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Circadian preferences and sleep in 15- to 20-year old Finnish students

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ABSTRACT

Purpose: Despite progress in research concerning adolescent and young adult sleep and circadian preferences, several aspects have remained unexamined. This study explored gender and diurnal rhythms in relation to several sleep-related factors: sleep duration, bedtime, wake-up time, tiredness, sleepiness, and optimal subjective sleep duration

Methods: Circadian preferences and sleep were investigated in 555 (Females N=247) Finnish students aged 15–20. The self-report measures included a shortened version of the Horne-Östberg Morningness-Eveningness Scale, the Epworth Sleepiness Scale as well as items probing feelings of tiredness, optimal subjective sleep durations, and bedtime and wake-up time on the most recent day and a typical weekend. Data were collected from Tuesday to Thursday during an ordinary school week.

Results and conclusion: The most frequent chronotype was the intermediate type (54%), and compared to previous studies, the prevalence of evening-oriented individuals was high (37%), whereas only 9% of the participants were classified as morning oriented. No gender-specific or chronotype-specific differences in sleep durations were observed, but girls/women and evening-orientated individuals reported suffering more from sleepiness, compared to boys/men and more morning-typed participants, respectively. About 20% of the total sample indicated that their subjective need for sleep was not satisfied during the weekdays nor the weekend, indicating chronic sleep deprivation. Among girls/women and evening-oriented individuals, the subjective sleep need was greater for weekday nights.

1. Introduction

The temporal organization of sleep varies among adults [1,2] and adolescents [3,4]. Between-individual differences in the preference for the timing of sleep and other daily activities is usually estimated with self-report questionnaires probing chronotypes, i.e., whether a person prefers to go to bed relatively early in the evening and wake up early in the morning (morningness, Morning-type=M-type) or go to bed late and also wake up late (eveningness, Evening-type=E-type) [1,2]. Most individuals, however, fall somewhere between these opposites and represent the Intermediate type (I-type). Children are prone to morningness [5], but the onset of puberty brings a major change towards eveningness [4,6–9]. However, a small shift back to morningness usually occurs before the age of 20, probably due to social pressure [4]. Recent research suggests that increased sensitivity to light may trigger this change toward eveningness in puberty [10]. Accordingly, youngsters living in rural areas with no electric lighting exhibit earlier bedtimes than their peers in more urban areas [11,12].

Several lines of recent evidence suggest that eveningness has a negative effect on sleep. Eveningness-typed adolescents report having a poorer quality of sleep than individuals exhibiting other chronotypes [3,7,13], and daytime sleepiness is often [3,14,15], but not always [16], reported by E-types. Short et al. [13] point out that daytime sleepiness or tiredness in E-types is caused by poor sleep quality. Compared to morning-orientated adolescents, E-types are reported to sleep less during the school week [3,7]. Although adults usually sleep for the same length of time on weekday nights irrespective of their chronotypes, E-typed adults complain of insufficient sleep [16,17].

Defining optimal sleep is a matter of considerable complexity [18]; in this study, only subjective sleep need was assessed. The discrepancy between reported sleep length and subjective need for sleep was used to define excessive sleep and sleep deprivation. Mercer et al. [19] found two groups of adolescents with respect to this: those wanting more sleep on weekday nights, and those satisfied with their sleep duration. They suggested that eveningness might explain why the respondents felt they needed more sleep.

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Compared to other chronotypes, adult E-types have shown equivalent sleep duration on weekday nights, but have expressed not having a sufficient amount of sleep [16]. The present article further tested whether differences exist in bedtime, wake-up time, duration of sleep, subjective sleep need, and tiredness among different chronotypes. Sleep-related factors in adolescence tend to be at least partly gender specific [4,6,20,21], therefore we were also interested in seeking possible differences between male and female participants.

In short, the present study was carried out to further explore sleep and morningness-eveningness in a student population. Based on previous work, we hypothesized that compared to morning-oriented students, participants with more evening-type orientation would a) sleep less during the school week and more on weekend nights, b) complain insufficient sleep during the school week in particular, and c) report a higher level of tiredness on weekdays. The relatively mixed previous results concerning gender differences do not lend themselves to hypotheses.

