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Prevalence of Metabolic Syndrome in University Students in Korea

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Abstract

This study was carried out to identify the prevalence of metabolic syndrome and its associated factors in Korean university students. Data from a convenience sample of 151 students from 2 universities were available for this study. Subjects completed a self-reported questionnaire that included questions on lifestyle and sociodemographics. Blood pressure; fasting glucose level; high-density lipoprotein cholesterol and triglyceride level; and anthropometric variables such as height, weight, and waist circumference were measured. Descriptive statistics were generated and logistic regression was applied to assess potential risk factors, while adjusting for potential confounding. The prevalence of metabolic syndrome was 4%, on the basis of the modified National Cholesterol Education Program-Third Adult Treatment Panel (NCEP-ATP III) guidelines. Multiple logistic regression analyses showed that male sex, poor sleep quality, and obesity were significantly associated with meeting 1 or more of the metabolic syndrome criteria. These findings suggest that sleep quality and obesity should be carefully assessed and treated in the management of metabolic syndrome risk.

Keywords: Metabolic Syndrome, Obesity, Sleep Quality

1. Introduction

Metabolic Syndrome (MetS) is characterized by dyslipidemia, elevated blood pressure, elevated fasting blood glucose level, and abdominal obesity[1]. It is known to increase the risk of developing diabetes mellitus or cardiovascular disease[2]. Globally, metabolic syndrome is common, with a reported age-adjusted prevalence of 22.9% in the US[3] and 31.2% in Venezuela[4], and the prevalence in Korea increased from 24.9% to 31.3% during 1998–2007[5]. Metabolic syndrome is associated with lifestyle factors, including physical activity, drinking, smoking, stress, or depressed mood[6].

The food culture of Korean people has become increasingly westernized. In particular, many adolescents spend their time studying and are often exposed to junk food. As a result, they are becoming increasingly inactive and consume foods that are high in calories. When they do transition into a university, they begin to make their own lifestyle choices. If bad habits are developed during this time, they can ultimately culminate in negative health consequences[7]. Lifestyle modification is one approach to prevent, as well as to treat, metabolic syndrome[2]. It is important to develop good health habits and identify ways to prevent metabolic syndrome among university students as they transition from adolescence to adulthood. Therefore, we conducted this study to determine the prevalence of metabolic syndrome among university students in Korea and identify potential risk factors that can be used for the prevention and management of metabolic syndrome in young adults.

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2. Methodology

2.1 Study Subjects and Data Collection

To identify potential participants, we used a convenience sampling approach, in which we placed an advertisement about research in the classroom and posted an announcement on the bulletin board. Inclusion criteria were that the subject had to be a university student and agree to participate in the research project after acknowledging that he or she understands the purpose and procedures of the present study. Exclusion criteria included clotting disorders or health concerns during blood collection, such as syncope. One hundred fifty-three students were enrolled from 2 universities. All study participants provided informed consent prior to data collection.

Subjects completed a self-reported questionnaire that captured sociodemographic variables and lifestyle factors such as smoking, drinking, exercise, and sleep quality. Sleep quality was evaluated by the Pittsburgh Sleep Quality Index (PSQI), which was developed by Buysse et al.[8]; the PSQI score ranged from 0 to 21. Blood samples were obtained for measuring fasting blood sugar and lipid profiles, such as high-density lipoprotein and triglyceride after a 12-hour fast. They were sent to the laboratory and were analyzed within 1 day after sampling. Blood pressure was checked 3 times by a mercury sphygmomanometer in the sitting position after the subject rested for at least 5 minutes. Height, weight, and waist circumference were measured with the subjects wearing light clothes and socks. Waist circumference was measured at the narrowest point between the lower rib and iliac crest, and the measurements were checked in triplicate. Body Mass Index (BMI) was calculated as height/weight^2 (kg/m^2). The average value of each anthropometric variable was calculated for use in the present study analyses. All data were collected by trained researchers and research assistants.

