Association Between Sleep Pattern and Depression in South Korean Adults: Sleep Duration and Sleep Inconsistency Between Weekdays and Weekends

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Abstract

Objectives

This study aimed to understand the relationship between sleep duration, inconsistency between weekdays and weekends and depression.

Methods

A total of 10,205 participants were included in the 2016 and 2018 Korea National Health and Nutrition Examination Survey. Sleep duration over a week was calculated by averaging sleep durations on weekdays and weekends. Sleep duration ratio was defined as sleep duration on weekends divided by that on weekdays and depression as Patient Health Questionnaire scores higher than 5. We stratified the participants by sex and analyzed using multiple logistic regression.

Results

In men, those who slept more than 9 hours was compared to those who slept between 7 and 7.9 hours. In women, those who slept less than 5.9 hours related to be more depressed. In men who slept for more than 9 hours and over 1.01 times more on weekends than on weekdays showed the highest chance of depression. In women, the highest odds ratio was associated with those who slept less than 5.9 hours and slept more on weekdays than on weekends.

Conclusions

In men, sleep durations that were too short or long were associated with depression. In women, extremely short sleep durations were associated with depression.

Introduction

Depression is one of the most common mental health disorders, with more than 264 million individuals suffering from depression worldwide [1]. According to the World Health Organization, depression is the leading cause of disability and suicide [2]. Several studies have reported an association between depression and suicide. Approximately half of those who commit suicide have depression, and up to 15% of individuals with depression are likely to die from it [3]. In addition, depression is known to have negative impacts on role functioning, quality of life, and physical health [4].

South Korea is no exception. Due to unprecedented economic growth and changes in social values over the last 50 years, the mental state of many South Koreans has not been healthy [5]. The prevalence of depression in South Korea has gradually increased from 4.0% in 2001 to 5.6% in 2006 and 6.7% in 2011 according to a quinquennial epidemiological study [6, 7]. In terms of suicide mortality rate, South Korea ranked in second place among Organization for Economic Co-operation and Development (OECD) countries in 2016 [8].

Depression is a complex mental disorder that is influenced by genetic factors, lifestyle factors, and the interactions between them [9–11]. Of these, sleep is one of the most important lifestyle factors that affect depression [12]. Consequently, several studies have aimed to understand the role of sleep in the incidence of depression. For example, chronic insomnia has been shown to increase the risk of major depressive disorder (MDD), and residual sleep disorders to predict depression relapse [13]. However, the results of previous studies remain controversial. While one cohort study concluded that the relationship between short sleep duration and depression is statistically significant [14], another prospective study concluded that it is not [15]. Therefore, the primary objective of this study was to clarify the relationship between sleep duration and depression, which has been established in previous studies, in Korean adults.

Methods

Study sample

The study used the 2016 and 2018 Korean National Health and Nutrition Examination Survey (KNHANES) data. The 2017 survey data that did not include the Patient Health Questionnaire (PHQ-9) were excluded. The KNHANES is a cross-sectional survey that consists of health interviews, health examinations, and nutritional surveys performed annually since 2007 by medical staff and dietitians of the Korean Centers for Disease Control and Prevention to measure the health status, health behaviors, and nutritional intake of people living in South Korea. The KNHANES also aims to provide valid statistics for establishing health policies and evaluating their effects. The KNHANES uses a complex, multistage, and stratified sampling strategy to reliably represent the non-institutionalized civilian population aged 1 year or more. Among the 16,142 individuals who took part in the 2016 and 2018 KNHANES, participants whose answers were incomplete, whose data were missing, or who were aged less than 19 years were excluded. In total, 10,205 eligible participants were included for statistical analysis.

Variables

Sleep duration

The variable of interest was sleep duration. The KNHANES provides information on average sleep duration, calculated over one week, based on surveyed bedtime and wake-up time. The average sleep duration during a week was calculated by averaging sleep durations on weekdays and weekends with different weighting (5/7 for average sleep duration on weekdays and 2/7 for average sleep duration on a weekend). After calculating weekly average sleep duration, we created five categories one hour apart (less than 5.9 hours, 6 to 6.9 hours, 7 to 7.9 hours, 8 to 8.9 hours and more than 9 hours).

