Prevalence and associated factors of metabolic syndrome among Chinese adults and elders with multi-level generalized estimation equation models

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Research

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Abstract

Aim:

The aim of this study is to examine prevalence of MetS and associated factors among Chinese adults and elders covering a broad age range from 18 to 80 years old with multi-level generalized estimation equation models.

Methods:

28,062 subjects completed all blood biochemical testing. Subjects meeting at least 3 of the 5 criteria qualify as having MetS. Multi-level generalized estimation equation model was used to examine the relationship between MetS and covariates in order to control the cluster effect of living area.

Results:

65.70% of all subjects had at least one clinical feature of MetS. 2926 subjects were diagnosed as MetS and the prevalence rate was 14.03%. The prevalence rate of MetS for males (12.31%) was lower than females (15.57%). After controlling the cluster effect of living areas, many demographic and life-style characteristics were associated with MetS. Overweight (OR=1.670, 95%CI: 1.600-1.743), obese subjects (OR=2.287, 95%CI: 2.136-2.449), current drinkers (OR=1.053, 95%CI: 1.020-1.086), physical laborers (OR=1.070, 95%CI: 1.040-1.101), subjects enjoying high-salted diet (OR=1.040, 95%CI: 1.009-1.071), subjects with hyperuricemia (OR=1.264, 95%CI: 1.215-1.316), subjects with less sleep duration (OR=1.032, 95%CI: 1.009-1.055), subjects with family history of cardiovascular diseases (OR=1.065, 95%CI: 1.019-1.113) or cerebrovascular diseases (OR=1.055, 95%CI: 1.007-1.104) could increase prevalence risk of MetS. risk of MetS would increase 6.9% (OR=1.069, 95%CI: 1.053-1.085) with each 5-percent increase of PBF.

Conclusion:

MetS has become a serious public health challenge in China. Changes of lifestyles including high fat, alcohol drinking, high-salted diet and less sleep duration were very important to control MetS.

Background

China and most countries all over the world are experiencing its greatest life expectancy ever. Nonetheless, the general health of the global population is far from at an all-time high. As a result of economic growth and associated sociodemographic changes, the burden from infectious diseases has diminished, but changes in lifestyles and diet have led to an increase in life expectancy and an increased burden of cardiovascular disease, diabetes and other chronic diseases [1-3]. Metabolic syndrome (MetS) which is characterized by a cluster of cardiovascular risk factors, including dyslipidemia, abdominal obesity, elevated blood pressure and blood glucose, is associated with the development of diabetes, cardiovascular diseases, and kidney diseases, which are the leading cause of mortality worldwide [4-7]. As overweight and obesity increased worldwide, MetS itself will also become common not only in the developed countries but also in the underdeveloped countries. Sherling DH considered that the overlap of several risk factors of MetS in each disease state, resulting in increased atherogenic risks, is worth examining as a broader entity rather than separately [8]. The incidence of metabolic syndrome often parallels the incidence of obesity type 2 diabetes (one of the outcome of MetS) [9]. The prevalence estimates vary based on the criteria used for the definition of MetS. Global data on metabolic syndrome is hard to measure, but Saklayen MG considered that the global prevalence of MetS can be estimated to be about one quarter of the world population and in other words, over a billion people in the world are now affected with metabolic syndrome [9]. It was reported that about one third of US adults have metabolic syndrome [10]. In China, Gu D reported that the prevalence rates of MetS were 9.8% for males and 17.8% for females in Chinese adults aged 35-74 [11] and Wang Y reported that the prevalence of MetS in China in 2017 would be about 15.5% [12]. Without a national emphasis on the prevention and control of MetS, the burden of this problem in China is likely to increase gradually in the near future.

Even with all of this information, more evidence is needed regarding the prevalence of MetS among representative Chinese populations that cover a broader age range and include more minorities and regions. Furthermore, subjects living in the same area were more likely to suffer from the effects of similar living circumstances, which had inevitable influence on the accuracy and generalization of study results of MetS and its components. However, most of previous studies about MetS has not considered and adjusted the cluster effect of living area, which had confusing influence for the study results of MetS. Specifically, the aim of this study is to examine prevalence of MetS and associated factors among Chinese adults and elders covering a broad age range from 18 to 80 years old by a large-scale cross-sectional national survey. And multi-level generalized estimation equation was modelled to examine the relationship between MetS and covariates by controlling the cluster effect of living area.

