Association between Sleep Duration and Obesity in Young Korean Adults

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Background: The purpose of this study was to investigate the association between number of sleep hours and obesity based on body mass index (BMI) after adjusting for socioeconomic position, health behaviors, and clinical factors.

Methods: Data from subjects aged 20–64 years ($n = 12,688$) in the Korea National Health and Nutrition Examination Survey in 2007–2009 was analyzed. Subjects were divided into two groups according to age: 20–44 (young adults) and 45–64 years (middle-aged adults). With respect to sleep time, subjects were classified as short sleepers (< 6 hr/day), long sleepers (≥ 9 hr/day), and normal sleepers (6–8.9 hr/day). Obesity was defined as a BMI ≥ 25 .

Results: The proportion of patients who were obese was 27.8%. The distribution of short sleepers, long sleepers, and normal sleepers was 6.4%, 13.7%, and 79.9%, respectively. The adjusted short sleeper and long sleeper odds ratios (OR) for obesity in young adults were significantly different from that in middle-aged adults after adjustment for confounding factors. In women, the adjusted short sleeper OR for obesity was 1.56 (95% CI, 1.02–2.37).

Conclusion: This community-based random sample of Korean adults showed that women with short sleep duration may be at significant risk of obesity.

Key words: Short sleepers, Obesity, Body mass index, Young adult, Sex

Introduction

Obesity is a major public health burden in developed countries^{1–3} and is also a well-known risk factor of cardiovascular disease (CVD). Short sleep duration is associated not only with obesity⁴, but also with diabetes mellitus⁵, heart disease^{6–8}, and death.⁹ An inverse relationship between inadequate sleep duration and obesity has been shown in young adults¹⁰, specifically in young women.¹¹ Associations between sleep duration and health indicators differ according to factors such as race, culture, and sex.¹² Koreans, in particular, are known to have relatively few sleep hours compared with those in other Organization for Economic Cooperation and Development (OECD) countries.¹³ However, few studies have focused on the association between sleep duration and obesity in the Korean population. Therefore, we investigated the association between sleep duration

and obesity after adjusting for socioeconomic position, health behaviors, and other clinical factors.

Methods

1. Study population

Data were collected from the 2007–2009 Korea National Health and Nutrition Examination Survey (KNHANES) conducted by the Ministry of Health and Welfare of Korea.¹⁴ The survey applied a stratified, multistage probability sampling design to the South Korean population using a three-stage, stratified, systematic sampling method. The KNHANES included three questionnaires: a health interview survey, a health behavior survey, and a health examination. The health interview survey sample included 13,800 households and 31,705 household members from 600 districts. One of every three

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health interview survey participants was selected for further participation in the health behavior survey and health examination. From the 2007-2009 KNHANES, 24,871 people aged one year and older were interviewed of the 31,705-person sample (response rate: 78.4%). We analyzed data from subjects aged 20-64 years with weighted variables ($n = 12,688$; 6,495 men and 6,193 women). The sample included 7,775 people aged 20-44 years (young adults; male 4,030 and female 3,745) and 4,913 people aged 45-64 years (middle-aged adults; male 2,465 and female 2,448).

The health interview questionnaire and health examination included several variables. Patients were divided in two groups according to age: 20-44 years and 45-64 years. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured after the subject had rested for five minutes in a sitting position. An average of three blood pressure measurements was used for data analysis. Blood samples were collected from the antecubital vein after overnight *nil per os* (NPO). Fasting plasma glucose, total cholesterol (TC), triglyceride (TG), and high density lipoprotein (HDL) levels were measured using enzymatic or colorimetric methods. Self-reported information on stress/depression status was obtained from the interviews, including usual stress perception and persistent depression for at least two weeks. Information on education level, monthly household income, family size, dietary consumption, regular physical activity, smoking status, alcohol consumption, employment status, hours worked per week, and sleep time in hours was also collected. A food frequency questionnaire (FFQ) consisting of 63 food items and the 24-hour recall method were used to document dietary consumption. Nutrient intake was calculated as a percentage of total daily energy consumption and the energy obtained from protein, fat, and carbohydrates. The study received ethical approval from the Institutional Review Board of Korea Centers for Disease Control and Prevention in Osong, Korea. Written informed consent was obtained from all participants in the study.

