Association between sedentary time and sleep quality based on the Pittsburgh Sleep Quality Index among South Korean adults

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Abstract

Background: Sleep problems increase the risk of premature illness and death. We evaluated the association between sedentary time and sleep quality among South Korean adults.

Methods: The data of adults (aged ≥ 19 years) from the 2018 Korea Community Health Survey were analyzed. Sedentary time, which included hours spent sitting or lying down daily, was categorized into four standardized groups. Poor sleep quality was defined using the global cutoff point (> 5 points) of the Pittsburg Sleep Quality Index. Multiple logistic regression analyses were performed to identify the association between sedentary time (≤ 3.9, 4.0–5.9, 6.0–7.9, and ≥ 8 hours /day) and sleep quality, by sex.

Results: Of the 224,118 participants, 35,784/100,454 men (35.6%) and 58,271/123,664 women (47.1%) had poor sleep quality. Compared with ≤ 3.9 h/day, sedentary times 4.0–5.9, 6.0–7.9, and ≥ 8 h/day were associated with worse sleep quality among men (odds ratio [OR]: 1.12, 95% confidence interval [CI]: 1.08–1.16; OR: 1.19, 95% CI: 1.14–1.25; OR: 1.30, 95% CI: 1.25–1.34, respectively) and women (OR: 1.06, 95% CI: 1.03–1.10; OR: 1.12, 95% CI: 1.08–1.16; OR: 1.22, 95% CI: 1.18–1.26, respectively). In subgroup analyses of sleep quality, subjective sleep quality, latency, disturbance, use of sleeping medication, and daytime dysfunction showed a strong dose-response relationship with increasing sedentary time in both sexes.

Conclusions: Regardless of sex, the longer the sedentary time, the stronger the association with poor sleep quality. Nationwide efforts are required to recommend standards for sedentary time and develop evidenced-based healthy behavior guidelines.

Keywords: Sedentary time, Insomnia, Sleep disorder, Sleep efficiency, Pittsburgh sleep quality index

Background

Insomnia is a common sleep disorder affecting approximately 10–20% of people worldwide. The World Health Organization recently identified poor sleep quality (SQ) as a public health problem that increases the risk of premature disease and death [1, 2]. Poor SQ is characterized by long sleep delays, low sleep efficiency, and sleep disorders [3].

Poor SQ causes health problems such as poor cardiovascular and metabolic function, depression, and other changes in mental health conditions [4, 5]. Deterioration in health makes life unstable, resulting in increased health cost burdens [6]. SQ deterioration, including insomnia, is a commonly reported symptom, especially in primary healthcare settings [7]. Nevertheless, sleep problems often remain undiagnosed and untreated [6], leading to the use of self-prescribed sleeping pills, including...
melatonin pills, and alcohol use [8]. The frequent use of self-prescribed drugs can increase the resistance to or dependence on substances over time and worsen sleep problem [9]. Provision of cognitive or behavioral therapy by trained professionals to treat sleep problems can be expensive and unaffordable [10, 11]. Therefore, treatments for sleep problems are needed that are low-cost, nonpharmacological, have a wide coverage, and can be easily administered [10]. Increasing physical activity and reducing sedentary time (ST) may be a cost-effective strategy to address this problem.

ST is consistently associated with progression to diabetes, metabolic syndrome, and other chronic diseases, regardless of sufficient physical activity [12]. Various suggestions have been made to reduce ST in the general population, which is a main cause of death [13]. Although the relationship among physical activity, mental health, and SQ is relatively well established [14], the relationship between ST and SQ remains unclear. The relationship of ST with sleep amount is reported only in few studies [15, 16]. A study suggested robust associations of poor SQ with poor functioning, regardless of ST, in the general population [17]. Therefore, it is necessary to study the relationship between SQ and ST, a comprehensive concept covering sleep duration and efficiency.

The Pittsburgh Sleep Quality Index (PSQI) is a widely used tool for measuring SQ [11, 18]. The PSQI, developed in 1989 by Buysse [2] and colleagues, is a self-reporting tool used for evaluating the quality and patterns of sleep over a month [3]. Existing literature on the PSQI provides information on its psychometric properties, internal consistency, test-retest reliability, validity, and factor structure [19, 20].