The sleep duration ratio was calculated by dividing the average sleep duration on a weekend with the average sleep duration on weekdays. This indicates a balance of sleep duration between weekends and weekdays. Therefore, a ratio of 1.00 means that sleep duration during the week and weekend were the same. If it was greater than 1.00 then the participant slept more on weekend. On the other hand, if it was below the 1.00 then they slept more on weekday.

Depression: Patient Health Questionnaire – 9 (PHQ-9)

The feeling of depression was our primary outcome. Depression was broadly defined as a PHQ-9 score higher than 5. The PHQ-9, which consists of nine items corresponding to the actual criteria of DSM-4 for depression diagnosis, is a self-administered diagnostic tool for screening depression and other mental disorders in primary care and other medical settings [16–20]. Each item of the PHQ-9 allows individuals to grade how often they felt disrupted during the past two weeks from 0 (not at all) to 3 (nearly every day). The PHQ-9 is more valid, sensitive, and specific than the PRIME-MD, which is a traditional clinician-administered tool; PHQ-9 is now commonly used in both clinical and research settings [21]. While a PHQ-9 score lower than 4 indicates that no depressive symptoms were observed and, thus, treatment is not indicated, potential depression patients with mild depressive symptoms, characterized by a PHQ-9 score higher than 5, may benefit from completing the PHQ-9 again. The other covariates in this study were socioeconomic factors, such as sex, age, region, education level, job, household income, marital status, and health-related factors, such as smoking, drinking, body mass index (BMI), physical activity, and stress.

Statistical analyses

The rate of depression is consistently higher in females than in males [22, 23]. Women are at a greater risk of being diagnosed with depression in their lifetime than are men [23]. Therefore, we stratified participants by sex because it was most likely a confounding variable. Multiple logistic regression modeling was performed with SAS software (version 9.4) to determine the association between sleep duration or sleep duration ratio (variable of interest) and depressive state (the dependent variable) while controlling for other covariates.

Results

Table 1 shows the general characteristics of the study participants. The total number of participants in this study was 10,205. There were 4,737 men and 5,468 women. There were 1,243 (12.2%) participants who on an average slept for less than 5.9 hours per day, 2,511 (24.6%) who slept between 6 and 6.9 hours, 3,454 (33.8%) who slept between 7 and 7.9 hours, 2,110 (20.7%) who slept between 8 and 8.9 hours, and 887 (8.7%) who slept more than 9 hours per day. Regarding the sleep duration ratio, 945 (9.3%) participants had values less than 0.99, 4,873 (47.8%) at 1.0, and 4,387 (43.0%) more than 1.01. There were 657 (13.9%) men and 1,270 (23.2%) women with depression.

