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ORIGINAL ARTICLE

The eveningness chronotype is associated with nightmare distress and dream recall: a cross-sectional study

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Abstract

Dreaming may be affected by sleep behavior; however, evidence of the effect of chronotypes on dreaming is limited. We investigated sleep patterns, dream recall, and nightmare distress according to chronotypes. This cross-sectional study retrospectively enrolled adult participants (age > 18 years) who visited a sleep laboratory between 2016 and 2021 and underwent standard polysomnography (PSG) and completed a self-reported questionnaire. Patients with major sleep disorders were excluded. Chronotypes and dreaming components were assessed using the Korean version of the morningness–eveningness questionnaire and a nine-item dreaming questionnaire (nightmare distress and dream recall), respectively. Among healthy participants without major sleep disorders, the eveningness chronotype correlated with better dream recall than the morningness and intermediate chronotypes. Participants with the eveningness chronotype were younger and more likely to be unmarried than those with the other chronotypes. No significant chronotype-based difference was observed in the subjective measurements of sleep quality, insomnia, daytime sleepiness, depression, and anxiety or in respiration and movement events on PSG. In multivariate linear regression analysis, the chronotypes were independently related to nightmare distress ($b = -0.296$; $p = 0.002$) and dream recall ($b = -0.334$; $p = 0.002$). The apnea–hypopnea index was associated with nightmare distress ($b = -0.209$; $p = 0.029$) and dream recall ($b = -0.189$; $p = 0.044$). Depression was positively correlated with nightmare distress ($b = 0.450$; $p = 0.002$). Dream recall was best in the eveningness group among healthy adults. Greater eveningness was associated with higher nightmare distress and better dream recall. Further research is needed to understand the role of chronotypes in dreaming.

Keywords Chronotype · Circadian rhythm · Dream · Nightmare · Dream recall

Introduction

A chronotype refers to an individual's preferred timing for sleep and activity [1]. Morningness corresponds to an earlier sleep–wake schedule than eveningness. Individuals with different chronotypes present significant variations in psychological, behavioral, and biological aspects [2]. A growing body of research indicates that chronotypes might impact general health, including physical and psychological outcomes [3]. Chronotypes may play a significant role in sleep features [4–6], including sleep efficiency, sleep duration, and sleep complaints, which differ between morningness and eveningness. Thus, eveningness may be associated with daytime sleepiness, maladaptive beliefs about sleep, irregular sleep–wake habits, and poor voluntary control of sleep habits [3–6]. As most of the previous studies evaluated sleep parameters using self-reported data from surveys, major sleep disorders, such as obstructive sleep apnea (OSA), have not been excluded, and inconsistent results have been reported in the laboratory setting [6–8].

Dreaming may be affected by sleep behavior [9], and several studies have shown the possibility of a relationship between nightmares and chronotypes [10–12]. However, with the exception of studies on nightmares, few studies have investigated the effect of chronotypes on dreaming, which may reflect brain mechanisms related to emotion and memory processing during sleep [9]. Dreaming has been investigated as a cognitive and psychological aspect [9, 13, 14]. Dream recall may be associated with sleep patterns as well as sex, waking life, personality, or mood [13, 15].

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However, evidence of the association between dream recall and chronotypes is limited.

This study aimed to investigate chronotype-based sleep patterns using polysomnography (PSG) and a self-reported questionnaire. Furthermore, dream recall and nightmare distress were investigated in relation to chronotypes in healthy people without major sleep disorders to help elucidate the relationship between dreaming and chronotypes.

Materials and methods

Participants and clinical data

In this cross-sectional study, we retrospectively enrolled participants who visited a sleep laboratory for the evaluation of sleep disorders between 2016 and 2021. Participants were eligible for the trial if they were older than 18 years and underwent a standard PSG. We excluded participants who had major sleep disorders, based on the International Classification of Sleep Disorders-Third edition, such as obstructive sleep apnea disorders (apnea–hypopnea index [AHI] ≥ 15 per hour), parasomnia (rapid eye movement [REM] sleep behavior disorder, nightmare disorder, sleepwalking, and sleep terror), chronic insomnia disorder, restless legs syndrome, circadian rhythm sleep–wake disorder, and narcolepsy. Diagnoses of mental, neurological, or other medical disorders were the additional exclusion criteria. Moreover, participants were excluded if the PSG and clinical data were insufficient. Finally, 87 participants were included.