Methods

Sample and participants

This study sample came from a large-scale population survey regarding Chinese physiological constants and health conditions conducted in 2007-2011. Two-stage cluster sampling method was used to recruit eligible subjects. In brief, this survey was carried out in six provinces or autonomous regions of China, including Hunan province, Yunnan province, Heilongjiang province, Inner Mongolia autonomous region, Sichuan province and Ningxia Hui autonomous region. Two or three cities were sampled based on their economic status and then several communities were randomly selected within each city. In these selected communities, all eligible people were referred to as our survey subjects, who aged 18-80 years old who had not run a high fever in the past 15 days. After signing informed consent forms, all subjects came to the temporary physical examination centers voluntarily to take part in the survey. The study has been approved by the review board of Institute of Basic Medical Sciences, Chinese Academy of Medical Sciences.

Clinical Laboratory Tests

All procedures were performed following a 9-12 hour overnight fast. Blood sample was drawn from the antecubital vein of the arm. Total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol and triglycerides were measured with a Beckman AU Series Automatic Biochemical Analyzer (Japan) and Sekisui Medical (Japan) reagents. Fasting blood glucose, creatine, blood urea nitrogen and uric acid were measured with the same instrument, with Beckman AU reagents.

Blood pressure measurement

Blood pressure was measured in the morning after subjects rested for five minutes in the seating position with their back supported, feet on the floor and right arm supported with cubit fossa at heart level. The appropriate cuff was chosen based on their arm circumference. OMRON HEM-7000 electronic sphygmomanometers (OMRON Health-Care, Kyoto, Japan) were used to measure blood pressure.

Definition of metabolic syndrome

According to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III), persons meeting at least 3 of the following 5 criteria qualify as having MetS: higher fasting glucose level, elevated blood pressure, lower high density lipoprotein cholesterol (HDL-C) level, higher triglyceride level and abdominal obesity [13-14]. The definitions are shown below in detail.

1) Elevated blood glucose: fasting blood glucose equal to or greater than 110 mg/dL or diagnosed diabetes;

2) Elevated blood pressure (systolic blood pressure equal to or greater than 130 mmHg and/or diastolic blood pressure equal to or greater than 85 mmHg) or history of hypertension;

3) Low HDL-C: serum HDL-C concentration less than 40 mg/dL for males and less than 50 mg/dL for females;

4) Elevated triglyceride: serum triglyceride concentration equal to or greater than 150 mg/dL;

5) Abdominal obesity: a waist circumference of equal to or greater than 102 cm for males and equal to or greater than 88 cm for females, as measured to the nearest 0.1 cm at the level of the navel, using a flexible steel tape.

Definition of covariates

Body Mass Index (BMI) was defined as weight (kg) divided by squared height (m^2). Weight was measured to the nearest 0.1 kg and height was measured to the nearest 1 mm. According to Chinese guidelines for prevention and control of adult overweight and obesity [15] and the Chinese criteria by Working Group on Obesity in China (WGOC) [16], normal weight is defined as BMI less than 24 kg/m^2, overweight is defined as BMI less than 28 kg/m^2 and equal to or greater than 24 kg/m^2, obesity is defined as BMI equal to or greater than 28 kg/m^2.

Percentage of body fat (PBF) was the proportion of body fat weight in total body weight, which was measured with the bioelectric impedance method. The Biodynamics BI-310 body composition analyzer was manufactured by American Biodynamics Corporation.

Subjects were categorized into three age groups, youth (18-34 years old), middle age (35-59 years old) and elders (60-80 years old).

Quality control

All researchers were trained based on the training manual. Trained medical professionals carried out the survey and interview. The same brand and model was used for all body composition analyzers and were adjusted every day before measuring in order to minimize measurement error. All the case report forms were double-checked to guarantee the authenticity and accuracy of raw data. The database was constructed with EPI3.02 software, with the data input twice by two data managers to guarantee the accuracy and integration of the data.

Statistical analysis

Statistical analysis was conducted with SAS9.4 software. Two-tailed $P<0.05$ was defined as statistically significant. Continuous data were described with mean and standard deviation (SD) and compared with t test. Categorical data were described with number and percentage and compared with Chi-square test. Considering that the subjects living in the same city were more likely to suffer from the effects of similar living circumstances, multi-level generalized estimation equation model was used to examine the relationship between metabolic syndrome and covariates in order to control the cluster effect of living area. Odds ratio (OR) and its 95% confidence interval (CI) were used to assess the relationship strength.