Table 1
General characteristics of the study participants

Variables	Depression (PHQ-9 >= 5)											
	Male (n = 4737)								Female (n = 5468)			
	TOTAL		YES		NO		P		YES		NO	
	N	%	N	%	N	%			N	%	N	%
Total	10,205	100.0	657	13.9	4,080	86.1			1,270	23.2	4,198	76.8
Sleep Duration (Hours)							< .0001					< .0001
~ 5.9	1,243	12.2	109	19.5	449	80.5			232	33.9	453	66.1
6 ~ 6.9	2,511	24.6	159	13.2	1,043	86.8			269	20.6	1,040	79.4
7 ~ 7.9	3,454	33.8	194	11.8	1,455	88.2			398	22.0	1,407	78.0
8 ~ 8.9	2,110	20.7	113	12.2	813	87.8			241	20.4	943	79.6
9 ~	887	8.7	82	20.4	320	79.6			130	26.8	355	73.2
Sleep Duration ratio (weekend/weekday)							0.0506					< .0001
~ 0.99	945	9.3	66	15.9	348	84.1			129	24.3	402	75.7
1	4,873	47.8	332	13.7	2,089	86.3			619	25.2	1,833	74.8
1.01 ~	4,387	43.0	259	15.8	1,643	84.2			522	21.0	1,963	79.0
Age							0.1851					< .0001
20 ~ 29	1,243	12.2	86	15.4	471	84.6			235	34.3	451	65.7
30 ~ 39	1,859	18.2	128	15.6	694	84.4			250	24.1	787	75.9
40 ~ 49	2,050	20.1	124	13.8	772	86.2			214	18.5	940	81.5
50 ~ 59	1,957	19.2	109	12.7	747	87.3			219	19.9	882	80.1
60 ~ 69	1,701	16.7	100	11.8	750	88.2			187	22.0	664	78.0
70 ~	1,395	13.7	110	14.6	646	85.4			165	25.8	474	74.2
Region							0.0654					0.525
Metropolitans	4,862	47.6	332	14.8	1,904	85.2			600	22.8	2,026	77.2
Rurals	5,343	52.4	325	13.0	2,176	87.0			670	23.6	2,172	76.4
Educational level							0.0052					0.002
Under highschool	6,143	60.2	413	15.1	2,328	84.9			837	24.6	2,565	75.4
College	4,062	39.8	244	12.2	1,752	87.8			433	21.0	1,633	79.0
Job							< .0001					< .0001
White	2,721	26.7	164	11.5	1,260	88.5			254	19.6	1,043	80.4
Pink	1,460	14.3	93	17.7	433	82.3			200	21.4	734	78.6
Blue	2,347	23.0	191	12.2	1,377	87.8			153	19.6	626	80.4
None	3,677	36.0	209	17.1	1,010	82.9			663	27.0	1,795	73.0
Household income							< .0001					< .0001
High	3,123	30.6	156	10.6	1,309	89.4			285	17.2	1,373	82.8
Middle high	2,895	28.4	158	11.6	1,200	88.4			348	22.6	1,189	77.4
Middle low	2,491	24.4	181	15.8	964	84.2			329	24.4	1,017	75.6
Low	1,696	16.6	162	21.1	607	78.9			308	33.2	619	66.8
Marriage							< .0001					< .0001
Yes	7,257	71.1	407	11.6	3,087	88.4			731	19.4	3,032	80.6
No	2,948	28.9	250	20.1	993	79.9			539	31.6	1,166	68.4

Variables	Depression (PHQ-9 ≥ 5)											
	Male (n = 4737)								Female (n = 5468)			
	TOTAL		YES		NO		P	YES		NO		
	N	%	N	%	N	%		N	%	N	%	
Smoke	0.0442											< .0001
Yes	4,431	43.4	536	14.4	3,187	85.6		299	42.2	409	57.8	
No	5,774	56.6	121	11.9	893	88.1		971	20.4	3,789	79.6	
Drink	0.4018											0.0001
2 ~ 4 times / week	2,552	25.0	249	14.1	1,519	85.9		228	29.1	556	70.9	
2 ~ 4 times / month	2,557	25.1	166	12.8	1,131	87.2		291	23.1	969	76.9	
Never or occasionally	5,096	49.9	242	14.5	1,430	85.5		751	21.9	2,673	78.1	
BMI†	0.6075											0.2846
Obese(≥ 25)	3,532	34.6	278	14.2	1,683	85.8		380	24.2	1,191	75.8	
Normal or under-weight(< 25)	6,673	65.4	379	13.7	2,397	86.3		890	22.8	3,007	77.2	
Physical activity	0.1757											0.8939
Yes	3,922	38.4	291	13.1	1,923	86.9		534	31.3	1,174	68.7	
No	5,683	55.7	366	14.5	2,157	85.5		736	23.3	2,424	76.7	
Stress	< .0001											< .0001
Lot	2,740	26.8	374	32.9	762	67.1		782	48.8	822	51.2	
Little	7,465	73.2	283	7.9	3,318	92.1		488	12.6	3,376	87.4	
BMI body mass index												
†Obesity status defined by BMI based on 2014 Clinical Practice Guidelines for Overweight and Obesity in Korea												

