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Effects of Aging and Chronotype on Sleep Habits in Korean Workers

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ABSTRACT

The Korean version of the morningness-eveningness questionnaire (MEQ) and sleep habits inventory were administered to 1,038 Korean male daytime workers and were analyzed according to age and chronotype to determine what these factors reveal about sleep habits in view of phase difference of circadian rhythm. The mean and distribution of scores on the MEQ moved significantly toward the morning type with aging. Bedtimes and waking times were progressively later from the morning, intermediate, to evening types, and were also earlier with aging. Preferred bedtimes and waking times showed more distinct differences than did the habitual times in each chronotype. The percentage of subjects who answered that sleep length was 'short', mood upon waking was 'bad', and variabilities of bedtime and sleep length were 'large' were greater in the young and evening types than in the elder and morning types, respectively. These findings suggested that subjects were shifted toward the morning type and the phase of circadian rhythm had moved forward with aging. Preferred bedtime and waking time were a better reflection of individual circadian rhythms than habitual bedtime and waking time.

Keywords: Sleep habit, chronotype, circadian rhythm, daytime worker

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1. Introduction

From the concept of morningness-eveningness (or larks-owls) by Kleitman (1963), the research for chronotype was promoted by the morningness- eveningness questionnaire (MEQ). The MEQ was initially developed by Öquist (1970) in Swedish, and it has been modified many times. Horne and Östberg (1976) modified and translated the MEQ from Swedish into English. The English version has since been translated into many languages (Ishihara et al., 1986; Adan & Almirali, 1990; Park et al., 1996) and applied widely. There has been extensive research of chronotype (or diurnal type) using the MEQ: research of behavior patterns or the differences of circadian rhythms including sleep-wake cycles, research of individual differences or characteristics of personality with phase difference of circadian rhythm, and research of the tolerance to night or shift work (Kerkhof, 1985). This research of individual differences has focused on age, sex, and personality. Previous research has suggested that bedtimes and waking times were earlier in the morning type than in the evening type (Horne & Östberg, 1976; Webb & Bonnet, 1978; Foret et al., 1982; Mecacci & Zani, 1983; Kerkhof, 1984; Ishihara et al., 1986; Park et al., 1997), and the percentage of morning types was larger in the aged than in the young (Mecacci & Zani, 1983; Torsvall & Akersted, 1980; Mecacci et al., 1986; Costa et al., 1987; Matsumoto & Morita, 1987; Ishihara et al., 1988, Wilson, 1990). It showed only how the distributions of morningness-eveningness (ME) scores and sleep habits changed by age, but did not show an investigated relationship of sleep habit with aging and chronotype.

The purpose of this study was to administer the MEQ to Korean workers in order to investigate how individual sleep-wake habits are influenced by such factors as aging and chronotype in view of phase differences of circadian rhythm.

2. Method

2.1 Subjects

The Korean version (Park et al., 1986) of the Horne and Östberg MEQ and Life Habits Inventory were given to 1,640 daytime workers from 62 mid-sized companies around Masan and Changwon, the most concentrated heavy mechanical industrial region in Korea, from September to December, 1996. The starting and ending time of these companies were 08:00 or 08:30, 17:00 or 17:30, respectively. The Life Habits Inventory

Table 1. The mean, standard deviations, skewness, kurtosis, and K-S test of ME scores by age group

	n	Mean	SD	Skewness	Kurtosis	Median	K-S test	
							value	P
Below 24 yr.	75	45.1	5.3	0.233	0.888	45	0.111	0.023
25-34 yr.	333	46.9	6.4	0.181	0.137	47	0.050	0.043
35-44 yr.	476	50.0	6.1	-0.019	-0.031	50	0.038	0.093
45.-54 yr.	141	52.5	6.2	-0.224	0.354	52	0.066	> 0.20
Above 55 yr.	13	54.5	7.0	-0.767	0.231	56	0.116	> 0.20

included sleep-wake habits, variability of sleep habit, sleep latency, number of awakenings, quality of sleep, and et cetera. There were 1,148 effective respondents (1,038 men and 110 women). Because of the substantial difference in the number of men and women, we used only the male data. The mean age of the male daytime workers was 36.3 years (SD=7.9), the minimum was 17 years, and the maximum was 60 years.

