Characteristics of napping in community-dwelling insomnia patients

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Abstract
Objective: We aimed to determine napping characteristics of community-dwelling patients with insomnia disorder (ID) compared to characteristics of normal controls (NC), and to examine the effect of napping on nocturnal sleep.

Methods: Adult volunteers who were more than 18 years old were recruited from three rural public health centers in Korea. Data from actigraphy recording and a sleep diary filled out for seven days were obtained. Finally, 115 ID patients and 80 NC subjects were included in this study. Parameters and timing of nocturnal sleep and nap were compared between the two groups. Two-way analysis of covariance (ANCOVA) was performed to determine the effect of ID diagnosis and napping on sleep parameters.

Results: Sleep efficiency (SE) in the ID group was significantly lower (p = 0.010), and wake time after sleep onset (WASO) was significantly greater (p = 0.023), compared to the NC group. There was no significant difference in nocturnal sleep or nap timing between the two groups. Nap frequency in the ID group was significantly higher than that in the NC group (p = 0.025). Although ID diagnosis and napping had no independent effect on fragmentation index, their interaction had a significant effect on fragmentation index (p = 0.021). Nap frequency was positively correlated with PSQI score (r = 0.166, p = 0.033).

Conclusion: Insomnia patients showed no significant difference in nap timing or nap duration compared to NC subjects. However, insomnia patients showed higher nap frequency. Frequent napping was associated with poorer subjective sleep quality. Therefore, although napping might not have a negative impact on nocturnal sleep in NC subjects, it did have an effect on nocturnal sleep in insomnia patients.

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1. Introduction
Insomnia disorder is caused by various factors, including physical illnesses, psychiatric disorders, medications, and psychosocial issues, resulting in significant impairment in daily function [1–3]. It has been known that older adults usually show poorer sleep quality with reduced sleep continuity, accompanied by changes in sleep architecture and sleep–wake pattern. Epidemiological studies show that insomnia disorder is highly prevalent among elderly persons, and, particularly in elderly individuals, is frequently associated with existing comorbid conditions [4,5].

Decreased quantity and quality of nocturnal sleep can cause daytime sleepiness, which can lead to serious car accidents [3], impaired cognitive performance [6–8], and poorer quality of life. Accordingly, daytime sleepiness has a clinical importance, and can result in increased napping [1,3].

Previous studies have reported some beneficial effects of napping on daytime alertness, task performance, and mood [6–12]. However, there have been some reports that daytime napping was associated with increased cardiovascular morbidity and higher mortality [13–19]. The causal relationship between daytime napping and the risk of cardiovascular disease has not been elucidated [20]; and needs to be investigated further.
The effect of napping on nocturnal sleep is a controversial issue. Some studies have found that napping is significantly associated with reduced total sleep time, lower sleep efficiency, and earlier wake time [11,16,21]. However, other studies have found no significant causal relationship between daytime napping and nighttime sleep [12,22–26].

Although many studies on napping have been conducted by using questionnaires and wrist actigraphy or polysomnography, their methods and results remain controversial [22,27]. One study compared nap characteristics between insomnia patients and normal control subjects, however it had the limitation that the nap behavior was assessed with self-questionnaire only [28].

In this study, we aimed to compare the questionnaire scores, nocturnal sleep parameters, nap variables including nap frequency and nap duration, and timing of nap and nocturnal sleep between an insomnia disorder (ID) group and normal control (NC) group, as well as examine whether insomnia or nap might have effect on nocturnal sleep.

2. Methods

2.1. Study subjects

Subjects who were above 18 years old were recruited from three Public Health Centers in a rural area of Korea from September 2013 to October 2015. The subjects voluntarily participated in our study after being recruited through advertisements when they visited public health centers to attend health promotion programs or to get a medical check-up. Questionnaires including the Korean version of the Epworth Sleepiness Scale (KESS) [29], the Pittsburgh Sleep Quality Index (PSQI) [30], and the Korean version of the Beck Depression Inventory (BDI-K) were administered to 252 subjects. There were other questions about shift work, sleep habits, caffeine intake, and whether the subject had been diagnosed with a sleep disorder. To rule out other sleep disorders such as obstructive sleep apnea syndrome and narcolepsy, which may cause excessive daytime sleepiness, clinical sleep specialists assessed the subjects in person. According to the criteria of the International Classification of Sleep Disorder, second edition (ICSD-2), insomnia was defined as a complaint of difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS), early morning awakening (EMA), or nonrestorative sleep (NRS) three or more times per week during a recent month.

