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Factors affecting metabolic syndrome by lifestyle

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Abstract. [Purpose] The aim of this study was to explore lifestyle factors in relation to metabolic syndrome so as to be able to utilize the results as baseline data for the furtherance of health-care and medical treatment. [Subjects and Methods] This study was conducted with patients who visited a health care center located in Seoul and had abdominal ultrasonography between 2 March 2013 and 28 February, 2014. Heights, weights, and blood pressures were measured by automatic devices. Three radiologists examined the patients using abdominal ultrasonography for gallstone diagnosis. The statuses of patients with regard to smoking, alcohol, coffee, and physical activities were explored for the lifestyle investigation. For investigating baseline demographics, we first used descriptive statistics. We then used the χ^2 test to analyze lifestyles and gallstone prevalence with regard to the presence of metabolic syndrome. Lastly, logistic regression analysis was conducted to discover the risk factors of metabolic syndrome. [Results] For men, body mass index, maximum gallstone size, and waist circumference were revealed as risk factors for metabolic syndrome, in descending order of the degree of risk. For females, gallstone presence was the most significant risk factor, followed by waist circumference. [Conclusion] Metabolic disease mainly presents itself along with obesity, and we should become more focused on preventing and treating this disease. A large-scale prospective study is needed in the future, as the cause of nonalcoholic steatohepatitis remained unclear in this study.
Key words: Metabolic syndrome, Gallstone, Lifestyle

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INTRODUCTION

Recent data in 2014 from the National Statistical Office demonstrated that malignancy, cerebrovascular disease, cardiovascular disease, pneumonia, and diabetes were, in order, the most common causes of death[1]. Metabolic syndrome was reported to be a cause of mortality related to these diseases[2–9]. Furthermore, westernized diets and lifestyle habits have caused the obesity rate grow in Korea. The mean prevalence rate of obesity in Organization for Economic Cooperation and Development (OECD) countries is 53.5%, more than half of the population. The prevalence in Korea is 33.7%, which is much lower than that in western countries. However, when we look at the annual rate of increase, obesity in Korea has continuously increased. In 2008, the obesity prevalence was 35.3% in males and 25.2% in females; in 2011, it was 35.1% in males and 27.1% in females; and in 2012, it was 36.3% in males and 28% in females; these rates are based on the BMI value of 25 kg/m^2 as an index[10]. Obesity is known as major factor for chronic disease, and it can also affect quality of life and reduce life expectancy[11].

Gallstones are common, and the prevalence of gallstones is around two times higher in females in western countries[12]. The prevalence rate becomes higher with age, so in the elderly population, it finally reaches approximately 30% in people in their 70s regardless of gender. Currently, abdominal ultrasonography is most widely used for the diagnosis of gallstones, as it is cost-effective. Gallstone presence without symptoms is common, and it is supposed that it may be closely related to

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metabolic syndrome[13].

Several trials have demonstrated that lifestyle is correlated with the diagnosis of metabolic syndrome, so that the syndrome could be prevented by lifestyle modification[14]. In the US, its prevalence was 23.7% for ages over 20 years, and about 44% for ages over 50 years[15]. As for the Korean adult population, the prevalence rate was 17.7% for males, and 14.2% for females in 1998[16]. However, it has rapidly grown and was 31.9% with males and 25.6% with females in 2010[10]. Metabolic syndrome could be a predisposing factor for type 2 diabetes mellitus and for any kind of cardiovascular disease[17]. Also, the prevalence could be increasing because of the aging of the population and the adoption of westernized eating habits. Hence, it is meaningful to investigate the clinical impact of metabolic syndrome[10]. The aim of this study was to explore lifestyle factors that are related to the occurrence of metabolic syndrome so as to be able to utilize the results as baseline data for the furtherance of health care and medical treatment.

