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Habitual Sleep Duration, Unmet Sleep Need, and Excessive Daytime Sleepiness in Korean Adults

Young Hwangbo[a]
Won-Joo Kim[b]
Min Kyung Chu[c]
Chang-Ho Yun[d]
Kwang Ik Yang[e]

[a]Department of Preventive Medicine, Soonchunhyang University College of Medicine, Cheonan, Korea
[b]Department of Neurology, Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, Korea
[c]Department of Neurology, Hallym University College of Medicine, Anyang, Korea
[d]Clinical Neuroscience Center, Department of Neurology, Seoul National University Bundang Hospital, Seongnam, Korea
[e]Sleep Disorders Center, Department of Neurology, Soonchunhyang University College of Medicine, Cheonan Hospital, Cheonan, Korea

Background and Purpose Sleep need differs between individuals, and so the same duration of sleep will lead to sleep insufficiency in some individuals but not others. The aim of this study was to determine the separate and combined associations of both sleep duration and unmet sleep need with excessive daytime sleepiness (EDS) in Korean adults.

Methods The participants comprised 2,769 Korean adults aged 19 years or older. They completed questionnaires about their sleep habits over the previous month. The question regarding sleep need was "How much sleep do you need to be at your best during the day?" Unmet sleep need was calculated as sleep need minus habitual sleep duration. Participants with a score of >10 on the Epworth Sleepiness Scale were considered to have EDS.

Results The overall prevalence of EDS was 11.9%. Approximately one-third of the participants (31.9%) reported not getting at least 7 hours of sleep. An unmet sleep need of >0 hours was present in 30.2% of the participants. An adjusted multivariate logistic regression analysis revealed a significant excess risk of EDS in the groups with unmet sleep needs of ≥2 hours [odds ratio (OR), 1.80; 95% confidence interval (CI), 1.27−2.54] and 0.01−2 hours (OR, 1.42; 95% CI, 1.02−1.98). However, habitual sleep duration was not significantly related to EDS.

Conclusions EDS was found to be associated with unmet sleep need but not with habitual sleep duration when both factors were examined together. We suggest that individual unmet sleep need is more important than habitual sleep duration in terms of the relation to EDS.

Key Words sleep, hypersomnolence, Korea, adult.

INTRODUCTION

Excessive daytime sleepiness (EDS) is a recurrent uncontrollable compulsion to sleep when intending to stay awake.[1,2] Sleepiness lowers the ability of an individual to perform various daytime functions, and is a risk factor for traffic accidents and occupational injuries.[3-5] Sleepiness also has negative effects on general health, social engagement, and quality of life,[6-8] and has been associated with cardiovascular disease and metabolic abnormality.[9-14] These findings have led to daytime sleepiness receiving increasing attention as an important public health issue.[15]

The prevalence of EDS has ranged widely in many studies worldwide, from 2.5% to 26%.[2,9,12,13,15-27] This high variability is mainly due to the use of different tools to measure sleepiness and the different definitions of EDS. In population-based studies using the Epworth Sleepiness Scale (ESS), which is a well-validated survey instrument used to quantify daytime sleepiness, the prevalence of EDS is estimated to range between 9% and 26%.

Several studies performed in Western countries have determined the prevalence of EDS, but there have been few reports on the nationwide prevalence of EDS in Korea. Most previous epidemiologic studies have investigated the possible determinants of EDS in rela-

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Correspondence
Kwang Ik Yang, MD, PhD
Sleep Disorders Center, Department of Neurology, Soonchunhyang University College of Medicine, Cheonan Hospital, 31 Soonchunhyang 6-gil, Dongnam-gu, Cheonan 31151, Korea
Tel +82-41-570-2290
Fax +82-41-592-3810
E-mail neurofan@schmc.ac.kr

tion to sleep duration or insufficient sleep separately. Since the sleep need differs between individuals, the same duration of sleep will lead to sleep insufficiency in some individuals but not others.[28] For example, self-reported short sleepers may include individuals with no sleep insufficiency and others with sleep insufficiency who purposefully curtail their sleep even if they need more sleep. This makes it necessary to differentiate the effects of short sleep duration and unmet sleep need on EDS. However, few studies have evaluated the effects of both sleep duration and unmet sleep need on EDS.

