Teaching Chronobiology and Sleep Habits in School and University

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ABSTRACT—Early morning school schedules are in the opposite direction to the sleep–wake cycle in adolescence and early adulthood. This conflict leads to sleep deprivation and irregular patterns whose consequences are scarcely explored. This article discusses the effects of three educational experiences with high school students, parents, teachers, and medical students. The first experience was developed with high school students in Natal, Brazil, to determine whether sleep habits would improve with increased awareness. Positive effects were observed in some aspects of sleep knowledge and practices. In the second experience in Atlanta, GA, sleep education activities were presented to middle and high school teachers, parents, and students to emphasize the importance of sleep. In the third program in Murcia, Spain, undergraduate medical students were introduced to chronobiology of sleep by a practical exercise that pointed out to what extent they shared most of adolescent sleep characteristics. Educational chronobiological experiences about sleep are essential to develop healthy sleep habits in the general population, particularly in students.

INTRODUCTION

This article presents three educational outreach programs targeted to adolescents in grade school and to young adults in university. The goals of programs were to increase awareness about the importance of sleep for school performance and to encourage high school and undergraduate medical students, teachers, and parents to prioritize sleep hygiene. In the first program (I), a sleep education program was administered to high school students in Natal, Brazil, to determine whether sleep habits would improve with increased awareness. In this program, students were given a standard sleep questionnaire before and after program administration to determine whether their sleep habits exhibited improvement. In the second program (II) in Atlanta, GA, National Space Biomedical Research Institute (NSBRI)-sponsored sleep education lectures and activities were presented to middle and high school teachers and students to emphasize the importance of sleep. In this program, Morehouse School of Medicine (MSM) provided faculty to inform parents, teachers, and students about sleep and also a radio program to reveal findings that healthy sleep increases learning ability in schools. In the third program (III) in Murcia, Spain, undergraduate medical students were introduced on chronobiology of sleep through a practical exercise consisting of evaluating themselves by their sleep patterns using sleep and feeding time logs. Data recorded by the students were presented back in the lectures, so in addition to teaching them chronobiology, they were given advice on their sleep habits during weekends. Altogether, these programs contribute to the initiative to apply knowledge gained from empirical studies on sleep and school performance in high school and undergraduate medical students, the very populations these studies seek to assist.

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SLEEP HABITS IN HIGH SCHOOL

Early morning school schedules are in the opposite direction to sleep–wake cycle during adolescence. Teenagers tend to exhibit a delay in sleep–wake schedules due to biological and social changes (Andrade, Benedito-Silva, Domenice, Arnhold,

& Menna-Barreto, 1993; Carskadon, Acebo, & Jenni, 2004; Carskadon, Vieira, & Acebo, 1993). For instance, during this phase, parents' control of sleep schedules decreases while academic obligations and socializations increase (for a review, see Crowley, Acebo, & Carskadon, 2007). Teenagers typically display more interests in later time activities, such as watching TV, using the computer, dating, meeting friends, or going to parties. To complicate matters, they also begin taking on jobs that may have a negative impact on sleep schedules (Carskadon, 1990; Teixeira et al., 2004).

Early morning school schedules impose earlier wake-up times on adolescents, who present a later temporal organization to wakefulness. Thus, adolescents are requested to increase academic performance when they would prefer to sleep (Hansen, Janssen, Schiff, Zee, & Dubocovich, 2005). Furthermore, later bedtimes and earlier wake-up times reduce sleep duration on school days, resulting in longer and later sleep on the weekends. It is not clear whether this modification at weekends is due to a compensation for sleep loss during school days (Carskadon, Acebo, & Seifer, 2001; Mindell, