



The Association between Short or Long Sleep Times and Quality of Life (QOL): Results of the Korea National Health and Nutrition Examination Survey (KNHANES IV–V)

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Study Objectives: Sleep can affect quality of life (QOL). We examined the association between self-reported sleep time and QOL independent of perceived health status and depressive disorder using the EuroQol-5 Dimension (EQ-5D) and a visual analog scale (VAS).

Methods: We used the nationwide cross-sectional survey data of 28,178 subjects from the Korea National Health and Nutrition Examination Survey (KNHANES) IV–V. Self-reported sleep time was assessed by average hours of sleep per day. QOL was measured using the EQ-5D and VAS. A generalized additive model and multiple linear regression analysis were used to estimate the effect of sleep time on the QOL while adjusting for potential confounding variables.

Results: We found a significant inverted U-shaped relationship between sleep time and QOL using both the EQ-5D and VAS indices. Compared with subjects who slept

7 h/day, Korean men whose sleep time was very short (≤ 4 h/day) or very long (≥ 10 h/day) had substantially worse QOL (-3.125 in EQ-5D, $p < 0.001$ and -4.387 on the VAS, $p = 0.000$ for ≤ 4 h/day; -1.763 in EQ-5D, $p = 0.001$ and -1.944 on the VAS for ≥ 10 h/day, all $p = 0.038$). A similar inverted U-shape was observed between sleep time and QOL in Korean women.

Conclusions: Inappropriate sleep time (either short or long) in both men and women was significantly associated with lower QOL. In particular, such an association was more apparent among persons whose perceived health status was poor.

Keywords: EQ-5D, KNHANES, perceived health status, quality of life (QOL), sleep time, VAS

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Sleep problems have been recognized as one of the most common issues in modern society and are pervasive in developed countries.¹ Organisation for Economic Co-operation and Development (OECD) reported sleep time on an average day in min in 18 OECD countries. That figure for Koreans was about 470 min, which was the shortest among the surveyed nations.²

Common sleep problems include difficulty initiating sleep, difficulty maintaining sleep, time in bed, waking after sleep onset, sleep onset latency, sleep quality, time at which one goes to bed in the evening (retiring time), time at which lights are turned out with the intention to sleep (lights-out time), wake time in the morning (awakening time), and time at which one gets out of bed in the morning (arising time), as well as total sleep time.^{3,4} A number of studies have indicated that short and/or long sleep time could be an important indicator of perceived individual health status,⁵ and is related to an elevated suicide risk and an increased risk of chronic disease and all-cause mortality.^{6–8}

Therefore, sleep disturbance may reduce quality of life (QOL) and can affect health outcome,⁹ which is defined as a person's self-reported satisfaction with his or her life.¹⁰ Preliminary evidence indicates that cross-cultural and ethnic differences exist in both QOL and sleep problems. Insufficient

BRIEF SUMMARY

Current Knowledge/Study Rationale: While sleep times are important from the viewpoint of health management, few studies have examined the association between sleep time and health-related quality of life using well-established and commonly used generic instruments and the results have been controversial. In this study, we examined the associations between self-reported total sleep times and quality of life independent of perceived health status and depressive disorder.

Study Impact: Our study found that there was an inverted U-shape association between sleep time and quality of life suggesting that inappropriate sleep time (either short or long) is related with worse quality of life. In particular, such an association was more apparent among persons whose perceived health status was poor.

sleep contributes to decreasing functional status, fatigue, pain, wound healing, immune function, clinical anxiety, and depression.^{11–15} In patients with chronic disease, sleep disruption has been shown to be a chronic problem causing severe distress, resulting in greater QOL deficit.^{16–19} Similarly, sleep disturbances have been shown to adversely affect the QOL in patients with chronic disease.²⁰ These results are in line with the assumption that sleep affects QOL.²¹

Studies using the EuroQol-5 Dimension (EQ-5D) index, which is often used to measure QOL, have demonstrated lower scores in older individuals compared with younger

individuals,^{22,23} in women than in men,²² and in individuals with lower socioeconomic status compared with individuals of higher socioeconomic status.²⁴

However, although a variety of tools to measure QOL have been used in the previous studies, its results have been controversial,²⁵ and few studies have examined the association between sleep time and QOL using indices such as the EQ-5D and a visual analog scale (VAS), which are well established and commonly used generic instruments for assessing health-related QOL. Therefore, in this study, we examined the associations between self-reported total sleep time and QOL independent of perceived health status and depressive disorder.

METHODS

Study Subjects

The data used in this study were obtained from the Korea National Health and Nutrition Examination Survey (KNHANES), which was conducted by the Korea Ministry of Health and Welfare and the Korea Centers for Disease Control and Prevention (KCDC). The fourth and fifth KNHANES was conducted over 3 y of 2007–2009 and 2010–2012, respectively. The KNHANES is composed of the Health Interview Survey, the Health Examination Survey, and the Nutrition Survey. The Health Interview Survey was performed using self-administered structured questionnaires to obtain information regarding sociodemographic characteristics, health status, health service use, and health behaviors. Trained interviewers visited each household and assisted the participants with specific items in the self-administered tool. The survey response rate was 71.2–82.8% for 2007–2012.^{26,27} We used the fourth and fifth KNHANES data of adults age 19 y or older. After excluding 12,400 subjects age 18 years or younger and 9,872 subjects with missing information, 28,178 individuals were included in the analysis. All participants in this survey signed an informed consent form. Because KNHANES IV and V include secondary data released to the public for scientific use and do not contain private information, our study did not have to address ethical concerns.

Variables

Independent Variable of Main Interest

Sleep time referred to self-reported data in response to the question, “How many hours do you usually sleep per day?” Responses were categorized into seven groups: ≤ 4 , 5, 6, 7, 8, 9, or ≥ 10 h. We considered 7 h as “appropriate sleep” time, ≤ 5 h as “short sleep” and ≥ 9 h as “long sleep”²⁸, given the definition by the International Classification of Sleep Disorder 2nd edition.

Dependent Variables: QOL Indices

EQ-5D

The EQ-5D is a brief, self-completed instrument for describing and evaluating quality of health states defined by the EQ-5D index. The EQ-5D asks respondents to simply “mark an X on the scale to indicate how your health is today” and then to

“write the number you marked on the scale in the box below.” The descriptive system comprises five dimensions: (1) mobility, (2) self-care, (3) usual activities, (4) pain/discomfort, and (5) anxiety/depressive mood. Each dimension has five levels: no problem, slight problem, moderate problem, severe problem, and extreme problem. Respondents are asked to indicate their health state by placing a cross in the box close the most appropriate statement for each of the five dimensions. This decision results in a one-digit number expressing the level selected for that dimension. The digits for the five dimensions can be combined into a five-digit number describing the respondent’s health state (EuroQol Group, <http://www.euroqol.org>).²⁹

VAS

The VAS recorded the respondent’s self-rated health on a 20-cm vertical scale with endpoints labeled “the best health you can imagine” and “the worst health you can imagine.” This information can be used as a quantitative measure of health as judged by the individual respondent.²⁹

Covariates

Socioeconomic and Demographic Factors

Age, household income, residency region, occupation, and marital status were included as sociodemographic factors in the analysis. Equivalized household income was used by dividing the household monthly income by the square root of household size³⁰ and grouped into four household income quartiles. Education level was categorized into four groups: elementary school or lower, middle school, high school, and college or higher. The residency regions were categorized into urban (administrative divisions of a city: Seoul, Daejeon, Daegu, Busan, Incheon, Kwangju, or Ulsan) or rural (not classified as a city). Occupational status was divided into three categories: white collar (administrative, engineering, scientific, teaching and related occupations, sales and related occupations, service occupation), blue collar (farming, forestry, fishing, and hunting occupations, craft and repair, operators, fabricators, and laborers), and unemployed (including housewife and student). Individuals were classified as married, single, and separated (including widowed, previously married and divorced).

Health Behavior Factors

Health risk and behavior factors such as frequency of alcohol use, smoking status, and number of walking days per week were included as covariates in our analyses.³¹ Smoking status was categorized into three groups: current smoker, former smoker, and never smoker. Frequency of alcohol use was further assessed by questioning the participants about their average frequency (days per week or month) of alcohol drinking during the last year. The “number of chronic disease(s)” variables included conditions such as high blood pressure, diabetes, stroke, myocardial infarction, and angina and was operationalized into four different categories depending on how many were present: 0, 1, 2, or > 2 . Using the cutoffs suitable for our population according to a previous study,³² body mass index (BMI) was categorized into three groups: thin or normal (< 18.5 kg/m²); moderate weight (18.5–23.9 kg/m²); overweight (24–26.9 kg/m²); and obese (> 27 kg/m²) adults. In response

to the question “Do you have major depression that a doctor diagnosed?”, depression was subcategorized as either “yes,” “no,” or “never sick.” The answer “yes” meant that the subject received a diagnosis of depression by a doctor, “no” meant that the subject has been feeling depressed but not received a diagnosis by a doctor, and “never sick” was those who have never been feeling depressed. Perceived physical health status was assessed with the question, “How do you usually perceive your health?” (“very good,” “good,” “normal,” “poor,” “very poor”). The responses “very good” and “good” were considered to indicate “good,” and “poor” and “very poor” were considered to indicate “poor.”

Statistical Analysis

The independent *t* test and Chi-square test were used for the univariate analysis. Multiple linear regression analysis and a generalized additive model (GAM) were used to analyze whether sleep time was related to QOL and what is the shape of the association while adjusting for potential confounding variables such as demographic factors, perceived health status, and mental disorders.

GAM provides a flexible and effective technique for modeling nonlinear data.³³ Measured data have a discrete distribution, and the discreteness is particularly pronounced for QOL data such as the EQ-5D utilities.³⁴ Therefore, we determined whether semiparametric modeling of the utility data could check for nonlinearity³⁴ and used the GAM because it can help diagnose and accommodate nonlinearity. We further examined the subgroup analysis by perceived health status. Statistical Analysis Software version 9.2 (SAS Institute, Cary, NC, USA) was used for the data analysis.

RESULTS

Table 1 presents the demographic characteristics of the study subjects. The 28,178 study participants included 10,691 men and 17,487 women. The average EQ-5D score was 96.6 (standard deviation [SD], 10.0), and the average VAS score was 75.8 (SD, 15.9) in men. The mean EQ-5D score was 93.2 (SD, 13.1), and the mean VAS score was 73.0 (SD, 18.8) in women. There were 2.5% of Korean men and 4.8% of Korean women who reported sleep time ≤ 4 h/day, and 2.0% of Korean men and 2.0% of Korean women reported sleep time ≥ 10 h/day. These results suggest that Korean women experienced more inappropriate sleep patterns than did men (**Table 1**). Furthermore, differences associated with other demographic characteristics were observed, including household income level, marital status, occupation, smoking status, alcohol consumption, and BMI. More women than men reported that their perceived health status was poor (64.6% of women and 35.4% of men), and more had received a diagnosis of depression (81.9% of women and 18.1% of men).

When we explored the smoothed nonlinear relationship between sleep time and QOL using GAM, an inverse U-shaped relationship was observed independent of health status, health behavior, and sociodemographic factors (**Figure 1**). **Tables 2** and **3** present the estimated coefficients from multiple linear regression analyses after adjusting for potential confounding variables. Compared with subjects who slept 7 h/day, Korean

men whose sleep time was very short (≤ 4 h/day) or very long (≥ 10 h/day) had significantly worse QOL (-3.125 on EQ-5D and -4.387 on VAS for ≤ 4 h/day; -1.763 on EQ-5D and -1.944 on VAS for ≥ 10 h/day, all $p < 0.01$) (**Table 2**). Compared with subjects who slept 7 h/day, Korean men whose sleep time was short (5 h/day) had significantly worse QOL (-1.648 on VAS for 5 h/day, $p < 0.01$) (**Table 2**). QOL was worse for women whose sleep was very short (≤ 4 h/day) compared with those who slept 7 h/day (-3.652 on EQ-5D and -3.535 on VAS, all $p < 0.0001$), which was similar to that of men. QOL was worse for women whose sleep time was short (5 h/day) compared to that for women who slept 7 h/day (-1.395 on EQ-5D, $p < 0.00$) (**Table 3**). Long sleep time was also significantly associated with lower QOL in women (-1.301 on EQ-5D for 10 h/day, $p < 0.01$) (**Table 3**). QOL in men with poor perceived health status was worse (-6.743 on EQ-5D and -16.735 , all $p < 0.0001$) (**Table 2**) compared with subjects with good perceived health status. QOL in women with poor perceived health status was worse than that of subjects with good perceived health status (-8.793 on EQ-5D and -18.265 , all $p < 0.0001$) (**Table 3**).

The QOL indices were positive predictive factors of perceived health status in both males and females. Additionally, our pilot study indicated an interactive effect between perceived health status and sleep time. Therefore, we conducted a stratified analysis according to perceived health status.

Tables 4 and **5** present the subgroup analysis by perceived health status. Among men whose perceived health status was good, sleep time was not related to significantly worse QOL than those who slept for 7 h/day. However, among men whose perceived health status was average, those who slept for less than 4h/day had significantly worse QOL than those who have had sleep 7h/day (-2.596 on EQ-5D, $p = 0.008$ for ≤ 4 h/day). The effect of too long or too short sleep time was even more apparent among men whose perceived health status was bad (-4.250 on EQ-5D, $p = 0.013$ and -7.087 on VAS, $p = 0.012$ for ≤ 4 h/day; -3.711 on EQ-5D for ≥ 10 h/day, $p = 0.048$) (**Table 4**).

Women who have slept for less than 4 h/day had significantly worse QOL than those who have slept for 7 h/day in women with good perceived health status (-3.609 on EQ-5D, $p = 0.021$ for ≤ 4 h/day). Women who have slept for less than 4 h/day had significantly worse QOL than those who have slept for 7 h/day in women with average perceived health status (-1.788 on EQ-5D, $p = 0.011$ and -4.132 on VAS, $p = 0.002$ for ≤ 4 h/day). Women who have slept for more than 10 h/day had significantly worse QOL than those who have slept for 7 h/day in women with average perceived health status (-1.835 on EQ-5D, $p = 0.027$ for ≥ 10 h/day). Women who slept for less than 4 h/day had significantly worse QOL than those who slept for 7 h/day with bad perceived health status (-5.169 on EQ-5D, $p < 0.0001$ and -3.643 on VAS, $p = 0.019$ for ≤ 4 h/day) (**Table 5**).