A few studies have evaluated the association between SQ and ST, focusing on older adults [18] and college students [21]. However, research on the relationship between SQ and ST remains insufficient. Thus, this study investigated the association between ST and SQ in the adult South Korean population using the PSQI.

Methods

Data and study population

For this study, we used raw data from the 2018 Korea Community Health Survey (KCHS). The Korea Centers for Disease Control and Prevention conducts this survey every year since 2008. At the time of the survey, trained investigators visited sampled households containing adults aged ≥ 19 years to conduct a 1:1 interview using a laptop equipped with a survey program [22]. The KCHS data are published with open access. Additionally, participants’ information was fully anonymized and deidentified before analysis.

Of the 228,558 participants considered for inclusion in this study, we excluded those who answered, “don’t know,” provided invalid responses to the questions, or did not answer all the questions included in this study (n = 4,440). Finally, a total of 224,118 participants (100,454 men and 123,664 women) were selected. Based on a previous study that reported a significant difference in SQ by sex (due to differences in the physiological levels of sex hormones), we performed analyses stratified by sex [23].

Variables

Dependent variable

Poor SQ was defined using the PSQI, a 19-item self-reported questionnaire. The 19 items are divided into the following seven factors: subjective SQ, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction; each component is scored on a scale ranging from 0 to 3. The SQ score is calculated by adding the scores of all components and ranges from 0 to 21. The PSQI has been widely applied in the general population; the PSQI-Korean version has demonstrated high sensitivity and specificity [20]. However, various studies conducted in Korea provided different cutoff points for SQ, unlike the global cut-off point of a score of 5 or more [20, 24]. In this study, the global cutoff point was applied, with scores of ≤ 5 points and >5 points defined as good and poor SQ, respectively. This cutoff has generally been used in various studies in the Korean population [25, 26], which makes it possible to discriminate transcultural differences.

Independent variable

ST was evaluated using the KCHS exercise and physical activity categories: How many hours/minutes (except sleep) did you spend sitting or lying down in a normal day? This included time spent sitting on chairs or benches to watch television on weekdays or weekends, visiting friends, reading books, sitting in churches, using the Internet, and listening to music. The daily sitting time or ST categories were similar to those used in recent studies: ≤ 3.9, 4.0–5.9, 6.0–7.9, and ≥ 8.0 h/day [27, 28].

Control variables

Other covariates such as socioeconomic and health factors were also included as potential confounding variables. Socioeconomic factors included age, marital status, education level, and household income. Occupation was categorized according to the Korean version of the Standard Classification of Occupations, based on the International Standard Classification of Occupations developed by the International Labor Organization. We re-classified occupation into four categories: white collar (office work), pink collar (sales and service), blue
Table 1  General characteristics of the study population