SUBJECTS AND METHODS

This study was conducted with patients who visited a health-care center in Seoul and had abdominal ultrasonography between 2 March 2013 and 28 February, 2014. All participants signed a written informed consent form approved by the Institutional Review Board of the Hallym University of Graduate Studies. The eligible patients were divided into four groups and then underwent randomization: patients with a gallstone and metabolic syndrome, patients with a gallstone but without metabolic syndrome, patients who had metabolic syndrome without a gallstone, and patients who did not have either metabolic syndrome or a gallstone. We included both genders but required the patient's age to be over 20. However, we excluded patients who lacked medical records or had undergone hepatobiliary surgery. The total study population comprised 256 males and 172 females. Heights (m) and weights (kg) were measured by automatic devices and used in body mass index calculations (kg/m^2). Obesity was calculated as (current weight / standard weight) and expressed as a percentage. Waist circumference was measured by using a measuring tape in centimeter units. When the patient stands in an upright position, the narrowest point between the lower rib and upper edge of the iliac crest was measured circumferentially. Systolic and diastolic blood pressure were measured at the upper right arm using an automatic manometer. If the systolic blood pressure was more than 140 mmHg or the diastolic blood pressure was higher than 90 mmHg, the patients were required to rest for around 1 hour, and the blood pressure was checked again. Three radiologists examined the patients using abdominal ultrasonography and diagnosed the presence of a gallstone if they could find any acoustic shadow behind the gallbladder or movement of a hyperechoic lesion by changing the patients' position. Patients were excluded if there was any other disease in the gallbladder other than of gallstones. Total number of gallstones was recorded based on radiographic imaging or its report. When there were more than 10 gallstones in one patient, the number was regarded as 10. The diameter of the largest stone in each patient was measured in centimeters. The ultrasonography machine was the SSD-σ7 from Aloka. Regarding lifestyle, we investigated the statuses of smoking, alcohol, coffee, and physical activities. Smoking status was classified as "never" smoker, "former" smoker, or "current" smoker based on the patient's current smoking status. The mean number of cigarettes per day was recorded as the smoking amount, and the number of years the patient had smoked was recorded as the smoking period. For alcohol, the status was classified as "never" or "ever". If the status was regarded as "ever", then the mean number of days the patient consumed alcohol per week was recorded. The amount was also recorded, regardless of alcohol type, based on the number of glasses per day. The patients were divided into two groups with regard to consumption of coffee: "yes" or "no". We recorded the number of cups per day, but not the total duration of taking coffee. Physical activities were recorded as "yes" if the patient got any exercise during the week, and were recorded as "no" if the patient did not get any exercise. When the status was recorded as a "yes", we further investigated their pattern of physical activities according to exercise intensity: light, moderate, and intense. We used a self-reported questionnaire in order to discover the patients' exercise patterns, but we excluded patients with incomplete answers. For intensive exercise, the question was "Please note the number of days on which you became highly out of breath for a duration of more than 20 minutes exercise", the question was, "Please note the number of days you became slightly out of breath for a duration of more than 30 minutes". For light exercise, the question was "Please note the number of days you walked more than 30 minutes per day, with each time you walked lasting at least 10 minutes". The collected data were statistically analyzed by using a personal computer program, IBM SPSS Statistics for Windows (version 19.0; IBM Corp., Armonk, NY, USA). For investigating baseline demographics, we first used descriptive statistics. Then we used the χ^2 test to analyze lifestyle and gallstone prevalence according to presence of metabolic syndrome. Finally logistic regression analysis was conducted to discover risk factors of metabolic syndrome. $P<0.05$ was regarded as statistically significant.

RESULTS

When analyzing baseline characteristics, the mean values of age, height, weight, body mass index, obesity, and waist circumference were 42.6±9 years, 173.2±7 cm, 79.6±12 kg, 26.4±3 kg/m^2, 120.5±1% and 89.9±9 cm, respectively, in men. Their mean systolic blood pressure was 122±14 mm/Hg, and their mean diastolic blood pressure the mean value was 77.3±10 mm/Hg. In women, the mean values of age, height, weight, body mass index, obesity, and waist circumference were 38.7±10 years, 160.9±5, 61.2±11 kg, 23.5±4 kg/m^2, 111.6±20%, and 77.08±11 cm, respectively. Their mean values for systolic and diastolic blood pressure were respectively 111.6±13 mm/Hg and 69.5±10 mm/Hg (Table 1).