Results

The average age was 43.4±16.1 years old for all 20,862 subjects. The average age was 43.3±16.7 years old for 9864 males and 43.4±15.6 years old for 10,998 females. The subjects came from dozens of ethnicities, including Han (13, 279, 63.7%), Yi (2031, 9.7%), Miao (343, 1.6%), Mongolia (1143, 5.5%), Tibetan (608, 2.9%), Korean (717, 3.4%), Hui (1808, 8.7%), Tujia (625, 3.0%) and others (308, 1.5%).

65.70% (N=13,707) of all subjects had at least one clinical feature of MetS (1 or more components). 32.74%, 18.93%, 10.25%, 3.25% and 0.53% of all subjects had one, two, three, four and five risk factors respectively. Components in order of prevalence were elevated blood pressure (41.90%), elevated triglyceride (28.14%), low HDL-C (27.14%), elevated blood glucose (10.82%) and abdominal obesity (9.21%). The most prevalent grouping of two components was blood pressure and low HDL-C (9.64%). The most prevalent grouping of three components was elevated blood pressure, elevated triglyceride and low HDL-C (5.56%).

All in all, 2926 subjects were diagnosed as MetS and the prevalence rate was 14.03%. The prevalence rate of MetS for males (12.31%) was lower than females (15.57%), P<0.0001. The average age was 53.4±12.9 years old for subjects with MetS and 41.8±16.0 years old for subjects without MetS. The prevalence rate of MetS was 3.59% for youths, 16.72% for middle-aged adults and 26.13% for elders. With aging, the prevalence rates increased gradually, P<0.0001. Among minorities, Tibetan subjects held the lowest prevalence rate of MetS (5.59%) and Korean subjects the highest one (20.50%). Physical laborers had higher prevalence rates (17.39%) of MetS than counterparts. Subjects with hyperuricemia (26.56%) or enjoying high-salted diet (15.74%) had higher prevalence rates of MetS than counterparts. Compared to subjects without disease family history, subjects with family history of cardiovascular diseases (17.41%) or cerebrovascular diseases (17.75%) had higher prevalence rates of MetS. Subjects who were accustomed to sleeping less than six hours per day had higher prevalence rates (15.50%) of MetS than counterparts. Compared to subjects with normal body mass, overweight and obese subjects had higher prevalence rates (21.10% and 46.40%) of MetS. The average PBF was 26.9%±7.9% for subjects with MetS and 21.0%±8.6% for subjects without MetS. The prevalence and related componens of MetS as related to different demographic characteristics were shown in details in table 1.

Table 2 gives the results of the univariate and multivariate multi-level generalized estimation equation models of associated factors for MetS. After controlling the cluster effect of living areas and other covariates, no significant association was found between gender, smoker and MetS. Compared to youths, middle-aged (OR=1.461, 95%CI: 1.371-1.557) and elder subjects (OR=1.667, 95%CI: 1.535-1.812) were associated with higher prevalence odds of MetS. Compared to normal-weight subjects, overweight (OR=1.670, 95%CI: 1.600-1.743) and obese subjects (OR=2.287, 95%CI: 2.136-2.449) were associated with higher prevalence odds of MetS. The higher age or BMI means higher prevalence odds of MetS. Compared to Hans, Koreans had more odds of MetS (OR=1.120, 95%CI: 1.053-1.191), however Yis (OR=0.953, 95%CI: 0.923-0.984) and Tibetans (OR=0.853, 95%CI: 0.813-0.895) had less odds of MetS. Current drinkers (OR=1.053, 95%CI: 1.020-1.086), physical laborers (OR=1.070, 95%CI: 1.040-1.101), subjects enjoying high-salted diet (OR=1.040, 95%CI: 1.009-1.071), subjects with hyperuricemia (OR=1.264, 95%CI: 1.215-1.316), subjects who were accustomed to sleeping less than six hours per day (OR=1.032, 95%CI: 1.009-1.055), subjects with family history of cardiovascular diseases (OR=1.065, 95%CI: 1.019-1.113) or cerebrovascular diseases (OR=1.055, 95%CI: 1.007-1.104) could increase prevalence risk of MetS. We found the risk of MetS would increase 6.9% (OR=1.069, 95%CI: 1.053-1.085) with each 5-percent increase of PBF. Contrary to univariate analysis results, association of smoking conditions and MetS was not significant in the multivariate model.