2.2 Clinical Definitions

Poor sleep quality was defined as a global PSQI score greater than 5 according to criteria of Buysse et al[8]. Based on the World Health Organization BMI classification[9], obesity was defined as a BMI of 25 or higher. Metabolic syndrome was defined as the presence of 3 or more of the following criteria, according to the modified National Cholesterol Education Program-Third Adult Treatment Panel (NCEP-ATP III) guidelines[10]: increased waist circumference (≥90 cm in men and ≥85 cm in women) based on the Korean criteria for abdominal obesity[11], elevated blood pressure (≥130 mmHg systolic blood pressure or ≥85 mmHg diastolic blood pressure), hyperglycemia (fasting blood sugar ≥100 mg/dL), elevated triglyceride (≥150 mg/dL), or low high-density lipoprotein cholesterol levels (<40 mg/dL in men and <50 mg/dL in women).

2.3 Statistical Analysis

Data from 151 subjects were available for analysis after excluding 2 subjects with incomplete data. Descriptive statistics were generated for general characteristics, metabolic syndrome criteria, and metabolic syndrome prevalence. Multiple logistic regression analysis was used to determine the association between select factors and meeting 1 or more metabolic syndrome criterion, while adjusting for potential confounders (variables that were found to have statistical significance in simple logistic analyses).

3. Results

3.1 General Characteristics of the Subjects

The general characteristics of our study subjects are shown in Table 1. The mean age of the subjects was 20.7 years and 31.1% were male. The mean BMI was 22.6 kg/m2 and the proportion of obese subjects was 25.2%. Among 151 subjects, seventeen (11.3%) of subjects were current smokers. A total of 34.4% of subjects reported having poor sleep quality.

3.2 Mean Values of Metabolic Syndrome Criteria

Table 2 describes the mean values of the continuously measured criteria for metabolic syndrome of subjects. The mean waist circumference was 82.6 (±10.6) cm and 70.8 (± 8.80) cm in men and women respectively. The mean high-density lipoprotein cholesterol level was 55.2 (±12.99) mg/dL and 57.8 (±9.81) mg/dL in men and women respectively. The mean total cholesterol level was 171.5 (±29.73) mg/dL, and the mean low-density lipoprotein cholesterol level was 97.5 (±26.26) mg/dL.

3.3 Prevalence of Metabolic Syndrome

Table 3 shows the prevalence of metabolic syndrome and individual metabolic syndrome criteria. Four percent of

Table 1. General Characteristics of the Subjects (N = 151)

Variables	Categories	Frequency (%)	Mean (SD)
Age(years)			20.7(2.31)
	<20	51(33.8)	
	≥20	100 (66.3)	
Sex	Male	47 (31.1)	
	Female	104 (68.9)	
Grade	Freshman	47 (31.1)	
	Sophomore	42 (27.8)	
	Junior	20 (13.3)	
	Senior	42 (27.8)	
Smoking	Yes	17 (11.3)	
	No	134 (88.7)	
Drinking	Yes	123 (81.5)	
	No	28 (18.5)	
Exercise	Yes	62 (41.1)	
	No	89 (58.9)	
Sleep quality			5.0(3.11)
	Good	99(65.6)	
	Poor	52(34.4)	
BMI(kg/m^2)			22.6(3.59)
Obesity	Yes	38 (25.2)	
	No	113 (74.8)	

SD: Standard Deviation.

Table 2. Mean Laboratory Values Related to Metabolic Syndrome Criteria

Variables	Mean (SD)
Waist circumference (cm)	74.4(10.85)
Systolic pressure (mmHg)	106.3(11.35)
Diastolic pressure (mmHg)	74.2(8.86)
HDL cholesterol (mg/dL)	57.0(10.92)
Triglyceride (mg/dL)	85.7(38.96)
Glucose (mg/dL)	86.4(6.87)

HDL: High-Density Lipoprotein ; SD: Standard Deviation

Table 3. Prevalence of Metabolic Syndrome Criteria (N = 151)

No. of Metabolic Syndrome Criteria	Frequency (%)
None	101(66.9)
1	33(21.9)
2	11(7.3)
3 or more	6(4.0)

study subjects had metabolic syndrome. One or more metabolic syndrome criteria were met in 21.9% of study subjects. Prevalence of abdominal obesity was high at 13.9%, and the prevalence of elevated fasting glucose was low at 3.3%.

