Association between lifestyle factors and the risk of metabolic syndrome in the South Korea

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This study aimed to examine the association between lifestyle factors and metabolic syndrome risk in South Korean adults. Korea National Health and Nutrition Examination Survey 2016–2018 data were used. The study included 6,995 subjects (2835 male; 4,160 female). Multiple logistic regression was used to estimate the relationship between the lifestyle factors, including sedentary time, sleep duration, alcohol consumption, smoking status, and dietary intake. Metabolic syndrome prevalence in healthy adults was 25.6% and 12.4% in men and women, respectively. Male with over four lifestyle risk factors had a higher OR for metabolic syndrome risk (over four lifestyle factors: OR 1.97, CI 1.18–3.27). Female with more than one lifestyle risk factor had a higher OR for metabolic syndrome risk (one lifestyle factor: OR 1.58, CI 1.10–2.28; two lifestyle factors: OR 2.08, CI 1.39–3.11; three lifestyle factors: OR 1.94, CI 1.20–3.13). In particular, female with more lifestyle factors had increased likelihood of abdominal obesity, hypertension, and high triglycerides. Male with more lifestyle factors had increased likelihood of high triglycerides. Sedentary time was significantly associated with increased metabolic syndrome in male and female. This study found a significant association between the number of lifestyle risk factors and the risk of metabolic syndrome in Korean adults. The greater the number of lifestyle risk factors, the higher the risk of metabolic syndrome in both sexes. People with a greater number of poor lifestyle behaviors tended to exhibit increased likelihood of especially elevated triglyceride levels.

Due to the association between cardiovascular disease and metabolic syndrome as well as their common occurrence, researchers have exhibited keen interest in these conditions. People with metabolic syndrome have high risks of morbidity and mortality because of cardiovascular disease and type 2 diabetes. The prevalence of metabolic syndrome in Korean adults increased from 24.9% in 1998 to 31.3% in 2007. In other words, approximately one in three adults in Korea has metabolic syndrome. Further, cardiovascular disease incidence has continuously increased over the past 10 years and has become the second most common cause of mortality in Korea. Due to increasing disease duration and accompanying disabilities, the socioeconomic burden posed by these diseases is predicted to increase. Therefore, it is important to prevent and reduce the prevalence of metabolic syndrome.

The World Health Organization (WHO) defined metabolic syndrome as a pathologic condition comprising abdominal obesity, insulin resistance, hypertension, and hyperlipidemia. Metabolic syndrome is not a single disease but a group of risk factors for cardiovascular disease.

The main strategy for metabolic syndrome prevention and treatment are the change of poor lifestyle through various approach based on physical exercise, a healthy diet and education. It means that risk factors for metabolic syndrome can be mitigated by modifiable lifestyle factors. To support this opinion, there are various studies related to risk factor of metabolic syndrome and lifestyle intervention for metabolic syndrome. For instance, prior studies suggests that lifestyle risk factors, such as poor diet, alcohol consumption, physical inactivity, smoking, and sedentary time increase the risk of metabolic syndrome.

According to recent studies, sleep duration is also a lifestyle factor that potentially acts as an important health status indicator. To reduce the prevalence of metabolic syndrome, lifestyle and pharmacological method modifications are of paramount importance.

Whereas many studies are focused on the prevalence of single- or double-risk factors and their association with metabolic syndrome, including that in people with comorbid disease, we investigated the association of overall lifestyle factors with metabolic syndrome and its affected components of metabolic syndrome, excluding

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that in patients with comorbid disease. Such a design potentially demonstrates the prevalence, trends, and determinants of metabolic syndrome. Accordingly, in the present study, we used cross-sectional data to examine the association of lifestyle risk factors with the risk of metabolic syndrome and its components. An enhanced understanding of the association between lifestyle behavior and metabolic syndrome potentially improves the planning of new effective health programs and result in improved health outcomes.

