



Patient Health Questionnaire-9, Body Mass Index, Household Income According to Sleep Duration: Findings From a Community Health Survey

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Background and Objective Research on the relationship between sleep duration and Patient Health Questionnaire-9 (PHQ-9), body mass index (BMI), and income in South Korea was scarce. This study aimed to investigate the relationship between sleep duration and the PHQ-9, BMI, and household income.

Methods We used data from the Korean Community Health Survey (KCHS) conducted by the Korean Center for Disease Control and Prevention in 2018 which included a total of 228340 participants from across the country. We divided the participants into four groups based on their sleep duration and used one-way analysis of variance (ANOVA) to compare the mean values of PHQ-9, BMI, and household income among the groups.

Results A total of 227899 respondents were included in the study. Based on a one-way ANOVA, the mean PHQ-9 score tended to increase as sleep duration decreased. However, the group with a sleep duration of 9 hours or more had an exceptionally higher mean PHQ-9 score than the group with a sleep duration of 7 to 9 hours. The BMI score generally decreased as the sleep duration increased. Additionally, the group with a sleep duration of 5 to 7 hours and 7 to 9 hours had higher household income than the group with a sleep duration of 5 hours or less or 9 hours or more.

Conclusions This study demonstrated the association between sleep duration and PHQ-9, BMI, and household income. Sleep duration was found to be a factor influencing PHQ-9, BMI, and household income. **Sleep Med Res 2023;14(1):37-42**

Keywords Sleep duration; Patient Health Questionnaire; Body mass index; Income.

INTRODUCTION

In South Korea, approximately 5% of the population has been diagnosed with insomnia, with 17%–23% reported experiencing insomnia symptoms [1-3]. The Centers for Disease Control and Prevention (CDC) recommend that adults sleep for more than 7 hours each night to promote optimal health and well-being [4]. Conversely, sleeping less than 7 hours per night is associated with increased cardiometabolic risks such as hypertension, obesity, and diabetes mellitus, and is even associated with all-cause mortality [5-7].

Previously, it has been established that sleep duration is closely related to depression. Both an insufficient and excessive amount of sleep are known to increase the risk of depression [8]. As sleep disturbance is one of the core symptoms of major depressive disorder, sleep duration is an important factor to consider [9,10]. However, there is a lack of research on how specific sleep disturbance is reflected in different sleeping times. It is also necessary to

investigate whether sleep duration is associated with depression screening tool which could help identify people with depression in advance by paying attention to sleep duration. This study purposed to find an association between sleep duration and Patient Health Questionnaire-9 (PHQ-9) which has been shown to be a valid and reliable measure for identifying depression and estimating depression severity [11].

Meanwhile, it is well known that reduced sleep duration is linked with obesity [12,13]. This is because sleep modulates neuroendocrine function and glucose metabolism. Reduced sleep duration alters metabolic and endocrine functions, leading to an increase in evening cortisol levels, decreased glucose tolerance, and decreased insulin sensitivity. Previous studies have shown that when sleep duration decreased, ghrelin, a hunger-promoting hormone, increased while leptin, a satiety-precepting hormone, decreased [14].

Moreover, previous studies have demonstrated a correlation between income level and sleep duration, indicating that lower income levels are associated with both short and long sleep duration [15-18]. Additionally, it has been found that households with lower income levels have a higher incidence of sleep duration of less than 6 hours [19]. Given that the average sleep duration in South Korea is less than 6.5 hours which is less than the worldwide average of 7.2 hours of sleep [20,21], there is a need to investigate whether this association holds true in Korea.

Despite the aforementioned importance of exploring the relationship between sleep duration and PHQ-9, body mass index (BMI), and household income, no South Korean data exists to reflect the special circumstances of the population. No large-scale studies have investigated the division of sleep duration specifically into four groups and compared the difference in PHQ-9, BMI, and income based on sleep duration. Therefore, we aimed to use a nationwide survey to investigate the difference in PHQ-9, BMI, and household income based on sleep duration. We hypothesized that PHQ-9, BMI, and household income would have differences among the groups divided by sleep duration.

