Abstract

Background

The circadian rhythm has been identified in several animals. Diurnal and nocturnal rhythm in humans is classified as either morning-type or evening-type based on differences in rhythm phase. Current lifestyles often involve activities during the day and at night, and disruption of life habits and sleep-wake rhythms may result in circadian rhythm disorders.

Objective

We assessed the relation between morning-type and evening-type concerning life habits and sleep habits by using the Japanese-language version of Horne and Ostberg's Morningness-Eveningness Questionnaire and the Tokyo Neurosciences General Laboratory Formula Examination of Life Habits.

Methods

Our study included 52 graduate students. We used two types of questionnaires, one which examined whether the subjects were morning-type or evening-type, and another examined life habits and sleep-wake rhythms.

Results

Of the 52 subjects, 9.6% were morning-types, 71.2% were intermediate-types, and 19.2% were evening-types. Of the evening-types, 40% had a variation in sleep time of more than two hours, and 20% had a variation in awakening time of more than two hours. Approximately 80% of the morning-types and 20% of the evening-types reported pleasant awakening experiences.

Conclusions

Assessment of actual conditions of life and sleep habits using simple and highly reliable questionnaires may be useful in the prevention of sleep disorders and in the improvement of life and sleep habits.

Keywords: circadian rhythm, morningness-eveningness questionnaire, morning-type, evening-type, life habits

Introduction

The daytime sleepiness might interfere to the social life, and is caused by sleep disorders of sleep apnea syndrome, circadian rhythm sleep disorder, periodic limb movement disorder, restless legs syndrome and so on (Table 1). Polysomnography and multiple sleep latency test are enforced to the differential diagnosis of sleep disorders.

Humans are known to typically exhibit a circadian rhythm of approximately slightly more than 24 hours. Circadian rhythms affect life habits, sleep and waking rhythms, endocrine activity, and autonomic activity (Honma et al., 1997; Otsuka et al., 1997). Various behaviors, sleeping, wakefulness, endocrinal functions, and activities of the autonomic nervous system all follow the approximately 24-hour circadian rhythm. Sleep-wake rhythms may be used to classify people as "morning-types" if they are most active in the early hours of the day or as "evening-types" if they are most active in the afternoon and late in the day by observing differences in the rhythm phase. Morning-types tend to have early sleep schedules and

circadian rhythms, and have regular waking time, bedtime and sleep time. By contrast, evening-types tend to have late sleep schedules and circadian rhythms, and have irregular waking time, bedtime and sleep time. Current lifestyles often involve being active during extended periods of the day and night. Shift workers and night workers are often forced to have irregular sleep-wakefulness schedules. This may also result in an increase in the numbers of circadian rhythm disorders, leading to desynchronization of the biological clock and the sleep-wake rhythm (Akerstedt, 1985; Honma et al., 1997; Ostberg, 1973a, 1973b). However, the relationship between life habits and the sleep-wake rhythm and associated resultant disorders remains unclear.

Accordingly, we have used questionnaires to investigate the length of sleep time, the changes of waking time, bedtime, sleep time, having sufficient sleep (including staying up all night), times of eating breakfast, dozing and taking an afternoon nap, and so on, as well as to examine the relationships between whether subjects morning-types or evening-types (Takao et al., 2007). These differences in sleep-wake rhythms and sleep and

life habits, in waking experiences and variations in sleep time have been investigated using the Japanese-language version of Horne and Ostberg's Morningness-Eveningness Questionnaire (MEQ) (Adan and Almirall, 1991; Ishihara, 1986, 1990; Ostberg, 1973a, 1973b) and the Tokyo Neurosciences General Laboratory Formula Examination of Life Habits (TMIN-LHI) (Miyashita, 1994).

Methods

Subjects

A total of 52 college students (five males, 47 females), ranging in age from 19 to 21 (mean 19.4 ± 0.7), was studied, and each subject was asked to complete a questionnaire to determine whether the subject was a morning-type or an evening-type individual, and another questionnaire about life habits. The Nagoya University Ethics Committee approved all procedures associated with this study.

