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Are There Differences in Students' School Success, Biorhythm, and Daytime Sleepiness Depending on Their School Starting Times?

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A B S T R A C T

Chronotype is a characteristic of a person in a certain point of one's lifetime and it slowly changes with age. Adolescents start to go to bed later while schools impose early starting hours, which may become a problem for students who are unable to adapt their circadian rhythm. The aim of this study was to determine if differences in school starting times affect the students' chronotype, school success, or daytime sleepiness. We tested a total of 1020 students from four high schools in Osijek, Croatia. The students had alternating school shifts (school starting hours 7 AM or 13 PM and 8 AM or 14 PM, every other week, alternatively, respectively). The participants were tested using the Epworth Sleepiness Scale and the Morningness – Eveningness Questionnaire. Earlier chronotypes were characteristic of the students starting school earlier, but without significant difference in daytime sleepiness in comparison with those starting school later. Differences were also found between different age and gender groups, female and older students having earlier chronotypes. Students going to school earlier showed better school success than the latter. In conclusion, the study shows that students starting school earlier also have earlier chronotypes, which might be consequence of the adaptation to one hour earlier school starting time.

***Key words**: chronotype, daytime sleepiness, circadian rhythm, school starting hours*

Introduction

Sleep is one of the main requirements for normal psychophysical functioning of every person[1], especially needed during development or in situations of physical and psychical stress. The circadian rhythm is determined by a precise molecular sequence of expression of the transcription factors[2]. The ability of its regulation and certain chronotype (early-morning types and late-night types) are inherited[3]. At a certain point of their lifetime humans tend to adhere to a certain chronotype, but during the process of aging, especially in adolescence, the shift in chronotypes is frequent and evident[4]. Adolescent children start to go to bed later and later[5] due to biological and social reasons, such as increasing demands of school and extracurricular activities. This in turn may lead to various sleep disorders, such as Delay Sleep Phase Syndrome[6,7]. It is manifested in a difficulty to fall asleep and wake up, which, on the other hand, leads to daytime sleepiness. The students with later chronotypes are more likely to have behavioral/emotional problems, develop suicidal ideas and habitual substance abuse[8].

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The daytime sleepiness is shown to be associated with lower grades, a decrease in extracurricular activities, tardiness, being sleepy at school and missing social or sport events[8]. Also, students sleeping less than five hours a day showed impaired higher cognitive functions such as abstract thinking and verbal creativity, although they maintained their ability to perform routine tasks[9]. Contrary to the delay in circadian rhythm, schools impose early starting hours for classes, which may become a problem for students who are unable to adapt their circadian rhythm to the socially determined schedule. Consecutively, it leads to sleep deprivation and eventually psychoemotive problems[11]. Different authors suggest that a change in school starting times affects students' daytime sleepiness[11–14], but a consensus is yet to be made.

The aim of the study was to examine if one hour earlier than common school starting time affected students' daytime sleepiness, academic performance or chronotype, and if the students' were able to adjust to the change.

Materials and Methods

A total of 1020 (38.23%) students out of 2668 students enrolled in four high schools, two grammar schools and two vocational schools, in the Croatian town Osijek were questioned during the May and the June 2011. Hundred and ninety nine students were excluded from the analysis for not answering all the questions. Of the 821 students analyzed, 441 (54%) were males and 380 (46%) were females.

Male and female students weren't equally distributed in the groups divided by the school starting time: in the group of students starting school from at 7 AM there were 331 boys and 121 girls, while in the group starting at 8 AM there were 111 boys and 258 girls.

The age of the students ranged from 15 to 19 years (median age 17, interquartile range from 16 to 18). School started at 7 AM for 452 students, while for 369 of them started at 8 AM. Students from two schools, one vocational and one grammar school, were questioned in each group. School starting times were determined by the school administration and students weren't able to change school starting times at will, but they were aware of such schedule at enrolment. The school schedules were alternating, meaning that the school started one week in the morning, and in the afternoon, the next. Afternoon classes start at 1 or 2 PM, respectively. This type of schedule is due to extensive curriculum and the lack of classrooms in Croatian schools. All participants were tested using The Epworth Sleepiness Scale[15] (ESS© MW Johns 1990–1997. Used with permission) to determine Daytime Sleepiness and The Morningness – Eveningness Questionnaire[16] to determine the Self – assessed Chronotype. The score of the Epworth Sleepiness Scale ranges from 0 to 24, 24 being the sleepiest. The Morningness – Eveningness Questionnaire score ranges from 16 to 86, with earlier chronotypes related with higher values. Chronotype categories were determined as defined by Horne and Ostberg[17]. Both questionnaires are standardized and widely used in similar researches[17–21]. Data on gender, habits pertaining to napping, age and school success were also collected. School success was determined by the final grade in the last semester. Grades in Croatia vary from 1 to 5, 5 being the highest.