METHODS

Study Design and Population

This study utilized data from the 2018 Korean Community Health Survey (KCHS), a nationwide, cross-sectional survey conducted by the Korea Center for Disease Control and Prevention to assess the health status of adults over 19 years of age. The age range of the participants was 19–107 years (mean \pm standard deviation [SD]: 55.3 ± 17.5 years). The survey employed a probability-proportional-to-size sampling method based on resident registration address data, with primary sampling units and secondary sampling households selected using a two-stage stratified sampling method [22]. Trained investigators conducted computer-assisted personal interviews which included questions

on demographic information, health behaviors, medical history, quality of life, and personal hygiene.

The survey had a total of 228340 participants. For this study, we excluded individuals who did not respond to the sleep duration question ($n = 441$). Thus, a total of 227899 eligible participants were included in this study.

As sleeping less than 7 hours was associated with an increase in the risk of adverse health conditions such as high blood pressure and dyslipidemia [7] and sleeping less than 5 hours was associated with increased cardiometabolic risk [5], sleep duration was divided by 5 and 7 hours. Moreover, since a sleep duration of 9 hours or more has been the reference of idiopathic hypersomnia in previous research [23], 9 hours has also been the standard for dividing sleep duration in this study. Therefore, participant's sleep duration was divided into four groups; Group 1 (sleep duration less than 5 hours), Group 2 (sleep duration more than 5 hours and less than 7 hours), Group 3 (sleep duration more than 7 hours and less than 9 hours) and Group 4 (sleep duration more than 9 hours).

Statistical Analysis

One-way analysis of variance (ANOVA) was used to test for differences in average PHQ-9 score, BMI, and household income values across the four groups. The resulting p-value was < 0.001 confirming a significant difference. Post-analysis was conducted using the Dunnett T3 method to compare the average PHQ-9 score, BMI, and household income. Levene's test was applied for the Equal variance, and as the p-value was < 0.05 , the Dunnett T3 method was selected since equal variance could not be assumed.

Ethics Statement

The raw data from KCHS were downloaded from the KCHS website (<https://chs.kdca.go.kr/chs>) after obtaining permission from the administrator in 2023. All study procedures were conducted under the approval by the Institutional Review Board (IRB) of St. Vincent's Hospital, the Catholic University of Korea (approval number: VC23ZASI0063), and the requirement of informed consent was waived.

RESULTS

Demographic Characteristics

Of the total number of 227899 study participants, 44.8% were male and 55.2% were female. Based on their sleep duration, 4.3% slept for less than 5 hours, 38.6% slept for 5 to 7 hours, 51.9% slept for 7 to 9 hours, and 5.2% slept for more than 9 hours. In terms of marital status, 15.1% were single and 67.0% were married (Table 1).

The Association Between Sleep Duration and PHQ-9

Results of PHQ-9 according to sleep duration are demonstrated in Table 2. When comparing the mean PHQ-9 scores of the four groups, it was found that PHQ-9 tends to increase as sleep duration decreases. However, the mean PHQ-9 score was excep-

tionally higher in the group with a sleep duration of 9 hours or more than 7 hours and less than 9 hours. The mean PHQ-9 of the total participants was 2.20. The average PHQ-9 score was lowest in group 3 which was 1.79 (SD = 2.827), and highest as the mean value of 4.98 in group 1 (SD = 5.080). The PHQ-9 score of group 2 was 2.34 (SD = 3.260) and group 4 was 2.96 (SD = 4.282).