In summary, after controlling the cluster effect of living areas, age, gender, occupation, ethnicity, alcohol drinking, high-salted diet, BMI, PBF, sleep duration and disease family history were associated with MetS.

Discussion

Subjects living in the same area were more likely to suffer from the effects of similar living circumstances, which had inevitable influence on the accuracy and generalization of study results of MetS and its components. This study using multi-level generalized estimation equation examine the relationship between MetS and covariates controlled the cluster effect of same living city and similar living circumstances and guaranteed the accuracy and generalization of study results. In addition, our study was conducted with standard protocols and instruments, and strict training processes and vigorous quality assurance programs were accomplished in order to ensure the quality of the data collection.

We found that the prevalence rate was 14.03% for all subjects and the prevalence rate of MetS for males (12.31%) was lower than females (15.57%). The prevalence rate of MetS in our study were similar to the previous reports [11-12].

Changes in lifestyle and diet have led to not only an increase in life expectancy but also an increased burden of many chronic diseases. This study results indicated that high fat (overweight and obesity), alcohol drinking, high-salted diet, and less sleep duration contributed to the higher odds of MetS.

An important contributor to the pandemic of cardiovascular disease is that overweight and obesity are the major determinants of metabolic syndrome, an all too common and all too serious clinical and public health challenge [8]. Body fat mainly inhabits internal organs for males and under subcutaneous tissues for females, which is called ectopic fat disposition [17]. Excess body fat has been seen to be related to MetS [18]. Visceral adiposity was associated with BMI, was essential to assess cardiometabolic risk and may serve as a marker and target of therapy in cardiometabolic disease [19]. Djibo DA found that body adiposity index could distinguish ethnic differences in MetS confirmed by PBF [20]. Liu P found that higher fat mass index levels appeared to be independently and positively associated with the presence of MetS regardless of BMI and PBF by assessing the body composition in a Chinese population who participated in the annual health check-ups in one hospital [21].

Suliga E reported that consumption of alcohol/day was significantly associated with a higher risk of metabolic syndrome [22]. However, the association between drinking alcohol and the prevalence of MetS and its components is not consistent. One prospective study found a linear increase in metabolic syndrome risk with an increase in alcohol consumption [23]. Yet, another study indicated that alcohol drinking (0.1-5.0 g/day) contributed to decrease prevalence of MetS and components, including triglyceride and HDL cholesterol [24]. In order to explain the causal relationship between alcohol consumption and the metabolic syndrome and its components, prospective studies might be necessary.

Higher salt intake was closely associated with elevated blood pressure, which was an important component of MetS. Saha S reported ever that prevalence of obesity, hypertension, diabetes, dyslipidaemia, metabolic syndrome and short-term cardiovascular disease risk score were higher in urban subjects with high-salted diet in a cross-sectional survey [25].

Smiley A ever reported simiar results about the association of MetS and sleep duration, which showed that short sleep duration was associated with higher risk of MetS and higher scores of MetS severity score in men [26]. Iftikhar IH have ever reported that a dose-response relationship exists between short sleep duration and MetS and those who report a sleep duration of less than 5 hours have a 1.5 higher odds of having metabolic syndrome [27]. In fact, Habitual short sleep duration was also associated with a host of chronic health conditions such as hypertension, cancers, depression, obesity, diabetes and increased mortality [28-32].

Several limitations have to be mentioned. First, due to the cross-sectional design, it is not possible to explore the causal relationship between covariates and MetS. Second, given that our analysis excluded subjects suffering from some severe chronic diseases and having fever in the last 15 days, we believe the true prevalence of MetS in Chinese population would be underestimated. Third, because MetS had several different definiation methods, which limits the comparation of our study results and other reports about prevalence of MetS.

Conclusions

In conclusion, our findings showed that MetS has become a serious public health challenge in China. Many lifestyles were found closely associated with MetS, including high fat, alcohol drinking, high-salted diet and less sleep duration. Changes of lifestyles were very important for adults and elders in order to control MetS.

Abbreviations

MetS: Metabolic syndrome

NCEP ATP III: National Cholesterol Education Program Adult Treatment Panel III

HDL-C: high density lipoprotein cholesterol

BMI: Body Mass Index

WGOC: Working Group on Obesity in China

PBF: Percentage of body fat

SD: standard deviation

OR: Odds ratio

CI: confidence interval

Declarations

Ethics approval and consent to participate

The study has been approved by the review board of Institute of Basic Medical Sciences, Chinese Academy of Medical Sciences. All included subjects gave their informed consent forms to participate in the study.