Table 2 shows the odd ratio results of multiple logistic regression model between depression and sleep duration or sleep duration ratio when other covariates were controlled. For men, the odds ratio among those with sleep duration less than 5.9 hours per day (Odds Ratio [OR] = 1.32, 95% confidence interval [CI] = 0.94–1.87) was much higher, and the odds ratio among those with sleep duration between 6 and 6.9 hours per day (OR = 1.04, 95% CI = 0.77–1.40) was slightly higher than that of men who slept between 7 and 7.9 hours per day (reference group). Additionally, the odds ratio for men with sleep duration of more than 9 hours per day (OR = 1.51, 95% CI = 1.01–2.26) was much higher and the odds ratio for those with sleep duration between 6 and 6.9 hours per day (OR = 1.02, 95% CI = 0.74–1.40) was slightly higher than that of those with sleep duration between 7 and 7.9 hours per day. Thus, the odds ratios were associated with sleep duration in a U-shaped, that is, both shorter and longer sleep durations resulted in higher odds ratios in men. In women, the odds ratios among those with sleep duration less than 5.9 hours per day (OR = 1.60, 95% CI = 1.23–2.08) and more than 9 hours per day (OR = 1.26, 95% CI = 0.94–1.70) were higher than that among those with sleep duration between 7 and 7.9 hours per day. The odds ratio among men with high stress (OR = 6.67, 95% CI = 5.38–8.26) was significantly higher than that among men with low stress (reference group). The odds ratio of women with high stress (OR = 5.84, 95% CI = 5.01–6.82) was also significantly higher than that of women with low stress. Similar results in men and women increase the credibility of this finding. Other covariates such as age, job, household income, marriage, and smoking also showed statistical significance.

Table 2
Multiple logistic regression analysis of depression

Variables	Depression (PHQ-9 >= 5)											
	Male					Female						
	OR	95% CI				OR	95%CI					
Sleep Duration (Hours)												
~ 5.9	1.32	(	0.94	-	1.87	)	1.60	(	1.23	-	2.08	)
6 ~ 6.9	1.04	(	0.77	-	1.40	)	0.98	(	0.79	-	1.22	)
7 ~ 7.9	1.00						1.00					
8 ~ 8.9	1.02	(	0.74	-	1.40	)	0.96	(	0.77	-	1.19	)
9 ~	1.51	(	1.01	-	2.26	)	1.26	(	0.94	-	1.70	)
Sleep Duration ratio (weekend/weekday)												
~ 0.99	1.29	(	0.88	-	1.89	)	0.96	(	0.71	-	1.30	)
1	1.00						1.00					
1.01 ~	0.98	(	0.88	-	1.13	)	0.88	(	0.68	-	0.99	)
Age												
20 ~ 29	1.00						1.00					
30 ~ 39	1.73	(	1.15	-	2.62	)	0.82	(	0.60	-	1.12	)
40 ~ 49	1.98	(	1.26	-	3.10	)	0.73	(	0.53	-	0.99	)
50 ~ 59	1.72	(	1.09	-	2.71	)	0.93	(	0.68	-	1.28	)
60 ~ 69	1.53	(	0.96	-	2.44	)	0.84	(	0.58	-	1.21	)
70 ~	1.58	(	0.95	-	2.63	)	0.68	(	0.46	-	1.03	)
Region												
Metropolitans	1.00						1.00					
Rurals	0.86	(	0.69	-	1.06	)	1.01	(	0.84	-	1.21	)
Educational level												
Under highschool	1.00						1.00					
College	1.04	(	0.81	-	1.34	)	0.95	(	0.77	-	1.18	)
Job												
White	1.00						1.00					
Pink	1.62	(	1.16	-	2.28	)	0.98	(	0.73	-	1.32	)
Blue	1.16	(	0.84	-	1.62	)	1.04	(	0.76	-	1.42	)
None	1.51	(	1.06	-	2.15	)	1.63	(	1.29	-	2.06	)
Household income												
High	1.00						1.00					
Middle high	0.99	(	0.73	-	1.35	)	1.29	(	1.02	-	1.61	)
Middle low	1.45	(	1.07	-	1.97	)	1.33	(	1.06	-	1.67	)
Low	2.01	(	1.37	-	2.94	)	1.89	(	1.40	-	2.57	)
Marriage												
Yes	1.00						1.00					
No	2.16	(	1.68	-	2.78	)	1.63	(	1.34	-	1.98	)
Smoke												
Yes	1.22	(	0.89	-	1.68	)	2.03	(	1.62	-	2.54	)
BMI, body mass index; CI, confidence interval; OR, odds ratio; PHQ-9, Patient Health Questionnaire												