2. Method

2.1. Procedure and sample

The study design was approved by an ethical board at the University of Helsinki. The participants were recruited from different high schools (49% of the sample) and vocational schools (51% of the sample). In Finland, after 9-year compulsory comprehensive school, about a half of the cohort continues to high school and half studies further in vocational school. Only a very small minority discontinue their education. Data were collected in three major metropolitan cities (together comprising about 1 million inhabitants) and two towns (54,000 and 21,000 inhabitants) in southern Finland. These municipalities are located between 60° and 61° North latitudes and 24° and 26° East longitudes.

Permission to carry out the study was received from local school authorities. The authors of the present article gathered the data during regular school lessons. To obtain the most accurate sleep information possible, data collection was organized only from Tuesday to Thursday on ordinary school weeks and unconnected to holidays over two academic years from 2013 to 2015. Sampling took place from September to October and March to May during these academic years. Most of the data were gathered from March to May, when there is much daylight in southern Finland. Using paper and pencil, the participants responded to several scales exploring sleep and well-being in a 20-minute session. About 580 participants produced eligible answers, but those older than 20 were removed from the data. Hence, 555 students (247 females, 44.5%, one missing gender value) aged 15–20 years remained in the data. Missing values, which were relatively infrequent and random, decreased the number of informants in some scales.

2.2. Measures

2.2.1. Chronotypes

A shortened version [22] of the Morningness-Eveningness Questionnaire [23] was used to assess the chronotypes of the participants. The shortened version includes six items, yielding 5–27 points. Participants obtaining 19–27 points were classified as M-types, those with 13–18 points intermediate types, and those with 5–12 points evening types [17].

Generally, in addition to questionnaires probing daily activities and sleep habits, circadian preferences are often estimated using the sleep midpoint time (the time between sleep onset and sleep offset): the later the sleep midpoint is, the more the respondent is inclined towards eveningness. Two indices of mid-sleep were calculated in this study: one for a school weeknight, and another for a weekend night [2].

2.2.2. Self-reported sleep length and subjective sleep need

Sleep durations during the school week and the weekend were enquired about with four questions: "When did you go to bed yesterday?", "When did you wake up today?", "When do you usually go to bed on Friday and Saturday?", and "When do you usually wake up on Saturday and Sunday?" The actual time in bed was calculated using these values. In addition, the participants were asked to indicate how many hours of sleep they would need on weekday and weekend nights to remain alert during the daytime.

2.2.3. Sleepiness/tiredness

The *Epworth Sleepiness Scale* (ESS) [24] is an eight-item measure of daytime sleepiness. The participants are asked to evaluate how likely it is that they doze or fall asleep in everyday situations (e.g., "Sitting and reading" and "As a passenger in a car for an hour without a break"). The scale includes four options: 0 = would never doze, 1 = slight chance of dozing, 2 = moderate chance of dozing, and 3 = high chance of dozing. A total score over the eight items was calculated.

Tiredness was estimated using four questions (1 = very alert – 5 = very tired) concerning how tired the participant was in the morning and during the day on weekends and weekdays. Composite scores (range 2–10) were calculated for tiredness on weekdays and during weekends.

2.3. Data analysis

The data were analyzed using SPSS 22 software. To reveal gender-specific and chronotype-specific differences in sleep variables, a series of two-way ANOVAs was carried out. For pairwise group comparisons, a Least Significant Difference (LSD) test was applied. Cross-tabulation was used to compare whether the same individuals showed excessive sleep or sleep deprivation during both the school week and over the weekend. The significance level in all analyses was set at $p < .05$ to indicate nominal significance, and after Bonferroni correction at $p < .0027$.

3. Results

Descriptive information is shown in Table 1. The internal consistencies that could be calculated for the measures were acceptable. When school week and weekend sleep were compared, some significant differences were seen. The participants reported that they slept about two hours less on weeknights than weekend nights, $t(549) = -26.87$, $p < .001$, and were more tired during the school week, $t(553) = 29.93$, $p < .001$. Compared to weekends, they also went to bed earlier on weekdays, $t(554) = -25.62$, $p < .001$, and woke up earlier, $t(549) = -47.17$, $p < .001$.