2. Sleep duration

Self-reported sleep duration was grouped according to number of sleep hours. Patients were classified into three categories: short sleepers (< 6 hours (h)/day), long sleepers (≥ 9 h/day), and normal sleepers (6-8.9 h/day).¹⁵⁻¹⁸ The sleep duration question was phrased as “How many hours do you usually sleep per day?”

3. Obesity

Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. Obesity was defined as a BMI ≥ 25 .^{19,20}

4. Standing height measurement

We measured subjects' standing height using anthropometry (SECA225, Germany SECA). First, they stood with heels together and toes apart. The subjects were checked to confirm that the back of the head, buttocks, and heels made contact with the backboard. Second, the head was aligned in the Frankfort horizontal plane. We used an anthropometric bar on the subjects' heads and measured the result to the nearest centimeter.

5. Weight measurement

Subjects were weighed in kilograms using a scale (GL-6000-20, CAS Korea), and the results was determined when gradation was stabilized after a set zero on the scale with no load.

6. Socioeconomic factors

The socioeconomic factors used in this study were education level and equivalent household monthly income. Education level was classified into three categories: 1) elementary school; six years or less of schooling, 2) middle/high school; 7-12 years of schooling, and 3) college, university; > 12 years of schooling. Equivalent household monthly income (equivalent income) was calculated using the following formula created by the OECD²¹: $W_{ij} = Y_i / S_i^\epsilon$, where Y_i is the i^{th} household income, S_i is the i^{th} household family size, and W_{ij} is the equivalent income of the j^{th} member in the i^{th} household. Equivalent elasticity, ϵ , which is an equivalency of household size, was set to 0.5. Equivalent income was then calculated by dividing the obtained monthly household income by the square root of family size. Equivalent income was categorized into three levels: low (< 130), middle (130-849), and high (≥ 849). Employment status consisted of currently working or not working and included full-time and part-time positions. Finally, the number of hours worked per week included full- and part-time work.

7. Health behavior factors

A subject was identified as a current smoker if he or she had smoked within one year of the survey date. A subject was defined as

a current drinker if he or she had consumed an alcoholic beverage within one year of the survey date. Regular physical activity was defined as having walked 30 minutes at a time, more than five days a week.

8. Statistical analyses

Differences in general characteristics, socioeconomic factors, health behaviors, and clinical data between non-obese and obese groups were analyzed using Student's *t*-tests for continuous variables and χ^2 -tests for categorical variables. The mean ($\pm$ standard error) of BMI by sleep duration (from less 5 to over 10) was determined for all groups, including by sex, and the 20-44 years and 45-64 years groups were analyzed using one-way analysis of variance. Multiple logistic regression analysis was used to determine the association between sleep duration (< 6 hours vs $\geq$ 9 hours vs 6-8.9 hours) as the independent variable and obesity as the dependent variable after adjusting for age, sex, socioeconomic position, health behaviors, and other clinical factors. The sample weights proposed by the Korea Institute of Health and Social Affairs to estimate nationwide prevalence were applied for all analyses.²² *P* values less than 0.05 were reported as statistically significant. Data were analyzed with Statistical Analysis System (SAS) software, version 9.3 (SAS Inc., Cary, NC, USA).

Results

Of our total sample, 31.6% were obese. A significantly higher proportion of obese people had short sleep hours compared with normal sleep hours in the young adult group ($P < 0.001$). Generally, obese people were more likely to be male, under stress, less educated, and currently employed compared to non-obese people ($P < 0.05$). In contrast, the proportion of people who regularly engaged in regular physical activity was higher among non-obese people than obese people ($P < 0.001$). TG levels in the obese group were higher than those of the non-obese group ($P < 0.01$) (Table 1).

The adjusted odds ratios (OR) of short sleep hours [1.56 (95% Confidence Interval (CI), 1.02-2.37)] and long sleep hours [2.41 (95% CI, 1.28-4.54)] were statistically significant in young women after adjusting for potential confounders (Table 2). Furthermore, in young women, shorter the sleep duration was associated with higher BMI (Fig. 1).