Methods
This cross-sectional study used data from the 2016–2018 Korea National Health and Nutrition Examination Survey (KNHANES) conducted by the Korea Centers for Disease Control and Prevention. The KNHANES is a cross-sectional, nationally representative survey that has been conducted regularly since 1998 to examine the general health and nutritional status of Korean citizens. Our study did not require Institutional Review Board approval because the KNHANES provides a secondary dataset, which is available in the public domain and does not contain private information. And respondents consented the survey for collecting data before participating in the survey.[6]

Participants. The total survey population from 2016 to 2018 included 24,269 individuals. Individuals younger than 19 years of age (n = 4880) were excluded. Moreover, we excluded individuals undergoing treatment for previously diagnosed hypertension (n = 4223), diabetes mellitus (n = 1697), and hyperlipidemia (n = 2358) as well as those with diagnoses of angina (n = 362), myocardial infarction (n = 209), and stroke (n = 421). Finally, 6995 participants were selected for participation in this study after excluding missing data (n = 7,347).

Variables. The main variables in this study were the number of abnormal lifestyle among the following five lifestyle factors: sleep duration, sedentary time, alcohol use disorders, smoking status, and dietary intake, the data of which were self-reported. Sleep duration was assessed using the following question: “How long do you usually sleep on a weekday and weekend?” Sleep duration was calculated as the total five-weekday plus total two-day-weekend sleep durations divided by 7 days. Subjects were categorized into two groups: (1) short sleep (<6 h) and long sleep (≥9 h) duration and (2) normal sleep duration (6 h ≤ and <9 h). Sedentary time was assessed using the following question: “How much time do you usually spend sitting?” The sedentary time was then calculated by dividing the sitting time by the time spent awake. Thereafter, we set the median as the cutoff, resulting in one category being Q1–Q2 and the other Q3–Q4: (1) normal sedentary time (Q1–Q2) (2) long sedentary time (Q3–Q4). In a previous study, shorter sleep duration was found to be related to a longer sedentary time.[17] We used the Alcohol Use Disorders Identification Test (AUDIT-C) score to assess the pattern of alcohol use disorders as follows:

1. “How often have you had a drink containing alcohol in the last year?”
2. “How many drinks containing alcohol did you have on a typical drinking day in the last year?”
3. “How often in the last year have you had six or more drinks on one occasion?”

A high-risk alcohol level was assigned an AUDIT-C score ≥8. For both sexes. Subjects were categorized into two groups: (1) never-mild drinking (AUDIT-C < 8), (2) heavy drinking (AUDIT-C ≥ 8). Smoking status was divided into the following two categories: (1) ex- or never-smoker and (2) current smoker. Dietary intake was assessed using the 24-h dietary recall method. We categorized carbohydrate and fat consumption reflected current dietary by cutoff which was recommended by the Korea Ministry of Health and Welfare and the Korean Nutrition Society.[18,19]. Poor dietary pattern was defined as having one or two of the following two components: (1) high fat intake corresponded to exceeding 30% of dietary energy intake and (2) high carbohydrate intake corresponded to exceeding 65% of dietary energy intake. If either component is applicable, it was assigned to the abnormal group.

The dependent variable was metabolic syndrome. The definition provided by the modified Third National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults as well as the specific waist circumference values provided by the WHO and Korean Society for the Study of Obesity were used to determine metabolic syndrome and its components[6], which were as follows: (1) abdominal obesity (waist circumference ≥90 cm in men and ≥85 cm in women), (2) high blood pressure (systolic ≥130 mmHg or diastolic ≥85 mmHg), (3) low high-density lipoprotein cholesterol level (<40 mmHg/dL in men and <50 mmHg/dL in women), (4) high triglyceride level (≥150 mg/dL), and (5) high glucose level (≥100 mg/dL).