Questionnaires

Circadian rhythm was judged using the Japanese-language version of the MEQ (Ishihara et al., 1986). Total scores were calculated and categorized for 19 questions on the MEQ. We then used Horne's criteria (Horne and Ostberg, 1976) and classified a score of 70-86 as a definite morning-type,

59-69 as a moderate morning-type, 42-58 as an intermediate-type, 31-41 as a moderate evening-type, and 16-30 as a definite evening-type. Sleep and life habits were evaluated by using the standard TMIN-LHI questionnaire (Miyashita, 1994), which consisted of 52 questions. The responses extracted related to sleep time, regularity of sleep habits, quality of sleep, regularity of life habits, and tendency to insomnia and sleepiness (Giannotti et al., 2002; Kripke et al., 1979; Monroe, 1967; Russo et al., 2007; Taub, 1978; Webb, 1979).

Subjects were classified as either being long sleepers or short sleepers using Miyashita's criteria (Kripke et al., 1979; Webb, 1979) of sleep time. The question asked was: "How long sleep was your sleep time?" Short sleepers had less than the average sleep time by 1.5 SD or more, and long sleepers had more than the average sleep time by 1.5 SD or more. Regularity of a subject's sleep habits was judged using Taub's criteria (Taub, 1978). The questions asked were: "What time is your waking time and bedtime? How much difference exists in waking time, bedtime, and sleep time day by day?" Irregular sleepers had a change of 2-4 hours in waking time, bedtime, and

sleep time. The quality of sleep was based on satisfaction with sleep, feelings upon awakening, and depth of sleep using Monroe's criteria (Monroe, 1967). The questions asked were: "Do you have satisfaction with sleep time? How do you feel on waking? Do you have deep sleep?" Moreover, we extracted responses regarding, for example, whether a subject often stayed up all night, often dozed off, often took afternoon naps, and regularly ate breakfast.

Statistical analysis

When results are presented as "X/Y (Z)", X out of a total of Y showed the factor, and Z was the percentage X/Y. The analysis of chi-square test using StatView was used to compare the responses to the questionnaires for each type. Probability (p) values < 0.05 were considered to be statistically significant.

Results

Classification by MEQ

The results of classification using the MEQ were as follows. There were no definite morning-types among the 52 subjects, 5/52 subjects (9.6%) were of the moderate morning-type, 37/52 subjects (71.2%) were of the intermediate-type, 9/52 subjects (17.3%) were of the moderate evening-type, and 1/52 subject (1.9%) was of the definite evening-type.

Sleep habits

Sleep time was normal for all subjects (6.1 ± 0.6 h). There were no significant differences among the three types (6.5 ± 0.5 h for the morning-types, 6.1 ± 0.7 h for the intermediate-types, and 6.0 ± 0.9 h for the evening-types) (Figure 1). There were 13 short sleepers (25.0%), but no long sleepers. Of the short sleepers, 10 were intermediate-type subjects and three evening-type subjects. Among the morning-types, no subjects had variances

of awakening and bedtime of more than two hours. Among the evening-types, however, 40% of the subjects had variances of sleep time of more than two hours, and 20% had variances in awakening time and bedtime of more than two hours. There were no significant differences in sleep time among the three types (Table 2).

The morning-type, the intermediate-type and the evening-type subjects expressed similar feelings of insufficient sleep time. The morning-types felt they had sufficient sleep time, but the intermediate-types and the evening-types felt their sleep time was extremely compromised (Table 2). Pleasant or fairly pleasant feelings upon awakening were present in 80% of the morning-types, 21.6% of the intermediate-types, and 20% of the evening-types (Figure 2). The sensation of exceptionally unpleasant feelings upon awakening was reported by 40% of the evening-types, 2.7% of the intermediate-types, and none of the morning-types (Figure 3). The ability to sleep deeply was reported by 40% of the morning-types, 40.5% of the intermediate-types, and 40% of the evening-types.

Life Habits

Among the 52 subjects, a few of the evening-type and the intermediate-type subjects stayed up all night more than once a month. The intermediate-type and the evening-type subjects answered that they habitually dozed. Also, habitually taking afternoon naps was observed in 20% of the evening-types but none of the morning-types or intermediate-types subjects (Figure 4). Subjects who answered that they definitely ate breakfast were all of the morning-types, but a few evening-types and the intermediate-types subjects did not eat breakfast (Table 2).