Discussion

Although long sleep duration was found to be associated with obesity in both sexes in the young age group in this study, obesity was associated with short sleep duration in the 20-44 years group in women. The results of this present study are similar to those of an earlier study. The United States (US) civilian noninstitutionalized population study that used the National Health and Nutrition Examination Survey I showed an association between short sleep duration and obesity in women.²³ Additionally, an internal medicine clinic patient study showed that short sleep time predicted obesity in women aged 18 to 49 years in the US.²⁴

Multiple studies have been conducted in various countries and have indicated that there is an association between obesity and sleep duration. For example, adults in Australia¹⁷ and the US²⁵ showed an association between obesity and short/long sleep duration. Additionally, studies of young Swedish women¹¹, a community prospective cohort study in Zurich²⁶, Brazilian adults²⁷, and a population-based study in the US²⁸ showed that obesity was associated with short sleep duration. The Insulin Resistance Atherosclerosis Study Family Study, which measured abdominal fat using computed tomography²⁹, showed an association between short sleep duration and obesity in adults younger than 40 years. Short sleep duration has been shown to be associated with reduced leptin, elevated ghrelin, and increased BMI.^{30,31} Furthermore, sex hormones and reproductive events may explain the differences between men and women.³² Decreases in sleep duration and quality of sleep were observed in postpartum women. In a Korean study, Park et al.³³ determined that short and long sleep durations were associated with psychiatric disorders and obesity. Unfortunately, they did not analyze their data according to age or sex. However, the Penn State Cohort³⁴ and the White Hall II Study¹² did not show a significant association between short sleep duration and obesity. Although a causal effect between long sleep hours and obesity has not been established, a previous study showed that long sleepers were more likely to experience obesity, depression, lower SEP, and social isolation.³⁵

In the present study, obesity was associated with short sleep duration only in women, although longer sleep duration was associated with obesity in both sexes in the young age group. The association between sleep duration and BMI in women is not in accordance with the large epidemiologic study by Kripke et al.⁹, which reported a U-

Table 1. Distribution of general characteristics, sleep hours, mental stress, socioeconomic position, health behaviors, and clinical factors by age group and body mass index

Variables	20-64 years (n=12,688)			20-44 years (n=7,775)			45-64 years (n=4,913)		