Variables	Depression (PHQ-9 ≥ 5)				
	Male			Female	
	OR	95% CI		OR	95%CI
No	1.00			1.00	
Drink					
2 ~ 4 times / week	0.90	(0.69 - 1.17)		1.23	(0.97 - 1.56)
2 ~ 4 times / month	0.92	(0.70 - 1.21)		1.10	(0.88 - 1.36)
Never or occasionally	1.00			1.00	
BMI†					
Obese(≥ 25)	1.07	(0.86 - 1.34)		0.97	(0.80 - 1.16)
Normal or under-weight(< 25)	1.00			1.00	
Physical activity					
Yes	1.00			1.00	
No	1.03	(0.85 - 1.25)		0.94	(0.78 - 1.13)
Stress					
Lot	6.67	(5.38 - 8.26)		5.84	(5.01 - 6.82)
Little	1.00			1.00	
BMI, body mass index; CI, confidence interval; OR, odds ratio; PHQ-9, Patient Health Questionnaire					

Table 3 shows the results of the subgroup analysis by covariates for the sleep duration ratio in men and women. In men who slept more than 9 hours per day on average, the odds ratio was slightly higher in the group with a sleep duration ratio of 1.00 (OR = 1.45, 95% CI = 0.82–2.57) and much higher in the group with a sleep duration ratio of over 1.01 (OR = 2.33, 95% CI = 1.08–5.03) than in the group with a sleep duration ratio less than 0.99 (OR = 1.37, 95% CI = 0.47–4.04). Among women who slept more than 9 hours per day on average, the odds ratio was slightly higher in the group with a sleep duration ratio of 1.00 (OR = 1.74, 95% CI = 1.21–2.51) and much higher in the group with a sleep duration ratio less than 0.99 (OR = 4.94, 95% CI = 1.98–12.37) than in the group with a sleep duration ratio over 1.01 (OR = 0.87, 95% CI = 0.34–2.21).