2.2 Procedure

The ME preference was assessed by a score based on the questionnaire consisting of 19 questions. We calculated personal scores and classified them five categories on the basis of criteria from Horne and Östberg (1976). These five categories were extreme morning type (70-86), moderate morning type (59-69), intermediate type (42-58), moderate evening type (31-41), and extreme evening type (16-30). To analyze the differences in sleep parameters we used the two-way analysis of variance (ANOVA) by age group and chronotype. To evaluate the response ratio of variability in sleep parameters we used the chi-square test.

3. Results

3.1 Distribution of ME scores

The mean and standard deviations of ME scores for all subjects were 49.1 (6.6), and the median was 49.0. The distribution of ME score for all age groups was not normally distributed by the Kolmogorov-Smirnov (K-S) test (statistic= 0.039, df=1038, $p<0.001$). As shown in Table 1, we divided the subjects into five age groups and show the ME scores for each: below 24 yr. (number of subjects: 75), 25-34 yr. (333), 35-44 yr. (476), 45-54 yr. (141), and above 55 yr. (13).

The distribution of ME scores shifted toward the morning type from the young to the old groups, and there were significant

Table 2. The classifications of chronotype by age group

Total	Morning type		Intermediate type		Evening type		Total	
	77	(7.4 %)	837	(80.6 %)	124	(11.9 %)	1,038	(100 %)
Below 24 yr.	2	(2.7 %)	56	(74.7 %)	17	(22.7 %)	75	(7.2 %)
25-34 yr.	13	(3.9 %)	259	(77.8 %)	61	(18.3 %)	333	(32.1 %)
35-44 yr.	35	(7.4 %)	401	(80.1 %)	40	(8.4 %)	476	(45.9 %)
45-54 yr.	23	(16.3 %)	113	(61.5 %)	5	(3.5 %)	141	(13.6 %)
Above 55 yr.	4	(30.8 %)	8	(61.5 %)	1	(7.7 %)	13	(1.3 %)

Table 3. The means and standard deviations of sleep variables by age group and chronotype

		Bedtime				Waking time				Sleep length(weekdays)				Sleep length (weekends)	
		Habitual		Preferred		Habitual		Preferred		Habitual		Preferred			
	N	M[1]	SD[2]	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Above 24 yr.	75	23:49	48	23:31	63	6:39	37	7:36	78	6:44	55	8:05	96	8:56	114
Interm.	56	23:50	48	23:22	55	6:37	37	7:21	66	6:44	52	7:59	91	8:39	96
Evening	17	23:56	45	24:04	78	6:44	40	8:26	99	6:35	66	8:23	114	9:46	155
25-34 yr.	333	23:28	47	23:22	62	6:31	30	7:19	66	6:57	55	7:56	82	8:44	88
Morning	13	23:05	44	22:39	46	6:16	39	6:37	58	7:15	40	7:58	86	8:05	96
Interm.	259	23:27	45	23:17	57	6:30	29	7:12	65	6:59	52	7:55	84	8:41	90
Evening	61	23:40	56	23:57	72	6:36	28	7:59	55	6:57	65	8:02	75	9:03	77
35-44 yr.	476	23:09	47	22:56	52	6:18	31	6:44	57	6:59	51	7:48	70	8:12	87
Morning	35	22:55	51	22:44	53	6:01	32	5:58	36	6:55	56	7:14	54	7:34	65
Interm.	401	23:09	47	22:54	51	6:19	30	6:44	54	6:59	51	7:50	70	8:09	85
Evening	40	23:40	33	23:23	54	6:27	31	7:25	62	6:57	48	8:02	67	8:36	99
45-54 yr.	141	23:01	50	22:48	47	6:01	36	6:37	61	6:50	54	7:49	64	8:04	94
Morning	23	22:42	31	22:25	28	5:42	46	6:10	42	6:47	67	7:45	51	7:34	70
Interm.	113	23:04	52	22:51	46	6:04	32	6:39	60	6:50	50	7:48	65	8:09	98
Evening	5	23:32	56	23:24	80	6:34	9	7:48	78	7:18	72	8:24	91	8:36	54
Above 55 yr.	13	22:23	58	22:33	57	5:25	34	6:05	68	6:44	74	7:31	44	8:21	93
Morning	4	22:53	71	22:30	60	5:12	43	5:30	35	5:45	90	7:00	49	7:15	57
Interm.	8	22:04	49	22:17	27	5:34	30	5:56	25	7:19	48	7:39	33	8:53	99
ANOVA															
Age(df=4,1023)		2.65*		2.71*		11.84***		7.08***		n.s		n.s		3.63**	
Chrono(df=2,1023)		4.52*		13.36***		3.20*		23.65***		n.s		n.s		3.12*	
Interact.(df=8,1023)		n.s		n.s		n.s		n.s		2.02*		n.s		n.s	