	Non-obese (n=8,679)	Obese (n=4,009)	P value*	Non-obese (n=5,648)	Obese (n=2,127)	P value*	Non-obese (n=3,031)	Obese (n=1,882)	P value*
Percentages									
Age, years, mean (SD)	39.3 (16.7)	42.9 (14.5)	0.334	32.1 (10.5)	33.8 (8.76)	0.077	52.7 (6.06)	53.2 (6.07)	0.889
Sex, female	53.4	38.5	<0.001	54.1	32.3	<0.001	52.1	46.0	<0.001
Sleep hours, mean (SD)	6.95 (1.49)	6.77 (1.46)	0.925	7.07 (1.50)	6.84 (1.38)	0.699	6.74 (1.10)	6.70 (1.30)	0.846
Sleep hours			<0.001			<0.001			0.132
≥ 9	8.2	6.4		9.1	6.7		6.5	6.1	
6-9	82.2	79.9		83.0	82.1		79.2	77.3	
< 6	9.6	13.7		7.9	11.2		14.3	16.6	
Perceived stress	29.2	31.6	0.025	31.6	35.7	0.004	24.5	27.0	0.080
Perceived depression	13.1	13.2	0.937	11.7	11.2	0.594	15.7	15.3	0.721
Education level			<0.001			0.003			0.001
College, University	46.8	39.4		61.4	57.3		24.4	29.4	
Middle/High school	44.2	46.1		37.8	41.5		56.0	51.2	
Elementary school	9.0	14.5		0.8	1.2		19.6	19.4	
Income level†			0.053			0.151			0.522
High	29.7	25.0		32.2	31.3		25.0	25.2	
Middle	33.3	31.7		32.6	30.6		34.0	32.4	
Lower	40.5	43.3		35.2	38.1		41.0	42.4	
Walking practice, Yes	82.3	79.1	<0.001	83.0	77.8	<0.001	81.0	80.7	0.766
Current smoker, Yes	4.7	3.9	0.212	5.6	3.0	0.494	3.1	2.7	0.806
Current drinker, Yes	91.5	91.2	0.579	94.6	95.2	0.396	85.8	86.8	0.339
Employment status, Yes	64.7	71.0	<0.001	63.7	71.6	<0.001	66.4	70.6	0.004
Hours worked per week, mean (SD)	45.9 (22.5)	48.8 (21.2)	0.081	45.1 (21.6)	48.9 (20.6)	0.088	47.5 (22.7)	48.7 (23.7)	0.288
Mean (SD)									
Systolic blood pressure (mmHg)	112.2 (24.2)	120.8 (21.1)	0.442	108.4 (19.5)	117.2 (17.5)	0.639	119.1 (20.9)	124.9 (19.9)	0.445
Diastolic blood pressure (mmHg)	74.7 (18.6)	81.0 (15.2)	0.101	72.8 (16.5)	79.6 (13.8)	0.083	78.3 (14.3)	82.5 (13.4)	0.564
Fasting plasma glucose (mg/dL)	93.0 (23.2)	100.9 (29.1)	0.068	90.2 (20.2)	95. (22.6)	0.325	98.2 (23.6)	106.7 (32.9)	0.059
Total cholesterol (mg/dL)	180.5 (42.8)	195.2 (44.3)	0.446	174.2 (40.5)	192.6 (44.2)	0.249	192.2 (36.8)	198.1 (42.9)	0.346
Triglyceride (mg/dL)	115.5 (114.5)	173.5 (165.8)	0.003	104.2 (103.7)	171.7 (163.7)	0.030	136.5 (118.3)	175.5 (166.1)	0.028
High density lipoprotein (mg/dL)	49.2 (17.7)	43.5 (12.6)	0.509	49.9 (17.2)	43.3 (11.9)	0.805	48.0 (12.6)	43.8 (12.1)	0.918
Body mass index	21.8 (1.86)	27.4 (2.53)	<0.001	21.5 (2.25)	27.6 (2.77)	<0.001	22.3 (1.65)	27.1 (2.17)	<0.001
Waist circumference (cm)	76.2 (11.1)	90.6 (9.50)	0.052	74.8 (10.5)	90.4 (9.69)	0.295	78.8 (8.26)	90.7 (7.81)	0.058
Energy (kcal/day)	1,930.7 (1,101.7)	2,036.7 (1,149.0)	0.634	1,966.8 (1,062.7)	2,113.5 (1,150.6)	0.197	1,865.4 (959.8)	1,954.7 (1,069.7)	0.518
Protein (g/day)	70.0 (49.5)	73.6 (50.1)	0.806	72.0 (50.4)	77.6 (50.5)	0.818	66.4 (38.5)	69.2 (44.3)	0.877
Fat (g/day)	40.3 (40.7)	40.8 (40.8)	0.585	44.8 (39.8)	47.4 (38.8)	0.299	32.1 (33.4)	33.6 (37.4)	0.776
Carbohydrates (g/day)	308.0 (169.1)	318.4 (163.3)	0.191	304.7 (159.4)	313.0 (160.9)	0.029	314.0 (157.9)	324.0 (153.9)	0.709