| Variables                        | Poor sleep quality (PSQI > 5) |            |            | P-value | Women |            |            |            | P-value |
|----------------------------------|--------------------------------|------------|------------|---------|-------|------------|------------|------------|---------|
|                                  |                                | TOTAL      | Yes        | No      | N     | TOTAL      | Yes        | No        | N       |
| Total (N=224,118)                |                                | 100,454    | 100.0      | 35,784  | 35.6  | 64,670     | 64.4       |           |         |
| Sedentary time (hours/day)       |                                |            |            |         | <.0001|            |            | <.0001     |         |
| ≤3.9                             |                                | 32,998     | 32.8       | 10,496  | 31.8  | 22,502     | 68.2       |           |         |
| 4.0–5.9                          |                                | 23,450     | 23.3       | 8,194   | 34.9  | 15,256     | 65.1       |           |         |
| 6.0–7.9                          |                                | 13,197     | 13.1       | 4,827   | 36.6  | 8,370      | 63.4       |           |         |
| ≥8.0                             |                                | 30,809     | 30.7       | 12,267  | 39.8  | 18,542     | 60.2       |           |         |
| Age                              |                                |            |            |         | <.0001|            |            | <.0001     |         |
| 19-29                            |                                | 11,181     | 11.1       | 3,358   | 30.0  | 7,823      | 70.0       |           |         |
| 30-39                            |                                | 13,115     | 13.1       | 4,468   | 34.1  | 8,647      | 65.9       |           |         |
| 40-49                            |                                | 17,015     | 16.9       | 5,813   | 34.2  | 11,202     | 65.8       | <.001      | <.001   |
| 50-59                            |                                | 19,778     | 19.7       | 6,824   | 34.5  | 12,954     | 65.5       |           |         |
| 60-69                            |                                | 19,030     | 18.9       | 6,841   | 35.9  | 12,189     | 64.1       |           |         |
| ≥70                              |                                | 20,335     | 20.2       | 8,480   | 41.7  | 11,855     | 58.3       |           |         |
| Marital status                   |                                |            |            |         | <.0001|            |            | <.0001     |         |
| Living with spouse               |                                | 72,622     | 72.3       | 25,124  | 34.6  | 47,498     | 65.4       |           |         |
| Living without spouse            |                                | 27,832     | 27.7       | 10,660  | 38.3  | 17,172     | 61.7       |           |         |
| Occupational categories          |                                |            |            |         | <.0001|            |            | <.0001     |         |
| White                            |                                | 22,346     | 22.2       | 7,196   | 32.2  | 15,150     | 67.8       |           |         |
| Pink                             |                                | 9,885      | 9.8        | 3,238   | 32.8  | 6,647      | 67.2       |           |         |
| Blue                             |                                | 42,023     | 41.8       | 14,687  | 34.9  | 27,336     | 65.1       |           |         |
| Inoccupation                     |                                | 26,200     | 26.1       | 10,663  | 40.7  | 15,537     | 59.3       |           |         |
| Educational level                |                                |            |            |         | <.0001|            |            | <.0001     |         |
| Middle shool or lower            |                                | 26,914     | 26.8       | 11,072  | 41.1  | 15,842     | 58.9       |           |         |
| High school                      |                                | 31,545     | 31.4       | 11,125  | 35.3  | 20,420     | 64.7       |           |         |
| College or higher                |                                | 41,995     | 41.8       | 13,587  | 32.4  | 28,408     | 67.6       |           |         |
| Household income                 |                                |            |            |         | <.0001|            |            | <.0001     |         |
| Low                              |                                | 15,795     | 15.7       | 6,919   | 43.8  | 8,876      | 56.2       |           |         |
| Mid-low                          |                                | 30,637     | 30.5       | 11,529  | 37.6  | 19,108     | 62.4       |           |         |
| Mid-high                         |                                | 26,618     | 26.5       | 8,724   | 32.8  | 17,894     | 67.2       |           |         |
| High                             |                                | 27,404     | 27.3       | 8,612   | 31.4  | 18,792     | 68.6       |           |         |
| Smoking status                   |                                |            |            |         | <.0001|            |            | <.0001     |         |
| Current smokers                  |                                | 35,155     | 35.0       | 13,053  | 37.1  | 22,102     | 62.9       |           |         |
| Past smokers                     |                                | 37,909     | 37.7       | 14,146  | 37.3  | 23,763     | 62.7       |           |         |
| Nonsmoker                        |                                | 27,390     | 27.3       | 8,585   | 31.3  | 18,805     | 68.7       |           |         |
| Drinking status                  |                                |            |            |         | <.0001|            |            | <.0001     |         |
| Yes                              |                                | 67,608     | 67.3       | 23,653  | 35.0  | 43,955     | 65.0       |           |         |
| No                               |                                | 32,846     | 32.7       | 12,131  | 39.6  | 20,715     | 60.4       |           |         |
| Walking frequently               |                                |            |            |         | <.0001|            |            | <.0001     |         |
| Yes                              |                                | 45,799     | 45.6       | 15,599  | 34.1  | 30,200     | 65.9       |           |         |
| No                               |                                | 54,655     | 54.4       | 20,185  | 36.9  | 34,470     | 63.1       |           |         |
| Obesity status (BMI)             |                                |            |            |         | <.0001|            |            | <.0001     |         |
| Underweight & normal range       |                                | 2,337      | 2.3        | 982     | 42.0  | 1,355      | 58.0       |           |         |
| Overweight                       |                                | 44,744     | 44.5       | 16,131  | 36.1  | 28,613     | 63.9       |           |         |
| Obese                            |                                | 53,373     | 53.1       | 18,671  | 35.0  | 34,702     | 65.0       |           |         |
| The number of chronic diseases   |                                |            |            |         | <.0001|            |            | <.0001     |         |
collar (agriculture, forestry, fishery, and armed forces), and in occupation (those with no jobs, housewives, and students). Health factors included smoking status, drinking status, walking frequency, number of chronic diseases, perceived health status, and perceived stress.