In the present data, the prevalence of the morning type was low (N = 47, 8.9%). The proportion of the intermediate type was the highest (N = 298, 54.5%), followed by evening type (N = 194, 35.0%). The genders were equally represented in the chronotypes, Pearson $\chi^2(2) = 1.79$, n.s.

Sleep deprivation and excessive sleep during the school week were calculated by subtracting the subjective sleep need from the self-reported sleep length. Not all 555 participants produced eligible answers to the items investigating sleep length. Of the 549 participants with eligible answers, 310 (56.5%) reported having slept less during the previous night than their optimal sleep need, whereas 195 (35.5%) indicated that their sleep length during the

Table 1
Descriptive statistics for main variables.

Measure	Cronbach's α	All participants	
		Mean	*SD*
Morningness-Eveningness Questionnaire (5–27)	.67	13.81	3.68
Mid-point sleep, school week (h:min)	N/A	03:23	0:54
Mid-point sleep, weekend (h:min)	N/A	05:54	1:20
Bedtime, school week (h:min)	N/A	23:31	1:09
Wake-up, school week (h:min)	N/A	07:15	1:06
Bedtime, weekend (h:min)	N/A	01:09	1:26
Wake-up, weekend (h:min)	N/A	10:47	1:33
Sleep length, school week (h:min)	N/A	07:43	1:22
Sleep length, weekend (h:min)	N/A	09:46	1:23
Subjective sleep need, school week, (h:min)	N/A	08:11	1:17
Subjective sleep need, weekend, (h:min)	N/A	09:00	1:26
Sleep deprivation, school week, $N=310$, (h:min)	N/A	–1:34	1:29
Excessive sleep, school week, $N=195$, (h:min)	N/A	1:11	1:08
Sleep deprivation, weekend, $N=139$, (h:min)	N/A	–0:59	0:29
Excessive sleep, weekend, $N = 323$, (h:min)	N/A	1:50	1:10
Tiredness, school week (2–10)	.67	6.47	1.58
Tiredness, weekend (2–10)	.79	3.90	1.58
Sleepiness, ESS (0–24)	.79	6.79	4.26

Abbreviations: N/A=not assessed, ESS=Epworth Sleepiness Scale.

previous night exceeded their optimal sleep need. Further, 44 (8.0%) participants reported that their actual sleep length during the previous night was exactly the same as their optimal sleep length.

Sleep deprivation over the weekend was calculated by subtracting the subjective sleep need during the weekend from the usual sleep length. Of 545 respondents, 139 (25.0%) stated that their actual sleep length was shorter than the optimal sleep amount over the weekend. As well, 323 (58.2%) reported that they slept more than they needed, and 83 (15.0%) said that their sleep length corresponded to their subjectively experienced optimal sleep amount. Only sleep deprivation and excessive sleep concerning the school week and weekend were further investigated in this study.

The results of the analysis of variance are summarized in Tables 2 and 3. Means and standard deviations of the groups are given in Table 3. Several gender differences emerged: compared to boys, girls went to bed somewhat earlier, expressed more sleepiness (ESS), were more tired during the school week, and felt that their need for sleep was greater on weekdays. No gender differences in sleep length, wake-up time on weekdays, or subjective sleep need over the weekend were observed.

Table 2 also presents the differences concerning sleep variables in the three chronotypes. Group means and standard deviations for each chronotype, as well as the outcome of *post hoc* tests (Fisher's least significant difference tests), are given in Table 3. As could be expected, late bedtimes and late wake-up during the weekend, as well as late mid-point sleep times, were associated with eveningness. No difference was observed between the chronotypes in the amount of sleep; only the timing of sleep was different. The same finding pertains to the weekend: the chronotypes showed no statistically significant difference in sleep quantity but, compared to M-types for instance, E-types went to bed 1 h 20 min later and woke up 1 h 30 min later.

Tables 2 and 3 also present the results of the analysis of subjectively reported sleep deprivation and excessive sleep. No gender difference emerged, and no group difference was observed for excessive sleep. The only difference was in sleep deprivation during the school week: eveningness was associated with greater sleep loss.

Eveningness was also related to the probability of dozing (sleepiness, ESS) in everyday situations. Belonging to an evening-orientated chronotype explained 22% of experienced tiredness on weekdays, but circadian preferences played no role in tiredness during the weekend.

