 kg/m² or greater, according to the WHO definition [22, 23].

2.4 Statistical analyses

Analysis of covariance for continuous variables and logistic regression models for categorical variables were applied for the comparison across ferritin quartiles. Analysis of covariance was used to compare ferritin concentrations between sexes and geographic locations. Participants were classified into four groups according to their serum ferritin quartiles. Multivariate logistic regression models were used to estimate the odds ratio for MetS, obesity, overweight, and diabetes. Potential confounding variables included age, sex, geographic location, lifestyle factors, education level, and dietary factors, including total energy intake, dietary protein, and dietary fat. Data management and statistical analyses

were performed using SAS 9.2 (SAS Institute Inc., Cary, NC). Statistical tests were two sided and $p < 0.05$ was considered statistically significant.

3 Results

Ferritin concentrations were higher among men than women (201.55 ± 3.6 versus 80.46 ± 1.64 ng/mL, $p < 0.0001$). Transferrin concentrations were lower among men than women (2.80 ± 0.01 versus 2.95 ± 0.01 g/L, $p < 0.0001$). There are no significant differences in fasting insulin, the homeostatic model assessment-insulin resistance (Homa-IR) and Homa- β between men and women (Table 1). There are significant differences in prevalence of chronic diseases. The prevalence of MetS, diabetes, obesity, and overweight in our study population was 8.05, 8.97, 4.67, 25.88 among men and 14.23, 6.58, 5.81, 26.82 among women, respectively (Table 1).

The prevalence of MetS, obesity, overweight, and diabetes among men and women is shown, according to the residents in China in 2009. The prevalences of MetS were 10.9% (7.3% among men and 14.2% among women) in rural area and 12.1% (9.6% among men and 14.4% among women) in urban area, respectively. The prevalences of diabetes were higher in urban than in rural area (5.0% versus 2.1% among men and 4.5% versus 1.6% among women). The prevalences of obesity were 6.4% among men and 6.0% among women in urban area and 3.8% among men and 5.7% among women in rural area, respectively. The prevalences of overweight were higher in urban than in rural area (29.1% versus 24.3% among men and 27.1% versus 26.7% among women) (Fig. 1).

Overall, older subjects have higher ferritin, lower transferrin concentrations (all $p < 0.0001$). Subjects with higher ferritin concentrations have higher BMI, WC, TC, (TG, LDL-c, insulin, glucose, Homa-IR, and lower HDL-c and transferrin concentrations (all $p < 0.0001$) (Table 2).

We examined the gender differences in these associations between ferritin and metabolic diseases and we found that higher concentrations of ferritin were significantly related with higher risk of MetS ($p < 0.0001$), obesity ($p = 0.010$), overweight ($p < 0.0001$), high TG ($p < 0.0001$), high WC ($p < 0.0001$), high glucose ($p < 0.0001$), and low HDL-c ($p < 0.0001$) among men. However, elevated level of ferritin was only associated with increased risk of high TG among women. We did not observe significant associations between ferritin concentrations and risk of high blood pressure among both men and women (Table 3).

Serum ferritin concentrations increased gradually with age among women after adjustment for region, smoking, alcohol drinking, dietary factors (total energy intake, fat intake, and protein). The inverted U-shaped association between serum ferritin and age was observed among men (Fig. 2).

Remarkably, serum ferritin concentrations increased gradually with increasing numbers of MetS components among men and women after adjustment for age, sex, region, smoking, alcohol drinking, dietary factors (total energy intake, fat intake, and protein) (Fig. 3).

4 Discussion

Serum ferritin concentrations were higher in men than in women. Men have lower prevalence of MetS, obesity, and overweight, while higher prevalences of diabetes than women. We found strong gender differences in associations between ferritin and risk of MetS, obesity, overweight, and diabetes. However, we did not observe the significant associations between ferritin concentrations and risk of high blood pressure among both men and women.

During the past several decades, the populations mean BMI and prevalences of diabetes, MetS, obesity, and overweight have increased. A national survey conducted in 1994, involving 224 251 Chinese residents from 19 provinces, showed that the prevalence of diabetes was 2.5% [24]. The China National Diabetes and Metabolic Disorders Study showed that the age-standardized prevalence of total diabetes was 9.7% (10.6% among men and 8.8% among women) accounting for 92.4 million adults with diabetes. The prevalence of diabetes was higher among urban residents than among rural residents (11.4% versus 8.2%) [25]. Data from the 2002 national nutrition and health survey showed that 14.7% of Chinese were overweight and another 2.6% were obese in 2002 [26]. A cross-sectional survey was conducted in a nationally representative sample of 15 540 Chinese adults in 2000–2001. It was shown that the prevalences of overweight and obesity were 24.1 and 2.8% in men and 26.1 and 5.0% in women, respectively [27]. The age-standardized prevalence of MetS was 9.8% in men and 17.8% in women [21]. The prevalences of the MetS and overweight was higher in northern than in southern China, and higher in urban than rural residents [21]. In our present study, the prevalences of MetS, diabetes, obesity, and overweight in our study population were 8.05, 8.97, 4.67, and 25.88% among men and 14.23, 6.58, 5.81, and 26.82% among women.