We controlled for participant’s covariates, such as sociodemographic and socioeconomic factors, health behaviors, and health conditions, in this study. The sociodemographic factors were age (19–29, 30–39, 40–49, 50–59, and ≥60 years) and sex (male and female). The socioeconomic factors were education level (middle school or lower, high school, or university or higher), region (metropolitan or rural area), marital status (married or not married), occupation (white collar, pink collar, blue collar, or unemployed), and household income (high, middle-high, middle-low, or low). Health conditions included subjective health condition (good, normal, or bad); stress (yes or no); and family history of hypertension, diabetes mellitus, and/or hyperlipidemia (yes or no).

Statistical analysis. To confirm the association between lifestyle risk factors and the risk of metabolic syndrome, the covariates were compared using the chi-squared test. Multiple logistic regression analysis was performed to evaluate the relationship between lifestyle risk factors and metabolic syndrome. The results were reported using odds ratios (ORs) and confidence intervals (CIs). Model fitting was performed using the PROC
Elevated triglyceride levels. Especially, triglyceride levels were more likely associated with an increased risk of abdominal obesity, hypertension, and TG level. Some studies have investigated the combination of metabolic syndrome components with more than one lifestyle risk factor had a higher OR for metabolic syndrome risk (over four lifestyle factors: OR 1.97, CI 1.18–3.27). Female with more than one lifestyle risk factor had a higher OR for metabolic syndrome risk (one lifestyle factor: OR 1.58, CI 1.10–2.28; two lifestyle factors: OR 2.08, CI 1.39–3.11; three lifestyle factors: OR 1.94, CI 1.20–3.13).

Table 3 shows subgroup analysis findings stratified by dependent variables. Apparently, a higher frequency of poor lifestyle factors was considerably associated with an increased risk of abdominal obesity, hypertension, and elevated triglyceride levels. Especially, triglyceride levels were more likely of metabolic syndrome among both male and female. (men: 2 lifestyle factor: OR 1.77, CI 1.18–2.66; 3 lifestyle factors: OR 2.30, CI 1.50–3.52; 4 or more lifestyle factors: OR 3.29, CI 1.99–5.45; women: 2 lifestyle factor: OR 1.98, CI 1.37–2.87; 3 lifestyle factors: OR 2.31, CI 1.50–3.54; 4 or more lifestyle factors: OR 3.62, CI 1.62–8.09).

Table 4 displays logistic regression analysis results stratified by variables of poor lifestyle. People who sat longer is more likely of metabolic syndrome among both male and female. (male: Q4 sedentary time: OR 1.63, CI 1.21–2.19; female: Q4 sedentary time: OR 1.85, CI 1.31–2.62).

Discussion
In this study, we found that people who have more poor lifestyle behaviors tended to have an increased risk of metabolic syndrome in the Korean adult population. And the association with metabolic syndrome was more shown in female group than male group. In prior studies, sex difference in lifestyle factor were shown the relationship with metabolic syndrome.21–23. This sex difference was derived from energy metabolism and difference of physical characteristic. Women have higher proportion of body fat than men and have different effects on hormones.24.

In our study, women who had four poor lifestyle factors did not show any significant association because of poor data regarding smoking status. Our study was based on self-reported data. According to some previous studies, validity assessments of self-reported smoking status data among women have revealed discrepancies in self-reported, non-smoker data.25. So we think that the value with over four lifestyle risk factors in female is affected to the defect.

The prevalence and trend of metabolic syndrome in Korea vary widely, that is, 5.2–35.3% in the male population and 9.0–39.2% in the female population.26. In our study, the prevalence of metabolic syndrome was 25.6% and 12.4% in the male and female groups, respectively. We excluded patients with diagnoses of angina, myocardial infarction, and stroke because baseline cardiovascular diseases and stroke have a strong relationship with the risk of metabolic syndrome and the diagnoses of disease is a great trigger to change people’s lifestyle. Further, people undergoing treatment for hypertension, diabetes mellitus, and hyperlipidemia have been linked to lifestyle behaviors in previous studies, and if we were to include that subgroup in our study, the association between lifestyle and metabolic syndrome would have been underestimated.