The participants were asked about their optimal sleep length on schooldays and over the weekend. As indicated in Tables 2 and 3, eveningness-orientated participants considered their subjective sleep need to be greater than more morning-orientated participants.

Cross-tabulation over the participants who expressed sleep deprivation and excessive sleep is shown in Table 4. Generally, those who reported being sleep derived or sleeping excessively during the school week also tended to report similar behavior over the weekend, Pearson $\chi^2(1)=31.03$, $p<.001$. Nevertheless, over half of those who indicated sleep deprivation on weekday nights declared excessive sleep over the weekend. A total of 103 students indicated that they did not sleep enough on weeknights or during the weekend. This group of chronically sleep-deprived individuals

Table 2
Group differences.

Measure	Gender effect			Chronotype effect			Interaction effect	
	F (df)	*p*	η^2	*F (df)*	*p*	η^2	*F (df)*	*p*
Morningness-eveningness	3.13(1523)	n.s.	–	984.65(2523)	< .001	.79	.07(2,523)	n.s.
Mid-point sleep, school week	13.07(1522)	< .001	.02	25.11(2522)	< .001	.09	.52(2522)	n.s.
Mid-point sleep, weekend	25.61(1520)	< .001	.05	41.12(2520)	< .001	.14	1.81(2520)	n.s.
Bedtime, school week	14.10(1523)	< .001	.03	20.16(2523)	< .001	.07	.24(2523)	n.s.
Wake-up, school week	3.53(1522)	n.s.	–	11.73(2522)	< .001	.04	1.65(2522)	n.s.
Bedtime, weekend	19.42(1523)	< .001	.04	29.06(2523)	< .001	.10	.87(2523)	n.s.
Wake-up, weekend	18.88(1520)	< .001	.04	32.93(2520)	< .001	.11	2.12(2520)	n.s.
Sleep length, school week	2.52(1522)	n.s.	–	1.71(2522)	n.s.	–	1.55(2522)	n.s.
Sleep length, weekend	.07 (1520)	n.s.	–	1.16(2520)	n.s.	–	.54(2520)	n.s.
Subjective sleep need, school week	7.29(1519)	< .01	.01	7.21(2519)	< .01	.03	.69(2519)	n.s.
Subjective sleep need, weekend	.81(1515)	n.s.	–	16.17(2515)	< .001	.06	.18(2515)	n.s.
Sleep deprivation, school week, $N=310$	1.64(1286)	n.s.	–	4.86(2286)	< .01	.03	.29(1286)	n.s.
Excessive sleep, school week, $N=195$	.02(1182)	n.s.	–	.06(2182)	n.s.	–	.10(2182)	n.s.
Sleep deprivation, weekend, $N=139$	.50(1128)	n.s.	–	2.95(2128)	n.s.	–	.05(2128)	n.s.
Excessive sleep, weekend, $N = 323$	.26(1303)	n.s.	–	1.00(2303)	n.s.	–	.44(2,303)	n.s.
Tiredness, school week	10.47(1523)	< .01	.02	73,66(2523)	< .001	.22	.79(2523)	n.s.
Tiredness, weekend	3.82(1523)	n.s.	–	1.21(2523)	n.s.	–	.63(2523)	n.s.
Sleepiness, ESS	7.61(1505)	< .01	.02	6.87(2505)	< .01	.03	.16(2505)	n.s.

Abbreviations: n.s.=not significant, ESS=Epworth Sleepiness Scale.

Table 3
Descriptive statistics for participant groups and differences among chronotypes.