Patient information, including age, sex, marital status, body mass index, calculated as the weight in kilograms divided by the square of the height in meters, Epworth Sleepiness Scale scores, Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index (ISI), Beck Depression Inventory (BDI) scores, and State-Trait Anxiety Inventory-State (STAI-S) scale scores, as well as the proportion of each sleep stage, sleep latency, total sleep time, sleep efficiency, wake after sleep onset, AHI, minimum arterial oxygen saturation ($minSaO_2$), and periodic limb movement index (PLMI) were collected.

The chronotypes were assessed using the Korean version of the morningness–eveningness questionnaire (MEQ) [16]. Scores ranged between 16 and 86 points, and chronotypes were classified as the evening-type (16–41 points), intermediate-type (42–58 points), and morning-type (59–86 points).

To assess dreaming components in the study population, a dreaming questionnaire with nine items, to determine nightmare distress and dream recall, was used [14]. This self-reported measure used a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) points.

This study was approved by the Institutional Review Board of Chung-Ang University College of Medicine (IRB No. 2204-021-19417). Written informed consent was obtained from each participant before enrollment in the study.

Sleep studies

The participants arrived at the laboratory at approximately 9 pm with the completed questionnaires. The “light off” time was 11 pm and the “light on” time was at the final wake-up time or at 8 am. The participants were assessed using Level 1 in-laboratory PSG (Nihon Kohden, Shinjukuku, Tokyo, Japan). Electroencephalography according to the International 10–20 system (F4-A1, F3-A2, C4-A1, C3-A2, O2-A1, O1-A2), right and left electrooculogram, chin and leg electromyogram, electrocardiogram, oronasal thermal airflow sensor and nasal pressure transducer for airflow detection, thoracic and abdominal respiratory inductance plethysmography belts for monitoring respiratory effort, sensors for snoring and body position, and finger-pulse oximetry for arterial oxygen saturation and pulse rate were performed. The impedance for all the electrodes was maintained less than 5 kΩ.

Sleep and associated events were scored according to the American Academy of Sleep Medicine guidelines [17]. Sleep stages were segmented into REM or R sleep stage and non-REM (NREM) sleep stages 1 (N1), 2 (N2), and 3 (N3). The total sleep time was defined as the time spent in the N1, N2, N3, and R stages, and sleep latency was defined as the duration from lights out to the first epoch of any sleep phase. The sleep efficiency index in percentage is the ratio of total sleep time (based on PSG recordings) to the time spent in bed (period between "lights off" and "light on"). “Wake after sleep onset” refers to the periods of wakefulness that occur after the defined sleep onset. Apnea was defined as a ≥ 90% drop in the peak thermal sensor excursion from the baseline value for at least 10 s. Hypopnea was defined as a ≥ 30% drop in the nasal pressure signal excursion from the baseline value for 10 s that was accompanied by a ≥ 4% reduction in oxygen saturation from the pre-event baseline. AHI was defined as the average number of episodes of apnea and hypopnea per hour. Periodic limb movements were identified by the pattern of limb movement according to the American Academy of Sleep Medicine scoring manual (more than four limb movements and an interval of 5–90 s) [17]. The PLMI comprises the number of periodic limb movements per hour of sleep.

Statistical analysis

Normally distributed variables are expressed as means and standard deviations (SDs), and non-normally distributed variables are expressed as the medians and interquartile ranges. To compare the clinical characteristics between chronotype

subgroups (morningness, intermediate, and eveningness), the analysis of variance (ANOVA), Kruskal–Wallis test, and Fisher's exact test were used. The analysis of covariance (ANCOVA) and ranked ANCOVA were used to adjust for the age effect. The Bonferroni correction was used for *post-hoc* analyses.

Linear regression analyses were performed to investigate the association between chronotypes and dreams. In the univariate linear regression analysis, we investigated variables related to nightmare distress or dream recall scores. Among demographic factors (age and sex), sleep parameters (AHI and PLMI in PSG, PSQI score, and ISI score), and psychological variables (BDI and STAI-S scores), variables with $p < 0.05$ in the univariate analyses were entered into the multivariate linear regression analysis. Nightmare distress and dream recall scores were the dependent variables, and the MEQ score was the independent variable. Multivariate linear regression analyses were performed to determine whether the MEQ score was independently associated with nightmare distress and dream recall. Data were analyzed using SPSS Statistics version 26.0 (SPSS Inc., Chicago, IL, USA).