The approval from the School of Medicine Osijek's Ethical Committee, written consent for students of full age and parental consent for under aged students were acquired prior to the study.

Statistics

Data are presented as absolute frequencies, means with standard deviations and medians with interquartile range (IQ range), where appropriate. Correlation between variables was assessed with the Spearman's rank-order correlation coefficient. Differences between independent samples were tested using the standard inferential statistical tests employed with two or more independent samples: Student's t-test and ANOVA (or Mann-Whitney test and Kruskall-Walis test, where appropriate). The homogeneity of variances was tested using the Levene's test. All p-values were two sided. Significance level was set at $\alpha=0.05$. The analysis was conducted using the SPSS software (ver. 15.0, SPSS Inc., Chicago, IL, USA).

Results

The majority of the tested students (65.4%) fell into the chronotype group »Neither Type« The other students mostly had a Moderately Evening Type Chronotype (29.6%) (Table 1).

Differences related to self-assessed chronotype were observed when comparing the numerical values rather than using the categorical chronotypes. There is a significant difference in chronotypes between different age groups ($p=0.004$, ANOVA), older students having the earliest chronotype (Table 2). The peak in lateness is observed in 17 year old students. There was no significant difference in daytime sleepiness between the age groups ($p=0.079$, Kruskal-Wallis test).

The students going to school earlier have shown earlier chronotypes. The difference in comparison with students going to school later is significant ($p<0.001$, Student's t-test). There is no significant difference ($p=0.118$, Mann-Whitney Test) in their daytime sleepiness (Table 3).

TABLE 1
DISTRIBUTION OF SELF–ASSESSED CHRONOTYPES (N=821)

Self-assessed chronotype	N	%
Definitely Morning Type	0	0.0
Moderately Morning Type	32	3.9
Neither Type	537	65.4
Moderately Evening Type	243	29.6
Definitely Evening Type	9	1.1
Total	821	100.0

TABLE 2
SELF-ASSESSED CHRONOTYPES AND DAYTIME SLEEPINESS BY AGE GROUP (N=821)

	Years of age					p
	15	16	17	18	19	
Self–assessed chronotype [$\overline{X}$ (SD)]	45.5 (7.3)	45.0 (6.9)	44.5 (6.8)	46.3 (7.9)	48.5 (7.0)	0.004*
Daytime sleepiness [median (IQ range)]	8 (5–12)	10 (2–13)	9 (6–12)	9 (6–12)	9 (6–12)	0.079†

* ANOVA; † Kruskal-Wallis test

TABLE 3
DAYTIME SLEEPINESS AND SELF–ASSESSED CHRONOTYPES AND SCHOOL SUCCESS IN GROUPS BY TIME OF STARTING SCHOOL (N=821)

	School starts at		p
	8 AM	7 AM	
Self-assessed chronotype, $\overline{X}$ (SD)	43.5 (7)	47 (7.2)	<0.001*
Daytime sleepiness, median (IQ range)	9 (7–12)	9 (6–12)	0.118†
School success, $\overline{X}$ (SD)	3.28 (1.19)	3.60 (1.08)	<0.001†

* Student's t-test; † Mann-Whitney test

TABLE 4
DAYTIME SLEEPINESS AND SELF–ASSESSED CHRONOTYPE IN RELATION TO THE HABIT OF NAPPING ON WEEKDAYS (N=821)

	Napping during the day on weekdays		p
	Yes	No	
Self–assessed chronotype, $\overline{X}$ (SD)	44.4 (7.2)	47.5 (7.8)	<0.001*
Daytime sleepiness, median (IQ range)	10 (7–13)	7 (4–10)	<0.001†

* Student's t-test; † Mann-Whitney test

TABLE 5
GENDER RELATED DIFFERENCES IN SELF–ASSESSED CHRONOTYPE, DAYTIME SLEEPINESS AND SCHOOL SUCCESS (N=821)

	Male	Female	p
Self-assessed chronotype, $\overline{X}$ (SD)	46.4 (7.2)	44.3 (7.2)	<0.001*
Daytime sleepiness, median (IQ range)	9 (6–12)	9 (7–12)	0.036†
School success, median (IQ range)	4 (3–4)	4 (3–4)	0.004†

* Student's t-test; † Mann-Whitney test

We found a weak negative correlation between the self-assessed chronotypes and the daytime sleepiness, with Spearman's $\rho=-0.1832$ ($p<0.001$). Students that stated that they usually napped, also tended to be sleepier ($p<0.001$, Mann-Whitney test) and had a later chronotype (<0.001, Student's t-test) (Table 4).