The aim of this study was to determine the prevalence of EDS in Korean adults and identify the separate and combined associations of both habitual sleep duration and unmet sleep need with EDS.

METHODS

Study population and survey method

The participants in this study comprised adults aged 19 years and older who resided in South Korea. Detailed information regarding the study population and survey method is available elsewhere.[29] Briefly, the survey was conducted by Gallup Korea in 2010 using multistage clustered sampling and involved participants from 15 administrative districts (metropolitan and provincial areas); all administrative districts except Jeju Island (a province) were included. All administrative divisions were further divided into si, gun, or gu, which are the basic units of administrative districts in South Korea. Using the proportionate quota sampling method according to the population distributions of sex and age, Gallup Korea approached 7,615 individuals, of which 2,836 subjects completed this survey. Seventy-six trained interviewers conducted the face-to-face interviews. All of the respondents provided informed consent before the survey. We excluded 67 participants with missing questionnaire responses on smoking, alcohol consumption, exercise, education level, body mass index (BMI), occupation, Insomnia Severity Index (ISI), ESS score, and sleep habits; data from 2,769 participants were therefore used in the analyses. This study was approved by the Institutional Review Board of the Soonchunhyang University Cheonan Hospital.

Measurement of excessive daytime sleepiness

Daytime sleepiness was assessed using the ESS, which is a well-validated questionnaire consisting of eight items that quantify the likelihood of dozing in eight different situations.[1] The total ESS score ranges from 0 to 24, and daytime sleepiness was considered excessive in this study if the score was >10.

Sleep questionnaire

The main independent variables for this study were habitual sleep duration and unmet sleep need. The weekday and weekend average sleep durations of the participants over the previous month were recorded from their answers to a specific question in the questionnaire. Habitual sleep duration was defined as [(weekday sleep duration×5)+(weekend sleep duration×2)]/7. For sleep need, participants were asked "How much sleep do you need to be at your best during the day?" Unmet sleep need was calculated as the sleep need minus the habitual sleep duration. We used the ISI to measure the intensity of insomnia. The ISI is a brief self-report instrument consisting of seven items rated on a numeric scale from 0 to 4. Scores on the ISI may range from 0 to 28, and insomnia severity was classified as follows: 0−7, no clinically significant insomnia; 8−14, subthreshold insomnia; and 15−28, clinical insomnia.[30]

Other measures

Information on age, sex, height, weight, education level, physical activity, smoking, alcohol consumption, occupation, and snoring was self-reported. BMI was calculated by dividing the weight in kilograms by the square of the height in meters.

Statistical analysis

All of the statistical analyses were performed using STATA (version 11.0, StataCorp., College Station, TX, USA). Unadjusted differences in continuous and categorical variables between the EDS and non-EDS groups were assessed for significance using the *t*-test or the χ^2 test, as appropriate. We used logistic regression analyses to examine odds ratios (ORs) and 95% confidence intervals (CIs) of EDS scores associated with habitual sleep duration and unmet sleep need, separately and then together; this also included adjustment for relevant covariates. The statistical models were progressively adjusted. The covariates included in the model were age (continuous), sex, BMI (<18.5, 18.5−25, or ≥25 kg/m^2), smoking (yes or no), alcohol consumption (yes or no), physical activity (none, 1 or 2, or ≥3 times/week), education level (lower than high school, high school, or higher than high school), and ISI (normal, subthreshold insomnia, or clinical insomnia), and snoring (none, 1−3, or ≥4 days/week). A probability level of $p<0.05$ was considered statistically significant.