3.4 Associated Factors of 1 or More Metabolic Syndrome Criteria

Table 4 describes the results of the logistic regression analyses. Factors associated with 1 or more abnormal metabolic syndrome criteria were analyzed owing to the lower prevalence of metabolic syndrome. One or more of the metabolic syndrome criteria were significantly associated with male sex (OR: 4.70, 95% CI: 1.70–2.97), poor sleep quality (OR: 2.93, 95% CI: 1.12–7.69), and obesity (OR: 15.44, 95% CI: 5.46–43.62), after adjusting for age, sex, obesity, sleep quality, smoking, and exercise.

4. Discussion and Conclusion

Metabolic syndrome is known to an important lifestyle-related disease[6] and can ultimately lead to cardiovascular diseases[2]. The prevalence of metabolic syndrome in the present study was 4%, similar to that of previous studies. Fernandes and Lofgren[7] reported that the 3.7% of college students aged 18–24 years had metabolic syndrome, with 28% of subjects meeting at least 1 criterion for metabolic syndrome. About 22% of our subjects met at least 1 or more criteria for metabolic syndrome, which is lower than that reported by Fernandes and Lofgren[7]. In contrast, Cha et al.[12] reported that the prevalence of metabolic syndrome in overweight and obese college students was 13.1% in the male students and 8.3% in the female students, as defined by the NCEP-ATP III criteria. Further, 45.9% of the male students and 50.0% of the female stu-

Table 1. Substrate Parameters

Variables		Crude OR (95% CI)	Adjusted OR [a] (95% CI)
Age	≥20	1.99 (0.93, 4.27)	
	<20	1	
Sex	Male	6.37(2.98, 13.59)	4.70 (1.70, 2.97)
	Female	1	1
Sleep quality	Poor	2.41 (1.19, 4.87)	2.93 (1.12, 7.69)
	Good	1	1
Obesity	Yes	17.44 (6.97, 43.63)	15.44 (5.46, 43.62)
	No	1	1
Drinking	Yes	0.78 (0.31, 1.68)	
	No	1	
Smoking	Yes	6.06 (2.00, 8.38)	2.99 (0.65, 3.72)
	No	1	1
Exercise	No	0.35 (0.18, 0.71)	0.64 (0.25, 1.62)
	Yes	1	1

[a] Adjusted for age, sex, obesity, sleep quality, smoking, and exercise;

OR: Odds Ratio; CI: Confidence Interval.

dents had at least 1 metabolic risk factor[12]; this difference is likely due to the degree of obesity of the participants in the study. The metabolic syndrome prevalence in the present study was also lower than that of Hung et al.[13], who reported a higher prevalence of metabolic syndrome, at 26.2%, but this higher value seems to be due to the difference in age of the study population.

This study showed that one or more metabolic syndrome criteria were associated with sex, obesity, and sleep quality. Obesity, defined in our study as a BMI ≥ 25, was significantly associated with a 15.44-fold increased risk of meeting at least 1 of the metabolic syndrome criteria in our study. This result is supported by several previous studies[4,7,14–16]. Ryu et al.[17] reported a significant difference of weight between subjects with and without metabolic syndrome. They also reported that weight change was a risk factor for the incidence of metabolic syndrome in 30–39-year-old men. Morrell et al.[18] also reported that college students who were overweight or obese were more likely to have metabolic syndrome than those of normal weight. Khashayar et al.[19] showed that 15.4% of overweight or obese participants and 1.8% of normal-weight participants had metabolic syndrome. They also reported that the odds ratio of overweight or obesity was 9.6819. It seems that metabolic syndrome is associated with an altered lipid profile due to obesity.

This study showed that male subjects had a 4.70-fold increased risk of meeting at least 1 of the metabolic syndrome criteria relative to female subjects, which again, is consistent with results from previous studies[14,15,20,21]. Jennings et al.[22] reported that men are more prone to metabolic syndrome. Cha et al.[12] reported that the prevalence of metabolic syndrome in male obese college students was 21.3% and 8.3% in female students according to the International Diabetes Federation criteria. Morrell et al.[18] found that metabolic syndrome prevalence was 9.9% in male college students and 3.0% in female college students. Mattsson et al.[23] reported that the prevalence of metabolic syndrome with age increased more dramatically, in men compared with women. However, this result is not in accordance with the study by Florez et al.[4], in which sex was not associated with metabolic syndrome in subjects aged 20 years or older, after adjusting for confounding factors. Yu et al.[1] reported that prevalence of metabolic syndrome was higher in women than in men that female sex was one of the risk factors. Therefore, additional studies of university students with large sample sizes are needed to better clarify this relationship.

