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SLEEP-WAKE CYCLE IRREGULARITY AND DAYTIME SLEEPINESS IN ADOLESCENTS ON SCHOOLDAYS AND ON VACATION DAYS

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ABSTRACT

Background and objective: Comparing the sleep-wake cycle (SWC) and daytime sleepiness in adolescents when they attend morning classes and during school vacations.

Methods: The sleep-wake cycle was evaluated based on the student's sleep log, and daytime sleepiness was evaluated by the Karolinska Sleepiness Scale (KS). Comparison between these variables was performed with 42 Brazilian adolescent students (14-19 years old) based on a one-week period on schooldays and a one-week period on vacation days. SWC irregularity was evaluated through standard deviation in bedtime and wake-up time on weekdays and on weekends. For statistical analysis, dependent T-test and Repeated Measures Anova were applied ($p < 0.05$).

Results: During the vacation period, sleep irregularity is maintained, but in contrast to the schoolday period, adolescents have a more extended sleep period on weekdays than on weekends. Bedtime and wake-up time are delayed, and sleep duration increases along the week. Sleepiness shows a daily pattern characterized by higher sleepiness levels at wake-up time and bedtime, and during vacations, such levels decrease at wake-up time and at 2:00pm. Moreover, during vacations frequency of naps decreases both on weekdays and on weekends.

Conclusion: The morning school schedule is not the sole cause for the adolescent's sleep irregularity. Sleep habits associated with other factors involving the adolescent's socio-cultural context may influence such behavior. It is important to investigate the extent at which sleep schedule irregularity starts to be detrimental to the individual's sleep quality.

Keywords: Sleep-wake cycle, adolescent, vacation, school schedules, partial sleep deprivation

INTRODUCTION

Although people show different physiological needs in relation to sleep, social schedules do not take into consideration such needs (1). For adolescents, who usually go to sleep later and wake up later than infants (2,3), starting classes before 08:00am is doubtlessly a problem, and this schedule can be observed in several countries including Israel (4), USA (5), Italy (6), Brazil (7), and Korea (8). The difficulty parents have when waking their children on time to go to school, which is often perceived as as laziness, conceals a problem that has been recurrent among the society, that is, partial sleep deprivation (4-8). We frequently hear reports from parents and teachers about adolescents' excessive daily sleepiness (9-14) coupled with frequent and extended naps (6,10). Other consequences of partial sleep deprivation may include learning difficulties, depressive mood, and behavioral problems (9,14).

Such conflict between social schedules and biological schedules, termed by Wittmann and collaborators as "social jetlag" (15), is considered the major cause for partial sleep deprivation in adolescent students and is associated with irregularity in bedtime and wake-up time schedules on weekdays and on weekends (1,6 8,10,15,17). This happens because on weekends adolescents tend to compensate for the sleep deficit accumulated during weekdays by increasing their night sleep period by 2 hours, in addition to sleeping and waking up later (10,18). Irregularity in bedtime and wake-up time contributes to increased daily sleepiness (17,19) and reduced sleep efficiency (17), and it generates unsatisfactory academic performance (19).

Even recognizing that morning school schedules are the chief cause for adolescents' partial sleep deprivation and sleep schedule irregularities, practicing certain habits close to bedtime limits the adolescent's capacity to adjust to school schedules, thus exacerbating the problem. For example, adolescents usually watch TV, navigate on the internet, study until late at night (20-23), or ingest stimulant substances such as coffee or soda, shortly before bedtime (20). Such behaviors are normally associated with exposure to artificial light, which may further delay the individual's sleep schedule (24). On a study conducted with adolescents, Cortesi and collaborators (25) found that in a sample of 425 students, 34% exhibited sleep hygiene habits associated with a high level of daytime sleepiness and low performance.