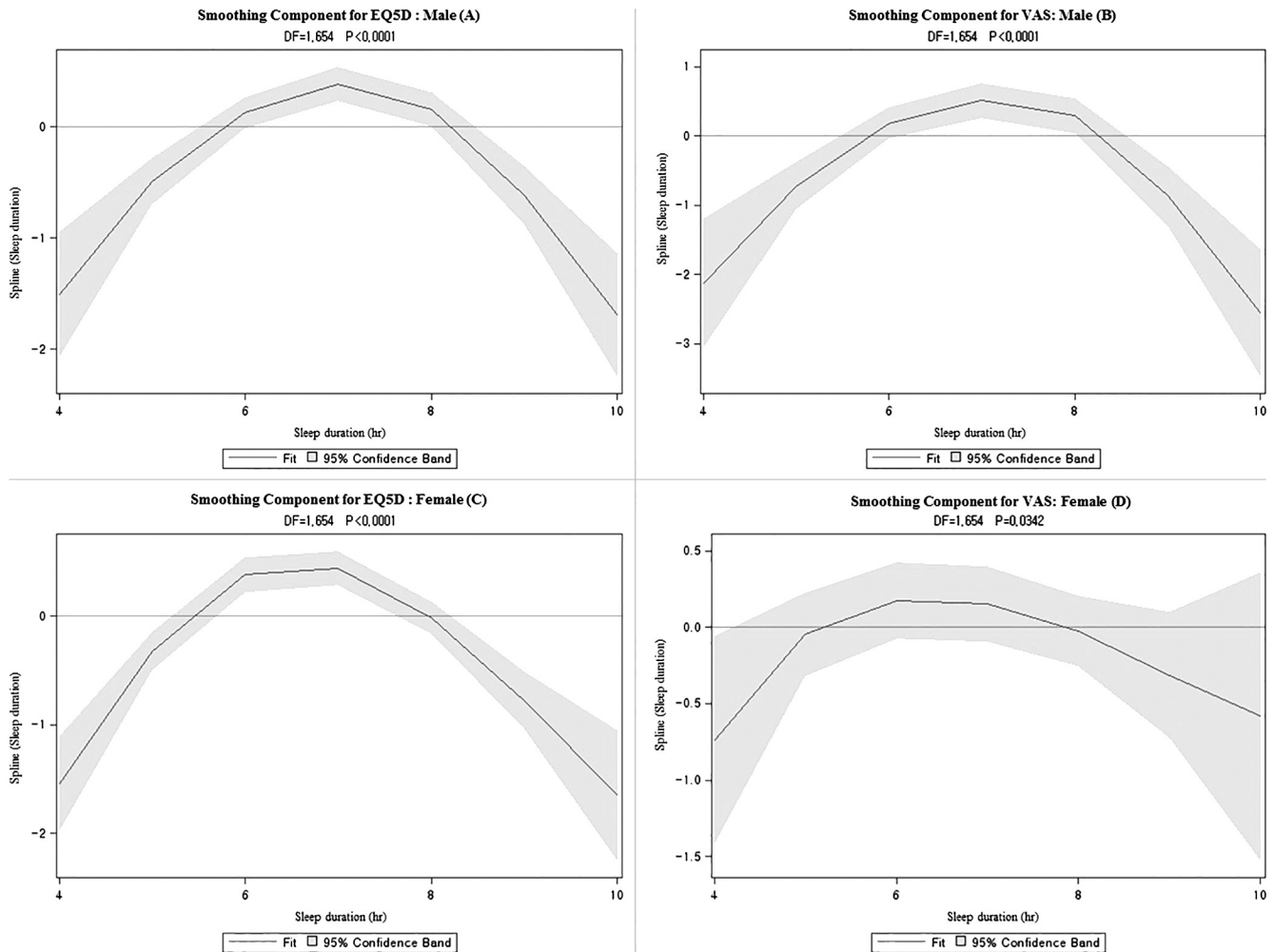
DISCUSSION

Although the tools used to measure QOL in this study are controversial,²⁵ the EQ-5D is a common tool for measuring QOL,³⁵ and when the range of quality is measured, a continuous visual change scale (VAS, 0–100 score) is typically used.³⁶

Table 1—Demographic characteristics of the study participants.