Statistical analyses

Descriptive statistics are presented as frequencies (N) and percentages (%), and the chi-square test was used to assess significant difference in all covariates by ST and SQ categories. After adjusting for demographic and health factors, logistic regression analysis was performed to calculate the odds ratios (ORs) for all ST categories (4.0–5.9, 6.0–7.9, and ≥ 8.0 h/day) and compare the data with those of the shortest ST category (≤ 3.9 h/day); the lowest frequency was observed for an ST of 6.0–7.9 h/day (17.3 and 13.1%).

Figure 1 shows the subgroup analyses of the association between ST and poor SQ stratified by dependent variables. As shown in Fig. 1, greater sedentary time was associated with higher odds of poor SQ across each of the components of the PSQI such as sleep quality, sleep latency, sleep disturbance, use of sleeping medication, and daytime dysfunction.

Discussion

Our results show that more women have poor SQ than men, which is similar to those of previous studies [29, 30]. The reasons for the poorer SQ in women than in men have been explained in previous studies. Some reasons include hormonal differences due to menstruation, pregnancy and menopause [23], differences in the amounts of leisure time, socio-cultural factors due to

| Table 1 (continued) |
|---------------------|
| Variables           | Poor sleep quality (PSQI > 5) |
|                     | Men                              | Women                             |
|                     | TOTAL | Yes | No | P-value | TOTAL | Yes | No | P-value |
| N %     | N %     | N %     | N %     | N %     | N %     | N %     | N %     | N %     | N %     | N %     | N %     | N %     |
| 0       | 68,031 67.7 | 22,909 33.7 | 45,122 66.3 | 83,451 67.5 | 35,941 43.1 | 47,510 56.9 |
| 1       | 25,143 25.0 | 9,812 39.0 | 15,331 61.0 | 31,566 25.5 | 17,249 54.6 | 14,317 45.4 |
| 2       | 7,280 7.2  | 3,063 42.1 | 4,217 57.9 | 8,647 7.0  | 5,081 58.8 | 3,566 41.2 |
| Perceived health status<sup>a</sup> | <.0001 | <.0001 | | | | |
| Yes     | 77,817 77.5 | 24,276 31.2 | 53,541 68.8 | 93,964 76.0 | 39,192 41.7 | 54,772 58.3 |
| No      | 22,637 22.5 | 11,508 50.8 | 11,129 49.2 | 29,700 24.0 | 19,079 64.2 | 10,621 35.8 |
| Perceived stress<sup>b</sup> | <.0001 | <.0001 | | | | |
| Less    | 40,442 40.3 | 10,585 26.2 | 29,857 73.8 | 38,489 31.1 | 12,459 32.4 | 26,030 67.6 |
| More    | 60,012 59.7 | 25,199 42.0 | 34,813 58.0 | 85,175 68.9 | 45,812 53.8 | 39,363 46.2 |

<sup>a</sup> Three groups (white, pink, blue) based on the International Standard Classification Occupations code. Inoccupation group includes housewives

<sup>b</sup> Walking frequency: Based on the recommended walking volume according to the physical activity guidelines in Korea

<sup>c</sup> BMI: Body mass index/obesity status defined by BMI based on the 2018 Clinical Practice Guidelines for Overweight and Obesity in Korea