Table 1. Sociodemographic characteristics of participants (n = 227899)

Characteristics	N (%)
Gender	
Male	102124 (44.8)
Female	125775 (55.2)
Marriage status	
Single	34497 (15.1)
Married	152734 (67.0)
Separated	3108 (1.4)
Divorced	8885 (3.9)
Widowed	28360 (12.4)
Non-responder	315 (0.1)
Total sleep time	
Less than 5 hours	9829 (4.3)
More than 5 hours and less than 7 hours	88042 (38.6)
More than 7 hours and less than 9 hours	118244 (51.9)
More than 9 hours	11784 (5.2)

The Association Between Sleep Duration and BMI

Results of BMI according to sleep duration are demonstrated in Table 3. When comparing the association between sleep duration and BMI, the shorter the sleep duration, the higher the BMI score tended to be. However, there was no statistically significant difference between the group with less than 5 hours of sleep and the group with more than 5 hours and less than 7 hours (p = 0.994). The mean BMI of the total participants was 23.9567. The mean BMI score of each group 1, 2, 3, and 4 was 24.1263 (SD = 3.71949), 24.1506 (SD = 3.50556), 23.8368 (SD = 3.47995), and 23.5809 (SD = 3.79380), respectively.

The Association Between Sleep Duration and Household Income

Results of household income according to sleep duration are demonstrated in Table 4. Comparing the mean household income according to sleep duration, household income was highest in group 2, and the second highest in group 3. The mean household income of the total participants was 334.9466 (10000 won per month). The mean household income in group 1 and

Table 2. The association between sleep duration and depressive symptoms (PHQ-9)

Total sleep time	Number of participants (n = 227317)	Mean value of PHQ-9	Standard deviation	Standard error	95% confidence interval
Less than 5 hours	9794	4.98	5.080	0.051	4.88–5.08
More than 5 hours and less than 7 hours	87846	2.34	3.260	0.011	2.32–2.36
More than 7 hours and less than 9 hours	117977	1.79	2.827	0.008	1.78–1.81
More than 9 hours	11700	2.96	4.282	0.040	2.89–3.04
Total	227317	2.20	3.282	0.007	2.19–2.22

One-way ANOVA

	Sum of squares	Degree of freedom	Mean square	F value	p-value
Between groups	104137.146	3	34712.382	3366.731	< 0.001
Within groups	2343690.378	227313	10.310	-	-
Total	2447827.524	227316	-	-	-

Post-hoc analysis (Dunnnett T3)

Variable 1	Variable 2	Mean difference	Standard error	p-value	95% confidence interval
Less than 5 hours	More than 5 hours and less than 7 hours	2.644	0.052	< 0.001	2.51–2.78
	More than 7 hours and less than 9 hours	3.193	0.052	< 0.001	3.06–3.33
	More than 9 hours	2.021	0.065	< 0.001	1.85–2.19

PHQ-9, Patient Health Questionnaire-9; ANOVA, analysis of variance.

Table 3. The Association between sleep duration and BMI

Total sleep time	Number of participants (n = 179451)	Mean value of BMI	Standard deviation	Standard error	95% confidence interval
Less than 5 hours	7936	24.1263	3.71949	0.04175	24.0444–24.2081
More than 5 hours and Less than 7 hours	68997	24.1506	3.50556	0.01335	24.1244–24.1767
More than 7 hours and Less than 9 hours	92989	23.8368	3.47995	0.01141	23.8144–23.8592
More than 9 hours	9529	23.5809	3.79380	0.03886	23.5047–23.6571
Total	179451	23.9567	3.52233	0.00831	23.9404–23.9730
One-way ANOVA					
	Sum of squares	Degree of freedom	Mean square	F value	p-value
Between groups	5504.407	3	1834.802	148.251	< 0.001
Within groups	2220893.739	179447	12.376	-	-
Total	2226398.146	179450	-	-	-
Post-hoc analysis (Dunnett T3)					
Variable 1	Variable 2	Mean difference	Standard error	p-value	95% confidence interval
Less than 5 hours	More than 5 hours and less than 7 hours	-0.02433	0.04383	0.994	-0.1398–0.0912
	More than 7 hours and less than 9 hours	0.28944	0.04328	< 0.001	0.1754–0.4035
	More than 9 hours	0.54538	0.05704	< 0.001	0.3972–0.6935

BMI, body mass index; ANOVA, analysis of variance.

group 4 was 242.8423 (SD = 243.63230) and 252.4020 (SD = 239.39146), respectively. The mean household income in group 2 and group 3 was 346.6678 (SD = 264.47013) and 342.1039 (SD = 259.58275), respectively.