	Total (28,178)		Men (10,691)		Women (17,487)		p value
	Mean	SD	Mean	SD	Mean	SD	
EQ-5D index	94.8	12.2	96.6	10.0	93.2	13.1	< 0.0001
VAS scale	74.3	17.8	75.8	15.9	73.0	18.8	< 0.0001
	N	%*	N	%*	N	%*	p value
Sleep time							< 0.0001
≤ 4	1,328	3.7	345	30.4	983	69.6	
5	3,054	9.9	1,023	40.7	2,031	59.3	
6	7,222	26.8	3,006	50.2	4,216	49.8	
7	8,052	29.0	3,121	47.5	4,931	52.5	
8	6,305	22.9	2,394	45.4	3,911	54.6	
9	1,258	4.3	397	37.0	861	63.0	
≥ 10	959	3.4	405	46.1	554	53.9	
Age (y)							< 0.0001
≤ 29	3,681	20.6	1,557	51.9	2,124	48.1	
30–39	5,642	22.0	2,278	50.4	3,364	49.6	
40–49	5,519	22.6	2,190	46.9	3,329	53.1	
50–59	5,137	17.2	1,859	43.1	3,278	56.9	
60–69	4,438	9.7	1,586	38.6	2,852	61.4	
≥ 70	3,761	7.8	1,221	30.2	2,540	69.8	
Household income level							< 0.0001
Low	5,597	15.6	1,846	39.3	3,751	60.7	
Lower middle	7,205	26.5	2,758	45.1	4,447	54.9	
Upper middle	7,648	29.1	3,023	48.1	4,625	51.9	
High	7,728	28.8	3,064	48.2	4,664	51.8	
Marital status							< 0.0001
Married	20,165	66.9	8,125	46.1	12,040	53.9	
Single	4,103	22.4	2,016	58.3	2,087	41.7	
Separated	3,910	10.7	550	19.1	3,360	80.9	
Occupation							< 0.0001
White collar	9,347	38.6	4,155	51.7	5,192	48.3	
Blue collar	7,740	26.2	4,184	63.4	3,556	36.6	
Unemployed	11,091	35.2	2,352	26.6	8,739	73.4	
Residential region							0.9487
Urban	18,369	70.5	6,938	45.9	11,431	54.1	
Rural	9,809	29.5	3,753	45.9	6,056	54.1	
Smoking status							< 0.0001
Never smoked	18,473	59.6	2,519	18.7	15,954	81.3	
Former smoker	3,185	11.3	2,606	82.3	579	17.7	
Current smoker	6,520	29.1	5,566	87.8	954	12.2	
Frequency of alcohol use							< 0.0001
Never drink	8,284	23.6	1,654	23.9	6,630	76.1	
1 times or less per mo	8,302	29.4	1,974	30.5	6,328	69.5	
2–4 times per w	9,695	40.1	5,534	63.9	4,161	36.1	
4 times or more per w	1,897	7.0	1,529	82.4	368	17.6	
Number of days of walking per w							< 0.0001
Never	4,263	14.2	1,487	43.3	2,776	56.7	
1–3	8,087	29.3	2,963	44.1	5,124	55.9	
4–6	5,971	22.2	2,068	42.1	3,903	57.9	
Everyday	9,857	34.3	4,173	51.1	5,684	48.9	
BMI							< 0.0001
Thin (< 18.5 kg/m ²)	1,363	5.1	377	29.1	986	70.9	
Moderate (18.5–23.9kg/m ²)	14,778	52.3	5,226	42.5	9,552	57.5	
Overweight (24.0–26.9kg/m ²)	7,823	27.3	3,395	53.0	4,428	47.0	
Obese (≥ 27 kg/m ²)	4,214	15.2	1,693	50.7	2,521	49.3	
Perceived health status							< 0.0001
Bad	6,244	18.9	1,836	35.4	4,408	64.6	
Average	11,545	43.1	4,340	45.7	7,205	54.3	
Good	10,389	38.0	4,515	51.5	5,874	48.5	
Depression diagnosed by doctor							< 0.0001
Yes	1,136	3.5	154	18.1	982	81.9	
No	3,009	9.3	510	20.9	2,499	79.1	
Never ever sick	24,033	87.2	10,027	49.7	14,006	50.3	
Number of chronic diseases***							< 0.0001
0	21,084	80.4	8,096	46.9	12,988	53.1	
1	5,334	15.1	1,950	42.5	3,384	57.5	
≥ 2	1,760	4.5	645	40.6	1,115	59.4	

*Weighted %. ***Number of chronic diseases hypertension, diabetes, stroke, myocardial infarction, angina, and arthritis. p values are for independent t test. SD, standard deviation.

Figure 1—Association between sleep time and quality of life index using the generalized additive model.

(A) Differences in EQ-5D according to sleep time in males. **(B)** Differences in visual analog scale (VAS) according to sleep time in males. **(C)** Differences in EuroQol-5 Dimension (EQ-5D) according to sleep time in females. **(D)** Differences in VAS according to sleep time in females. From the generalized additive model (GAM) adjusted for age, household income level marital status, occupation, residential region, smoking status, frequency of alcohol use, number of days of walking per week, body mass index, perceived health status, depression diagnosed by doctor, and number of chronic disease. DF, degrees of freedom.

In this study, we examined whether sleep time was associated with the QOL indices using multiple regression analysis.

According to an international comparative study on the use of time, adult Korean men work an average of 381 min per day, American men work 262 min per day, and German men work an average of 225 min per day. The average working time of adult Korean women is 217 min per day, whereas American women work an average of 179 min per day, and German women work an average of 124 min per day.³¹ These findings indicate that Korean adults work longer hours than adults in comparable nations and are therefore more likely to be sleep deprived.³⁷

As our results were consistent with past studies,³⁸ the QOL indices decreased with age. As perceived health status decreased, the likelihood of inappropriate sleep time (≤ 5 h/day or ≥ 9 h/day), compared with 7 h, increased, and both men and women with poor perceived health status showed significant deterioration in QOL.

Overall, this study is important as QOL was significantly decreased in those with poor sleep times and all domains were

affected. Our results indicate that inappropriate sleep time (≤ 5 h/day or ≥ 9 h/day) in both men and women was strongly associated with lower QOL independent of perceived health status and depressive disorder. Given the smooth nonlinear relationship between sleep time and QOL, we used GAM model and the relationship between sleep time and the QOL indices (EQ-5D and VAS scores) showed an inverted U-shaped with a steep slope in both males and females (**Figure 1**). In particular, both males and females with poor perceived health status had significantly decreased EQ-5D index and VAS scores with a steep slope (**Table 4** and **Table 5**). This trend had a larger effect on the reduction in QOL when sleep time was associated with increasingly poor sleep habits. Based on this result, poorer perceived health status and sleep time were associated with lower EQ-5D index and VAS scores.

Several studies have explored the association between sleep time and QOL. For example, one study³⁹ examined 3,834 people age 60 y and older and found that both short and long sleep were associated with poor QOL. In addition, in a study of

Table 2—Factors associated with quality of life in Korean men.