	Gender				Chronotype					
	Girls		Boys		Morning		Intermediate		Evening	
Measure	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Morningness-eveningness	13.39	.24	14.14	.22	20.85	1.76	15.21[m]	1.63	10.01[m,i]	1.73
Mid-point sleep, school week (h:min)	03:16	0:49	03:39	0:57	02:42	0:57	03:21[m]	0:50	03:37[m,i]	0:50
Mid-point sleep, weekend (h:min)	05:37	1:14	06:08	1:21	04:55	1:22	05:43[m]	1:13	06:26[m,i]	1:19
Bedtime, school week (h:min)	23:23	1:05	23:42	1:11	22:45	1:17	23:27[m]	1:05	23:48[m,i]	1:07
Wake-up, school week (h:min)	07:13	.59	07:16	1:12	06:38	0:55	07:15[m]	1:04	07:25[m]	1:04
Bedtime, weekend (h:min)	00:43	1:23	01:14	1:25	00:10	1:24	0:49[m]	1:21	01:30[m,i]	1:24
Wake-up, weekend (h:min)	10:31	1:24	11:00	1:38	09:41	1:41	10:36[m]	1:21	11:19[m,i]	1:40
Sleep length, school week (h:min)	07:55	1:16	07:34	1:26	07:57	1:09	07:48	1:20	07:37	1:25
Sleep length, weekend (h:min)	09:48	1:18	09:45	1:27	09:30	1:25	09:47	1:11	09:48	1:37
Subjective sleep need, school week, (h:min)	08:21	1:06	08:04	1:24	07:41	1:07	08:05	1:09	08:27[m,i]	1:28
Subjective sleep need, weekend, (h:min)	09:14	1:18	09:06	1:31	08:22	1:07	9:01[m]	1:18	09:34[m,i]	1:32
Sleep deprivation, school week, $N=310$, (h:min)	−1:27	1:21	−1:40	1:35	−1:10	0:44	−1:21	1:10	−1:51[i]	1:45
Excessive sleep, school week, $N=195$, (h:min)	1:12	0:55	1:09	1:05	1:13	1:11	1:11	0:58	1:09	1:05
Sleep deprivation, weekend, $N=139$, (h:min)	−1:28	1:15	−1:17	1:17	−1:13	0:54	−1:06	0:42	−1:39	1:40
Excessive sleep, weekend, $N=323$, (h:min)	1:38	1:11	1:40	1:00	1:43	0:54	1:34	0:58	1:44	1:17
Tiredness, school week	6.81	1.54	6.21	1.56	4.85	1.32	6.13[m]	1.29	7.33[m,i]	1.54
Tiredness, weekend	4.06	1.52	3.76	1.62	3.83	1.70	3.81	1.50	4.02	1.58
Sleepiness, ESS	7.72	3.90	6.06	4.39	5.36	3.77	6.43	4.24	7.73[m,i]	4.25

Abbreviations: [m]differs from morning type, [i]differs from intermediate type, ESS=Epworth Sleepiness Scale.

Table 4
Crosstabulation over individuals with sleep deprivation and excessive sleep during the school week and weekend.

School week	Weekend		Total
	Sleep deprivation	Excessive sleep	
Sleep deprivation	103	146	249
Excessive sleep	27	144	171
Total	130	290	420

consisted of 53 (54%) E-types, 43 (43%) I-types, and 3 (3%) M-types. Consequently, 144 participants reported that they slept more than their optimal sleep need would be during both school weeks and weekends. Of these, the chronotypes were identified for 139 individuals. This group included 80 (58%) intermediate-type participants, 39 (28%) evening-type, and 20 (14%) morning-type. Overall, these percentages suggest that subjectively experienced sleep deprivation is linked to eveningness and, tentatively, that morningness is related to excessive sleep.

4. Discussion

The present study endeavored to further explore whether marked differences exist in bedtime, wake-up time, sleep duration, sleep need, and daytime tiredness between chronotypes in students aged 15–20 years. On average, our participants slept 7 h 43 min per night on weekdays. An international comparison suggests that, with some exceptions (e.g., Australia) [6,25], sleep length less than 8 h is typical for high school-aged students. The participants in this study slept an average of 13 min more than Finnish 18–80-year-old adults are reported to sleep [26]. This can be considered small, given that the majority of our participants were 15–17-year-old adolescents who are generally thought to need up to some 50 min more sleep per night on average [27] than adults. The average sleep length in the present data falls within the limits of recent recommendations [28]. Nevertheless, the average sleep amount appears to conceal the fact that many of the respondents here considered their amount of sleep to be insufficient. In line with previous research [2,6,9,29], we found that compared to weekdays, bedtime and wake-up time were later and time in bed longer during the weekend.