We excluded the following: individuals with an irregular sleep–wake schedule due to shift work; those with major depressive disorder, substance use disorder, or other psychiatric disorders based on Diagnostic and Statistical Manual of Mental Disorder, fourth Edition, Text Revision (DSM-IV-TR); those with present illness including heart disease, chronic pulmonary disease, cancer, uncontrolled diabetes, or uncontrolled hypertension; those with a prior history of cerebrovascular disease, central nervous system disease, or evidence of central nervous system injury; those with current medications affecting sleep or wakefulness; and those suspected of having primary sleep disorders that cause excessive daytime sleepiness (ie, obstructive sleep apnea, restless legs syndrome, narcolepsy, etc.).

After excluding five individuals with depressive disorder, three individuals who refused the actigraphy recording, and one person who was taking psychotropic drugs, actigraphy recordings (Actiwatch 2, Philips Respironics, Monroeville, PA) were conducted for 243 subjects for seven days, along with filling out a sleep diary.

After excluding eight subjects who abandoned the study in the middle of obtaining actigraphic data, 15 subjects without recorded data due to technical errors of Actiwatch software (Actiware version 6.0.2.), 15 subjects with incorrect sleep diaries, six subjects who wore actigraphy instruments for too short a time, three subjects with sleep–wake patterns that deviated from their ordinary ones due to special events or alcohol drinking, and one subject who took an antihistamine, a total of 195 subjects were included in the final analysis. If there were any invalid data for one or two dates for reasons described above, such data were excluded from statistical analysis.

The study was approved by the Institutional Review Board at Kangwon National University Hospital. Written informed consent was obtained from each enrolled subject. All procedures in the study were carried out in accordance with the principles of the Declaration of Helsinki.

2.2. Nap analysis by actigraphy

Bed time and wake time were manually set into the actogram to determine rest intervals based on each subject’s sleep diary. Sleep intervals were automatically detected by an Actiware version 6.0.2 (Actiwatch Communication and Sleep Analysis Software) algorithm, once rest intervals were defined. Included intervals were manually set when subjects removed the Actiwatch or for periods with invalid data. Analysis was conducted with Actiware using one minute sampling epochs and a wake threshold value of 40 activity counts. Nocturnal sleep parameters from actigraphy included the time in bed (TIB), total sleep time (TST), sleep onset latency (SOL), wake time after sleep onset (WASO), sleep efficiency (SE), and fragmentation index (FI) [31,32].

In nap analysis, a sleep period was computed automatically within the rest interval, excluding nocturnal sleep period based on the sleep diary. This was considered as a nap period. Rest intervals were automatically obtained with a sensitivity setting at medium level. A minimum minor rest interval was set at 40 min.

For 18 subjects who described naps in detail in their sleep diaries, agreement between naps recorded in the sleep diary and naps computed automatically by the Actiwatch software was analyzed. Variabilities in timing and duration of the first nap between the two nap data sets were compared using mean absolute deviation. As a result, the mean absolute deviation of the start time, end time, midtime, and duration were 4.12 ± 8.50 min, 1.27 ± 2.57 min, 2.21 ± 3.82 min, and 5.39 ± 9.35 min, respectively. Pearson correlation analysis showed that these parameters were significantly correlated each other (r = 0.997, 1.000, 0.999, and 0.914, respectively; p < 0.001). These results indicated that the nap parameters analyzed by actigraphy were relatively valid.

Nap timing data such as nap start time, end time, midtime, and interval between wake-up time and start time of the following nap were obtained for ID and NC groups. These parameters were determined only for the first nap if there were two or more naps per day.

2.3. Statistical analysis

Demographic variables and scores of the KESS, PSQI, and BDI-K were compared between the ID and NC groups with independent t test, χ² test, or analysis of covariance (ANCOVA) controlling for age.

Nocturnal sleep parameters and nap parameters were compared between the ID and NC groups by ANCOVA controlling for age. Effects of ID diagnosis and napping on nocturnal sleep parameters were analyzed using two-way ANCOVA controlling for age. In the combined group, partial correlations after controlling age were conducted among questionnaire scores, nap variables, and nocturnal sleep parameters. All statistical analyses were performed using the SPSS software package, version 18.0 (SPSS Inc, Chicago, IL). Two-sided p values of less than 0.05 were considered statistically significant.
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