<sup>d</sup> Chronic disease was defined as diagnosed diseases: hypertension, diabetes. The number of chronic diseases is the sum of the number of diagnosed above diseases the sum of the number of diagnosed above diseases

<sup>e</sup> Perceived health status was classified the respondents of ‘very good’ and ‘good’ as ‘Yes’ and of ‘normal’, ‘bad’, and ‘very bad’ as ‘No’ group

Results

We analyzed each of the variables stratified by sex. Table 1 shows the general characteristics of the study population. Among the 224,118 study participants, poor

SQ was observed in 35,784/100,454 (35.6%) men and 58,271/123,664 (47.1%) women. As shown in Table 1, most men (32.8%) and women (39.7%) reported an ST of ≤ 3.9 h/day; the lowest frequency was observed for an ST of 6.0–7.9 h/day (17.3 and 13.1%).

Table 2 presents the factors associated with poor SQ by sex. In men, the odds of poor SQ increased with increasing ST: 4.0–5.9 h/day (OR: 1.12, 95% CI: 1.08–1.16), 6.0–7.9 h/day (OR: 1.19, 95% CI: 1.14–1.25), and ≥ 8.0 h/day (OR: 1.30, 95% CI: 1.25–1.34). Similarly, in women, the odds of poor SQ increased with increasing ST: 4.0–5.9 h/day (OR: 1.06, 95% CI: 1.03–1.10), 6.0–7.9 h/day (OR: 1.12, 95% CI: 1.08–1.16), and ≥ 8.0 h/day (OR: 1.22, 95% CI: 1.18–1.26).

Figure 1 shows the subgroup analyses of the association between ST and poor SQ stratified by dependent variables. As shown in Fig. 1, greater sedentary time was associated with higher odds of poor SQ across each of the components of the PSQI such as sleep quality, sleep latency, sleep disturbance, use of sleeping medication, and daytime dysfunction.
Table 2  Association between sedentary time and poor sleep quality