DISCUSSION

This study has confirmed the association between sleep duration and PHQ-9, BMI, and household income respectively using a large sample group through the KCHS. The mean PHQ-9 score tended to increase as sleep duration decreased but the group with a sleep duration of 9 hours or more had an exceptionally higher mean PHQ-9 score than the group with a sleep duration of 7 to 9 hours. The BMI score generally decreased as the sleep duration increased. Additionally, the group with a sleep duration of 5 to 7 hours and 7 to 9 hours had higher household income than the group with a sleep duration of less than 5 hours or more than 9 hours.

This study investigated the association between sleep duration and PHQ-9 score which screens for major depressive disorder. Our study results indicated that the mean PHQ-9 score tends to increase as sleep duration decreases and the lowest mean PHQ-9 was between 7 to 9 hours. This shows that the PHQ-9 score is higher when sleep duration is either more than 9 hours or less than 7 hours, compared to the mean PHQ-9 score of all participants. Previous studies have shown that sleep disturbance

is a primary symptom of major depressive disorder [9,10]. In South Korea, among 944 patients with depressive disorders from the Clinical Research Center for Depression of South Korea study, symptoms of insomnia were present in 93% of depressive patients [24]. A cut-off value of PHQ-9 has been established for depression as 10 out of a total of 27 points with reported sensitivity and specificity of 88%. PHQ-9 scores of 5, 10, 15, and 20 represent mild, moderate, moderately severe, and severe depression, respectively [11]. The Korean version of PHQ-9 has also been found to have reliability and validity in screening for depressive symptoms [25]. Our finding was consistent with previous studies that both an insufficient and excessive amount of sleep are known to increase the risk of depression [8], and this study specifically divided sleep duration of less than 7 hours into two subgroups: less than 5 hours and 5 to 7 hours.

In terms of the association between sleep duration and BMI revealed in this study, less sleep duration was associated with higher BMI. Previously, there has been an epidemiological study that revealed the association between short sleep duration and obesity [26]. Several endocrinal and metabolic pathways may explain the association between sleep duration and BMI. Short sleep duration is associated with low leptin and high ghrelin levels [14,27], which likely increase hunger and appetite and explain the increased BMI observed with short sleep duration. Additionally, short sleep duration impairs glucose metabolism and lowers insulin sensitivity [28,29]. This dysfunction also results in a behavioral pathway that makes food intake overridden without

Table 4. The Association between sleep duration and household income

Total sleep time	Number of participants (n = 218899)	Mean value of household income (10000 won per month)	Standard deviation	Standard error	95% confidence interval
Less than 5 hours	9424	242.8423	243.63230	2.50967	237.9228–247.7618
More than 5 hours and less than 7 hours	84502	346.6678	264.47013	0.90979	344.8846–348.4510
More than 7 hours and less than 9 hours	113636	342.1039	259.58275	0.77005	340.5946–343.6131
More than 9 hours	11337	252.4020	239.39146	2.24833	247.9949–256.8092
Total	218899	334.9466	261.34548	0.55859	333.8517–336.0414
One-way ANOVA					
	Sum of squares	Degree of freedom	Mean square	F value	p-value
Between groups	174622094.842	3	58207364.947	862.272	< 0.001
Within groups	14776430982.722	218895	67504.653	-	-
Total	14951053077.564	218898	-	-	-
Post-hoc analysis (Dunnett T3)					
Variable 1	Variable 2	Mean difference	Standard error	p-value	95% confidence interval
Less than 5 hours	More than 5 hours and less than 7 hours	-103.82549	2.66949	< 0.001	-110.8263–-96.8246
	More than 7 hours and less than 9 hours	-99.26154	2.62515	< 0.001	-106.1584–-92.3647
	More than 9 hours	-9.55973	3.36949	0.022	-18.3161–-0.8034