Results

Clinical characteristics according to chronotype

The clinical and polysomnographic characteristics of each chronotype are shown in Table 1. The mean age was 46.2 (SD = 14.8) years, and participants with the eveningness

Table 1 Clinical characteristics according to the participant's chronotype

	Chronotype				
	Eveningness ($n=25$)	Intermediate ($n=52$)	Morningness ($n=10$)	p	p*
Age, years, mean ± SD	36.9 ± 16.7	49.1 ± 12.6	54.6 ± 9.3	< 0.001	
Female sex, *n* (%)	12 (48.0%)	22 (42.3%)	2 (20.0%)	0.352	
Married, *n* (%)	8 (38.1%)	40 (76.9%)	9 (90.0%)	< 0.001	
Body mass index, kg/m^2, mean ± SD	23.7 ± 3.9	24.5 ± 3.3	23.3 ± 2.9	0.500	0.539
Sleep latency, minutes, median (interquartile range)	6.0 (3.8–19.0)	6.0 (4.0–16.5)	3.3 (2.0–7.1)	0.150	0.183
Wake after sleep onset, minutes, median (interquartile range)	39.0 (24.0–76.3)	53.0 (28.5–93.5)	33.3 (16.8–71.0)	0.503	0.475
Total sleep time, minutes, median (interquartile range)	347.0 (302.4–371.5)	357 (328.7–368.0)	376.8 (343.0–425.2)	0.232	0.076
Sleep efficiency, %, median (interquartile range)	85.5 (72.0–92.6)	84.1 (75.0–92.3)	89.6 (83.4–95.1)	0.322	0.229
Proportion of NREM sleep stage 1, minutes, median (interquartile range)	14.7 (12.1–21.0)	18.9 (16.0–22.2)	10.1 (5.0–26.0)	0.477	0.378
Proportion of NREM sleep stage 2, minutes, median (interquartile range)	58.9 (54.3–62.2)	60.0 (57.5–62.8)	61.0 (53.0–66.4)	0.806	0.634
Proportion of NREM sleep stage 3, minutes, median (interquartile range)	10.3 (8.3–15.4)	6.1 (5.9–9.6)	9.8 (5.6–15.5)	0.081	0.104
Proportion of REM sleep stage, minutes, median (interquartile range)	12.6 (10.8–16.2)	12.8 (11.5–14.7)	15.6 (10.0–18.5)	0.503	0.478
Apnea–hypopnea index, per hour, median (interquartile range)	7.7 (4.0–9.9)	8.0 (4.9–12.0)	6.3 (1.8–10.0)	0.374	0.434
Minimal arterial oxygen saturation, %, median (interquartile range)	92.0 (86.5–94.0)	89.0 (85.3–92.0)	92.0 (87.3–95.0)	0.167	0.182
Periodic limb movement index, per hour , median (interquartile range)	0.0 (0.0–34.5)	0.0 (0.0–36.0)	0.0 (0.0–36.0)	0.662	0.718
Pittsburgh sleep quality index, median (interquartile range)	2.0 (2.0–3.0)	2.0 (1.0–3.0)	2.0 (1.0–3.0)	0.505	0.267
Epworth sleepiness scale, median (interquartile range)	8.0 (4.0–12.0)	8.0 (3.0–12.0)	8.0 (3.0–12.0)	0.833	0.911
Insomnia severity index, mean ± SD	12.9 ± 5.8	13.4 ± 7.6	12.1 ± 8.2	0.868	0.566
Beck's depression inventory, mean ± SD	13.7 ± 8.8	12.1 ± 6.7	12.2 ± 5.9	0.674	0.899
State trait anxiety inventory-state scale, mean ± SD	43.2 ± 13.2	41.7 ± 10.5	42.2 ± 10.9	0.867	0.950
Nightmare distress, median (interquartile range)	12.0 (5.5–14.5)	6.5 (5.0–11.0)	5.5 (5.0–8.8)	0.039	0.092
Dream recall, mean ± SD	13.5 ± 3.7	10.2 ± 3.1	9.8 ± 2.8	< 0.001	0.007

Adjusted for age using analysis of covariance (ANCOVA) or ranked ANCOVA

NREM nonrapid eye movement, *REM* rapid eye movement

chronotype were significantly younger than those with the other chronotypes (ANOVA, $p < 0.001$), specifically the intermediate (Bonferroni; $p = 0.001$) and morningness groups (Bonferroni; $p = 0.002$) (Table 1). The proportion of married people was 90.0% for the morningness chronotype and 76.9% for the intermediate chronotype; however, 38.1% of the eveningness chronotype were married (Fisher's exact test, $p = 0.002$), and were more likely to be unmarried than those with the intermediate (Bonferroni, $p = 0.001$) and morningness chronotypes (Bonferroni, $p = 0.008$).