RESULTS

The sociodemographic and sleep-related characteristics in the participants with and without EDS are compared in Ta-

ble 1. The overall prevalence of EDS in the study population was 11.9% (95% CI, 10.7–13.2). Participants with EDS were older, more likely to have less than a high-school education, and had a higher BMI than those without EDS. The distributions of sex, smoking, alcohol consumption, and physical activity did not differ between those with and without EDS. In terms of sleep-related factors, participants with EDS had shorter sleep durations and a longer unmet sleep need compared with those without EDS. The prevalence of insomnia and frequent snoring was higher among participants with EDS than among those without EDS.

The prevalence rates of EDS according to sociodemographic and sleep-related characteristics are presented in Table 2. Of all the subjects, 883 (31.9%) reported not getting at least 7 hours of sleep. An unmet sleep need of >0 hours was present in 835 (30.2%) of the participants. The prevalence of EDS increased with age, and was significantly higher in those aged 60–69 years (15.5%) than in those aged 19–29 years (9.7%). The prevalence rates of EDS were 15.9% and 16.3% in the underweight and overweight groups, respectively, and these were both significantly higher than that in the normal-weight group (10.2%). The prevalence of EDS among those with less than a high-school education was 15.2%, which was significantly higher than those in the groups with a high-school and a higher level of education. The prevalence of EDS was 33.6% in the clinical insomnia group and 22.4% in the subclinical insomnia group; these were significantly higher than that in the normal group (9.1%). The prevalence of EDS was 18.1% in habitual snorers (snoring ≥4 days/week), which was significantly higher than in those who did not snore (10.6%). The prevalence of EDS was 15.8% in the group with sleep durations of <6 hours and 14.4% in the group with sleep durations of 6 to 7 hours, which was significantly higher than that in the group with sleep durations of ≥8 hours (9.4%). The prevalence of EDS was 19.6% in the group with an unmet sleep need of ≥2 hours, and 15.4% in the group with an unmet sleep need of 0.01 to 2 hours; these were significantly higher than that in the group with a sufficient sleep duration (9.5%).

Logistic regression analyses were performed to assess the

Table 1. Baseline characteristics of study participants

	EDS	Non-EDS	*p*-value*
Number of subjects (%)	330 (11.9)	2439 (88.1)	
Age (years)	46.7±15.4	44.1±15.0	0.003
Sex, women (%)	50.0	50.1	0.983
Body mass index (kg/m^2)	23.7±3.3	22.9±2.9	<0.001
Smoking (%)	26.7	27.0	0.905
Drinking (%)	62.4	65.5	0.275
Physical activity (times/week, %)			0.131
None	57.9	52.1	
1–2	19.1	20.8	
≥3	23.0	27.1	
Education leves (%)			0.043
Lower than high school	23.0	17.4	
High school	41.5	44.0	
Higher than high school	35.5	38.6	
ESS score	13.1±2.3	4.6±3.0	<0.001
Sleep duration (hours/day)	7.1±1.5	7.3±1.2	0.004
Unmet sleep need (hours/day)	1.0±1.4	0.5±1.0	<0.001
Insomnia (%)			<0.001
Normal	63.3	85.4	
Subthreshold insomnia	23.7	11.1	
Clinical insomnia	13.0	3.5	
Snoring			<0.001
None	54.5	62.1	
1–3 days/wk	17.3	20.7	
≥4 days/wk	28.2	17.2	

Data are presented as mean±standard deviation or percentage.
*Significance tests for the difference between 2 groups are based on the χ^2 test for categorical variables and on the *t*-test for continuous variables.
EDS: excessive daytime sleepiness, ESS: Epworth Sleepiness Scale.