Table 1. Baseline characteristics of the study population by gender

Gender	Variable	Average	Gender	Variable	Average
Male	Age (years)	42.7±9.8	Female	Age (years)	38.7±10.6
	Height	173.2±7.2		Height	160.9±5.8
	Weight	79.7±12.2		Weight	61.2±11.4
	BMI	26.4±3.78		BMI	23.5±4.3
	Degree of obesity	120.6±17.5		Degree of obesity	111.6±20.9
	Waist circumference	99.0±9.6		Waist circumference	77.0±11.4
	Systolic BP	122.09±14.0		Systolic BP	111.6±13.9
	Diastolic BP	77.3±10.4		Diastolic BP	69.5±10.0

Mean±SD

Table 2. Characteristics of study population lifestyles based on gender

Gender	Variables	Mean	Gender	Variables	Mean
Male	Smoking status	2.1±0.8	Female	Smoking status	1.2±0.5
	Smoking period (yr)	13.0±10.0		Smoking period (yr)	1.1±3.5
	Cigarettes per day (no.)	11.2±9.2		Cigarettes per day (no.)	1.0±3.4
	Alcohol consumption status	1.8±0.3		Alcohol consumption status	1.6±0.4
	Alcohol consumption per week	2.0±1.4		Alcohol consumption per week	1.0±1.0
	Amount of alcohol consumed per day (glasses)	5.9±4.4		Amount of alcohol consumed per day (glasses)	2.1±2.4
	Coffee consumption status	1.9±0.2		Coffee consumption status	1.8±0.3
	Coffee consumed per day (cups)	2.0±1.3		Coffee consumed per day (cups)	1.6±0.9
	Exercise	1.8±0.3		Exercise	1.7±0.4
	Intense exercise (times per week)	1.2±1.4		Intense exercise (times per week)	0.7±1.1
	Moderate exercise (times per week)	1.4±1.5		Moderate exercise (times per week)	1.1±1.5
	Light exercise (times per week)	2.9±2.1		Light exercise (times per week)	2.8±2.2
	Gallstone maximum size	1.2±0.5		Gallstone maximum size	1.1±0.4
	Gallstone numbers	4.0±3.3		Gallstone numbers	3.8±3.2

In men, the average of smoking period was 13.00±10.76 years. For current and former smokers, the mean smoking amount was 11.26±9.27 cigarettes per day. The mean alcohol drinking days was 2.0±1.4 days per week, and for every drinking day the mean alcohol amount was 5.9±4 glasses. The mean numbers of physical exercise sessions were 1.2±1 for intensive exercise, 1.4±1 for moderate exercise, and 2.9±2 for light exercise. The maximum gallstone size was 1.26±0.5 cm. For women, the mean smoking period was 1.19±3.5, years and for current and former smokers, the mean smoking amount was 1.08±3.4 cigarettes per day. Regarding the mean number of physical activity sessions, the mean number of sessions was 0.7±1.0 for intensive exercise, 1.4±1 for moderate exercise, and 2.8±2 for light exercise. The mean size of the largest gallstone was 1.18±0.4 cm, and the average number of gallstones was 3.8±3.2 per patient (Table 2). The total study population comprised 428 patients; there were 256 males and 172 females. Of the males, there were 23 patients in their 20s (9%), 74 patients in their 30s (28.9%), 98 in their 40s (38.3%), 48 patients in their 50s (18.8%), 9 in their 60s (2.5%), and 4 patients in their 70s (1.6%). Among them, a total of 165 patients (64.5%) had metabolic syndrome, and the distribution was 9 patients in their 20s (3.5%), 48 patients in their 30s (18.8%), 69 patients in their 40s (27.0%), 30 patients in their 50s (11.7%), 6 patients in their 60s (2.3%) and 3 patients in their 70s (1.2%). There was a lack of relationship between the number of patients in each age group and the prevalence of metabolic syndrome, as no significant differences were found ($p>0.05$) (Table 3). For females, there were 34 patients in their 20s (19.8%), 68 in their 30s (39.5%), 40 patients in their 40s (23.3%), 24 patients in their 40s (14.0%), 5 in their 60s (2.9%) and 1 in her 70s (0.6%). A total of 50 patients (29.1%) had metabolic syndrome, and regarding the occurrence by age group, there were 5 patients in their 20s (2.9%), 12 patients in their 30s (7.0%), 16 in their 40s (9.3%), 16 patients in their 50s (9.3%), 1 patients in her 60s (0.6%), and no patients in their 70s. It presented direct proportion regarding number of patient of each age and distribution of metabolic syndrome. And for elderly patients also disease risk increased, with statistical significance ($p<0.05$) (Table 4). Regarding smoking status, there were 72 never smokers (28.2%), 84 former smokers (32.9%), and 99 current smokers (38.8%) among all of the men. Among the subpopulation of 165 patients with metabolic syndrome (64.3%), there were 33 never smokers (12.9%), 61 former smokers (23.9%), and 70 current smokers (27.5%). Metabolic syndrome was more prevalent among current smokers, with clinical significance ($p>0.05$) (Table 3).