Consent for publications

All participants gave verbal or written consent for their accounts to be anonymously published.

Availability of supporting data

Data are held at the Institute of Basic Medical Sciences, Chinese Academy of Medical Sciences. All relevant data are within the paper.

Competing interests

The authors declare that they have no competing interests.

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ContributionsTX participated in the design of the study and the field survey, preformed the statistical analysis and drafted the manuscript. GZ conceived of the study. SH conceived of the study and participated in its design. All authors read and approved the final manuscript.

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Tables

Table 1 Prevalence (%) of metabolic syndrome about demographic characteristics

	Total	One component	Two components	Three components	Four components	Five components	MetS	P^*
All subjects	20862	6831(32.74)	3950(18.93)	2139(10.25)	677(3.25)	110(0.53)	2926(14.03)	
Age (years)								<0.0001
18-34	6963	2275(32.67)	727(10.44)	209(3.00)	38(0.55)	3(0.04)	250(3.59)	
35-59	10156	3326(32.75)	2283(22.48)	1269(12.50)	382(3.76)	47(0.46)	1698(16.72)	
60-80	3743	1230(32.86)	940(25.11)	661(17.66)	257(6.87)	60(1.60)	978(26.13)	
Gender								<0.0001
Male	9864	3377(34.24)	2106(21.35)	978(9.91)	216(2.19)	20(0.20)	1214(12.31)	
Female	10998	3454(31.41)	1844(16.77)	1161(10.56)	461(4.19)	90(0..82)	1712(15.57)	
Occupation								<0.0001
Physical laborer	11081	3687(33.27)	2329(21.02)	1364(12.31)	475(4.29)	88(0.79)	1927(17.39)	
Mental laborer	9781	3144(32.14)	1621(16.57)	775(7.92)	202(2.07)	22(0.22)	999(10.21)	
Ethnicity								<0.0001
Han	13279	4156(31.30)	2466(18.57)	1415(10.66)	475(3.58)	79(0.59)	1969(14.83)	
Yi	2031	784(38.60)	408(20.09)	140(6.89)	33(162)	5(0.25)	178(8.76)	
Miao	343	102(29.74)	63(18.37)	32(9.33)	11(3.21)	0	43(12.54)	
Mongolia	1143	369(32.28)	216(18.90)	132(11.55)	32(2.80)	5(0.44)	169(14.79)	
Tibetan	608	208(34.21)	63(10.36)	24(3.95)	8(1.32)	2(0.33)	34(5.59)	
Korean	717	241(33.61)	152(21.20)	108(15.06)	35(4.88)	4(0.56)	147(20.50)	
Hui	1808	675(37.33)	417(23.06)	218(12.06)	68(3.76)	14(0.77)	300(16.59)	
Tujia	625	207(33.12)	115(18.40)	47(7.52)	9(1.44)	1(0.16)	57(9.12)	
Others	308	89(28.90)	50(16.23)	23(7.47)	6(1.95)	0	29(9.42)	
Smoker								0.6483
No	15550	5018(32.27)	2803(18.03)	1552(9.98)	523(3.36)	96(0.62)	2171(13.96)	
Yes	5312	1813(34.13)	1147(21.59)	587(11.05)	154(2.90)	14(0.26)	755(14.21)	
Alcohol drinker								0.7354
No	15688	5074(32.34)	2799(17.84)	1570(10.01)	528(3.37)	95(0.61)	2193(13.98)	
Yes	5174	1757(33.96)	1151(22.25)	569(11.00)	149(2.88)	15(0.29)	733(14.17)	
High-salted diet								0.0170
No	18759	6172(32.90)	3536(18.85)	1897(10.11)	605(3.23)	93(0.50)	2595(13.83)	
Yes	2103	659(31.34)	414(19.69)	242(11.51)	72(3.42)	17(0.81)	331(15.74)	
Hyperuricemia								<0.0001
No	18207	6116(33.59)	3292(18.08)	1630(8.95)	475(2.61)	75(0.41)	2180(11.97)	
Yes	2564	701(27.34)	656(25.59)	446(17.39)	200(7.80)	35(1.37)	681(26.56)	
Family history of cardiovascular diseases								<0.0001
No	18972	6230(32.84)	3548(18.70)	1889(9.96)	607(3.20)	101(0.53)	2597(13.69)	
Yes	1890	601(31.80)	402(21.27)	250(13.23)	70(3.70)	9(0.48)	329(17.41)	
Family history of cerebrovascular diseases								0.0009