Nightmare distress (Kruskal–Wallis test, $p = 0.039$) and dream recall (ANOVA, $p < 0.001$) differed among the chronotypes. We found a significant difference in dream recall (ANVOCA, $p = 0.007$) even after adjusting for age, but not in nightmare distress (ranked ANCOVA, $p = 0.092$). Individuals with the eveningness chronotype presented higher dream recall than those in the intermediate (Bonferroni; $p = 0.002$) and morningness groups (Bonferroni; $p = 0.032$) in post hoc analysis (Table 1).

Association of chronotypes with nightmare distress

In the univariate linear regression analysis (Table 2), the MEQ score was related to nightmare distress ($b = -0.327$; $p = 0.002$). A higher body mass index ($b = -0.269$; $p = 0.012$), higher AHI ($b = -0.277$; $p = 0.009$) and lower $minSaO_2$ ($b = 0.296$; $p = 0.005$) were related to lower nightmare distress, whereas lower sleep quality (higher PSQI; $b = 0.223$; $p = 0.038$) and higher insomnia severity ($b = 0.229$; $p = 0.033$) were associated with higher nightmare distress. Higher BDI ($b = 0.518$; $p < 0.001$) and STAI-S ($b = 0.386$; $p < 0.001$) scores were associated with higher nightmare distress.

The multivariate linear regression model for nightmare distress consisted of the MEQ, AHI, PSQI, ISI, BDI, and STAI-S scores (Table 3). Chronotypes were identified as independent factors that were related to nightmare distress ($b = -0.296$; $p = 0.002$), and depression was also associated with nightmare distress ($b = 0.450$; $p = 0.002$), independently. Furthermore, a higher AHI was associated with decreased nightmare distress ($b = -0.209$; $p = 0.029$). However, the statistical significance of the PSQI, ISI, and STAI-S

Table 2 Results of linear regression for nightmare distress and dream recall (univariate)

	Nightmare distress			Dream recall		
	Standardized coefficients	*t*	*p* value	Standardized coefficients	*t*	*p* value
	B			B		
Age, years, mean (SD)	−0.189	−1.963	0.080	−0.361	−3.573	0.001
Female sex, *n* (%)	−0.095	−0.876	0.384	−0.177	−1.660	0.101
Married, *n* (%)	−0.189	−1.775	0.080	−0.400	−4.027	< 0.001
Body mass index, kg/m^2	−0.269	−2.563	0.012	−0.285	−2.724	0.008
Sleep latency, minutes	0.029	0.263	0.793	0.013	0.116	0.908
Wake after sleep onset, minutes	0.141	1.304	0.196	0.158	1.463	0.147
Total sleep time, minutes	0.090	0.837	0.405	−0.047	−0.432	0.667
Sleep efficiency, %	−0.052	−0.484	0.630	−0.088	−0.818	0.415
Proportion of NREM sleep stage 1, minutes	−0.100	−0.929	0.355	−0.090	−0.833	0.407
Proportion of NREM sleep stage 2, minutes	−0.019	−0.175	0.861	0.015	0.136	0.892
Proportion of NREM sleep stage 3, minutes	0.081	0.746	0.458	0.130	1.212	0.229
Proportion of REM sleep stage, minutes	0.121	1.126	0.263	−0.016	−0.143	0.886
Apnea–hypopnea index, per hour	−0.277	−2.655	0.009	−0.311	−3.013	0.003
Minimal arterial oxygen saturation, %	0.296	2.854	0.005	0.185	1.735	0.086
Periodic limb movement index, per hour	0.025	0.225	0.823	0.044	0.405	0.686
Pittsburgh sleep quality index	0.223	2.107	0.038	0.147	1.372	0.174
Epworth sleepiness scale	0.114	1.062	0.291	−0.002	−0.016	0.987
Insomnia severity index	0.229	2.173	0.033	0.140	1.306	0.195
Beck's depression inventory	0.518	5.383	< 0.001	0.447	4.441	< 0.001
State trait anxiety inventory-state scale	0.386	3.721	< 0.001	0.390	3.768	< 0.001
Morningness–eveningness questionnaire	−0.327	−3.189	0.002	−0.423	−4.305	< 0.001