People with a greater number of poor lifestyle factors tended to be increased likelihood of abdominal obesity, hypertension and TG level. Some studies have investigated the combination of metabolic syndrome components.27,28. For abdominally obese Korean females and males, the most prevalent metabolic syndrome combination is “triglyceride + HDL-cholesterol” and “triglyceride + blood pressure”, respectively.27. In the other studies, the combination of abdominal obesity, low HDL and hypertriglyceridemia is significantly different between socioeconomic status and sex in Korea.23. The combination is more prevalence in lower SES group and female. In other country, the relationship between abdominal obesity, high TG and reverse HDL-C is observed.29. Therefore, components of metabolic syndrome may have different prevalence with regard to external effect.

Several studies have demonstrated that long sedentary time has a negative effect on health outcomes.30. Sedentary behavior, generally characterized by a mere lack of physical activity, has also been associated with worse health outcomes, such as obesity, diabetes, insulin resistance, metabolic syndrome, and cardiovascular disease.30,31. Some studies have also found alcohol consumption to have a positive relationship with metabolic syndrome. Alcohol intake has been positively associated with body weight, high-density lipoprotein cholesterol levels, and hypertension.32. Current smoking was found to affect all components of metabolic syndrome in the male group only. In this study, the proportion of current smokers was 38.6% and 7% in the male and female groups,
| Variables                                      | Male                     | Female                   | P-value     | Male                     | Female                   | P-value     |
|-----------------------------------------------|--------------------------|--------------------------|-------------|--------------------------|--------------------------|-------------|
| **Total**                                     | 2835                     | 4160                     |             |                          |                          |             |
| **The number of poor lifestyle factor**       |                          |                          |             |                          |                          |             |
| 0                                             | 189                      | 522                      | <0.0001     | 397                      | 125                      | 47          |
| 1                                             | 786                      | 1733                     |             | 207                      | 41.7                     | 11.9        |
| 2                                             | 1076                     | 1465                     |             | 203                      | 35.2                     | 13.9        |
| 3                                             | 576                      | 393                      | <0.0001     | 339                      | 9.4                      | 13.7        |
| ≥ 4                                           | 208                      | 47                       |             | 6                        | 12.8                     | 41          |
| **Age (years)**                               |                          |                          |             |                          |                          |             |
| 19–29                                         | 617                      | 705                      | <0.0001     | 683                      | 16.9                     | 3.1         |
| 30–39                                         | 676                      | 993                      | <0.0001     | 914                      | 23.9                     | 8.0         |
| 40–49                                         | 625                      | 1079                     |             | 949                      | 25.9                     | 12.0        |
| 50–59                                         | 452                      | 798                      | <0.0001     | 677                      | 19.2                     | 12.1        |
| ≥ 60                                          | 465                      | 585                      | <0.0001     | 420                      | 14.1                     | 28.2        |
| **Marital status**                            |                          |                          |             |                          |                          |             |
| Living w/ spouse                              | 1821                     | 2922                     | <0.0001     | 2538                     | 70.2                     | 13.1        |
| Living w/o spouse                             | 1014                     | 1238                     | 0.032       | 1105                     | 29.8                     | 10.7        |
| **Region**                                    |                          |                          |             |                          |                          |             |
| Capital area                                  | 1865                     | 2756                     | <0.0001     | 2419                     | 66.3                     | 12.2        |
| Rural                                         | 970                      | 1404                     | <0.0001     | 1224                     | 33.8                     | 8.0         |
| **Occupational categories**                   |                          |                          | 0.002       |                          |                          |             |
| White                                         | 1101                     | 1348                     | <0.0001     | 1251                     | 32.4                     | 9.2         |
| Pink                                          | 336                      | 641                      | <0.0001     | 555                      | 15.4                     | 8.6         |