Table 3
Subgroup analysis of depression

Variables	~ 5.9 Hours		6 ~ 6.9 Hours				7 ~ 7.9 Hours	8 ~ 8.9 Hours		
	OR	95% CI		OR	95%CI		OR	OR	95%CI	
Male										
Sleep Duration ratio (weekend/weekday)										
~ 0.99	0.80	(0.25 - 2.58)		1.30	(0.53 - 3.16)		1.00	1.25	(0.39 - 4.05)	
1	1.87	(1.15 - 3.05)		1.17	(0.75 - 1.84)		1.00	0.94	(0.61 - 1.45)	
1.01 ~	0.93	(0.66 - 1.70)		0.83	(0.51 - 1.48)		1.00	1.33	(0.83 - 2.21)	
Drink										
2 ~ 4 times / week	1.82	(1.04 - 3.19)		1.02	(0.61 - 1.70)		1.00	1.34	(0.81 - 2.23)	
2 ~ 4 times / month	1.56	(0.82 - 2.95)		1.19	(0.66 - 2.13)		1.00	1.30	(0.71 - 2.38)	
Never or occasionally	1.00	(0.58 - 1.72)		1.13	(0.73 - 1.74)		1.00	0.64	(0.36 - 1.14)	
BMI†										
Obese(≥ 25)	1.02	(0.59 - 1.76)		1.14	(0.73 - 1.80)		1.00	0.87	(0.51 - 1.47)	
Normal or under-weight(< 25)	1.71	(1.11 - 2.63)		1.08	(0.73 - 1.60)		1.00	1.24	(0.82 - 1.88)	
Physical activity										
Yes	1.29	(0.83 - 2.01)		1.04	(0.69 - 1.58)		1.00	0.96	(0.63 - 1.46)	
No	1.50	(0.91 - 2.48)		1.13	(0.76 - 1.70)		1.00	1.11	(0.70 - 1.74)	
Female										
Sleep Duration ratio (weekend/weekday)										
~ 0.99	4.94	(1.98 - 12.37)		2.34	(1.08 - 5.07)		1.00	0.90	(0.40 - 2.00)	
1	1.74	(1.21 - 2.51)		0.91	(0.65 - 1.29)		1.00	1.07	(0.76 - 1.48)	
1.01 ~	0.99	(0.74 - 1.51)		0.90	(0.61 - 1.37)		1.00	0.94	(0.72 - 1.46)	
Drink										
2 ~ 4 times / week	2.00	(1.08 - 3.69)		0.87	(0.49 - 1.55)		1.00	1.69	(0.98 - 2.93)	
2 ~ 4 times / month	2.45	(1.32 - 4.54)		0.92	(0.55 - 1.52)		1.00	0.89	(0.57 - 1.38)	
Never or occasionally	1.30	(0.95 - 1.76)		1.05	(0.79 - 1.41)		1.00	0.82	(0.61 - 1.09)	
BMI†										
Obese(≥ 25)	1.59	(0.98 - 2.56)		1.04	(0.69 - 1.57)		1.00	1.04	(0.69 - 1.57)	
Normal or under-weight(< 25)	1.62	(1.19 - 2.21)		0.98	(0.75 - 1.28)		1.00	0.82	(0.63 - 1.07)	
Physical activity										
Yes	1.86	(1.23 - 2.82)		1.03	(0.73 - 1.46)		1.00	1.17	(0.83 - 1.65)	
No	1.39	(0.98 - 1.98)		0.92	(0.68 - 1.24)		1.00	0.79	(0.58 - 1.07)	
BMI, body mass index, CI, confidence interval, OR, odds ratio										

Among men who slept less than 5.9 hours per day on average, the odds ratio was the highest in the group that consumed alcohol between 2 and 4 times per week (OR = 1.82, 95% CI = 1.04–3.19), followed by the group that drank between 2 and 4 times per month (OR = 1.56, 95% CI = 0.82–2.95), and the lowest in the group that drank between 2 and 4 times per week (OR = 1.00, 95% CI = 0.58–1.72), compared to those who slept between 7 and 7.9 hours per day (reference group). Moreover, for men who slept for more than 9 hours per day, the odds ratio was higher in the group with no physical activity (OR = 1.65, 95% CI = 0.97–2.79) than in the physically active group (OR = 1.44, 95% CI = 0.78–2.68), and it was higher in the obese group (OR = 1.82, 95% CI = 1.03–3.23) than in the group that had a normal weight or was underweight (OR = 1.41, 95% CI = 0.78–2.54), compared to those who slept between 7 and 7.9 hours per day on average.

Discussion

The purpose of this study was to investigate the association between sleep duration and depressive status in Korean adults. The results indicate that the odds ratios of depression among Korean adults varied depending on their sleep duration. Sleep duration of less than 5.9 hours per day and sleep duration longer than 9 hours per day were highly associated with a depressive state. The relationship between sleep duration and the rate of depression was more apparent in men than in women. This result concurred with previous findings that indicated that both short and long sleep durations increased the risk of depression among adults who participated in seven prospective studies [24]. Short sleep durations seem to negatively affect one's depressive state by increasing daytime tiredness [27], which predicts the risk of depression [25]. Daytime tiredness, which includes sleepiness and fatigue, increases negative events and negative emotional states that predispose individuals to depression [26].