	EQ-5D			VAS		
	B ^b	SE	p value	B ^b	SE	p value
Sleep time						
≤ 4	-3.125	0.699	< 0.0001	-4.387	1.228	0.000
5	-0.286	0.286	0.316	-1.648	0.626	0.009
6	-0.163	0.174	0.348	-0.569	0.380	0.135
7	0.000			0.000		
8	0.209	0.196	0.286	0.613	0.416	0.141
9	-0.269	0.460	0.559	-1.628	0.921	0.077
≥ 10	-1.763	0.550	0.001	-1.944	0.936	0.038
Age (y)						
≤ 29	6.513	0.641	< 0.0001	4.954	1.030	< 0.0001
30–39	5.976	0.611	< 0.0001	3.880	0.878	< 0.0001
40–49	5.615	0.631	< 0.0001	4.951	0.848	< 0.0001
50–59	4.700	0.629	< 0.0001	3.661	0.832	< 0.0001
60–69	3.294	0.651	< 0.0001	2.749	0.814	0.001
≥ 70	0.000			0.000		
Household income level						
Low	-2.123	0.342	< 0.0001	-1.965	0.613	0.001
Lower middle	-0.144	0.186	0.439	-0.772	0.422	0.068
Upper middle	-0.096	0.155	0.535	-0.245	0.390	0.530
High	0.000			0.000		
Marital status						
Married	0.251	0.473	0.597	0.178	0.789	0.822
Single	0.517	0.516	0.316	-0.955	0.943	0.311
Separated	0.000			0.000		
Occupation						
White collar	2.076	0.279	< 0.0001	0.839	0.485	0.084
Blue collar	1.744	0.299	< 0.0001	0.309	0.501	0.538
Unemployed	0.000			0.000		
Residential region						
Urban	0.436	0.179	0.015	-0.494	0.372	0.185
Rural	0.000			0.000		
Smoking status						
Never smoked	0.283	0.172	0.100	1.839	0.403	< 0.0001
Former smoker	-0.212	0.202	0.294	1.775	0.393	< 0.0001
Current smoker	0.000			0.000		
Frequency of alcohol use						
Never drink	-0.798	0.398	0.045	1.204	0.664	0.070
1 times or less per mo	-0.200	0.293	0.496	1.246	0.606	0.040
2–4 times per w	0.028	0.254	0.913	0.824	0.514	0.109
4 times or more per w	0.000			0.000		
Number of days of walking per w						
None	-0.887	0.271	0.001	-2.365	0.551	< 0.0001
1–3	-0.057	0.189	0.762	-0.617	0.373	0.099
4–6	0.318	0.180	0.078	-0.053	0.407	0.897
Everyday	0.000			0.000		
BMI						
Thin (< 18.5 kg/m ²)	-0.131	0.484	0.787	-1.115	0.885	0.208
Moderate (18.5–23.9kg/m ²)	0.000			0.000		
Overweight (24.0–26.9kg/m ²)	-0.194	0.168	0.249	-0.237	0.351	0.500
Obese (≥ 27 kg/m ²)	0.064	0.217	0.767	0.213	0.441	0.629
Perceived health status						
Bad	-6.743	0.319	< 0.0001	-16.735	0.585	< 0.0001
Average	-0.993	0.130	< 0.0001	-9.352	0.312	< 0.0001
Good	0.000			0.000		
Depression diagnosed by doctor						
Yes	-5.609	1.128	< 0.0001	-2.508	1.452	0.084
No	-4.459	0.594	< 0.0001	-3.465	0.896	0.000
Never ever sick	0.000			0.000		
Number of chronic diseases ^a						
0	2.092	0.644	0.001	1.644	0.875	0.061
1	1.978	0.666	0.003	1.619	0.914	0.077
≥ 2	0.000			0.000		

^aChronic diseases: hypertension, diabetes, stroke, myocardial infarction, angina, and arthritis. B, betas, estimates of regression coefficients from a multiple linear regression model; BMI, body mass index; EQ-5D, EuroQol-5 Dimension; SE, standard errors of estimated regression coefficients; VAS, visual analog scale.

Table 3—Factors associated with quality of life in Korean women.