Nevertheless, such habits may develop due to a lack of knowledge about behaviors that impact sleep (25), or because the individual chooses to maintain certain habits that are knowingly detrimental to sleep quality, as in the case of individuals suffering from insomnia (26). In a study conducted with university students, Brown and collaborators (27) observed that knowledge about sleep hygiene measures is related to behaviors that contribute to improve sleep quality, such as trying to maintain a regular schedule concerning bedtime. A similar result was observed in adults by Gallasch and Gradisar (28) and in adolescents by Sousa and collaborators (10).

On the other hand, during vacations, when adolescents are free from any school obligations, sleep deprivation on weekdays is reduced or nonexistent, as the majority of adolescents can sleep as much as they wish, according to their physiological needs. Thus, in adolescents who attend morning classes, sleep schedules and sleep duration are different on schooldays and on school vacations. For example, Hansen and collaborators (29) found that adolescents' bedtime and wake-up times are delayed on vacations, and that their sleep period on weekdays increases 120 minutes, and on weekends it increases around 30 minutes, when compared to the first week after classes start. Similarly, Crowley and collaborators (30) observed that during vacations, the initial half sleep period and the beginning of melatonin release occur later when compared to schooldays. In addition, these authors reported that there is a closer correlation between sleep schedules and the beginning of melatonin release during schooldays. That is, during vacations, the adolescents express their endogenous tendency of delaying sleep schedules and extending the night sleep period, reinforcing the internal temporal order that had been disturbed by the effect of social synchronizers, such as school schedules.

Thus, during vacations, the possibility of sleeping later on weekdays is associated with an increase in night sleep duration, and it may reduce irregularity in sleep schedules both on weekdays and on weekends, as well as reduce daily sleepiness. Evaluation of adolescents' sleep-wake cycles during schooldays and during vacations enables an understanding of how school schedules impact adolescents' sleep-wake cycles and on sleepiness. Such evaluation is quite important, as these parameters affect, and often compromise, studetns' performance at school, mainly in the case of students who have partial sleep deprivation. For this reason, the objective of the present study was to compare adolescent students' sleep-wake cycles (SWC) and daily sleepiness on schooldays and on vacation days.

MATERIALS AND METHODS

Participants

After project approval by UFRN Ethical Committee, 127 students from three high school classes were invited to participate in this study upon signing the informed consent form. Any student included in one of the three classes could participate in the study after it was completed by his/her parents. At the end of the study, 42 students (14-19 years old) completed the research, which was conducted at a private school in the city of Natal, state of Rio Grande do Norte (05º46´S 35º12´W).

Procedures

Data collection was carried out during two weeks: the first one in the first semester of the school year (June) and the second during the vacation period (July). SWC and daily sleepiness were evaluated on both weeks.

For SWC evaluation, sleep logs were utilized (31), and for evaluation of daily sleepiness, the Karolinska Sleepiness Scale was applied (KSS) (32,33). The sleep log included questions related to bedtime and wake-up time schedules, sleep latency, way of waking up, frequency of naps, and time of naps. The Karolinska Sleepiness Scale is an analog scale in which the lowest values represent the lowest levels of sleepiness and vice-versa. In this study, the adolescents fill in the scale upon waking up, at 8:00am, 11:00am, 02:00pm, and at bedtime.

The questionnaires to be filled in during vacations were delivered shortly before the beginning of the vacation period. During

vacations, on the week when data collection should start, the participants received a phone call reminding them to start filling in the questionnaire. On schooldays, the researcher went to the classes to remind the students and to verify that the questionnaires had been duly filled in.

Comparison between sleep schedules on the five weekdays and the two weekend days both during the school period and during the vacation period was performed with the use of a dependent T-test. SWS was evaluated by comparing the standard deviation in bedtime and wake-up time schedules on weekends during schooldays and during vacation days by means of a dependent T-test.

Sleepiness levels on both schedules were evaluated through a repeated measures Anova. In addition, sleepiness on each schedule was evaluated through a dependent T-test. The significance index for all tests was 5%.