Discussion

We showed differences in the regularity of sleep satisfaction or quality of sleep and life habits between morning-type and evening-type subjects. Although the morning-types and the evening-types did not significantly differ in the sleep time, morning-types maintained more regular sleep habits, had more pleasant feelings upon awakening, and were more satisfied with the quality of their sleep.

As for regularity of sleeping habits, 20% of the evening-types had a variation of more than two hours concerning wake time and bedtime, and 40% had a variation of more than two hours regarding their sleep time. Conversely, in the morning-types, none of the subjects had a variation of more than two hours in their sleep time, wake time or bedtime. We found that the morning-types maintained more regular sleep and life habits.

Patients with delayed sleep phase syndrome (DSPS) have difficulty living in a society with a diurnal lifestyle. This is because their sleep phase is extremely delayed. Sleep habits and circadian preference have been

extensively analyzed in adolescents and children (Gaina et al., 2006; Giannotti et al., 2002; Russo et al., 2007). These results were similar to our findings in college students.

Regarding the quality of sleep, Webb and Bonnet (1978) reported that individuals in evening-types were more strongly dissatisfied with their sleep than those in morning-types. We demonstrated that there were no significant differences regarding the feeling of sleep depth between morning-types and evening-types. However, unpleasant feelings upon awakening were more prominent among the evening-types than in the morning-type subjects. Additionally, evening-type subjects tended to be less satisfied with their sleep. Therefore, it was presumed that evening-type subjects had a compromised quality of sleep.

In the present study, subjects who would sit up all night accounted for 20% of evening-types but none of the morning-type subjects. Regarding other life habits, subjects who dozed and napped were found much more frequently among evening-types. Concerning the habit of eating breakfast, 100% of the morning-types ate breakfast every day, whereas only half of the

evening-types did so. Therefore, irregular sleeping habits and poor sleep quality seem to have adverse effects on life habits.

In conclusion, subjects classified as evening-types more commonly had irregular sleep and life habits, and were more often dissatisfied with their sleep. Assessment of the actual conditions of sleep and life habits in a large population, using a simple and highly reliability questionnaire, promises to be useful for the prevention of sleep disorders and improvement of sleep and life habits of the Japanese population.

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References

Adan A, Almirall H. 1991. Horne & Ostberg morningness-eveningness questionnaire: a reduced scale. Pers Individ Differ 12: 241-253.

Akerstedt T. 1985. Adjustment of physiological circadian rhythm and the sleep-wake cycle to shift work. In: Forkard S, Monk TH, editors. Hours of Work: Temporal Factors in Work Scheduling. John Wiley & Sons, New York.

Gaina A, Sekine M, Kanayama H, Takashi Y, Hu L, Sengoku K, Kagamimori S. 2006. Morning-evening preference: sleep pattern spectrum and lifestyle habits among Japanese junior high school pupils. Chronobiol Int 23: 607-621.

Giannotti F, Cortesi F, Sebastiani T, Ottaviano S. 2002. Circadian preference, sleep and daytime behaviour in adolescence. J Sleep Res 11: 191-199.

Honma K, Hashimoto S, Endo T, Honma S. 1997. Light and plasma melatonin rhythm in humans. Biol Signals 6: 307-312.

Horne JA, Ostberg O. 1976. A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. Int J Chronobiol 4: 97-110.

Ishihara K, Honma Y, Miyake S. 1990. Investigation on the children's version of the morningness-eveningness questionnaire with primary and junior high school pupils in Japan. Percept Mot Skills 71: 1353-1354.

Ishihara K, Miyashita A, Inugami M, Fukuda K, Yamazaki K, Miyata Y. 1986. The results of investigation by the Japanese version of Morningness-Eveningness Questionnaire. Shinrigaku Kenkyu (in Japanese) 57: 87-91.

Kripke DF, Simons RN, Garfinkel L, Hammond EC. 1979. Short and long sleep and sleeping pills. Is increased mortality associated? Arch Gen Psychiat 36: 103-116.

Miyashita A. 1994. Handbook of sleep science and sleep medicine. The Japanese Society of Sleep Research pp533-538.