NREM nonrapid eye movement, *REM* rapid eye movement

Table 3 Results of linear regression for nightmare distress and dream recall (multivariate)

	Nightmare distress			Dream recall		
	Standardized coefficients *b*	*t*	*p* value	Standardized coefficients *b*	*t*	*p* value
Morningness–eveningness questionnaire	−0.296	−3.214	0.002	−0.334	−3.281	0.002
Age, years, mean (SD)				−0.101	−0.975	0.333
Female sex, *n* (%)						
Apnea–hypopnea index, per hour	−0.209	−2.222	0.029	−0.189	−2.053	0.044
Pittsburgh sleep quality index	−0.036	−0.288	0.774			
Insomnia severity index	0.036	0.285	0.776			
Beck depression inventory	0.450	3.165	0.002	0.246	1.759	0.083
State trait anxiety inventory-state scale	−0.011	−0.077	0.939	0.143	1.037	0.303

scores in the multivariate analysis disappeared in relation to nightmare distress.

Association of chronotypes with dream recall

In the univariate linear regression analysis (Table 2), the MEQ score was related to dream recall ($b = -0.423$; $p < 0.001$). Moreover, aging ($b = -0.361$; $p = 0.001$), marriage ($b = -0.400$; $p < 0.001$) and increased body mass index ($b = -0.285$; $p = 0.008$) reduced the scores of dream recall. A higher AHI was related to a lower dream recall ($b = -0.311$; $p = 0.003$), whereas higher BDI ($b = 0.447$; $p < 0.001$) and STAI-S ($b = 0.390$; $p < 0.001$) scores were associated with higher dream recall.

The multivariate linear regression model for dream recall consisted of the MEQ, age, AHI, BDI, and STAI-S scores (Table 3). The results showed that the chronotypes were independently related to dreaming recall ($b = -0.334$; $p = 0.002$). A higher AHI was associated with diminished dream recall ($b = -0.189$; $p = 0.044$).

Discussion

After excluding patients with sleep disorders in PSG, this study identified that individuals with the eveningness chronotype had better dream recall than those with morningness and intermediate chronotypes. Greater eveningness positively correlated with nightmare distress and dream recall. Previous studies have mostly focused on nightmares [10–12], and few studies have investigated dream recall. Herein, we identified a relationship between the eveningness chronotype and dream recall. Sleep is influenced by circadian rhythms, which results in a higher dream recall frequency at the end of the night than at the beginning of the night, irrespective of the sleep stage [18]. On average, dream reports are longer, more vivid, story-like, and bizarre in the second part of the night than at other times [15]. The most vivid dreaming occurs during REM sleep, close to the early morning peak of REM propensity, which is also when most nightmares occur [11]. The dream recall frequency is higher after awakening during REM sleep than after awakening during NREM sleep [19]. Those with the evening chronotype not only habitually wake up at a later time than individuals with the morning chronotype but also wake up at an earlier circadian phase, closer to the acrophase of REM sleep propensity. Possibly, the evening types are more likely to awaken from the REM stage and subsequently recall the most intense dreams or nightmares. A related possibility stems from the fact that eveningness is correlated with sleep duration [20]—that is, longer sleep may entail proportionally more REM sleep in the morning and thus may present a greater likelihood of recalling vivid dreams or nightmares [11]. However, in a previous study of posttraumatic stress disorder (PTSD), the authors speculated that the higher REM density in the eveningness chronotype would be associated with worse PTSD symptoms, such as nightmares [21]. They revealed that greater eveningness correlated with higher glucose metabolism in REM sleep-generating brainstem regions during wakefulness and REM sleep, which may be related to the hyperarousal symptom of PTSD. However, this mechanism may differ from that of healthy participants without mental illnesses, such as PTSD. Rather, it is speculated that awakening from the REM phase which is caused by the habitual timing of the evening chronotype, and the consequent fragmentation of REM sleep, may be more related to nightmare distress and dream recall in healthy individuals. Nielsen et al. suggested that REM sleep propensity was abnormally low for the frequent nightmare group [22]. Therefore, further research which investigates dreaming related to REM/NREM sleep characteristics according to chronotypes in healthy people without sleep disorders is needed.