	EQ-5D			VAS		
	B ^a	SE	p value	B ^a	SE	p value
Sleep time						
≤ 4	-3.652	0.634	< 0.0001	-3.535	0.889	< 0.0001
5	-1.395	0.325	< 0.0001	-0.471	0.524	0.369
6	-0.507	0.211	0.016	-0.637	0.368	0.084
7	0.000			0.000		
8	-0.159	0.197	0.422	0.063	0.357	0.860
9	-0.164	0.379	0.667	-0.369	0.702	0.599
≥ 10	-1.301	0.589	0.027	1.603	0.819	0.051
Age (y)						
≤ 29	10.680	0.602	< 0.0001	4.646	0.946	< 0.0001
30–39	10.436	0.551	< 0.0001	5.745	0.825	< 0.0001
40–49	10.016	0.546	< 0.0001	5.757	0.827	< 0.0001
50–59	7.990	0.543	< 0.0001	5.831	0.787	< 0.0001
60–69	5.298	0.556	< 0.0001	2.270	0.828	0.006
≥ 70	0.000			0.000		
Household income level						
Low	-2.650	0.331	< 0.0001	-3.528	0.517	< 0.0001
Lower middle	-0.288	0.196	0.142	-1.200	0.373	0.001
Upper middle	-0.222	0.170	0.192	-0.563	0.342	0.100
High	0.000			0.000		
Marital status						
Married	1.452	0.344	< 0.0001	0.954	0.488	0.051
Single	0.941	0.444	0.034	0.808	0.708	0.254
Separated	0.000			0.000		
Occupation						
White collar	0.752	0.168	< 0.0001	-0.497	0.327	0.130
Blue collar	0.926	0.263	0.001	0.363	0.428	0.396
Unemployed	0.000			0.000		
Residential region						
Urban	0.914	0.218	< 0.0001	-0.844	0.349	0.016
Rural	0.000			0.000		
Smoking status						
Never smoked	0.900	0.412	0.029	2.986	0.633	< 0.0001
Former smoker	-0.869	0.574	0.131	0.898	0.913	0.326
Current smoker	0.000			0.000		
Frequency of alcohol use						
Never drink	-1.080	0.651	0.098	1.334	1.093	0.223
1 times or less per mo	-0.458	0.637	0.472	1.511	1.093	0.167
2–4 times per w	-0.528	0.643	0.412	0.920	1.102	0.404
4 times or more per w	0.000			0.000		
Number of days of walking per w						
None	-1.290	0.302	< 0.0001	-2.941	0.488	< 0.0001
1–3	0.176	0.208	0.397	-0.856	0.355	0.016
4–6	0.303	0.211	0.151	0.142	0.380	0.709
Everyday	0.000			0.000		
BMI						
Thin (< 18.5 kg/m ²)	0.396	0.297	0.183	0.738	0.566	0.192
Moderate (18.5–23.9kg/m ²)	0.000			0.000		
Overweight (24.0–26.9kg/m ²)	-0.494	0.209	0.018	0.555	0.348	0.111
Obese (≥ 27 kg/m ²)	-1.269	0.299	< 0.0001	-0.281	0.506	0.579
Perceived health status						
Bad	-8.793	0.294	< 0.0001	-18.265	0.431	< 0.0001
Average	-1.077	0.158	< 0.0001	-8.984	0.293	< 0.0001
Good	0.000			0.000		
Depression diagnosed by doctor						
Yes	-3.628	0.501	< 0.0001	-4.651	0.723	< 0.0001
No	-2.610	0.273	< 0.0001	-3.298	0.480	< 0.0001
Never ever sick	0.000			0.000		
Number of chronic diseases ^a						
0	1.798	0.621	0.004	-0.453	0.836	0.588
1	1.623	0.624	0.009	-0.609	0.827	0.462
≥ 2	0.000			0.000		

^aChronic diseases: hypertension, diabetes, stroke, myocardial infarction, angina, and arthritis. B, betas, estimates of regression coefficients from a multiple linear regression model; BMI, body mass index; EQ-5D, EuroQol-5 Dimension; SE, standard errors of estimated regression coefficients; VAS, visual analog scale.

Table 4—Association between sleep time and quality of life by perceived health status in Korean men.

Sleep Time	EQ-5D								
	Good (n = 4,515)			Average (n = 4,340)			Bad (n = 1,836)		
	B	SE	p value	B	SE	p value	B	SE	p value
≤ 4	-1.600	0.927	0.085	-2.596	0.976	0.008	-4.250	1.699	0.013
5	-0.338	0.285	0.236	0.150	0.411	0.716	-0.851	1.196	0.477
6	-0.104	0.194	0.594	-0.014	0.258	0.955	-1.010	0.755	0.182
7	0.000			0.000			0.000		
8	0.096	0.205	0.641	0.480	0.261	0.066	-0.253	0.917	0.782
9	0.339	0.352	0.336	-0.446	0.653	0.495	-0.933	1.501	0.535
≥ 10	-0.508	0.594	0.393	-1.158	0.722	0.109	-3.711	1.869	0.048
Sleep Time	VAS								
	Good (n = 4,515)			Average (n = 4,340)			Bad (n = 1,836)		
	B	SE	p value	B	SE	p value	B	SE	p value
≤ 4	-1.555	1.748	0.374	-4.663	1.940	0.016	-7.087	2.817	0.012
5	-0.264	0.765	0.731	-2.237	0.925	0.016	-2.996	2.054	0.145
6	-0.622	0.507	0.220	-0.600	0.581	0.302	-0.454	1.342	0.735
7	0.000			0.000			0.000		
8	1.373	0.525	0.009	-0.003	0.606	0.996	0.001	1.554	0.999
9	-1.130	1.450	0.436	-1.433	1.403	0.307	-2.608	2.351	0.268
≥ 10	-2.696	1.386	0.052	-0.712	1.395	0.610	-3.001	2.354	0.203

Adjusted for age, household income level, marital status, occupation, residential region, smoking status, frequency of alcohol use, number of days of walking per week, body mass index, depression diagnosed by doctor, number of chronic disease. B, betas, estimates of regression coefficients from a multiple linear regression model; EQ-5D, EuroQol-5 Dimension; SE, standard errors of estimated regression coefficients; VAS, visual analog scale.

Table 5—Association between sleep time and quality of life by perceived health status in Korean women.