RESULTS

Adolescents' sleep schedules are different on schooldays and on vacation days. Bedtime during vacations was delayed 107 minutes (t(197)= -10,57, p= 0.001); wake-up schedule was delayed 208 minutes (t(197)= -24,44, p= 0.001); and the time that the adolescents remain in bed increased 88 minutes (t(197)= -5,54, p= 0.001) (Table 1).

On weekends, the adolescents' bedtime was delayed 35 minutes (t(81)= -2,18, p= 0.001), and wake-up time, 48 minutes (t(81)= -3,68, p= 0.001). There was not, however, a significant difference between the time that they remain in bed on schooldays (517 minutes) and on vacation days (537 minutes) (t(81)= -1,06, p>0.05) (Table 1). Figure 1 depicts the sleep patterns of an adolescent on schooldays and on vacation days.

Table 1: Bedtime and wake-up time schedules; night sleep duration; and nap schedules of adolescents on schooldays and on vacation days (Dependent T-test, * p< 0,05).

CVS Parameters	Schooldays (average + SD)	Vacation days (average + SD)	p
Week			
Bedtime schedule (h:min)	22:33±70	24:21±135	*
Wake-up schedule (h:min)	6:21±77	9:48±124	*
Time in bed (min)	489±191	577±110	*
Naps			
Beginning (h:min)	13:45±116	14:24±131	ns
End (h:min)	15:24±130	16:15±144	ns
Duration (min)	98±52	110±88	ns
Weekend			
Bedtime schedule (h:min)	24:09±110	24:45±137	*
Wake-up time schedule (h:min)	8:54±106	9:42±120	*
Time in bed (min)	517±117	537±134	ns
Naps			
Beginning (h:min)	13:51±125	13:48±122	ns
End (h:min)	15:46±134	15:25±116	ns
Duration (min)	126±74	119±56	ns
Irregularity			
Sleeping	77±35	81±50	ns
Waking up	99±43	61±24	*

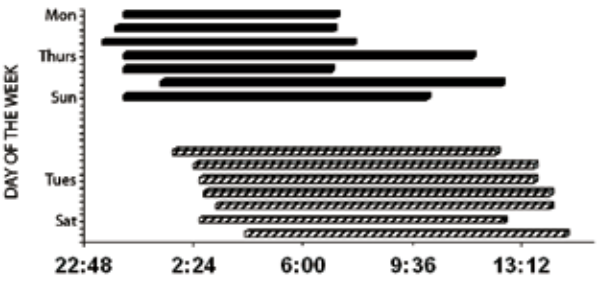

Figure 1: Actogram representing the sleep-wake cycle of an student during a school week (compact bars) and on a vacation week (intercepted bars).

The percentage of individuals who report waking up by themselves was greater during vacations than during schooldays (X^2= 115, p=0.001). No difference in the way of waking up on weekends could be observed (X^2= 1,49 p>0.05).

During vacations, sleep irregularity concerning bedtime remained (t(42)= -0,36, p>0.05). On schooldays, however, this pattern underwent an inversion, and sleep duration was greater on weekends (t(80)= -2,37, p=0.01); during vacations, adolescents had a more extended sleep period on weekdays (t(80)= 3,0, p=0.001) (Figure 2), whereas during schooldays, wake-up time was earlier (t(42)= 4,07, p=0.001) (Table 1).

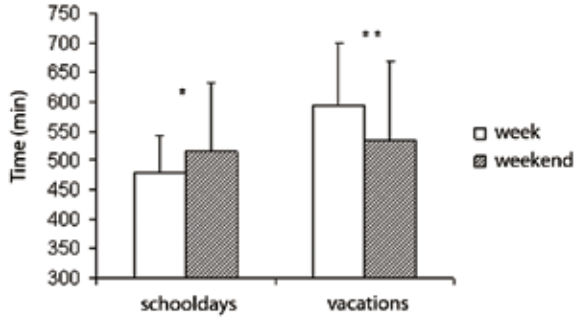

Figure 2: Student's sleep duration (average + standard deviation) on weekdays and between weekdays and weekends during schooldays and during vacation days; (*) extended sleep duration on weekends; (**) extended sleep duration on weekdays (dependent T-test, p< 0.05).