Monroe LJ. 1967. Psychological and physiological differences between good and poor sleepers. J Abnorm Psychol 72: 255-264.

Ostberg O. 1973. Circadian rhythms of food intake and oral temperature in "morning" and "evening" groups of individuals. Ergonomics 16: 203-209.

Ostberg O. 1973. Interindividual differences in circadian fatigue patterns of shift workers. Br J Ind Med 30: 341-351.

Otsuka K, Cornelissen G, Halberg F. 1997. Age, gender and fractal scaling in heart rate variability. Clin Sci (Lond) 93: 299-308.

Russo PM, Bruni O, Lucidi F, Ferri R, Violani C. 2007. Sleep habits and circadian preference in Itarian children and adolescents. J Sleep Res 16: 163-169.

Takao M, Ishihara N, Mori T. 2007. Morning-Evening type and stress-related personality in Japanese college students. Percep and Mot Skill 104: 687-690.

Taub JM. 1978. Behavioral and psychophysiological correlates of irregularity in chronic sleep routines. Biol Psychol 7: 37-53.

Webb WB. 1979. Are short and long sleepers different? Psychol Rep 44: 259-264.

Webb WB, Bonnet MH. 1978. The sleep of "morning" and "evening" types.

Biol Psychol 7: 29-35.

Table caption

Table 1. Diseases with excessive daytime sleepiness

Table 2. Comparison of each questions in the morning-type, the intermediate-type, and the evening-type.

Data are presented X/Y "(Z)". X is applying number of each types. Y is total number of each types. Z is a percentage of X/Y.

The chi-square test was used.

M-type = Morning-type. I-type = Intermediate-type. E-type = Evening-type.

Figure caption

Figure 1. Comparison of sleep time in the morning-type, the intermediate-type, and the evening-type

Figure 2. Pleasant or fairly pleasant feeling on waking

The chi-square test was used.

M-type: 4/5 = 80%, I-type: 8/37 = 21.6%, E-type: 2/10 = 20%, p=0.02

There were significant differences among Morning-type, Intermediate-type, and Evening-type.

Figure 3. Unpleasant feeling on waking

The chi-square test was used.

M-type: 0/5 = 0%, I-type: 1/37 = 2.7%, E-type: 4/10 = 40%, p=0.001

There were significant differences among Morning-type, Intermediate-type, and Evening-type.

Figure 4. Habit of taking an afternoon nap

The chi-square test was used.

M-type: 0/5 = 0%, I-type: 0/37 = 0%, E-type: 2/10 = 20%, p=0.01

There were significant differences among Morning-type, Intermediate-type, and Evening-type.

Table 1

- **intrinsic sleep disorders**

  psychophysiological insomnia

  sleep state misperception

  idiopathic insomnia

  narcolepsy

  recurrent hypersomnia

  idiopathic hypersomnia

  posttraumatic hypersomnia

  obstructive sleep apnea syndrome

  central sleep apnea syndrome

  central alveolar hypoventilation syndrome

  periodic limb movement disorder

  restless legs syndrome

  intrinsic sleep disorder NOS

- **extrinsic sleep disorders**

  inadequate sleep hygiene

  environmental sleep disorder

  altitude insomnia

  adjustment sleep disorders

  insufficient sleep syndrome

  limit-setting sleep disorder

sleep-onset association disorder

food allergy insomnia

nocturnal eating (drinking) syndrome

hypnotic-dependent sleep disorder

central nervous system stimulant-dependent sleep disorder

alcohol-dependent sleep disorder

toxin-induced sleep disorder

extrinsic sleep disorder NOS

- **circadian rhythm sleep disorder**

time zone change (jet lag) syndrome

shift work sleep disorder

irregular sleep-wake disorder

delayed sleep phase syndrome

advanced sleep phase syndrome

non-24-hour sleep-wake syndrome

circadian rhythm sleep disorder NOS

Table 2

	M-type	I-type	E-type	p value
Classify of each types	5/52 (9.6)	37/52 (71.2)	10/52 (19.2)	
Irregularity of waking time	0/5 (0)	7/37 (18.9)	2/10 (20)	0.56
Irregularity of bedtime	0/5 (0)	3/37 (8.1)	2/10 (20)	0.39
Irregularity of sleep time	0/5 (0)	10/37 (27.0)	4/10 (40)	0.26
Insufficient sleep	3/5 (60)	21/37 (56.8)	5/10 (50)	0.91
Severely insufficient sleep	0/5 (0)	4/37 (10.8)	2/10 (20)	0.50
Habit of staying up all night	0/5 (0)	3/37 (8.1)	2/10 (20)	0.39
Habit of eating breakfast	5/5 (100)	30/37 (81.1)	5/10 (50)	0.05
Habit of dozing	0/5 (0)	14/37 (37.8)	6/10 (60)	0.08