No	19938	6551(32.86)	3767(18.89)	2017(10.12)	642(3.22)	103(0.52)	2762(13.85)	
Yes	924	280(30.30)	183(19.81)	122(13.20)	35(3.79)	7(0.76)	164(17.75)	
BMI								<0.0001
Normal	12204	4284(35.10)	1547(12.68)	446(3.65)	83(0.68)	8(0.07)	537(4.40)	
Overweight	6436	2137(33.20)	1721(26.74)	1030(16.00)	292(4.54)	36(0.56)	1358(21.10)	
Obesity	2222	410(18.45)	682(30.69)	663(29.84)	302(13.59)	66(2.97)	1031(46.40)	
sleep duration								<0.0001
>=Six hours	14212	4725(33.25)	2680(18.86)	1418(9.98)	405(2.85)	59(0.42)	1882(13.24)	
<six hours	6650	2106(31.67)	1270(19.10)	721(10.84)	272(4.09)	51(0.77)	1044(15.70)	

[*] *P* values were derived from chi-square test for compare the difference of the prevalence rates of MetS among different demographic characteristics.

Table 2. Risk factors associated with metabolic syndrome

Characteristics		Univariate GEE model		Multivariate GEE model	
		OR	95%CI	OR	95%CI
Age (years)					
	18-34	1.0 (Ref.)	-	1.0 (Ref.)	-
	35-59	2.000	1.838-2.176	1.461	1.371-1.557
	60-80	2.570	2.319-2.847	1.667	1.535-1.812
Gender					
	Male	1.0 (Ref.)	-	1.0 (Ref.)	-
	Female	0.997	0.927-1.073	0.993	0.934-1.055
Occupation					
	Physical laborer	1.419	1.320-1.526	1.070	1.040-1.101
	Mental laborer	1.0 (Ref.)	-	1.0 (Ref.)	-
Ethnicity					
	Han	1.0 (Ref.)	-	1.0 (Ref.)	-
	Yi	0.835	0.667-1.045	0.953	0.923-0.984
	Miao	0.905	0.747-1.096	1.028	0.945-1.118
	Mongolia	0.904	0.827-0.989	0.986	0.939-1.035
	Tibetan	0.959	0.912-1.009	0.853	0.813-0.895
	Korean	1.194	1.060-1.034	1.120	1.053-1.191
	Hui	0.923	0.831-1.024	0.979	0.953-1.005
	Tujia	0.835	0.667-1.045	1.020	0.931-1.119
	Others	0.837	0.729-1.960	0.936	0.854-1.026
Smoker					
	No	1.0 (Ref.)	-	1.0 (Ref.)	-
	Yes	1.078	1.018-1.143	1.031	0.997-1.066
Alcohol drinker					
	No	1.0 (Ref.)	-	1.0 (Ref.)	-
	Yes	1.103	1.054-1.153	1.053	1.020-1.086
High-salted diet					
	No	1.0 (Ref.)	-	1.0 (Ref.)	-
	Yes	1.097	1.038-1.159	1.040	1.009-1.071
Hyperuricemia					
	No	1.0 (Ref.)	-	1.0 (Ref.)	-
	Yes	1.582	1.511-1.655	1.264	1.215-1.316
Family history of cardiovascular diseases					
	No	1.0 (Ref.)	-	1.0 (Ref.)	-
	Yes	1.145	1.083-1.211	1.065	1.019-1.113
Family history of cerebrovascular diseases					
	No	1.0 (Ref.)	-	1.0 (Ref.)	-
	Yes	1.127	1.048-1.212	1.055	1.007-1.104
BMI					
Normal		1.0 (Ref.)	-	1.0 (Ref.)	-
Overweight		2.077	1.941-2.223	1.670	1.600-1.743
Obesity		3.183	2.901-3.493	2.287	2.136-2.449
sleep duration					

>=Six hours	1.0 (Ref.)	-	1.0 (Ref.)	-
<six hours	1.158	1.089-1.230	1.032	1.009-1.055
PBF (5%)	1.184	1.157-1.212	1.069	1.053-1.085

* OR: Odds ratio; CI: confidence interval; GEE: generalized estimation equation