Table 2. Prevalence and unadjusted odds ratios (95% CI) of excessive daytime sleepiness according to socio-demographic and sleep-related variables

Variables	Categories	*n*	Prevalence % (95% CI)	Unadjusted OR (95% CI)
Age (years)	19–29	536	9.7 (7.3–12.5)	1.00 (reference)
	30–39	593	11.8 (9.3–14.7)	1.25 (0.85–1.82)
	40–49	593	9.9 (7.7–12.6)	1.03 (0.69–1.52)
	50–59	514	12.8 (10.1–16.0)	1.37 (0.93–2.02)
	60–69	459	15.5 (12.3–19.1)	1.70 (1.16–2.50)
	≥70	74	16.2 (8.7–26.6)	1.80 (0.91–3.56)
Sex	Female	1386	11.9 (10.2–13.7)	1.00 (reference)
	Male	1383	11.9 (10.3–13.8)	1.00 (0.80–1.26)
Body mass index (kg/m^2)	<18.5	126	15.9 (10.0–23.4)	1.65 (1.01–2.72)
	18.5–25	1991	10.2 (8.9–11.7)	1.00 (reference)
	≥25	652	16.3 (13.5–19.3)	1.70 (1.32–2.19)
Smoking	No	2023	12.0 (10.6–13.5)	1.00 (reference)
	Yes	746	11.8 (9.6–14.3)	0.98 (0.76–1.28)
Drinking	No	966	12.8 (10.8–15.1)	1.00 (reference)
	Yes	1803	11.4 (10.0–13.0)	0.88 (0.69–1.11)
Physical activity (times/week)	None	1462	13.1 (11.4–14.9)	1.00 (reference)
	1–2	569	11.1 (8.6–13.9)	0.83 (0.61–1.12)
	≥3	738	10.3 (8.2–12.7)	0.76 (0.58–1.01)
Education levels	<High school	500	15.2 (12.2–18.7)	1.00 (reference)
	=High school	1210	11.3 (9.6–13.2)	0.71 (0.53–0.96)
	>High school	1059	11.0 (9.2–13.1)	0.69 (0.51–0.95)
Insomnia	Normal	2293	9.1 (8.0–10.4)	1.00 (reference)
	Subthreshold insomnia	348	22.4 (18.1–27.2)	2.88 (2.16–3.85)
	Clinical insomnia	128	33.6 (25.5–42.5)	5.04 (3.40–7.48)
Snoring (days/week)	None	1695	10.6 (9.2–12.2)	1.00 (reference)
	1–3	561	10.2 (7.8–13.0)	0.95 (0.70–1.30)
	≥4	513	18.1 (14.9–21.7)	1.86 (1.42–2.45)
Sleep duration (hours/day)	<6	291	15.8 (11.8–20.5)	1.80 (1.23–2.64)
	6 to <7	592	14.4 (11.6–17.4)	1.61 (1.17–2.21)
	7 to <8	965	11.6 (9.7–13.8)	1.26 (0.94–1.69)
	≥8	921	9.4 (7.6–11.5)	1.00 (reference)
Unmet sleep need (hours/day)	0	1934	9.5 (8.2–10.9)	1.00 (reference)
	0.01 to <2	421	15.4 (12.1–19.3)	1.74 (1.28–2.36)
	≥2	414	19.6 (15.9–23.7)	2.31 (1.74–3.08)

associations of sleep duration and unmet sleep need with EDS, separately and then together, while adjusting for age, sex, BMI, smoking status, alcohol consumption, physical activity, and education level. Additionally, we progressively adjusted for insomnia and snoring (Table 3). The adjusted OR for EDS was significantly higher in subjects with a sleep duration of <6 hours a night (OR, 1.79; 95% CI, 1.21–2.64) and subjects with a sleep duration of 6 to 7 hours a night (OR, 1.62; 95% CI, 1.17–2.23) than in those with a sleep duration of ≥8 hours a night. The adjusted OR for EDS was significantly higher in subjects with an unmet sleep need of ≥2 hours (OR, 2.41; 95% CI, 1.80–3.23) and subjects with an unmet sleep need of 0.01 to 2 hours (OR, 1.87; 95% CI, 1.37–2.55) than in those with no unmet sleep need. The combination effect of sleep duration and unmet sleep need was then evaluated, which resulted in the association between sleep duration and EDS no longer being statistically significant. In contrast, there was a significantly higher risk of EDS in the groups with unmet sleep needs of ≥2 hours (OR, 2.32; 95% CI, 1.66–3.23) and 0.01 to 2 hours (OR, 1.79; 95% CI, 1.30–2.47). This trend persisted after also adjusting for insomnia and snoring, although the ORs for EDS were reduced to 1.80 (95% CI, 1.27–2.54) and 1.42 (95% CI, 1.02–1.98), respectively.