Figure 1

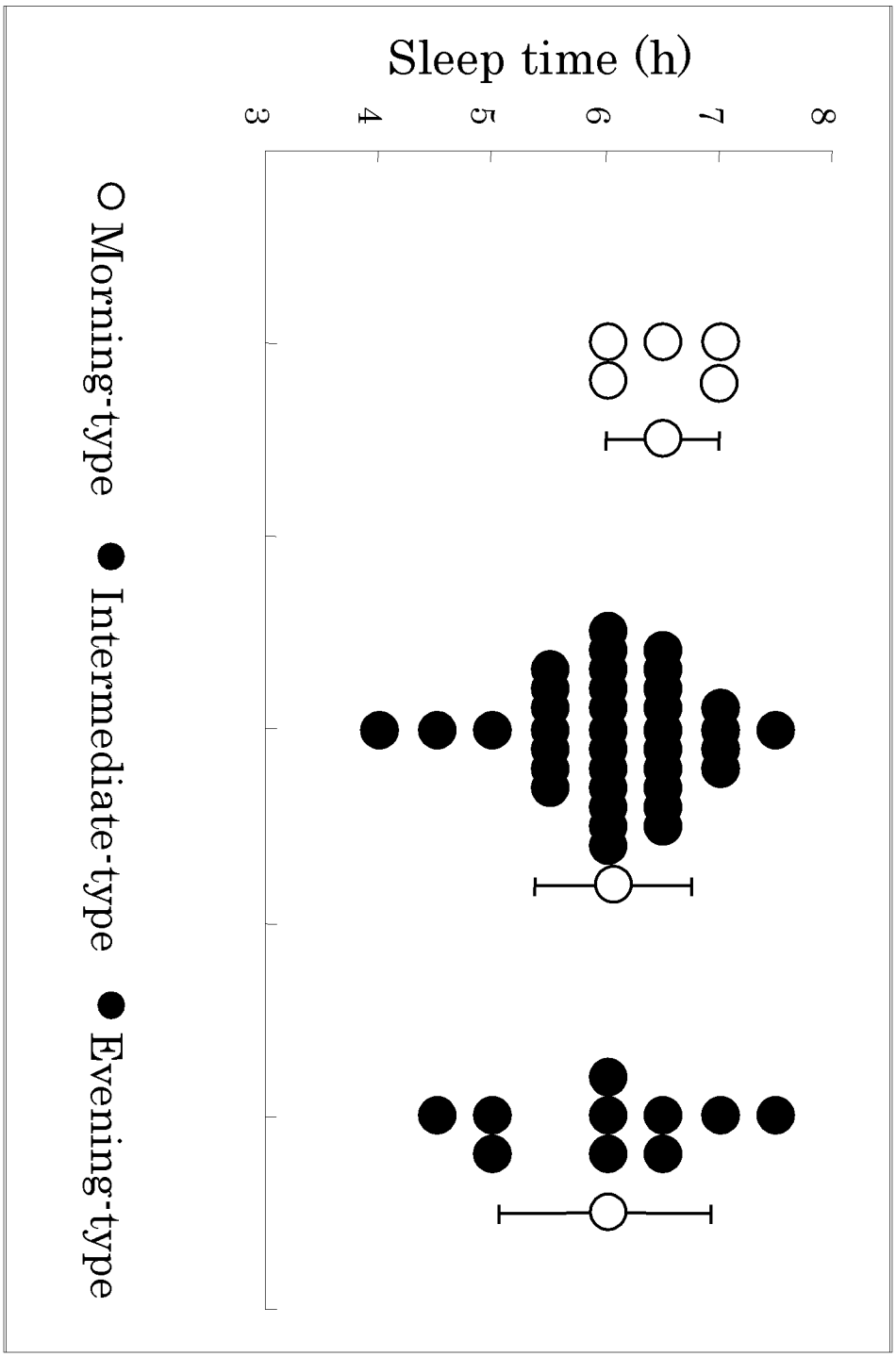

Sleep time (h)
3
4
5
6
7
8
○ Morning-type
● Intermediate-type
● Evening-type