Table 3. Chie-square test for metabolic syndrome prevalence in the male patients

Variables	Prevalence of metabolic syndrome (No)	Metabolic syndrome (Yes)	Total
Age groups			
20–29	14 (5.5)	9 (3.5)	23 (9)
30–39	26 (10.2)	48 (18.8)	74 (28.9)
40–49	29 (11.3)	69 (27)	98 (38.3)
50–59	18 (7.0)	30 (11.7)	48 (18.8)
60–69	3 (1.2)	6 (2.3)	9 (3.5)
70–79	1 (0.4)	3 (1.2)	4 (1.6)
Total	91 (35.5)	165 (64.5)	256 (100)
Smoking status			
Never	39 (15.3)	33 (12.9)	72 (28.2)
Former	23 (9.0)	61 (23.9)	84 (32.9)
Current	29 (11.4)	70 (27.5)	99 (38.8)
Total	91 (35.7)	164 (64.3)	255 (100)
Alcohol consumption			
Never	12 (4.7)	23 (9)	35 (13.7)
Ever	79 (31)	141 (55.3)	220 (86.3)
Total	91 (35.7)	164 (64.3)	255 (100)
Coffee consumption			
No	7 (2.8)	10 (4)	17 (6.8)
Yes	84 (33.6)	149 (59.6)	233 (93.2)
Total	91 (36.4)	159 (63.6)	250 (100)
Physical activity			
No	13 (5.1)	22 (8.6)	35 (13.7)
Yes	78 (30.6)	142 (55.7)	220 (86.3)
Total	91 (35.7)	164 (64.3)	255 (100)
Gallstones			
No	34 (13.3)	91 (35.5)	125 (48.8)
Yes	57 (22.3)	74 (28.9)	131 (51.2)
Total	91 (35.5)	165 (64.5)	256 (100)

Regarding alcohol, there were 35 patients classified as “never” (13.7%) and 219 patients classified as “ever” (85.9%). Among the 164 male metabolic syndrome patients, 23 patients were classified as “never” (9.0%), and 141 patients (55.3%) were classified as “ever” in terms of alcohol consumption status, but not with statistical significance ($p>0.05$).