During schooldays, the incidence of naps was greater than during vacations, both on weekdays and on weekends (X2=28,73, p=0.001) (X2=11,18, p=0.001). On schooldays, the incidence of naps was greater on weekdays than on weekends (X2=6,48, p=0.01), and this difference was not observed during vacations (X2=0,66, p>0.05) (Figure 3).

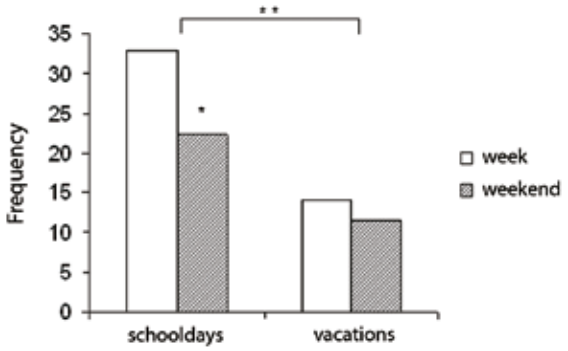

Figure 3. Frequency of naps on schooldays and on vacation days;(*) difference between weekdays and weekends; (**) difference between schooldays and vacation days. (Qui-square, * p<0.05).

No difference with respect to the beginning, end, and duration of naps between the two weeks could be observed (t; p>0.05) (Table 1).

Sleepiness levels were similar on both periods (Anova, F(1, 266) = 0.69, p>0.05). A variation in sleepiness depending on the time of the day could be observed; the highest sleepiness levels were observed at wake-up time and at bedtime (Anova, F(4, 1064) =152,67, p=0.001) (Figure 4).

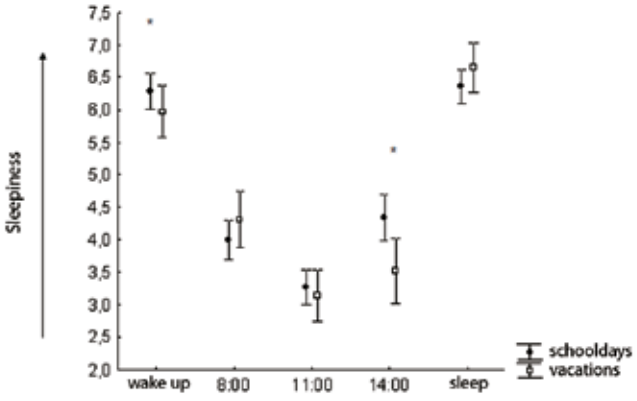

Figure 4. Sleepiness evaluated through KSS along the day on schooldays and on vacation days. (dependent T-test, * p<0.05).

Sleepiness levels during the vacation period were lower at wake-up time (t(173)= 5,53, p= 0.001) and at 02:00pm (t(157)= 5,39, p= 0.001) compared to those during the school period. At 08:00am (t(59)= -1,37, p>0.05), 11:00am (t(141)= -0.45, p>0.05), and at bedtime (t(166)= 1,22, p>0.05), no difference could be observed. On weekends, no difference in sleepiness levels could be observed in any of these schedules (T-test, p>0.05), neither on schooldays nor on vacation days.

During the vacation period, the KSS referring to the 08:00am schedule was not filled in by 68% of the adolescents, who reported being asleep at that time (X2=182, p=0.001).