Figure 2

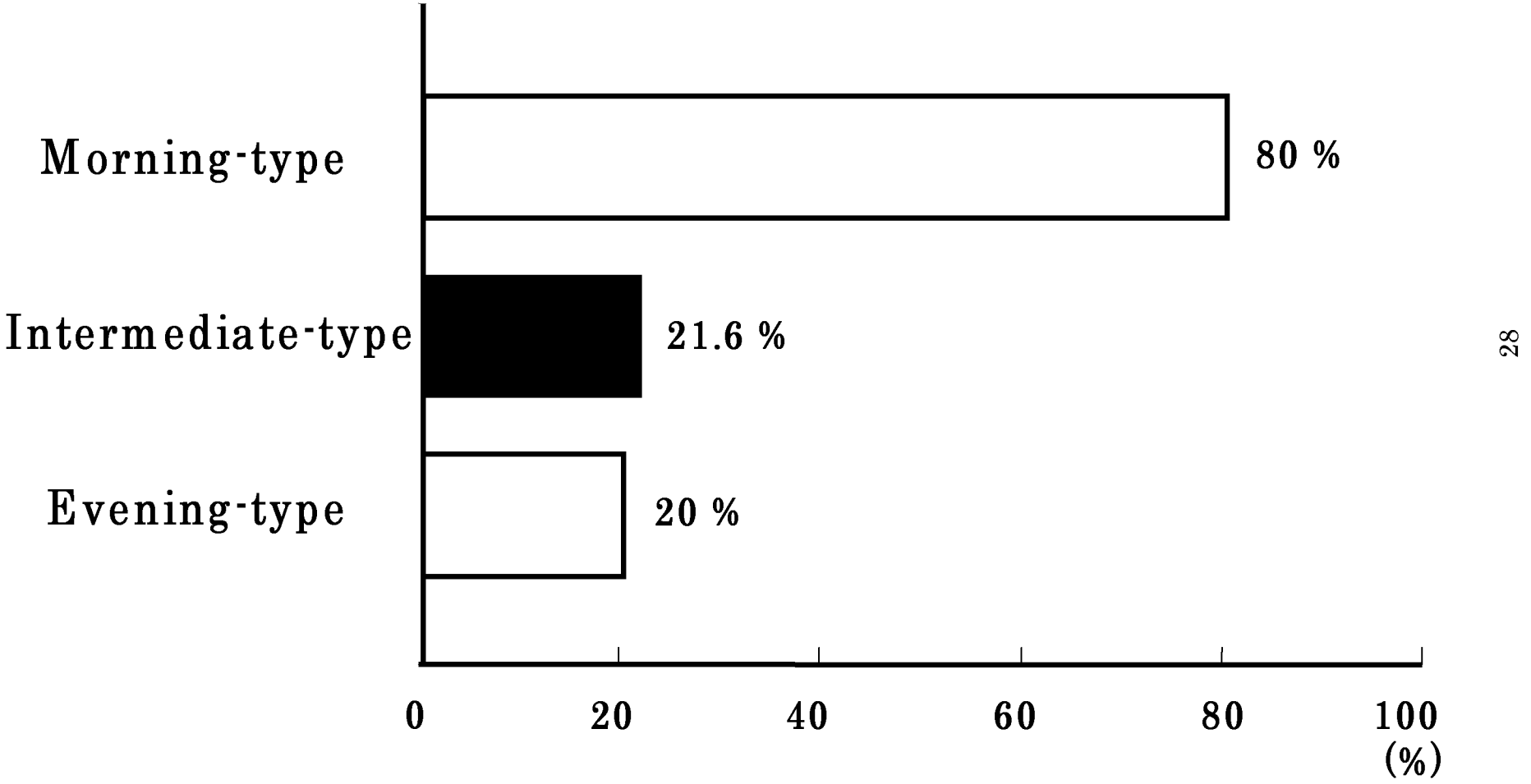

Morning-type
80 %
Intermediate-type
21.6 %
Evening-type
20 %
0
20
40
60
80
100
(%)