When analyzing the patients’ statuses regarding consumption of coffee, there were 17 men classified as “no” (6.8%) and 233 men classified as “yes” (93.2%). Of the 159 men (63.6%) with metabolic syndrome, 10 men were classified as “no” (4.0%) and men were classified as “yes” (59.6%). Although the incidence of metabolic syndrome was much higher in men classified as “yes”, the result was not statistically significant ($p>0.05$) (Table 3). In men, a higher risk of metabolic syndrome, with statistical significance ($p<0.05$), was associated with the following factors: age (1.029 times), weight (1.205 times), body mass index (2.347 times), obesity (1.203 times), waist circumference (1.477 times), systolic blood pressure (1.082 times), diastolic blood pressure (1.100 times), former smoker (3.134 times), current smoker (2.853 times), smoking period (1.043 times), total cigarette number (1.080 times), gallstones (0.485 times), and maximum size of gallstone (2.131 times) (Table 5). In women, metabolic syndrome was related to the factors as follows: age (1.072 times), weight (1.168 times), body mass index (1.731 times), obesity (1.103 times), waist circumference (1.314 times), systolic blood pressure (1.118 times), diastolic blood pressure (1.162 times) and gallstones (3.098 times), but not with statistical significance ($p>0.05$) (Table 6). When summarized, body mass maximum gallstone size, and waist circumference were associated with relatively high risks of metabolic syndrome in men in order of decreasing risk. Among women, the presence of a gallstone was associated with the highest risk, followed by waist circumference ($p<0.05$).

DISCUSSION

We tried to analyze the relationships among metabolic syndrome, gallstone occurrence, and lifestyle, by gender, in order to explore the risk parameters. Age, weight, body mass index, obesity, waist circumference, systolic blood pressure, diastolic

Table 4. Chie-square test for metabolic syndrome prevalence in the female patients

Variables	Prevalence of metabolic syndrome (No)	Metabolic syndrome (Yes)	Total
Age groups			
20–29	29 (16.9)	5 (2.9)	34 (19.8)
30–39	56 (32.6)	12 (7.0)	68 (39.5)
40–49	24 (14)	16 (9.3)	40 (23.3)
50–59	8 (4.7)	16 (9.3)	24 (14)
60–69	4 (2.3)	1 (0.6)	5 (2.9)
70–79	1 (0.6)	0 (0)	1 (0.6)
Total	122 (70.9)	50 (29.1)	172 (100)
Smoking status			
Never	105 (61)	42 (24.4)	147 (85.5)
Former	8 (4.7)	5 (2.9)	13 (7.6)
Current	9 (5.2)	3 (1.7)	12 (7.0)
Total	122 (70.9)	50 (29.1)	172 (100)
Alcohol consumption			
Never	37 (21.5)	19 (11)	56 (32.6)
Ever	85 (49.4)	31 (18)	116 (67.4)
Total	122 (70.9)	50 (29.1)	172 (100)
Coffee consumption			
No	13 (7.7)	7 (4.2)	20 (11.9)
Yes	106 (63.1)	42 (25)	148 (88.1)
Total	119 (70.8)	49 (29.2)	168 (100)
Physical activity			
No	25 (14.5)	16 (9.3)	41 (23.8)
Yes	97 (56.4)	34 (19.8)	131 (76.2)
Total	122 (70.9)	50 (29.1)	172 (100)
Gallstones			
No	75 (43.6)	17 (9.9)	92 (53.5)
Yes	47 (27.3)	33 (19.2)	80 (46.5)
Total	122 (70.9)	50 (29.1)	172 (100)

blood pressure, smoking status and period, and gallstone presence and maximum size were related to metabolic syndrome in men. In women, age, weight, body mass index, obesity, waist circumference, systolic blood pressure, and diastolic blood pressure were parameters related to metabolic syndrome. Regarding the body mass index, it was 28.28 kg/m^2 in male metabolic syndrome patients and 28.02 kg/m^2 in female metabolic syndrome patients, and these values were higher than those of patients without metabolic syndrome (23.02 kg/m^2 in males and 21.78 kg/m^2 in females) and higher than the standard parameter for obesity in the Korean population (25 kg/m^2).

The results are similar to those of Im et al.[18] and are also in agreement with the study of Kim et al.[19], which demonstrated relationships between obesity and metabolic syndrome factors that resulted in cardiovascular disease, hypertension, and hyperlipidemia.