[1]Mean (hr:min); [2]Standard deviation (min.); *p<.05; **p<.01; *** p<.001

effects in scores by age groups ($F_{4,1033}$= 34.7, p<.001). That is, the mean and standard deviation of ME score for all age groups was 45.2 (5.3) in the below 24 years group,

46.9 (6.4) in the 25-34 years group, 50.0 (6.1) in the 35-44 years group, 52.5 (6.2) in the 45-54 years group, and 54.5 (7.0) in the above 55 years group.

Table 2 shows the percentage of chronotype for each age group. Chronotype was divided into three categories: morning type (extreme and moderate morning types), intermediate type, and evening type (extreme and moderate evening types). The number of morning type subjects in the below 24 years group was as few as 2, and the number of evening type subjects in the above 55 years group was as few as 1. The portion of evening type subjects was large in the young groups, and the distribution shifted significantly toward the morning type with aging.

3.2 Sleep habits by age and chronotype

Table 3 shows the means and standard deviations of habitual and preferred bedtimes, waking times, and the mean length of sleep on weekdays or weekends by age and chronotype. Since the number of morning type in the below 24 years group and evening type in the above 55 years group was very few, we did not represent them in the Table. The preferred waking times and bedtimes were two of the items in the MEQ. These times were determined based on the subjects' responses to the question, "Considering only your own 'feeling best' rhythm, at what time would you go to bed or get up if you were entirely free to plan your day?" The preferred sleep length was then obtained from the preferred waking times and bedtimes.

Habitual and preferred bedtimes were earlier with aging, and these tendencies were clearer in the morning than in the evening or intermediate types for all age groups except for the above 55 years group. Habitual bedtimes in the intermediate and morning types were slightly later than preferred bedtimes in all age groups. Chronotype showed a significant effect on habitual and preferred bedtimes, and age groups only showed a significant effect on habitual bedtimes. There was no significant interaction between age and chronotype for habitual and preferred times.

Habitual and preferred waking times were also earlier with aging from the evening to the morning types. The differences in waking time by chronotype was clearly larger in the preferred than habitual times. The difference of habitual and preferred waking times was larger in the evening types than in the morning types in all age groups. Both age and chronotype showed significant effects on habitual and preferred waking times, but the interactions of both

Table 4. The correlation coefficients among age, ME score and sleep parameters

	ME score	Bedtime		Waking Time		Sleep length (weekdays)		Sleep length (weekends)
		Habitual	Preferred	Habitual	Preferred	Habitual	Preferred	
Age	0.350***	-0.297***	-0.278***	-0.372***	-0.328***	n.s	-0.072*	-0.190***
ME score	-	-0.282***	-0.333***	-0.322***	-0.462***	0.063*	-0.148***	-0.286***

*p<.05 ; ***p<.001

Table 5. The percentages for the responses to questions of sleep status by age group and chronotype

	Age group					Chronotype		
	Below 24	25-34	35-44	45-54	Above 55	Morning	Interm.	Evening
Variability of bedtime					n.s			χ^2_4= 21.1***
below 30	37.5	42.9	47.8	43.5	50.0	58.3	45.7	32.0
30-60min	36.1	41.7	40.9	42.8	33.3	29.2	41.7	43.4
above 1 hr	26.4	15.4	11.3	13.8	16.7	12.5	12.7	24.6
Variability of sleep length				χ^2_8= 23.1**				χ^2_4= 13.6**
about 30min	41.3	46.7	59.6	56.1	53.8	59.2	54.3	45.2
about 1 hr	45.3	46.1	35.4	36.7	46.2	36.8	39.9	41.1
above 2 hr	13.3	7.2	5.1	7.2	0.0	3.9	5.8	13.7
Variability of waking tim					n.s			n.s
below 10	40.0	41.2	34.0	37.7	30.8	26.7	37.2	43.5
10-30min	49.3	52.4	57.9	51.4	53.8	66.7	54.9	45.2
above 30	10.7	6.4	8.0	10.9	15.4	6.7	7.8	11.3
Depth of sleep				χ^2_8= 23.5**				n.s
very deep	25.3	40.8	37.0	34.0	23.1	32.5	36.1	44.4
deep	54.7	39.9	36.8	31.9	38.5	37.7	38.6	37.9
light	20.0	19.2	26.3	34.0	38.5	29.9	25.3	17.7
Mood upon waking				χ^2_4= 29.2***				χ^2_2= 56.0***
Good	42.7	57.0	68.0	71.6	76.9	80.5	65.9	34.7
Bad	57.3	43.0	32.0	28.4	23.1	19.5	34.1	65.3
Satisfaction on sleep length				χ^2_4= 19.2**				χ^2_2= 46.1***
short	64.0	57.8	46.4	45.4	30.8	33.8	48.9	75.8
satisfy	36.0	42.2	53.6	54.6	69.2	66.2	51.1	24.2