| Blue                                          | 778                      | 435                      | 0.002       | 365                      | 10.5                     | 8.3         |
| Inoccupation                                   | 620                      | 1736                     | <0.0001     | 1472                     | 41.7                     | 15.2        |
| **Educational level**                         |                          |                          |             |                          |                          |             |
| Middle school or less                         | 295                      | 614                      | 0.311       | 453                      | 14.8                     | 26.2        |
| High school                                   | 1042                     | 1448                     | <0.0001     | 1265                     | 34.8                     | 12.6        |
| College or over                               | 1498                     | 2098                     | 0.584       | 1925                     | 50.4                     | 8.2         |
| **Household income**                          |                          |                          |             |                          |                          |             |
| Low                                           | 265                      | 396                      | <0.0001     | 299                      | 9.5                      | 24.5        |
| Mid-low                                       | 594                      | 925                      | 0.0001      | 796                      | 22.2                     | 13.9        |
| Mid-high                                      | 879                      | 1294                     | <0.0001     | 1138                     | 31.1                     | 12.1        |
| High                                          | 1097                     | 1545                     | 0.0001      | 1410                     | 37.1                     | 8.7         |
| **Perceived stress**                          |                          |                          |             |                          |                          |             |
| Yes                                           | 769                      | 1236                     | 0.435       | 1092                     | 29.7                     | 11.7        |
| No                                            | 2066                     | 2924                     | 0.323       | 2551                     | 70.3                     | 37.3        |
| **Subjective health status**                  |                          |                          |             |                          |                          |             |
| Good                                          | 1075                     | 1391                     | <0.0001     | 1268                     | 33.4                     | 8.8         |
| Normal                                        | 1472                     | 2206                     | <0.0001     | 1905                     | 53.0                     | 13.6        |
| Bad                                           | 288                      | 563                      | <0.0001     | 470                      | 13.5                     | 16.5        |
| **Family history of HTN**                     |                          |                          |             |                          |                          |             |
| No                                            | 1874                     | 2446                     | 0.418       | 2136                     | 66.1                     | 41.0        |
| Yes                                           | 961                      | 1714                     | 0.566       | 1507                     | 33.9                     | 59.0        |
| **Family history of DM**                      |                          |                          |             |                          |                          |             |
| No                                            | 2300                     | 3263                     | 0.0001      | 2873                     | 81.1                     | 12.0        |
| Yes                                           | 535                      | 897                      | 0.070       | 770                      | 18.9                     | 14.2        |
| **Family history of hyperlipidemia**          |                          |                          |             |                          |                          |             |
| No                                            | 2656                     | 3798                     | 0.030       | 3314                     | 93.7                     | 12.7        |
| Yes                                           | 179                      | 362                      | <0.0001     | 90.9                     | 6.3                      | 31.7        |
| **Lifestyle factor**                          |                          |                          |             |                          |                          |             |
| Normal                                        | 1216                     | 1962                     | 0.913       | 1717                     | 42.9                     | 12.4        |
| Less or over                                  | 1619                     | 2198                     | 0.913       | 1926                     | 57.1                     | 12.4        |
| Continued                                     |                          |                          |             |                          |                          |             |
respectively. Smoking is known to increase insulin resistance and affect lipid metabolism in the body\(^{33}\). Smoking has also been considered to influence adverse abdominal obesity\(^{34}\), and those who quit smoking may exhibit high levels of hyperglycemia and triglycerides\(^{35}\). But in our study, it was not significant, which is that smoking surveyed by self-report is unreliable as mentioned above.