There are many studies on the relationship between sleep and metabolic syndrome[1,24]. Previous studies have reported that amount of sleep time was correlated with metabolic syndrome[25,26]. Hall et al.[25] showed that sleep duration was related to metabolic syndrome in midlife adults, reporting an odds ratio of 1.83 for metabolic syndrome for adults sleeping <6 hours/day, 1.48 for adults sleeping 6–7 hours/day, and 1.81 for adults >8 hours/day relative to adults sleeping 7–8 hours/day. Choi et al.[26] reported a hazard ratio of 1.80 for the incidence of metabolic syndrome in middle-aged women sleeping <6 hours/day relative to those sleeping 6–7.9 hours/day. Previous studies also reported associations between sleep disorders and poor sleep quality and metabolic syndrome. Obstructive sleep apnea[20,27] or snoring[28] have been reported to be associated with metabolic syndrome, which has been postulated to stem from intermittent hypoxia causing sympathetic overactivity, systemic inflammation, and endothelial dysfunction[29].

In the present study, we observed that poor sleep quality was significantly associated with meeting 1 or more of the metabolic syndrome criteria regardless of the presence or absence of obesity. The concept of sleep quality includes not only subjective aspects, like depth of sleep or restfulness, but also quantity of sleep, like sleep duration or number of arousals[8]. We found a 2.98-fold increased risk for metabolic syndrome in poor sleepers as compared with good sleepers in our study. This is supported by the results of several studies in which sleep quality and metabolic syndrome were associated[13,22,30]. Hung et al.[13] reported that sleep quality evaluated by PSQI had relationship to metabolic syndrome. Similarly, Jennings et al.[22] found that a 2.6-point increase in the global PSQI score was related to a 1.44-fold increase in metabolic syndrome risk. The effect of sleep quality on metabolic syndrome has also been studied longitudinally, with Troxel et al.[31] reporting that sleep symptoms, such as difficulty initiating sleep, unrefreshing sleep, and loud snoring, conveyed an increased risk for developing metabolic syndrome in adults from the community, further corroborating our findings. As mentioned above, previous studies found that sleep quality or quantity was associated with metabolic syndrome; poor sleep quality and short sleep duration affect endocrine and metabolic function[29].

Lifestyle factors, such as smoking, drinking, and exercise were not correlated with metabolic syndrome in our study. This is similar to the results of Ryu et al.[17], who also

found that smoking, alcohol drinking, and exercise were not associated with metabolic syndrome.

Hall et al.[25] also reported that smoking was not associated with metabolic syndrome. However, there are several studies in which alcohol consumption was associated with metabolic syndrome. Kang et al.[32] reported that heavy drinkers (defined as those who drink more than 5 drinks at any 1 sitting at least once per week) were associated with metabolic syndrome. Baik and Shin[33] reported that alcohol intake increased the risk of occurrence of metabolic syndrome. The multivariate relative risk of metabolic syndrome for middle-aged adults was 1.63 for heavy drinkers consuming >30 g/d, compared with non-drinkers[33]. This highlights the importance of assessing the quantity of alcohol consumption when evaluating the relationship between alcohol consumption and metabolic syndrome among university students. Since lifestyle factors were dichotomously measured as yes or no in our present study, further studies assessing the quantity of smoking, alcohol intake, and exercise are required.

There are several limitations to our study. The generalizability is restricted by the relatively small sample size and our convenience sampling method. In our analyses, we assessed risk factors for meeting 1 or more of the metabolic syndrome criterion owing to our low number of subjects with metabolic syndrome. Future studies should aim at replication of this study in a cohort with larger, random samples. Additionally, this study was cross-sectional in nature, so we cannot verify that associated factors (besides sex) preceded metabolic syndrome. In the future, longitudinal researches are needed to determine the causal relationship between these risk factors and metabolic syndrome in college students.

In summary, we found a relatively high prevalence of college students who had at least 1 of the criteria for metabolic syndrome. Maintenance of healthy weight through proper diet, physical activity, and exercise is important for preventing metabolic syndrome. Quality of sleep and obesity should be assessed in college students to help prevent metabolic syndrome. Future studies will aim to confirm risk factors that disturb sleep quality and develop programs to improve sleep quality.

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