Present and previous study detected gender-related influences on blood ferritin and prevalence of MetS [14, 28]. Insulin resistance appears to be a central feature of MetS. Metabolic control varies between men and women. Intrinsic sexual dimorphisms exist at the molecular and cellular levels and there is the presence of different sex steroid hormones [15]. Women have a more insulin-sensitive environment than men [29]. That could be one of the reasons that women had higher prevalences of MetS and obesity in the present study. By contrary, study showed that men were more insulin resistant than women [30]. Greater visceral fat accumulation and lower plasma adiponectin concentrations in men than women contribute to gender differences in insulin sensitivity and higher vulnerability to cardiovascular diseases [31]. In our present study, the higher insulin resistance in men than women may also help to explain the higher prevalences of diabetes. However, the protective effects of female sex hormones conferred on women dissipate rapidly after the age of 50 [32].

Several studies have suggested a possible link between high body iron stores and serum insulin [28] and glucose [3]. Consistent with previous studies, our present study showed that older subjects have higher ferritin concentrations. However, the possible reason why ferritin level increased with age is not understood. Subjects with elevated ferritin concentrations exhibited higher lipids, insulin, and glucose. However, another study on Chinese showed that

fasting serum ferritin concentrations correlated significantly with fasting plasma glucose and insulin concentrations, and Homa-IR only in women. None of the above metabolic variables was related to the fasting serum ferritin levels in men [28].

Strong positive associations between elevated plasma ferritin concentrations, and hypertension [1], dyslipidemia [2], obesity [8], and type 2 diabetes [5, 33, 34] were also observed. The findings from previous studies were conflicting and inconclusive among Chinese [11, 13]. A cross-sectional household survey carried out in 2002 in Jiangsu, China showed that iron status and iron intake were independently associated with risk of diabetes in Chinese women but not in men [11]. Another study reported that elevated circulating ferritin concentrations were associated with higher risk of type 2 diabetes and MetS in middle-aged and elderly Chinese independent of obesity, inflammation, adipokines [12]. As there are substantial differences in ferritin and transferrin concentrations by gender in the present and previous studies [35], we examined the gender differences in these associations between ferritin and metabolic disorders, we observed that elevated concentrations of ferritin were related with higher risk of MetS, obesity, overweight, and diabetes among men, while, not among women.

The influence of gender on metabolic disorders prevalences varies between populations mainly related to the characteristics of the population sampled and its definition [14]. It has been reported that women are distinctly different to men with regard to the actions of insulin, the susceptibility to develop insulin resistance, and the response to stimuli that are known to enhance or impair sensitivity to the effects of insulin. Females are intrinsically more insulin resistant than males, possibly because of specific sex-linked gene expression and the resulting differences in metabolic control elements (e.g. signaling pathway and substrate shuttling elements, receptors). Sex hormones, environmental and life-style factors augment or improve the female “genetic” disadvantage, in ways that are possibly also genetically predetermined [15]. Punnonen et al. examined CVD risk after premenopausal hysterectomy or myomectomy and found that a functioning uterus and loss of blood and iron are necessary for continued cardiovascular protection of women [36]. Therefore, the iron depletion effects were also raised to explain the phenomenon of gender differences.

Although the mechanisms for the potential effect of iron on the risk of metabolic disorders are not fully understood, it has been hypothesized that elevated iron stores may interfere with hepatic insulin extraction leading to peripheral hyperinsulinemia [9]. The major source of body iron is derived from the diet. Dietary iron exists as either heme or nonheme iron. Prospective cohort studies reported that intake of total or nonheme iron was not associated with the risk of type 2 diabetes, but heme iron was associated with elevated risk [34].