DISCUSSION

This study investigated the prevalence of EDS (defined as an ESS score of >10) according to sociodemographic fac-

Table 3. Odds ratios (95% confidence intervals) for excessive daytime sleepiness (ESS >10)

Characteristics	Model 1a*	Model 2*	Model 3†	Model 4†
Sleep duration (hours/day)				
<6	1.79 (1.21–2.64)		1.12 (0.72–1.73)	0.89 (0.56–1.40)
6 to <7	1.62 (1.17–2.23)		1.22 (0.87–1.72)	1.21 (0.85–1.72)
7 to <8	1.32 (0.98–1.77)		1.19 (0.88–1.61)	1.23 (0.91–1.68)
≥8	1.00 (reference)		1.00 (reference)	1.00 (reference)
Unmet sleep need (hours/day, vs. none)		1.00 (reference)	1.00 (reference)	1.00 (reference)
0.01–1.99		1.87 (1.37, 2.55)	1.79 (1.30, 2.47)	1.42 (1.02–1.98)
≥2		2.41 (1.80, 3.23)	2.32 (1.66, 3.23)	1.80 (1.27–2.54)
Insomnia (vs. normal)				1.00 (reference)
Subthreshold insomnia				2.61 (1.93–3.55)
Clinical insomnia				3.88 (2.52–5.96)
Snoring (days/wk, vs. none)				1.00 (reference)
1–3				0.89 (0.64–1.24)
≥4				1.45 (1.08–1.96)

*Model 1 & 2, adjusted for age, sex, BMI, smoking status, drinking, physical activity and education level, †Model 3, adjusted for the variables in model 1 plus unmet sleep need, †Model 4, adjusted for the variables in model 3 plus insomnia and snoring.
BMI: body mass index, ESS: Epworth Sleepiness Scale.

tors, and evaluated the association between sleep duration and/or unmet sleep need and EDS in a population of Korean adults. We found that the prevalence of EDS was 11.9% among both male and female Korean adults. Several studies have estimated the prevalence of EDS using the ESS in general populations. Studies involving Australian adults found that the prevalence of EDS ranged from 11.7% to 15.3%.[2,12,25] In French adults, 12.0% of men and 6.0% of women reportedly had EDS.[24] A previous Korean study using data from the Korean Genome Epidemiology Study found that the prevalence of EDS was 12.2%.[26] Another study found that the prevalence of EDS in Norwegian adults was 17.7%.[23] In the Sleep Heart Health Study, 29.7% of men and 20.8% of women had an ESS score of >10.[20] In the MONICA Study, 26.1% of a Polish population suffered from EDS.[18] The overall prevalence of EDS in the present study is similar to those found in Australia, New Zealand, and France, but lower than those in the US and Poland. These differences between studies may be caused by various factors, including differences in study methodologies and in the sociocultural and other characteristics of the included populations.