For more effective lifestyle interventions targeting metabolic syndrome, the current study proposes the following recommendations. The initial management of metabolic syndrome entails lifestyle modifications recommended by The National Cholesterol Education Panel Adult Treatment Panel\(^{36}\). First, when formulating a preventive program against metabolic syndrome in adults, we should consider that the effectiveness of the program potentially varies by sex. Second, according to sex, programs should target specific lifestyle risk factors for intervention. When evaluating people’s risks of metabolic syndrome, the number of poor lifestyle behaviors should be taken into account. Third, further research is required to establish reasons underlying sex differences in lifestyle behaviors that affect the risk of metabolic syndrome. Further, an investigation of the associations between the various components of metabolic syndrome and each lifestyle behavior is imperative.

The current study has certain limitations. First, this study was based on data from a cross-sectional study. Therefore, whereas associations could be confirmed, causality could not be evaluated. Second, our study relied on self-reported data. Hence, the measurement of lifestyle risk factors might not have been accurate. Future studies will need to perform precise measurements of lifestyle risk factors. Third, as the cutoff points for lifestyle risk factors were adopted from the KNHANES, it may be difficult to generalize our findings to different settings or populations\(^{37}\). Despite these limitations, this study has several strengths. We used the most recent, nationally representative database to determine the association between lifestyle risk factors and the risk of metabolic syndrome. Therefore, the results obtained are highly representative of healthy South Korean adults. In addition, we utilized American Heart Association/National Heart, Lung, and Blood Institutes Scientific Statement criteria for defining metabolic syndrome in Asians and diagnosing patients with metabolic syndrome.

**Conclusion**

This study found a significant association between the number of lifestyle risk factors and the risk of metabolic syndrome in Korean adults. The greater the number of lifestyle risk factors, the higher the risk of metabolic syndrome in both sexes. People with a greater number of poor lifestyle behaviors tended to exhibit increased likelihood of abdominal obesity, hypertension, and especially elevated triglyceride levels. Sedentary time was also strongly associated with the risk of metabolic syndrome.

### Table 1.

| Variables               | Metabolic syndrome | Male | Female | P-value | Male | Female | P-value |
|-------------------------|--------------------|------|--------|---------|------|--------|---------|
|                         | Total | %     | Yes   | No     | P-value | Total | %     | Yes   | No     | P-value |
| Alcohol use disorder    |       |       |       |       |         |       |       |       |       |         |
| Never or moderate       | 1875  | 66.1  | 438   | 23.4   | 1437   | 76.6  | 0.000 | 3833  | 92.1   | 478  | 12.5   | 3355  | 87.5  | 0.7750 |
| Severe                  | 960   | 33.9  | 288   | 30.0   | 672    | 70.0  | 0.003 | 327   | 7.9    | 39   | 11.9   | 288   | 88.1  | 0.6480 |
| Smoking                 |       |       |       |       |         |       |       |       |       |         |       |       |
| Nonsmoker or Ex-smoker  | 1832  | 64.6  | 436   | 23.8   | 1396   | 76.2  | 0.003 | 3944  | 94.8   | 488  | 12.4   | 3456  | 87.6  | 0.0001 |
| Current smoker          | 1003  | 35.4  | 290   | 28.9   | 713    | 71.1  | 0.923 | 216   | 5.2    | 29   | 13.4   | 187   | 86.6  | 0.1170 |
| Diet intake             |       |       |       |       |         |       |       |       |       |         |       |       |
| Normal                  | 1417  | 50.0  | 364   | 25.7   | 1053   | 74.3  | 0.003 | 1681  | 40.4   | 172  | 10.2   | 1509  | 89.8  | 0.0010 |
| Over                    | 1418  | 50.0  | 362   | 25.5   | 1056   | 74.5  | 0.923 | 2479  | 59.6   | 345  | 13.9   | 2134  | 86.1  | 0.1170 |
| Sleep duration          |       |       |       |       |         |       |       |       |       |         |       |       |
| Normal                  | 2317  | 81.7  | 578   | 24.9   | 1739   | 75.1  | 0.003 | 3349  | 80.5   | 403  | 12.0   | 2946  | 88.0  | 0.1170 |
| Less or over            | 518   | 18.3  | 148   | 28.6   | 370    | 71.4  | 0.003 | 811   | 19.5   | 114  | 14.1   | 697   | 85.9  | 0.1170 |