Study showed that iron modulates insulin action in healthy individuals and in patients with type 2 diabetes [10] furthermore, iron depletion has been demonstrated to be beneficial in endothelial dysfunction, insulin secretion, insulin action, and metabolic control in type 2 diabetes [10]. As iron can produce reactive oxygen species as a transitional metal and a potential catalyst in any cellular reactions, which contribute to tissue damage [37], elevated body iron could enhance lipid oxidation, in particular free fatty acids, through accelerated production of free radicals [38]. Elevated free fatty acids can damage pancreatic β -cells and

cause insulin resistance [33]. Therefore, iron-induced damage modulates the development of chronic diabetes complications [10]. Actually, these relationships are bi-directional: iron affects glucose metabolism, and glucose metabolism impinges on several iron metabolic pathways [10]. Oxidative stress and inflammatory cytokines also influence these relationships, amplifying and potentiating the initiated events [10]. Furthermore, increased iron content was found in peripheral muscle [39], which is the major site of glucose disposal. Higher iron accumulation may cause derangement of muscle glucose uptake because of muscle damage [40]. It is also possible that higher hepatic iron overload interferes with the relationship between serum ferritin and insulin resistance [41]. Previous study provided an insight into the phenomenology of intriguing mutual relationships between iron and glucose metabolisms. Body iron uptake in the intestine is regulated by hepcidin, a bioactive peptide originally identified in plasma and urine and subsequently in the liver. Study showed that hepcidin is also expressed in the pancreas of rat and man. The localization of this peptide to β -cells suggests that pancreatic β -cells may be involved in iron metabolism in addition to their genuine function in blood glucose regulation [42].

In conclusion, there were gender differences in associations between ferritin and MetS, obesity, and diabetes. Further evaluations of the variation in sex differences on these associations are warranted to understand the mechanisms behind these gender differences.

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5 References

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Figure 1.
Prevalences of MetS, obesity, overweight, and diabetes among men and women according to urban or rural residence. Bars indicate 95% confidence intervals.

Figure 2. Gender differences in association of serum ferritin concentrations and age. Data are shown as means $\pm$ SE after adjustment for region, smoking, alcohol drinking, dietary factors (total energy intake, fat intake, and protein)

Figure 3.

Serum ferritin concentrations according to the number of MetS components. Data are shown as means $\pm$ SE after adjustment for age, region, smoking, alcohol drinking, dietary factors (total energy intake, fat intake, and protein). $p < 0.001$ for trend.

Table 1.

Characteristics of studied population

	Men ^{a)}	Women ^{a)}	p-value
	n = 4023	n = 4541	
Age (years)	50.61 ± 0.24	50.78 ± 0.22	0.5633
BMI (kg/m ²)	23.32 ± 0.05	23.39 ± 0.05	0.3765
TG (mmol/L)	1.7 ± 0.03	1.48 ± 0.02	<0.0001
WC (cm)	84.34 ± 0.16	81.27 ± 0.15	<0.0001
TC (mmol/L)	4.81 ± 0.02	4.91 ± 0.02	<0.0001
LDL-c (mmol/L)	2.92 ± 0.02	3.03 ± 0.01	<0.0001
HDL-c (mmol/L)	1.39 ± 0.01	1.48 ± 0.01	<0.0001
Ferritin (ng/mL)	201.55 ± 3.60	80.46 ± 1.64	<0.0001
Transferrin (g/L)	2.80 ± 0.01	2.95 ± 0.01	<0.0001
Insulin (μIU/mL)	14.70 ± 0.37	14.17 ± 0.32	0.2799
Glucose (mmol/L)	5.48 ± 0.03	5.33 ± 0.02	<0.0001
Homa-IR	3.91 ± 0.11	3.63 ± 0.10	0.0765
Homa-β	278.89 ± 73.35	165.14 ± 15.67	0.1294
Smoke, n (%)	2460 (61.15)	182 (4.01)	<0.0001
Drink, n (%)	1869 (77.78)	204 (51.78)	<0.0001
MetS, n (%)	324 (8.05)	646 (14.23)	<0.0001
Diabetes, n (%)	361 (8.97)	299 (6.58)	<0.0001
Obesity, n (%)	188 (4.67)	264 (5.81)	<0.0001
Overweight, n (%)	1041 (25.88)	1218 (26.82)	<0.0001

p < 0.05 indicates significant difference between genders group.

Homa- β: homeostatic model assessment- β -cell function.

^{a)} Data are means ± SE or n (%).

Table 2.

Sample characteristics across ferritin categories in Chinese adults (n = 8564)