*p<.0.5 ; **<.01 ; ***p<.001

were not significant.

Sleep length was a little shorter for the morning types in the above 55 years group, but sleep lengths were not significant by age

groups except for the above 55 years group and chronotype. Preferred sleep length was a little longer in the evening type than in the morning type in all age groups, but differences in preferred sleep lengths were not significant by age and chronotype. The length of sleep on weekends was shorter with aging except in the intermediate type of the above 55 years group, and progressively larger from the morning type to the evening type in all age groups. Age and chronotype showed significant effects on the length of sleep during weekends, but the interactions of both were not significant. Sleep length during weekends as compared with the habitual sleep length was longer by 0.6 hr, 1.4 hr, and 2.3 hr for the morning, intermediate, and evening types, respectively. It was significantly longer in the evening type.

The correlation between age and sleep parameters for all subjects is shown in Table 4. Age had a significant negative correlation with habitual and preferred bedtimes, waking times, and sleep length during weekends, but did not have a significant correlation on habitual sleep length. The ME score also had a significant negative correlation with habitual and preferred bedtimes, waking times, and sleep length on weekends. There was a significant positive correlation between age and ME score.

3.3 Self-estimation of sleep-state

Table 5 shows, by self-estimation, the frequency of responses to questions that included the variability of bedtime, waking time, and sleep length during weekdays, depth of sleep, mood upon waking, and satisfaction of sleep length by age group and chronotype. The percentage of subjects who answered that their variability of bedtime and sleep length were 'below 30 min.' and 'about 30 min.' was progressively higher with aging from the morning, intermediate, to evening types. The percentage of subjects who answered that their sleep length was 'short' was higher in younger groups, and it increased progressively from the morning, intermediate, to evening types.

The percentage of subjects who answered that their sleep was 'light' increased progressively from the young to the aged groups, but there was no significant difference by chronotype. The percentage of subjects who answered that their mood upon waking was 'bad' was higher in the young than in the aged groups, and it was higher in the evening type than in the morning type. There were no differences in the variability of waking time and sleep latency by age and chronotype.

4. Discussion

The distribution of ME scores shifted toward the morning type with aging, and the correlation between age and ME score was significantly positive. These were in accord with previous research (Mecacci et al., 1986; Costa et al.,1987; Adan & Almirali, 1990; Ishihara et al., 1992). The aged had a smaller amplitude, shorter cycle and more advanced phase of circadian rhythm (like body temperature, for example) than did the young (Weitzman et al., 1982; Kerkhof, 1985). There was a strong negative correlation between the acrophase of body temperature and ME score (Weitzman et al, 1982) and the distribution of ME scores moved toward the morning type. From these facts, we concluded that this was the result of the forward movement of circadian phase with aging.

There was little research on how to change sleep habits from the young to the aged. Costa et al. (1987) reported that age had a significant negative correlation with bedtime, waking time, and meal times. These times became earlier with aging. In our research, habitual and preferred bedtimes and waking times had a significantly negative correlation with age. However, there was no effect on habitual bedtimes and waking times by age in the research by Ishihara et al. (1992). They pointed out that the differences between habitual and preferred bedtimes and waking times were larger with aging because the preferred times were a better reflection of age effects than habitual times due to restrictions by social conditions such as the hour they went to the office. In our research, habitual and preferred bedtimes and especially waking times were affected by age.