The less sleepy students and the students with earlier chronotypes have shown to be more successful in school. We found a weak correlation of $\rho=0.189$ between the school success and the self-assessed chronotype ($p<0.001$, Spearman's rho). A weak and negative, but significant correlation between daytime sleepiness and school success of $\rho=-0.114$ was also observed ($p=0.001$, Spearman's rho).

There was a significant difference in chronotype between male and female students ($p<0.001$, Student's t-test), female students having a later set chronotype (Table 5). The difference observed in the daytime sleepiness between the genders was weaker, but still significant ($p=0.036$, Mann-Whitney Test).

Discussion

This study showed several interesting results pertaining to the differences in chronotype and sleepiness and their relation to gender, age, and, most significantly, school success in the two groups of high school students, starting school in the earlier or the later hours. Earlier chronotypes were characteristic of the students starting school earlier, but without significant difference in daytime sleepiness in comparison with those starting school later. Differences were also found between different age

and gender groups, female and older students having earlier chronotypes. Students going to school earlier showed better school success than the latter. In the analysis of chronotypes, numerical variables were used rather than categories. The numerical variables showed to be much better at distinguishing fine differences between the samples. The problem of classifying the results into rigid categories was also stated in the work by Caci et al.[22].

Although our study suggests a strong link between daytime sleepiness and school success, a one hour earlier school starting time does not seem to affect the students' success, students going to school earlier even showed significantly better school success (Table 2) than those going to school later, implying that the students from our study were probably able to shift their chronotype to an earlier set, although other parameters, such as the difference in gender distribution between groups, might have affected the result. The main limitation of the study is the difference in the gender ratio between groups. Although the sample size is large, the response rate is rather low because the survey was done during class and the number of students we were able to examine was determined by school administration. Of all the students who were given the questionnaire, there were no non-responders or students who refused to participate in the study. The low response rate might also be considered as a limitation of the study. Students had different periods of adaptation, depending on their school years because school starting times were characteristic for schools and didn't change during the education of the participants of this study. Data pertaining to the variables before this schedule regimen are not known, thus a longitudinal study that tests the students' adaptability to an earlier school starting time is necessary to confirm these results completely. The use of sleep diaries and actinometry might also be useful in distinguishing fine differences in biorhythm in future studies. The students that are able to shift to an earlier chronotype might also be more disciplined and this may lead to better grades.

These data differ from the results of Dexter, Bijwadia, Schilling, and Applebaugh[12], who found significant differences in daytime sleepiness between students going to school 45 minutes earlier and those students going to school later. Several other authors[11,13,23] also found an increase in daytime sleepiness and a decrease in academic success in students forced to go to school earlier. Our data may be different due to social and ethnic differences, as well as the mean age of the subjects. The data were collected at the end of the school year, when the students had time to adapt to the school shifts. Likewise, in May and June, students' sun exposure increases and that also may lead to differences in their circadian rhythm. The national differences in habits related to sleep have been previously noted[24]. It is possible that high school students are able to adapt better than younger students and thus further research will be needed to verify this thesis.

Daytime sleepiness and chronotype correlated and earlier set chronotypes were associated with lower levels of sleepiness. This is possibly a result of earlier bed times that are characteristic of students with earlier chronotypes and a higher level of self-discipline, pertaining to their school obligations and sleep habits. The studies showed that students with later chronotypes are more prone to daytime sleepiness and napping during daytime, and they also showed lower grades, shorter attention span, and a habit of procrastination and self-harm[25]. The difference in chronotypes in students going to school one hour earlier compared to those going later suggests adaptation, which led to no difference in sleepiness, and thus, no difference in students' academic performance. These results match the results of other studies such as Giannotti et al.[25], and Eliasson, Lettieri, and Eliasson[26], who found an association between earlier bedtimes and better school success. Although we see no significant differences in student's success, we need to take into account that we tested four different schools, and the results might have been different if the school starting times were the other way around.