| Variables                          | Poor sleep quality (PSQI > 5) |          |          |
|------------------------------------|-------------------------------|----------|----------|
|                                    | Men                           | Women    |          |
|                                    | OR 95% CI                      | OR 95% CI|          |
| **Total**                          |                               |          |          |
| Sedentary time (hours/day)         |                               |          |          |
| ≤3.9                               | 1.00                          | 1.00     |          |
| 4.0-5.9                            | 1.12 (1.08 – 1.16)            | 1.06 (1.03 – 1.10)|          |
| 6.0-7.9                            | 1.19 (1.14 – 1.25)            | 1.12 (1.08 – 1.16)|          |
| ≥8.0                               | 1.30 (1.25 – 1.34)            | 1.22 (1.18 – 1.26)|          |
| Age                                |                               |          |          |
| 19-29                              | 1.00                          | 1.00     |          |
| 30-39                              | 1.28 (1.20 – 1.36)            | 1.15 (1.09 – 1.22)|          |
| 40-49                              | 1.29 (1.21 – 1.37)            | 1.07 (1.02 – 1.13)|          |
| 50-59                              | 1.33 (1.25 – 1.42)            | 1.32 (1.25 – 1.40)|          |
| 60-69                              | 1.35 (1.26 – 1.44)            | 1.39 (1.30 – 1.47)|          |
| ≥70                                | 1.47 (1.37 – 1.58)            | 1.53 (1.43 – 1.63)|          |
| Marital status                     |                               |          |          |
| Living with spouse                 | 1.00                          | 1.00     |          |
| Living without spouse              | 1.36 (1.31 – 1.41)            | 1.08 (1.05 – 1.11)|          |
| Occupational categories<sup>a</sup>|                               |          |          |
| White                              | 1.00                          | 1.00     |          |
| Pink                               | 1.02 (0.96 – 1.07)            | 1.07 (1.02 – 1.12)|          |
| Blue                               | 1.07 (1.03 – 1.12)            | 1.08 (1.03 – 1.13)|          |
| Inoccupation                       | 1.18 (1.12 – 1.24)            | 1.28 (1.23 – 1.33)|          |
| Educational level                  |                               |          |          |
| Middle school or lower             | 1.00                          | 1.00     |          |
| High school                        | 0.91 (0.87 – 0.94)            | 0.89 (0.86 – 0.93)|          |
| College or higher                  | 0.87 (0.83 – 0.92)            | 0.80 (0.77 – 0.84)|          |
| Household income                   |                               |          |          |
| Low                                | 1.00                          | 1.00     |          |
| Mid-low                            | 0.90 (0.87 – 0.94)            | 0.91 (0.88 – 0.94)|          |
| Mid-high                           | 0.82 (0.79 – 0.86)            | 0.85 (0.82 – 0.88)|          |
| High                               | 0.81 (0.77 – 0.85)            | 0.85 (0.82 – 0.89)|          |
| Smoking status                     |                               |          |          |
| Current smokers                    | 1.00                          | 1.00     |          |
| Past smokers                       | 1.00 (0.97 – 1.04)            | 0.90 (0.81 – 1.00)|          |
| Nonsmokers                         | 0.87 (0.84 – 0.90)            | 0.64 (0.59 – 0.68)|          |
| Drinking status                    |                               |          |          |
| Yes                                | 1.00                          | 1.00     |          |
| No                                 | 0.95 (0.92 – 0.98)            | 0.90 (0.87 – 0.92)|          |
| Walking frequently<sup>b</sup>     |                               |          |          |
| Yes                                | 1.00                          | 1.00     |          |
| No                                 | 1.03 (1.00 – 1.06)            | 1.05 (1.02 – 1.07)|          |
| Obesity status (BMI)<sup>c</sup>   |                               |          |          |
| Underweight & normal range         | 1.00                          | 1.00     |          |
| Overweight                         | 0.97 (0.89 – 1.06)            | 0.99 (0.93 – 1.06)|          |
| Obese                              | 0.92 (0.84 – 1.00)            | 0.96 (0.90 – 1.02)|          |
| The number of chronic diseases<sup>d</sup>|                             |          |          |
| 0                                  | 1.00                          | 1.00     |          |
| 1                                  | 1.04 (1.01 – 1.08)            | 1.05 (1.01 – 1.08)|          |
housework [31], and the high prevalence of mental disorders in women [32].

Our study results suggest there is a positive association between sedentary time and sleep problems. Several studies also demonstrate this association [30]. Furthermore, several mechanisms according to these associations have also been proposed [16, 33–36]. A potential mechanism for this is that sleep time can be impaired by the amount of time spent exercising certain behaviors, given that ST is usually associated with watching television or computer use [16, 33]. Insufficient sleep time can be a factor that naturally lowers the quality of sleep [30]. Increased ST, such as from watching television and computer use, may increase the risk of mental health problems by promoting social isolation and limiting development of social network [34, 37]. Consequently, increased ST is associated with mental health problems such as depression, which may contribute to poor SQ [38–40]. Furthermore, light-emitting diode (LED)-backlit displays are increasingly used in TV and computer screens. The LED-backlit display may cause significant suppression of melatonin, thus affecting the biological clock and possibly resulting in sleep problems [35]. In addition, sedentary behavior also contributes to the onset and progression of metabolic syndrome, which can cause sleep problems [41]. Moreover, compared to sedentary behavior, non-sedentary behavior is associated with increased energy expenditure/metabolic rate and fatigue, which may reduce the risk of sleep problems [42, 43]. Regardless of achieving sufficient physical activity, standing behavior alone can cope with this [2, 41].

In our study, from the subgroup analysis stratified by the seven items of PSQI, sleep duration and habitual sleep efficiency were not dose-response related to ST. This result is consistent with those of previous studies that defined ST as a comprehensive state and that examined the relationship between sleep duration and ST [16]. However, the result is inconsistent previous studies that examined the association of ST with sleep duration by focusing on screen time [44]. Therefore, because our study included all relevant activities while defining ST, including reading books, writing, and watching television, it seems that there was no difference in the relationship between ST and sleep duration. Additionally, previous studies showed different results for habitual sleep efficiency depending on how ST was defined [30]. Therefore, more in-depth research is needed to examine the relationship of ST with sleep duration and habitual sleep efficiency.