ANOVA, analysis of variance.

change in hormonal effect [30,31]. A previous study showed a significant U-shaped curvilinear relationship between average nightly sleep and BMI after adjustment for age and sex [27]. Therefore, it was expected that the group with a sleep duration of more than 9 hours was to have a higher mean BMI than the group with a sleep duration of 7 to 9 hours but the opposite result was observed. However, within the group sleeping less than 7 hours, it was in accordance with the previous studies [27]. Furthermore, there was no significant difference between the group of sleep duration less than 5 hours and 5 to 7 hours. This implies that sleeping less than 7 hours, rather than considering how much less, confers much more significance.

As for the results on the income level, past studies have demonstrated a correlation between income level and sleep duration, with lower income levels have been associated with both short and long sleep duration [15-18]. This study replicates previous research and found that when sleep duration is less than 5 hours or more than 9 hours, the mean value of household income was lower compared to the group with sleep duration between 5 to 9 hours.

There are several limitations that must be taken into consideration. Firstly, as it was a cross-sectional study, it does not establish a causal relationship between sleep duration and its effects on PHQ-9, BMI, and household income. Secondly, in the KCHS, sleep duration, PHQ-9, BMI, and household income were

self-reported assessments. Therefore, there was a possibility of recall bias. Thirdly, the possible causes of excessive or insufficient sleep duration were not reported and considered. Possibilities of voluntary sleep restriction or sleep disorders exist [32]. Furthermore, this study may have included factors such as other psychiatric disorders, mood, medications, caffeine or alcohol consumption, and physical activity that may have confounded the results. Also, as this study sampled participants from the general population, the mean PHQ-9 score did not exceed 5 or 10, which represents mild depression to major depressive disorder. Therefore, when PHQ-9 scores are below the cut-off value, a higher PHQ-9 score cannot necessarily indicate that depression is more severe. It should be also noted that item 3 of the PHQ-9 assesses sleep disturbance, which may have influenced the overall PHQ-9 score [33].

Nonetheless, this study had strengths, such as being a community-based study with a large nationally representative sample of South Korea. Additionally, this survey was conducted as a face-to-face interview during household visits which increased the accuracy and representativeness of the results.

In conclusion, our study highlights the association between sleep duration and PHQ-9, BMI, and household income. These findings suggest that sleep duration may be correlated with an individual's physical and mental health status. Therefore, further investigation and clinical attention is warranted.

Availability of Data and Material

The datasets generated or analyzed during the current study are available in the Korean Community Health Survey (KCHS) repository, <https://chs.kdca.go.kr/chs>.

Author Contributions

Conceptualization: all authors. Data curation: Jihyung Lee, Suk-Young Kim. Formal analysis: Suk-Young Kim, Jihyung Lee. Investigation: Jihyung Lee. Methodology: Seung-Chul Hong. Project administration: Jihyung Lee, Tae-Won Kim, Seung-Chul Hong. Resources: Jihyung Lee, Suk-Young Kim, Seung-Chul Hong. Software: Suk-Young Kim. Supervision: Yoo Hyun Um, Jong-Hyun Jeong, Ho Jun Seo, Young-Chan Kim, Sung Hoon Yoon. Validation: Suk-Young Kim. Visualization: Jihyung Lee. Writing—original draft: Jihyung Lee. Writing—review & editing: Tae-Won Kim, Seung-Chul Hong.

Conflicts of Interest

Seung-Chul Hong, a contributing editor of the *Sleep Medicine Research*, was not involved in the editorial evaluation or decision to publish this article. All remaining authors have declared no conflicts of interest.

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