*Three groups (white, pink, blue) based on International Standard Classification Occupations codes.*
| Variables                          | Metabolic syndrome |   |   |
|-----------------------------------|--------------------|---|---|
|                                  | Male OR 95% CI     | Female OR 95% CI |
| Total                             |                    |               |
| The number of poor lifestyle factor |                   |               |
| 0                                 | 1.00 (1.00–1.00)   | 1.00 (1.00–1.00) |
| 1                                 | 0.95 (0.61–1.48)   | 1.58 (1.10–2.28) |
| 2                                 | 1.28 (0.82–1.99)   | 2.08 (1.39–3.11) |
| 3                                 | 1.42 (0.89–2.26)   | 1.94 (1.20–3.13) |
| 4                                 | 1.97 (1.18–3.27)   | 2.58 (0.93–7.15) |
| Age (years)                       |                    |               |
| 19–29                             | 1.00               | 1.00           |
| 30–39                             | 2.53 (1.71–3.74)   | 2.35 (1.22–4.51) |
| 40–49                             | 2.78 (1.85–4.18)   | 4.06 (2.18–7.55) |
| 50–59                             | 3.57 (2.37–5.37)   | 4.71 (2.51–8.84) |
| ≥ 60                              | 3.11 (1.96–4.94)   | 7.72 (4.06–14.67) |
| Marital status                    |                    |               |
| Living with spouse                | 1.00               | 1.00           |
| Living without spouse             | 0.75 (0.57–1.00)   | 0.92 (0.66–1.29) |
| Region                            |                    |               |
| Metropolitan city                 | 1.00               | 1.00           |
| Rural                             | 1.43 (1.15–1.77)   | 1.11 (0.88–1.40) |
| Occupational categories*          |                    |               |
| White                             | 1.00               | 1.00           |
| Pink                              | 0.97 (0.71–1.32)   | 1.53 (1.05–2.22) |
| Blue                              | 0.81 (0.62–1.06)   | 1.16 (0.79–1.70) |
| Inoccupation                      | 0.80 (0.57–1.13)   | 1.60 (1.21–2.13) |
| Educational level                 |                    |               |
| Middle school or less             | 1.00 (0.69–1.44)   | 1.43 (0.95–2.14) |
| High school                       | 1.22 (0.94–1.58)   | 1.13 (0.86–1.49) |
| College or over                   | 1.00               | 1.00           |
| Household income                  |                    |               |
| Low                               | 1.34 (0.89–2.01)   | 2.00 (1.37–2.93) |
| Mid-low                           | 1.22 (0.90–1.64)   | 1.37 (1.01–1.87) |
| Mid-high                          | 1.18 (0.93–1.49)   | 1.31 (0.98–1.74) |
| High                              | 1.00               | 1.00           |
| Subjective health status          |                    |               |
| Good                              | 1.00               | 1.00           |
| Normal                            | 1.41 (1.13–1.77)   | 1.37 (1.04–1.80) |
| Bad                               | 1.77 (1.25–2.51)   | 1.44 (1.04–2.01) |
| Perceived stress                  |                    |               |
| Yes                               | 0.94 (0.75–1.19)   | 1.01 (0.80–1.27) |
| No                                | 1.00               | 1.00           |
| Family history of HTN             |                    |               |
| Yes                               | 0.98 (0.80–1.20)   | 1.09 (0.86–1.37) |
| No                                | 1.00               | 1.00           |
| Family history of DM              |                    |               |
| Yes                               | 1.54 (1.22–1.95)   | 1.25 (0.98–1.60) |
| No                                | 1.00               | 1.00           |
| Family history of Hyperlipidemia  |                    |               |
| Yes                               | 1.06 (0.72–1.58)   | 0.84 (0.53–1.34) |
| No                                | 1.00               | 1.00           |

Table 2. Results of factors associated with Metabolic syndrome. *Three groups (white, pink, blue) based on the International Standard Classification Occupations codes. Inoccupation group includes housewives.
Data availability
The datasets analyzed during the current study are available the KNHANES official website (https://knhanes.kdca.go.kr/knhanes/main.do).

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Author contributions
P.Y.S. and K.S.H. designed the study conducted the statistical analyses. P.Y.S. wrote the main manuscript text. All authors prepared the tables and reviewed the manuscript. The text was reviewed by J.S.I. and P.E.C.

Competing interests
The authors declare no competing interests.

Additional information
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