Regular physical activity: if subject had walked 30 minutes at a time, more than five days a week; Current smoker: if subject had smoked within one year of the survey date; Current drinker: if subject had consumed an alcoholic beverage within one year of the survey date; Employment status: if subject is currently working.

*Student's *t*-test or χ^2 -test; †Equivalent household monthly income.

shaped relationship between sleep duration and BMI in women. However, the distribution of sleep duration and obesity in the present study corresponds with the data from a Detroit population telephone interview self-reported sleep hour study²⁸ and the Penn State Cohort results.³⁶

The present study assessed the impact of carbohydrate overeating to determine if it is associated with obesity, using the 24-hour recall method. Young obese women did not report a higher carbohydrate

intake, although there was a significantly higher carbohydrate intake in young obese people overall (Online Appendix 1). Therefore, the association between obesity in young women with short sleep duration could be attributable to other factors, which could not be identified in this study.

There were several limitations to our study. First, it is difficult to show causality between obesity and short sleep duration using a cross-sectional study design, although this study does demonstrate

Table 2. Association between number of sleep hours and obesity after adjustment for age, sex, stress, socioeconomic position, health behaviors, and other clinical factors

Variables	Obesity (BMI >25)			
	Model 1	Model 2	Model 3	Model 4
20-64 years				
All				
≥ 9 hours	1.71 (1.38-2.12)	1.45 (1.17-1.81)	1.47 (1.13-1.92)	1.59 (1.20-2.12)
6-8.9 hours	1.0	1.0	1.0	1.0
< 6 hours	1.38 (1.20-1.58)	1.26 (1.09-1.45)	1.19 (1.01-1.41)	1.26 (1.05-1.52)
Male				
≥ 9 hours	1.44 (1.06-1.96)	1.38 (1.01-1.88)	1.37 (0.98-1.91)	1.43 (0.99-2.05)
6-8.9 hours	1.0	1.0	1.0	1.0
< 6 hours	1.14 (0.94-1.40)	1.11 (0.91-1.36)	1.12 (0.91-1.39)	1.18 (0.94-1.49)
Female				
≥ 9 hours	1.97 (1.51-2.56)	1.30 (0.98-1.71)	1.48 (0.98-2.21)	1.80 (1.17-2.75)
6-8.9 hours	1.0	1.0	1.0	1.0
< 6 hours	1.79 (1.50-2.13)	1.45 (1.21-1.73)	1.31 (1.01-1.70)	1.38 (1.03-1.84)
20-44 years				
All				
≥ 9 hours	1.92 (1.42-2.58)	1.73 (1.28-2.34)	1.68 (1.16-2.41)	1.99 (1.32-2.99)
6-8.9 hours	1.0	1.0	1.0	1.0
< 6 hours	1.43 (1.16-1.75)	1.44 (1.17-1.77)	1.36 (1.07-1.73)	1.40 (1.08-1.82)
Male				
≥ 9 hours	1.65 (1.06-2.57)	1.54 (0.98-2.41)	1.60 (0.99-2.58)	1.78 (1.04-3.04)
6-8.9 hours	1.0	1.0	1.0	1.0
< 6 hours	1.21 (0.90-1.61)	1.23 (0.92-1.65)	1.25 (0.92-1.70)	1.31 (0.95-1.81)
Female				
≥ 9 hours	1.88 (1.27-2.77)	1.57 (1.06-2.33)	1.73 (1.02-2.96)	2.41 (1.28-4.54)
6-8.9 hours	1.0	1.0	1.0	1.0
< 6 hours	1.81 (1.37-2.40)	1.77 (1.34-2.35)	1.62 (1.12-2.34)	1.56 (1.02-2.37)
45-64 years				
All				
≥ 9 hours	1.21 (0.91-1.61)	1.15 (0.97-1.37)	1.19 (0.84-1.69)	1.22 (0.85-1.74)
6-8.9 hours	1.0	1.0	1.0	1.0
< 6 hours	1.18 (1.00-1.40)	1.18 (0.89-1.57)	1.06 (0.85-1.33)	1.14 (0.89-1.45)
Male				
≥ 9 hours	1.15 (0.76-1.74)	1.16 (0.77-1.75)	1.10 (0.71-1.70)	1.07 (0.68-1.68)
6-8.9 hours	1.0	1.0	1.0	1.0
< 6 hours	1.03 (0.80-1.34)	1.05 (0.81-1.36)	1.04 (0.79-1.37)	1.09 (0.81-1.46)
Female				
≥ 9 hours	1.28 (0.86-1.89)	1.15 (0.77-1.72)	1.27 (0.72-2.24)	1.46 (0.81-2.64)
6-8.9 hours	1.0	1.0	1.0	1.0
< 6 hours	1.37 (1.17-1.70)	1.27 (1.02-1.59)	1.08 (0.76-1.54)	1.21 (0.84-1.75)

Model 1 is a crude odds ratio (OR).

Model 2 is adjusted for age.

Model 3 is adjusted for age, sex, mental stress, education level, equivalent household monthly income level, walking, smoking, and drinking. Statistical analysis was applied except in sex analysis.

Model 4 is adjusted for model 3+systolic blood pressure, diastolic blood pressure, fasting blood sugar, triglycerides, and high density lipoprotein levels.

that obesity is associated with short sleep duration in young Korean females. Second, KNHANES did not investigate the quality of sleep or conduct a quantitative assessment of regular physical activity, drink, and smoking. Third, this study utilized self-reported sleep duration instead of measured sleep duration. However, good agree-

ment between self-reported sleep durations and those obtained through actigraphic monitoring has been reported in previous studies.³⁷ Therefore, our study supports the hypothesis that there is an association between short sleep duration and obesity.

This study is highly representative of the Korean population since

Figure 1. One-way analysis of variance of mean (standard error) body mass index (BMI) and sleep duration according to age and sex.

it is a well-designed random sample study. Therefore, our results are applicable to the general Korean population.

This community-based random sample was drawn from a population of young Korean adults, especially women, and indicated that short sleep duration was significantly associated with obesity. These finding may have important clinical implications for the prevention of obesity, especially in young women, since sleep duration is a potentially modifiable risk factor.

Conflicts of Interest

None Declared.

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