Among participants without moderate to severe sleep apnea in this study, the AHI negatively correlated with nightmare distress and dream recall. There is seemingly conflicting evidence on the impact of sleep apnea on dreams. Some studies have reported increased dream recall and dream duration in patients with sleep-related breathing disorders [23], and thereby suggest that the stress caused by the apneas exerted only a very global emotional influence on manifest dreaming. In fact, dreams are more negative in sleepers with an AHI > 15, compared with patients with AHI < 5 [24]. Continuous positive airway pressure therapy decreases nightmare frequency in patients with sleep-related breathing disorders who are experiencing traumatic disorders [25]. In contrast, several large polysomnography-based studies that included patients with severe OSA revealed that patients with a higher AHI reported a lower recall of nightmares [26, 27]. Pagel et al. [26] suggested that these results might be due to the effects of OSA-induced REM sleep suppression. However, as our study targeted individuals with an AHI < 15, it is difficult to compare these results directly with those of previous studies that included patients with moderate to severe obstructive sleep apnea. It was not speculated that the stress caused by the apneas would induce nightmares distress among people with mild or no sleep apnea. Dreams reflect nocturnal cognitive processes [28]. It is the authors' suspicion that respiratory events during sleep may contribute to disturb cognitive processes, and consequently decrease dreaming. Further research which investigates dreaming related to respiratory events in people without significant sleep apnea is needed.

Previous studies have shown that nightmares are related to mood disorders [14, 29, 30]. Sheaves et al. [29] suggested that nightmare frequency and nightmare-related distress increased psychiatric symptoms, including depression. The relationship between depression and nightmares was also reported by Levin et al. [30]. Consistent with previous results, depression positively correlated with nightmare distress in our cohort.

In this study, we could not assess sleep architectures according to chronotypes, because PSG was not performed in accordance with the individual's habitual sleep time and the likelihood of the "first-night effect" of one-night PSG cannot be ruled out. However, we identified that there was no difference in the other PSG parameters, such as respiratory or movement events, according to chronotypes. Previous studies on sleep architecture, which analyzed data from sleep studies in a laboratory setting, provided conflicting results. Some studies found no difference between the morningness and eveningness chronotypes [6], whereas others variously found indications of better sleep quality in the morningness types [7] or eveningness types [8]. Mongrain et al. [6] revealed that sleep architecture did not differ in the morningness and eveningness types. However, those authors suggested a sex difference in the pattern of morningness–eveningness effects on sleep, with men being more affected by the chronotypes [6]. Future studies using serial PSG based on participants' habitual sleep time, including the adaptation period, may help to accurately identify the sleep architecture and understand the mechanism underlying the role of chronotypes in dreams.

The main strength of the present study is the analysis of the association between dreaming and chronotypes among healthy participants, after excluding individuals with other sleep disorders on PSG. Given the scarce evidence of this relationship, especially with regard to dream recall, further research is required. This study had several limitations worth mentioning. First, as this was a retrospective study, we did not schedule PSG based on the participants' habitual sleep time, and we collected only one-night PSG data. Therefore, the sleep architecture in our study deviates somewhat from the normal range [31], and we could not evaluate the sleep architecture variables. Further studies using serial PSG, based on each subject's habitual sleep time and including the adaptation period, may help evaluate the usual sleep architecture and examine the association between REM/NREM sleep characteristics and dreaming. Moreover, this approach may help elucidate the mechanisms hereby the chronotypes affect dreams. Second, dreaming was investigated using only questionnaires [14], which was translated and used as it was in the absence of a validated and standardized Korean version. However, there is no scientific consensus on the measurement of dreams, which makes it difficult to ascertain the validity of the collected data. Third, the cross-sectional study design, despite the focus on the effect of the circadian pattern on dreaming, precludes an evaluation of causal relationships. Finally, the sample size was small, which may have affected the presented sleep quality and mood scores. A large-scale prospective study using sleep log or actigraphy is required to further evaluate the abovementioned findings after overcoming these limitations.

In conclusion, our findings indicate that the eveningness chronotype was associated with nightmare distress and dream recall in healthy people without major sleep disorders. Further research is needed to understand the role of chronotypes in the dreaming process.

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Author contributions S-HH designed and conceptualized the study, and analyzed and interpreted the data. Y-SC drafted the manuscript. SWH and GeK revised the manuscript. All authors read and approved the final manuscript.

Declarations

Conflict of interest The authors have no potential conflicts of interest to disclose.

Ethical committee permission This study was approved by the Institutional Review Board of Chung-Ang University College of Medicine (IRB No. 2204-021-19417).

Informed consent Written informed consent was obtained from each participant before enrollment in the study.

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