Several geographical factors appear to have an influence on circadian preferences. For instance, a marked delay in diurnal activities was observed in local young people when moving from East to West, from South to North and from towns to villages within the same time zone in the Russian Federation [6]. Other studies have also reported variations in morningness-eveningness according to climate and geographical region [30,31]. Southern Finland has a relatively northern and western (relative to the time zone) location, which favors E-types [6]. This may have had some effect on circadian preferences in the present data. However, we assume that non-regional factors might be more influential in the findings.

The high prevalence of E-types may have implications on school achievement and well-being. Without any exception, of the hazards that do differ between the chronotypes, all have thus far been more common among E-types than M-types. Accordingly, E-types tend to have less resilience to adversity and less optimism about life [32], and their academic achievement is worse both as school pupils and as university students [33].

Research with twins as respondents has suggested that about half of the variation in adult circadian rhythms originates from genetic factors, and the other half from the environment [34,35], whereas one study [36] on a culturally homogenous adult population suggested that heritability might be accountable for only 23% of individual variation in morningness-eveningness. We consider it possible that in adolescence and young adulthood the environment may account for more than 50%. In particular, time spent in front of electronic screens seems to cause a shift towards eveningness [37], and may have contributed to the high number of E-types in our data. The extensive use of smartphones and computers is probably due to the need for peer interaction among young people. The role of peer group socialization has been assumed to play a major role in child and adolescent behavior [38]. Much of the electronic communication in adolescents is aimed at maintaining interaction with peers [39]. Because information and communication technology is nowadays continuously available to most Finnish young people [40], peer interaction may take place late in the evening and even at night, which may in turn be reflected in diurnal preferences. On the societal level, time use has

shifted in adolescents to increased time spent in front of a variety of screens for electronic games and media (smartphones, tablets, computers, consoles, televisions, etc.), which may contribute to sleep disturbances and tiredness [41–45]. However, more research on the timing of adolescents' and young adults' daily activities is needed.

Our results suggest that compared to boys, girls estimate their subjective need for sleep to be greater during the school week. Perhaps girls' need for sleep is best satisfied over the weekend. In the present study, boys went to bed later than girls and showed greater eveningness measured by the mid-point of sleep, which is in line with previous studies [4,6]. However, when we assessed the chronotypes using the morningness-eveningness scale, no gender difference was noted. Similar notions have been put forward by two Italian studies [3,7].

Unlike in some previous studies [3,7,46] and our hypothesis, in the present study the E-type students did *not* sleep less than their more morning-orientated peers. We observed equal sleep durations irrespective of chronotype, which is typical for adults [16,17]. The timing of sleep was, however, dissimilar for the chronotypes: late bedtime and late wake-up time were associated with eveningness. School begins at the same time daily (usually 8:00 or 9:00 a.m.), so the E-types, who wake up late, are forced to shorten their morning activities or perhaps skip the morning lesson. Because sleep length did not differ among the chronotypes, perhaps the optimal timing of sleep, which is possible for E-types only over the weekend, alleviated weekend tiredness in these participants.

Although sleep duration was not related to morningness-eveningness, many other sleep-related aspects were different in students with different circadian preferences. In line with previous work [3,7,13–15] and our hypotheses, eveningness in our results was related to daytime tiredness/sleepiness. Further, and as suggested by Mercer et al. [19], eveningness was related to the desire to be able to sleep longer hours. Interestingly, evening-orientated participants felt that their optimal need for sleep was not met even during the weekend, when sleep schedules are not restricted by early school mornings.

5. Conclusion

Our study has both its strengths and limitations. We investigated a large and relatively representative sample of adolescents and young adults using a set of sleep-related measures. Unlike most of the previous studies, we were interested in subjective sleep need. However, the study design is cross-sectional, and causal explanations are not possible. Data were collected only through self-report measures. The use of additional objective sleep research equipment would have strengthened the results.

In conclusion, no gender- or chronotype-specific differences in sleep durations were observed, but females compared to males and evening-orientated individuals compared to more morning-type participants reported suffering more from feelings of sleepiness, tiredness, and sleep loss, particularly during the school week. Finally, approximately 20% of the individuals in our sample indicated that their subjective need for sleep was not satisfied on weekdays or during weekends.

Disclosures

The authors declare that they have no competing interests.

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