Findings from the subgroup analysis on the sleep duration ratio of those who slept more on weekends than on weekdays showed a higher odds ratio of depression in men who slept more than 9 hours per day on average. This indicates that both excessive sleeping time and irregular weekend-centered sleeping patterns increase the risk of depression. Although the variation of sleep duration on weekdays and weekends was associated with depressive symptoms in South Korean workers, the direction of this association has not been clarified before [27]. In contrast, we found that sleeping more on weekends was associated with a lower risk of depression in women who slept less than 5.9 hours per day on average. This indicates that catching up on sleep during a weekend and having enough sleeping on a weekend can effectively relieve the weekday sleep debt and the feelings of tiredness that accumulate during weekdays [28].

In the subgroup analysis for other covariates, the risk of depression in men was higher for those who slept less than 5.9 hours per day and those who drank frequently. These results demonstrate that depression can lead to unhealthy, excessive alcohol consumption, which causes many other negative physical and psychological effects [29]. Long sleep durations seem to result in a poor outcomes in terms of depression because a long sleep duration is correlated with low physical activity [30, 31]. The same conclusion can also be drawn from the results of the subgroup analysis for other covariates, which demonstrated that both physically non-active or obese men and women, who slept for more than 9 hours per day, were more susceptible to depression than were those who are physically active or of normal weight. Physical activity increases the level of dopamine and serotonin neurotransmitters [32], increases the secretion of endorphin [33], distracts from stressful stimuli [34], and improves self-efficacy and self-esteem [35], thus positively affecting the depressive state. This mechanism may explain the results of this study.

This study had a few limitations. First, the design of the study was cross-sectional and not longitudinal. Thus, the study was not able to establish a causal relationship between sleep duration and depression. Second, the measurement of sleep duration relied on a self-reported survey method, which is considered less valid than actigraphy and golden-standard polysomnography [36]. Third, sleep quality was not considered when investigating the relationship between sleep duration and depressive state, as the KNHANES data did not include any indicators of sleep quality. Finally, the study does not explain the underlying biological and biochemical mechanisms by which sleep duration affects depression and vice versa. Therefore, additional studies that measure sleep duration and sleep quality using more objective methods are required. Although sleep is potentially associated with neurotransmitter imbalance, HPA disturbance, increased oxidative and nitrosative stresses, neuroprogression, and dysregulated immuno-inflammation, which are five pathogenic pathways that cause MDD, further studies about the exact mechanisms are also needed [12].

This study is important because it focused not only on sleep duration but also on the sleep duration ratio between weekends and weekdays as factors related to depression. It also included a large sample population and conducted stratified analyses by sex, which further increased the study validity.

The findings of this study have elucidated the importance of lifestyle factors, especially sleep duration, in depression. Comparing with that in other OECD countries, there is a current lack of mental and psychological health policies for patients with depression and those who are potentially depressed in South Korea [37]. To make matters worse, few studies have focused on sleep-related factors. This study confirms the necessity of establishing new policies and reinforcing current policies that target depression in South Korea.

Conclusion

Sleep duration and sleep duration ratio were found to be associated with depression. Sleep durations that are too long or too short may lead to a depressive state. Such observations were more apparent in men than in women. While excessive sleep contributed to the lack of exercise in daily life, sleep deficiency leads to a feeling of tiredness. Different sleep duration conditions brought about different impacts on the sleep duration ratio and its effect on depression. Sleeping longer on the weekend versus weekdays functioned differently among those with long and short sleep durations as irregular sleep patterns and as an effective tiredness reliever, respectively. These associations have not yet been confirmed by longitudinal or casual studies. The results of this study may be used as a reference when investigating sleep-related variables to reduce and prevent depression in the South Korean society using appropriate government-driven mental healthcare policies.

Declarations

Conflict of Interest

The authors declare no conflicts of interest associated with the materials presented in this paper.

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Author Contributions

Conceptualization: NHK and BYL Data curation: YSP, NHK, BYL, and YWC Formal analysis: YSP, NHK, BYL, and YWC Methodology: YSP, NHK, BYL, and YWC. Project administration: NHK. Writing original draft: NHK Writing - review and editing: YSP and ECP.

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