Previous research that investigated sleep habits by chronotype over a broad age range was very scarce. The reason was that old subjects of the evening type were few. The number of evening type in the above 55 years group was very small in our research. Habitual and preferred bedtimes was significantly earlier with aging, and these times were also earlier from the evening type to morning type for all age groups. Habitual and preferred waking times were also earlier with aging for all chronotypes, and progressively earlier from the morning, intermediate, to evening types for all age groups. The difference by chronotype was larger in preferred times than in habitual times for all age groups because habitual times were more easily affected by social restrictions than preferred times. We concluded preferred times more clearly represented individual circadian rhythm than habitual times.

Habitual and preferred sleep length during weekdays did not show differences by age and chronotype and had no correlation with age. These were in agreement with previous studies (Webb & Bonnet, 1978; Ishihara et al., 1988, 1992; Adan & Almirali,

1990) The length of sleep on weekends was longer in the young than the aged groups, and progressively longer from the morning, intermediate, to evening types. There was little previous research analyzing sleep length on weekends by chronotype.

In the research by Mecacci et al. (1983) for students and white-collar workers of the same age, the differences between the morning and evening types in bedtime and waking time were larger on weekends than on weekdays. Furthermore, they reported that bedtimes and waking times were later on weekends than on weekdays in the evening type. Costa et al. (1987) also reported that waking times on weekends of 670 subjects from various fields of employment in Verona were earlier about 1-2 hours in the morning type than in the evening type.

In our research, the difference in sleep length between weekdays and weekends became progressively longer from the morning, intermediate, to evening types. We concluded that the subjects compensated for lack of sleep during weekdays by lengthening the waking time rather than bedtime. We also concluded that the sleep length during weekends better reflects the circadian rhythm of personal choice. The reason for the need of longer sleep length during weekends in the evening type than in the morning type was not clear, but the evening type needed longer sleep because of short sleep length during weekdays owing to late sleep and early waking due to social restrictions.

The percentage of subjects that answered 'short' for the question of sleep length and 'bad' for the mood upon waking was significantly larger in the young than the aged groups, and in the evening type than in the morning type. These facts indicate that the subjects in the young group - high portion of the evening type - did not get a sufficient amount of sleep that they wanted during the week. The variabilities of bedtime and sleep length were larger in the young groups and evening types than the old groups and morning types, respectively.

From this fact, though the young and evening types are more adaptable to time change environments (like shift work) (Folkard, 1979), they may have discordance of phases between circadian and sleep-wake rhythms.

5. Conclusion

We administered the Korean version of the MEQ to 1,038 male workers in order to investigate the changes of individual sleep habits under the influence of such factors as aging and chronotype in view of phase differences of circadian rhythm.

The results are :

1) The mean and distribution of ME scores shifted toward the morning type with aging, and the scores had a significant positive correlation with age.

2) The habitual and preferred bedtimes and waking times were earlier with aging in all chronotype, and were significantly later from the morning, intermediate, to evening types.

3) The difference of waking times by chronotype was clearer in preferred times than in habitual times that were restricted by the social environment.

4) The length of sleep during weekends was significantly longer in the young than in the aged group, and was progressively longer from the morning, intermediate, to evening types.

5) However, habitual and preferred sleep length during weekdays were not significant by age and chronotype.

6) The percentage of subjects whose sleep length was short, mood upon waking was bad, and the variabilities of bedtime and sleep length were large, were greater in the young and evening types than in the elder and morning types, respectively.

From these results, there is a forward movement of circadian phase and a shift toward the morning type with aging. Preferred bedtimes and waking times better reflected individual circadian rhythm than habitual times.

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저자소개

◈ 박영만

일본 동아대학 대학원에서 학술 박사학위를 취득(1999년)하였으며, 1983년부터 경남대학교 정보통신공학부 산업공학전공에서 재직 중이다. 주요 연구 관심분야로는 수면생체리듬, 교대 근무, 고령자의 수면, 의사결정 등이다.

◈ 서유진

일본 동아대학 대학원에서 학술 박사학위를 취득(1997년)하였으며, 1981년부터 경남대학교 정보통신공학부 산업공학전공에서 재직 중이다. 주요 연구 관심분야로는 수면생체리듬, 교대제 근무와 안전, 산업피로(스트레스) 등이다.

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일본 北海道大學 대학원에서 학술 박사학위를 취득(1984년)하였으며, 일본 德島大學 대학원에서 의학 박사학위를 취득(1988년)한 후, 1989년부터 일본 동아대학 대학원 정보시스템 전공에서 재직 중이다. 주요 연구 관심분야로는 수면생체리듬, 교대제 근무와 안전, 산업피로(스트레스) 등이다.

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