DISCUSSION

According to Hansen et al. (29) and Crowley et al. (30), morning school schedules do have an influence upon the adolescents' SWC, leading them to sleep earlier and have shorter sleep duration. Irregularity in sleep schedules was maintained during the vacation period; thus, sleepiness cannot be attributed solely to partial sleep deprivation induced by school schedules. Daily sleepiness decreased during the vacation period as compared to the school period at wake-up time and at 02:00pm; on the other hand, no difference was observed on weekends.

During vacations, a bedtime delay and an increase in sleep duration on weekdays represent the expression of the biological rhythm, without any influence of school schedules. Thus, the adolescents wake up spontaneously, similarly to the adolescents observed by Carskadon on a study comparing schooldays with vacation days (5).

Nevertheless, freedom to "choose" bedtime during vacations does reduce irregularity in adolescents' sleeping schedules. In contrast to schooldays, during vacations, when their sleep period was greater on weekends, the adolescents slept more on weekdays. Thus, the pattern of reducing the sleep period on weekdays and extending it on weekends was inverted. It is probable that the weekend ceased to be the period when they compensated for sleep missed during the week; perhaps this has become the period when they develop stimulant social activities such as going to parties, navigating on the internet, or watching TV until late, a common practice among adolescents (20-23). With this in mind, considering that one of the main recommendations related to sleep hygiene measures is the maintenance of regularity in sleep schedules, it would be necessary to investigate the extent to which irregularity may be detrimental to the individual's sleep quality. However, in view of the adolescent's socio-cultural context, such measure may be difficult to implement in day-to-day life.

Even if adolescents maintain an irregular bedtime schedule, the increase in night sleep duration during the vacation period may have contributed to reduced sleepiness at wake-up time and at 02:00pm, as well as decreased frequency of naps. In healthy individuals, sleepiness levels show a daily pattern (32), with the highest values being observed at wake-up time, at the beginning of the afternoon (propitious moments for taking a nap), and close to bedtime. Nevertheless, partial sleep deprivation, common on weekdays and workdays, may raise the daily sleepiness curve, thus facilitating sleep episodes (33-35). On the other hand, during the vacation period, an increase in night sleep duration on weekdays was associated with a reduction in sleepiness levels at moments propitious to sleep and with a 50% reduction in frequency of naps.

The changes observed in adolescents' sleep patterns and daily sleepiness between schooldays and vacation days confirm prior findings on the negative effects of morning school schedules upon these parameters (4-7,11). Corroborating such findings, experiments conducted in schools evaluating later morning schedules represent a promising alternative for minimizing this problem. For example, Epstein and collaborators (36) observed that in students who started classes at 08:00am, the night sleep period was longer, they had fewer complaints about fatigue and daily

sleepiness, and they had a lower level of difficulty in concentrating and paying attention in classes, when compared to students who started classes at 07:10am. Similar results were observed in US students who started classes at 08:40am instead of 07:15am (37), and in university students who started classes at 10:00am (38).

Nevertheless, a change in school schedules should be carefully evaluated among each population (39), as it involves several sectors of the society, making its implementation difficult. Moreover, the change in itself may not be effective, as the students might take advantage of later school schedules by continuing to surf the internet, watch TV, or study until late at night (40). Even so, the possibility of planning bedtime and wake-up time schedules favors a reduction in sleep schedules (19,38) and an increase in its duration (19), as observed in adolescents who attend classes in the afternoon.

Thus, in this study and previous studies, the characteristics of adolescent sleep patterns point to the need for implementing sleep educational programs in schools, as some sleep habits may derive from the adolescent's lack of knowledge on the subject. However, such educational programs should take into consideration the adolescent's socio-cultural context, so that sleep hygiene measures are understood as proposals that might contribute to improve their welfare, not as a limitation to behaviors that are part of the adolescent's day-to-day life.

In the short run educational programs may help the adolescents acquire knowledge that might be utilized for promoting behavioral changes that favor sleep, as per what was observed in previous studies (10,25). In the long run, such knowledge might facilitate the school schedule changing process through a gradual and continuous enlightenment of today's adolescents, the adults of the future.

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