The statuses of smoking, coffee consumption, alcohol consumption, and physical activities are regarded as lifestyle factors. Although Phillips et al.[20] demonstrated that there is no significant relationship between smoking status and metabolic syndrome, we found that smoking period and smoking status both presented statistically significant relationships with regard to the presence of metabolic syndrome. This is in accordance with the study from Im et al.[18], which proved that there was a significant relation between smoking status and metabolic syndrome.

In the female group, the smoking profiles (smoking status, period, amount) did not show any significant relationship with metabolic syndrome. According to surveillance data from the National Health and Nutrition Estimation Survey (NHANES)[10], the smoking population differed by gender: 13.6% of females and 54.8% of males were smokers. The results of our study could also be consistent with this difference noted in the NHANE. The amount of alcohol consumed and alcohol consumption status were not related to metabolic syndrome prevalence in either gender. This was not in accordance with the studies of Ryu et al.[21] and Im et al.[18], which insisted that alcohol consumption status could affect the incidence of metabolic syndrome. However, Ryu et al.[22] demonstrated that there was no statistically significant correlation between alcohol consumption status and metabolic syndrome, which is well aligned with the results of our study. The NHANE survey showed high-risk drinking

Table 5. Binominal logistic regression analysis for metabolic syndrome by variables in the male patients

Variables	B	S.E.	OR	95%CI
Age	0.0280	0.014	1.029	1.001–1.057
Height	−0.015	0.019	0.985	0.948–1.024
Weight	0.186	0.023	1.205	1.152–1.260
BMI	0.853	0.108	2.347	1.899–2.902
Degree of obesity	0.185	0.024	1.203	1.149–1.260
Waist circumference	0.390	0.050	1.477	1.340–1.628
Systolic BP	0.079	0.013	1.082	1.055–1.110
Diastolic BP	0.096	0.017	1.100	1.064–1.137
Smoking status				
Former	1.142	0.340	3.134	1.609–6.107
Current	1.048	0.324	2.853	1.513–5.379
Smoking period (yr)	0.042	0.013	1.043	1.017–1.070
Cigarettes per day (no.)	0.077	0.016	1.080	1.046–1.115
Alcohol consumption				
Yes	−0.059	0.383	0.943	0.445–1.998
Alcohol consumption per week	0.090	0.092	1.094	0.915–1.310
Amount of alcohol consumed per day (glasses)	0.028	0.030	1.029	0.970–1.091
Coffee consumption				
Yes	0.216	0.511	1.242	0.456–3.383
Coffee consumed per day (cups)	0.122	0.105	1.130	0.920–1.388
Exercise				
Yes	0.073	0.377	1.076	0.514–2.253
Intense exercise (times per week)	0.088	0.095	1.092	0.908–1.315
Moderate exercise (times per week)	−0.021	0.083	0.980	0.832–1.153
Light exercise (times per week)	0.004	0.061	1.004	0.892–1.131
Gallstones				
Yes	−0.723	0.267	0.485	0.287–0.819
Gallstone maximum size	0.757	0.355	2.131	1.064–4.269
Gallstone numbers	−0.019	0.053	0.981	0.884–1.089

in 37.4% of people in their 20s and 30s, which is much higher than the figure of 10% of the worldwide population presented by the WHO[23]. High-risk drinking is the result of local cultures in Korea that involve drinking habits influenced by frequent parties.