Figure 3

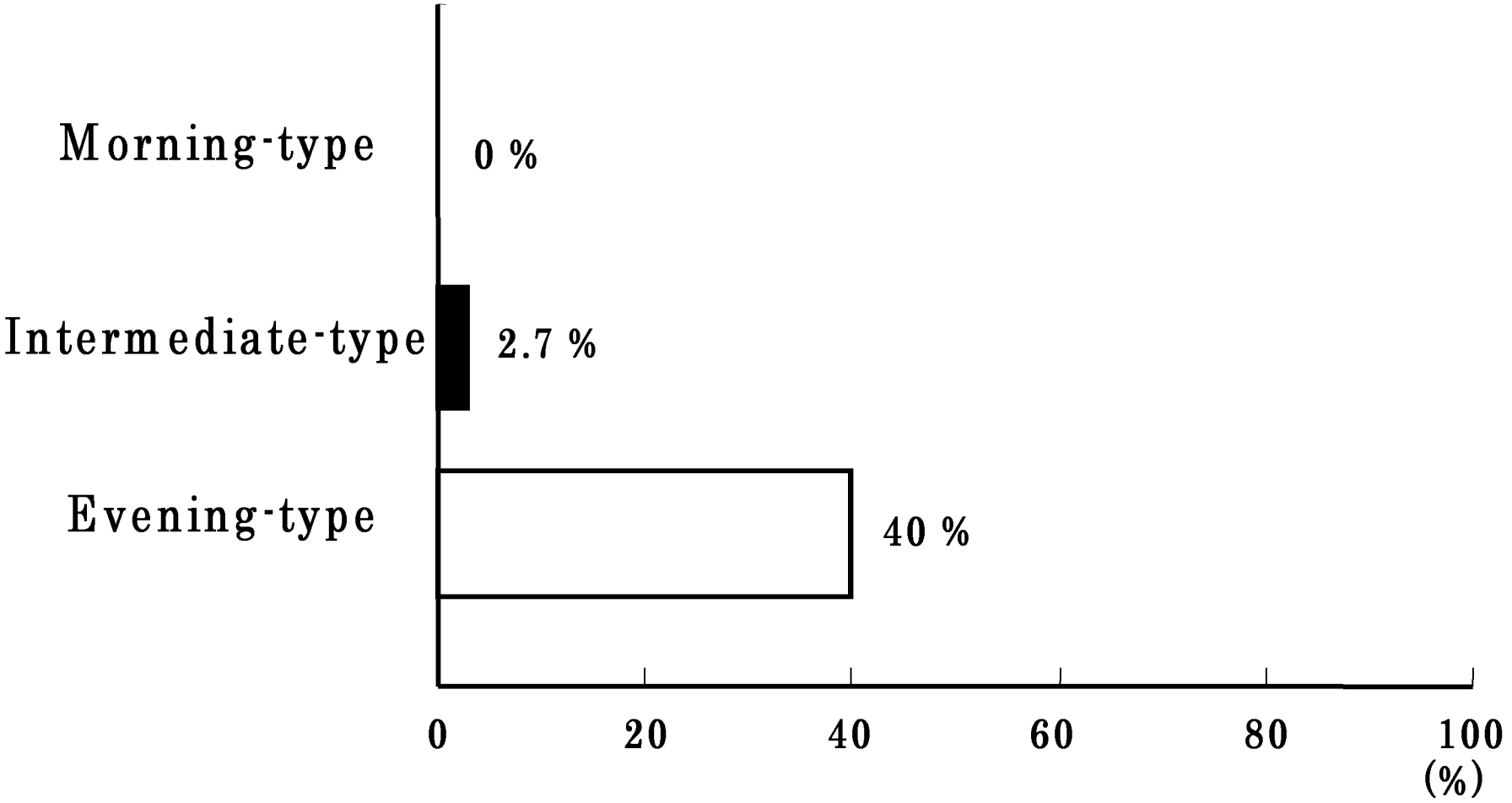
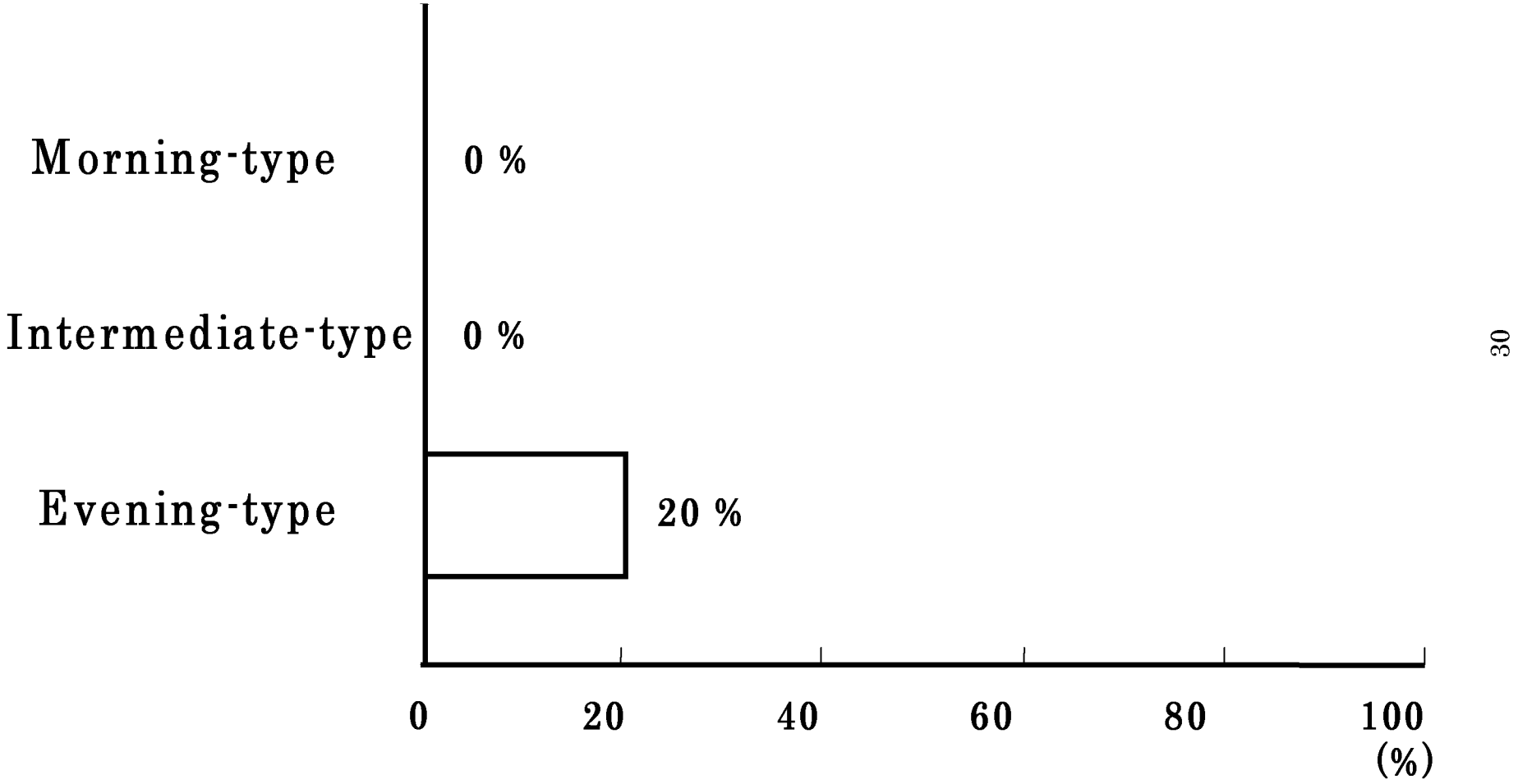

Morning-type
0 %
Intermediate-type
2.7 %
Evening-type
40 %
0
20
40
60
80
100
(%)

Figure 4


Morning-type
0 %
Intermediate-type
0 %
Evening-type
20 %
0
20
40
60
80
100
(%)