Although the results of this study can play an important role in clarifying how ST is associated with poor SQ, it has some limitations. First, we used cross-sectional data; thus, we could only determine the association between ST and SQ. We could not investigate the causal relationship between these two variables. According to a recent study, poor sleep quality for one night impacts daily life the following day, including increased sedentary time. As such, there is a possibility of a similar observation seen in the reverse direction [45]. Further explanatory research is needed to infer causality. Second, the sub-category measures of ST and SQ were self-reported. As such, these measures were dependent on participants’ ability to recall, and the responses might not have been accurate. Third, ST was broadly defined and investigated. ST is not specific because it was deduced from the response to one
question. Therefore, to examine the relationship between ST and SQ more precisely, detailed investigation of ST is needed in further studies.

Despite these limitations, our research has several advantages. As this study was conducted using a large sample, the results can be considered representative of the Korean population. Our study is meaningful because unlike previous studies, ST was comprehensively investigated and analyzed without focusing only on-screen time (watching TV and using the Internet). Furthermore, unlike previous studies, we used the PSQI, which is a useful tool that can comprehensively examine SQ.

**Conclusions**

This study confirmed that both men and women were at risk of the threat of poor SQ due to prolonged ST. Replacing ST with light-intensity physical activity or even standing time may have a positive effect on health [2, 18]. Therefore, to reduce ST and to promote healthy behaviors, the following points should be considered: As mental health-related studies involving ST and SQ are scarce, qualitative and quantitative research is needed to identify sedentary behavior patterns and to investigate their causal relationships with health status according to the types and classifications of sedentary behaviors. Furthermore, based on the results of these studies, national
programs will be needed, such as those for developing ST guidelines, which can then be used to develop and evaluate health programs. Additionally, the government should identify measures to limit excessive exposure to LED screens so that healthy leisure activities can be adopted to reduce ST.

Abbreviations
CI: Confidence interval; KCHS: Korea Community Health Survey; LED: Light-emitting diode; OR: Odds ratio; PQSI: Pittsburgh Sleep Quality Index; SQ: Sleep quality; ST: Sedentary time.

Acknowledgements
We express our gratitude to the Korea Centers for Disease Control and Prevention for providing the data of a nationwide survey. We also thank our colleagues at Yonsei University’s Health Research Institute for their advice on drafting the manuscript.

Authors’ contributions
SHJ, BNJ and S-U designed the study. SHJ, SHK and GRK collected the data, performed statistical analysis, and drafted the manuscript. SHJ, BNJ, SHK, GRK, E-CF and S-U contributed to the discussion and reviewed and edited the manuscript. SU is the guarantor of this work and, as such, had full access to all study data. SU assumes responsibility for the integrity of the data and the accuracy of the data analysis. All authors have read and agreed to the published version of the manuscript.

Funding
This work was supported by a grant of the Korea Health Technology R&D Project through the Korea Health Industry Development Institute (KHIDI), funded by the Ministry of Health & Welfare, Republic of Korea (grant number: HI20C1130).

Availability of data and materials
Publicly available datasets were analyzed in this study. These data can be found here: [https://chs.kdca.go.kr/chs/main.do](https://chs.kdca.go.kr/chs/main.do) (accessed on 6 May 2021).

Declarations

Ethics approval and consent to participate
The Korea Community Health Survey (KCHS) data are openly published. Participants’ data was completely anonymized prior to launch. Our study was exclude from the review list pursuant to Article 2.2 of the Enforcement Rule of Bioethics and Safety Act in Korea, since the data was exempted from IRB review. All procedures performed in studies involving human participants were in accordance with the ethical standards of the national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent for publication
Not applicable

Competing interests
The authors declare that they have no competing interests.

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Received: 28 May 2021 Accepted: 2 December 2021 Published online: 15 December 2021

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