The results pertaining to daytime napping are not consistent with the findings of Giannotti et al.[25], as they show that students with earlier chronotypes tend to nap more commonly than those with later chronotypes. Our data may suggest that students with an earlier chronotype adopted napping as another means of adaptation to early school starting hours. The students that tended to nap also showed a reduction in daytime sleepiness, in accordance with the data of Giannotti et al.[25].

The link between daytime sleepiness and academic success was established in earlier studies, showing that the sleepier students were prone to having worse GPA scores[8,21,25,27,28], and our results also confirm these findings. On the other hand, Eliasson et al.[29] found that there was no correlation between total sleep time and academic performance, although timing of the sleep was found to be very important.

The female students showed later chronotypes. This result is different from that of Giannotti et al.[25], who found no gender-related differences in morningness/eveningness scores. Wolfson and Carskadon[14] also found no significant differences in sleep habits of females compared to male students. On the other hand, it is stated[29] that in adolescence females have later chronotypes. It may be due to the fact that adolescence in women starts earlier. Since adolescence is followed by a significant delay in chronotype[31], females reach their maximum in lateness earlier (19.5 y). Men continue to delay their sleep until around the age of 21 (20.9 y) and are, on average, later chronotypes for most of their adulthood. Since female adolescents came closer to their peak of lateness, they have later set chronotypes compared to young men[32]. In the college population, after both genders reach their peaks of eveningness, females go to bed earlier and sleep longer than males[24].

Even though female students had a more delayed chronotype, they showed no significant difference in sleepiness when compared to male students. Edens[33] also found no difference in sleepiness of students when com-

pared by gender. This may be due to later waking up times at weekends, stated by Wolfson and Carskadon[14]. Female students also reported better grades. This suggests that for determination of school success, psychological and social differences are of greater significance than the differences in chronotypes and sleepiness.

Age is also one of the factors that affect chronotype: our study suggests that older students show the earliest chronotypes. This is different from the data found in the literature[29,31]. The latest chronotypes were found in students aged 17, after which a decrement in the lateness occurred. This may be due to different ethnic and social properties of our subjects and of those from other research studies, and it is possible that students from this survey peaked in lateness earlier. Older students also had the longest time to adapt to early school shifts, which may be the cause of earlier chronotypes in older students. Further research will be necessary to confirm this thesis. Interestingly, we found no difference in daytime sleepiness by age groups. This may result from different means of compensation, such as prolonged napping and longer sleeping at weekends. The other possibility may be that the students' need for sleep changes with age, Carskadon et al.[31]; however, it showed no results that could support our data.

Conclusion

Our study shows that students going to school earlier have earlier chronotypes. This may be a result of an adaptation. Students showed no differences in their daytime sleepiness. Furthermore, the study showed differences in chronotypes in groups different by gender, age and the school starting time. These differences, consequently, may lead to differences in school success.

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POSTOJE LI RAZLIKE U ŠKOLSKOM USPJEHU, BIORITMU I DNEVNOJ POSPANOSTI U OVISNOSTI O VREMENU POČETKA NASTAVE?

S A Ž E T A K

Kronotip je karakteristika pojedine osobe u određenom trenutku života, a mijenja se s dobi. Adolescenti liježu sve kasnije, dok škole nameću rani početak nastave. To može postati problem za one učenike koji ne mogu prilagoditi svoj cirkadijani ritam tim zahtjevima. Cilj ove studije bio je utvrditi utječu li razlike u vremenu početka nastave na kronotip učenika, njihov školski uspjeh ili dnevnu pospanost. Ispitali smo ukupno 1020 učenika iz četiri osječke srednje škole. Učenici su imali nastavu u dvije smjene (nastava im je počinjala ili u 7:00/13:00, ili u 8:00/14:00, naizmjenično svakog drugog tjedna). Ispitanike smo ispitali pomoću upitnika Epworth Sleepiness Scale i Morningness-Eveningness Questionnaire. Raniji kronotipovi bili su karakteristični za one učenike koji su imali raniju nastavu, ali nismo uočili značajnu razliku u pospanosti između skupina. Pronašli smo razlike i između dobnih i spolnih skupina, tako da su djevojke i stariji učenici, neovisno o spolu, imali kasniji kronotip Učenici koji su u školu polazili ranije, ostvarivali su i bolji školski uspjeh. Raniji kronotipovi koje smo uočili mogu biti posljedica prilagodbe na raniji početak nastave.