We found that the prevalence of EDS did not differ between the sexes. Although sex-based differences have been found in community-based studies,[20,31] several population-based studies produced conflicting findings.[13,32] This inconsistency may be due to differences in sampling methods leading to different sex ratios in the populations included in the different studies, or in the questionnaires used to measure daytime sleepiness, since men and women can interpret questions differently. Unadjusted analysis showed that the factors associated with EDS in the present study were older age, higher BMI, lower level of education, frequent snoring, and insomnia. Older people (aged 60–69 years) had a higher prevalence of EDS compared with younger people (aged 19–29 years) in our study, which may be attributed to the presence of underlying medical or sleep disorders and the different lifestyle of the elderly. Many older adults are not able to get sufficient sleep for various reasons, including conditions associated with depression, poor general health, physical inactivity, medical illness, and the use of numerous medications.[33,34] The prevalence of certain primary sleep disorders (e.g., sleep-disordered breathing, restless legs syndrome, and REM behavior disorder) increases with age and interferes with sleep, leading to daytime sleepiness. Obesity is known to be a risk factor for obstructive sleep apnea (OSA)[35,36] and a significant predictor of EDS, independent of underlying OSA.[37] Previous studies have found lower socioeconomic status (including the education level) to be associated with worse sleeping patterns.[38,39] The present study found that EDS was associated with a lower level of education, which tends to be present in older Koreans, like in many other societies. A better characterization of the factors associated with a higher prevalence of EDS among people with lower levels of education is needed. EDS is the most frequent presenting symptom in subjects with OSA syndrome.[40,41] Although we did not perform polysomnography, the presence of snoring as a symptom of OSA might be correlated with EDS. Insomnia is a subjective symptom of insufficient or nonrestorative sleep despite there being an adequate opportunity to sleep, resulting in sleepiness during the daytime. We used the ISI but could not define primary insomnia and could not exclude co-morbidities of insomnia; nevertheless,

it is well known that EDS is caused by insufficient sleep, and various types of sleep problems are linked to poor sleep quality, insomnia, misalignments of circadian rhythm (e.g., jet lag or shift work) and sleep-enhancing drugs.[17,19,27,42,43]

Unmet sleep need, insomnia, and snoring were significantly associated with an increased risk of EDS in the present study after adjusting for sociodemographic factors. These results are similar to those of previous studies.[16-19,21,22,24-27,44] We attempted to elucidate whether EDS is directly linked to sleep duration or unmet sleep need. When sleep duration and unmet sleep need were examined separately, significant associations were found with EDS, but when sleep duration and unmet sleep need were examined together, unmet sleep need alone accounted for the risk of EDS, with the association between sleep duration and EDS disappearing. This result did not change after performing additional adjustments for insomnia and snoring. In short, unmet sleep need is independently associated with EDS, suggesting that sleep duration is not directly linked to the risk of EDS. These results suggest that measuring unmet sleep need would be a more direct way of detecting EDS than measuring the habitual sleep duration, since the basal sleep requirement for preventing daytime sleepiness may differ between natural short sleepers and natural long sleepers, and it is necessary to differentiate between short-duration sleepers with a decreased basal sleep need and those experiencing insufficient sleep.[28,45]

Our study had several limitations that should be noted. First, the information on sleep duration was self-reported by the participants. However, previous studies have found adequate agreement between self-reported sleep durations and data obtained using actigraphic monitoring.[46,47] Thus, although self-administered questionnaires are not as accurate as actigraphy or polysomnography, they are widely used in population-based studies due to the method being rapid and simple to apply. Second, insufficient sleep may be influenced by subjectively perceived normative standards. For example, socioeconomic status and other factors may affect how subjects answer questions, thereby potentially introducing information bias.[48] Third, due to a survey limitation, we could not evaluate the presence of underlying primary sleep disorders such as OSA. Finally, this study had a cross-sectional design, and so causal relationships could not be elucidated.

Our study has revealed the prevalence of EDS using ESS in a general population of Korean adults. According to our results, 11.9% of Korean adults have EDS. When sleep duration and unmet sleep need were examined together, only the effect of unmet sleep need was associated with EDS. EDS was associated with unmet sleep need, insomnia, snoring, and BMI after adjusting for sociodemographic factors. We suggest that the unmet sleep need of an individual is more important than the habitual sleep duration in terms of the relationship with EDS.

Conflicts of Interest

The authors have no financial conflicts of interest.

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