Sleep Time	EQ-5D								
	Good (n = 5,874)			Average (n = 7,205)			Bad (n = 4,408)		
	B	SE	p value	B	SE	p value	B	SE	p value
≤ 4	-3.609	1.560	0.021	-1.788	0.699	0.011	-5.169	1.173	< 0.0001
5	-0.727	0.417	0.082	-1.656	0.462	0.000	-2.257	0.808	0.005
6	-0.075	0.253	0.767	-0.821	0.265	0.002	-0.771	0.717	0.282
7	0.000			0.000			0.000		
8	0.146	0.239	0.540	-0.381	0.239	0.110	-0.205	0.717	0.775
9	0.430	0.411	0.295	-0.605	0.503	0.229	-0.471	1.160	0.685
≥ 10	-0.724	0.592	0.222	-1.835	0.827	0.027	-2.290	1.366	0.094
Sleep Time	VAS scale								
	Good (n = 5,874)			Average (n = 7,205)			Bad (n = 4,408)		
	B	SE	p value	B	SE	p value	B	SE	p value
≤ 4	-1.689	2.036	0.407	-4.132	1.354	0.002	-3.643	1.548	0.019
5	-0.284	0.781	0.717	-1.116	0.815	0.171	0.334	1.192	0.779
6	-0.776	0.516	0.133	-1.049	0.557	0.060	0.354	0.977	0.717
7	0.000			0.000			0.000		
8	0.646	0.487	0.185	-0.689	0.575	0.231	0.540	1.061	0.611
9	0.037	1.007	0.971	-0.873	0.953	0.359	0.091	1.751	0.958
≥ 10	1.687	1.286	0.190	1.157	1.232	0.348	2.032	1.718	0.237

Adjusted for age, household income level, marital status, occupation, residential region, smoking status, frequency of alcohol use, number of days of walking per week, body mass index, depression diagnosed by doctor, number of chronic disease. B, betas, estimates of regression coefficients from a multiple linear regression model; EQ-5D, EuroQol-5 Dimension; SE, standard errors of estimated regression coefficients; VAS, visual analog scale.

adults in the United States, a positive association was observed between both shorter and longer sleep time and poor perceived health compared with a sleep time of 7 h.¹¹ In contrast, in another study⁴⁰ 273 people aged 40 to 64 y were interviewed

and no association between sleep time and QOL was found. Studies exploring the association between disturbed sleep and QOL have examined the role of comorbid conditions,^{41,42} sex,⁴² and race/ethnicity.⁴⁰ As subjective sleep sufficiency decreased,

symptoms of depression increased, indicating a linear, inverse-proportional relationship,^{10,43} and Japanese individuals with sleep time of either < 6 or > 8 h tended to be more depressed than those with a sleep time of 6–8 h.¹⁰ Another sleep study reported that health was optimum with a sleep time of 7–8 h and was poorer for shorter or longer sleep time (U-shaped association).⁴⁴ However, some studies have reported sex-specific differences in the presence of a U-shaped association.^{32,45} Still other studies have reported no U-shaped association.⁴⁶

Therefore, in the current study, analyses were performed to determine with an inverted U-shaped association existed between sleep time and QOL indices and to identify the mechanism underlying any such association.⁴³ Both the EQ-5D index and VAS scale showed an inverted U-shaped association, although this trend appeared stronger in males. Thus, ensuring appropriate sleep time appears to be important in improving QOL. Our results suggest that a universal association (inverted U-shaped association) exists between the QOL indices and sleep time independent of perceived health status and depressive disorder.

This study has some limitations. First, because it was a cross-sectional study, a causal relationship could not be established between the QOL indices and sleep time. Second, although many sleep problems exist, such as difficulty initiating or maintaining sleep (insomnia) and excessive daytime sleepiness, no objective methods of self-reported sleep time (total sleep time) were employed in this study to investigate the association between inappropriate sleep time and QOL. Third, there may have been recall bias and seasonal variation in the responses during the 5-y period of the study, which could have contributed to information bias. Fourth, although there was no pregnant woman in our data, it is possible that our data included some postpartum women who could not be identified due to lack of information in KNHANES data. Postpartum women are known to have fragmented sleep⁴⁷ and results may be different; however, we believe the number of postpartum women would be minimal in our data and would not alter our analysis results. Fifth, we could not control for the potential confounding of anxiety and only considered depression among neurological dysregulation, whereas both anxiety and depression represent the neurological dysregulation that is reflected in sleep quality.^{48,49}

The strength of this study is that it is the first to assess the relationship of sleep time with the EQ-5D index and VAS score independent of perceived health status and depressive disorder to report the existence of an inverted U-shaped association in Koreans. We also examined the relationship between various health-related factors and the QOL indices using a large, representative Korean sample. Finally, instead of fitting a linear dose-response relationship between sleep time and QOL indices, by employing GAM to our data, we could investigate the nonlinearity in the association between sleep time and EQ-5D index or VAS scores and succeeded to show the inverted-U shaped association.⁵⁰ We suggest that a through longitudinal follow-up study be planned, as it is necessary to measure precise sleep time using objective methods to improve study reliability.

ABBREVIATIONS

BMI, body mass index
EQ-5D, EuroQol-5 Dimension

GAM, generalized additive model
KNHANES, Korea National Health and Nutrition Examination Survey
OECD, Organisation for Economic Co-operation and Development
QOL, quality of life
SD, standard deviation
VAS, visual analog scale

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