When looking at the data regarding coffee consumption, there was no difference by gender. Previously Kim et al.[24] reported that there were no significant associations between the daily amount of coffee consumed and metabolic syndrome, and this is well in accordance with our study results. Recently, the customs office reported data regarding the current status of import of coffee, and it indicated that in the 5 years from 2007 to 2012, the total value of coffee imported increased from $231,000,000 to $717,000,000, an increment of 210.4%. This indicates a cultural change from tea or other things as a result of westernized diets and increased quality of life. This changed concept of tea would hinder the discrimination regarding coffee so that could contribute to the results of this study. Regarding physical activities, there was no difference between the genders. That finding is well aligned with the studies of Ryu.[22] and Im et al.[18] which insisted that physical activities and metabolic syndrome do not have any significant relationship. Exercise duration, endurance, and intensity all affected the results. Our data were self-reported, and the actual amount of exercise could vary depending on personal ability or other environmental factors, so this could be a kind of limitation. Mendez et al.[13] reported waist circumference as a risk factor for gallstones. In the present study, we found that gallstones were related to metabolic syndrome in both genders, as shown by the χ^2 test. In men with metabolic syndrome, the maximum size of gallstones was relatively higher than that of patients without metabolic syndrome. However, this was not the case in women. Using binominal logistic regression analysis, we found a 2.5 times higher risk of metabolic syndrome with gallstones, but this did not show statistical significance. The numbers of gallstones did not show any significant relation with metabolic syndrome. The main limitation of this study is the self-reported questionnaire for evaluating lifestyle. The lifestyle profiles of subjects would vary depending on the situation and would be relatively subjective, which would cause different investigators to reach different conclusions. However, the study included come from hematologic parameters in addition to criteria for metabolic syndrome, and were analyzed reflecting embryologi-

Table 6. Binominal logistic regression analysis for metabolic syndrome by variables in the female patients

Variables	B	S.E.	OR	95%CI
Age	0.070	0.017	1.072	1.036–1.109
Height	−0.045	0.031	0.956	0.900–1.015
Weight	0.155	0.025	1.168	1.111–1.228
BMI	0.549	0.085	1.731	1.464–2.046
Degree of obesity	0.098	0.016	1.103	1.070–1.137
Waist circumference	0.273	0.044	1.314	1.205–1.433
Systolic BP	0.111	0.018	1.118	1.078–1.159
Diastolic BP	0.150	0.025	1.162	1.106–1.222
Smoking status				
Former	0.446	0.599	1.562	0.483–5.051
Current	−0.182	0.691	0.833	0.215–3.230
Smoking period (yr)	0.066	0.045	1.068	0.978–1.166
Cigarettes per day (no.)	0.007	0.047	1.007	0.917–1.105
Alcohol consumption				
Yes	−0.342	0.352	0.710	0.356–1.415
Alcohol consumption per week	−0.198	0.176	0.820	0.581–1.158
Amount of alcohol consumed per day (glasses)	0.006	0.069	1.006	0.879–1.151
Coffee consumption				
Yes	−0.307	0.503	0.736	0.275–1.972
Coffee amount (cups)	0.273	0.180	1.313	0.923–1.869
Exercise				
Yes	−0.602	0.377	0.548	0.262–1.147
Intense exercise (times per week)	0.044	0.148	0.957	0.717–1.278
Moderate exercise (times per week)	−0.198	0.126	0.820	0.641–1.050
Light exercise (times per week)	−0.109	0.076	0.897	0.773–1.041
Gallstones				
Yes	1.131	0.352	3.098	1.555–6.172
Gallstone maximum size	0.926	0.515	2.523	0.920–6.922
Gallstone numbers	−0.043	0.071	0.958	0.833–1.100

cal characteristics of both genders. Also, in addition to investigating the relation between gallstones and metabolic syndrome, we explored the numbers of gallstones and the maximum sizes of gallstones, which were not studied previously. Recent studies of metabolic syndrome have mainly been cross-sectional investigations. At least 3 diagnostic criteria should be satisfied for metabolic syndrome to be diagnosed, and patients could have some changes as time goes by, so large-scale of trials would be needed with a duration of a duration of at least 2 or 3 years in order to obtain more objective and concise results. The growing obesity of the population, lifestyle changes, and westernized diets could accelerate the occurrence of metabolic syndrome. Also, for adolescents as well as the adult population, it will be necessary to explore related factors and to further investigate the prevalence rate of metabolic syndrome, as basic information for preventive medicine. Metabolic syndrome is a representative disease within the obese subpopulation. We need to pay more attention to prevention and treatment of this disease. Additional studies of nonalcoholic steatohepatitis are needed, as this study did not prove any direct causes for it.

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