Ferritin (ng/mL) ^{a)}	Q1 (low)	Q2	Q3	Q4 (high)	p for trend ^{b)}
Age (year) ^{c)}	44.11 ± 0.32	52.01 ± 0.32	53.71 ± 0.32	52.95 ± 0.32	<0.0001
BMI (kg/m ²)	22.75 ± 0.07	23.17 ± 0.08	23.32 ± 0.08	24.20 ± 0.08	<0.0001
WC (cm)	79.13 ± 0.22	82.23 ± 0.22	83.23 ± 0.22	86.28 ± 0.22	<0.0001
TG (mmol/L)	1.25 ± 0.03	1.40 ± 0.03	1.56 ± 0.03	2.12 ± 0.03	<0.0001
TC (mmol/L)	4.64 ± 0.02	4.84 ± 0.02	4.89 ± 0.02	5.08 ± 0.02	<0.0001
LDL-c (mmol/L)	2.81 ± 0.02	3.01 ± 0.02	3.04 ± 0.02	3.05 ± 0.02	< 0.0001
HDL-c (mmol/L)	1.49 ± 0.01	1.48 ± 0.01	1.42 ± 0.01	1.36 ± 0.01	<0.0001
Transferrin (g/L)	3.16 ± 0.01	2.82 ± 0.01	2.75 ± 0.01	2.78 ± 0.01	<0.0001
Ferritin (ng/mL)	29.60 ± 3.02	64.96 ± 3.02	110.99 ± 3.02	343.89 ± 3.02	<0.0001
Insulin (μIU/mL)	12.91 ± 0.48	14.12 ± 0.48	14.62 ± 0.48	16.03 ± 0.48	<0.0001
Glucose (mmol/L)	5.07 ± 0.03	5.26 ± 0.03	5.40 ± 0.03	5.88 ± 0.03	<0.0001
Homa-IR	3.09 ± 0.15	3.53 ± 0.15	3.77 ± 0.15	4.66 ± 0.15	<0.0001
Homa-β	150.66 ± 70.92	324.22 ± 70.80	171.70 ± 70.83	227.38 ± 70.83	0.3085

^{a)}Data are means ± SE.^{b)}p values were calculated using general linear model after adjustment for age, sex, region, smoking, drinking, dietary factors (total energy intake, fat intake, and protein).^{c)}Not adjusted for itself.

Table 3.

OR (95% CI) for metabolic disorders according to quartiles of serum ferritin in Chinese adults (n = 8564)

		Ferritin (ng/mL)				<i>p</i> for trend
		Q1 (low)	Q2	Q3	Q4 (high)	
Men ^{a)}						
	High glucose	1.00	1.16 (0.82, 1.64)	1.33 (0.95, 1.87)	2.22 (1.61, 3.06)	<0.0001
	High BP	1.00	1.21 (0.90, 1.62)	1.08 (0.80, 1.45)	1.34 (1.01, 1.79)	0.187
	Low HDL-c	1.00	1.68 (1.07, 2.65)	2.39 (1.56, 3.67)	3.79 (2.50, 5.74)	<0.0001
	High TG	1.00	1.59 (1.18, 2.13)	2.48 (1.87, 3.28)	4.61 (3.49, 6.08)	<0.0001
	High WC	1.00	1.11 (0.53, 2.33)	2.05 (1.05, 3.98)	3.32 (1.75, 6.28)	<0.0001
	Overweight	1.00	1.27 (0.94, 1.71)	1.72 (1.29, 2.28)	3.01 (2.28, 3.98)	<0.0001
	Obesity	1.00	1.27 (0.66, 2.45)	1.77 (0.96, 3.26)	2.47 (1.36, 4.45)	0.010
	Diabetes	1.00	0.66 (0.39, 1.11)	1.23 (0.78, 1.94)	2.52 (1.66, 3.81)	<0.0001
	MetS	1.00	1.73 (0.94, 3.18)	2.50 (1.41, 4.44)	5.46 (3.17, 9.39)	<0.0001
Women ^{a)}						
	High glucose	1.00	0.84 (0.26, 2.70)	2.64 (0.96, 7.26)	2.09 (0.73, 5.95)	0.051
	High BP	1.00	2.39 (0.78, 7.29)	2.01 (0.66, 6.13)	1.01 (0.31, 3.33)	0.163
	Low HDL-c	1.00	0.92 (0.48, 1.77)	0.86 (0.43, 1.69)	1.60 (0.80, 3.18)	0.229
	High TG	1.00	0.81 (0.36, 1.81)	1.32 (0.61, 2.87)	3.20 (1.48, 6.92)	0.001
	High WC	1.00	0.70 (0.33, 1.51)	0.99 (0.47, 2.06)	1.36 (0.64, 2.90)	0.358
	Overweight	1.00	0.89 (0.44, 1.78)	1.28 (0.65, 2.54)	1.70 (0.83, 3.45)	0.263
	Obesity	1.00	1.06 (0.17, 6.67)	2.67 (0.52, 7.82)	3.25 (0.61, 7.35)	0.306
	Diabetes	1.00	1.11 (0.17, 7.06)	1.86 (0.34, 6.23)	1.95 (0.35, 6.85)	0.793
	MetS	1.00	1.17 (0.36, 3.88)	2.37 (0.79, 7.09)	2.51 (0.82, 7.70)	0.192

BP, blood pressure.

^{a)}Adjusted for age, region, smoking, drinking, dietary factors (total energy intake, fat intake, and protein).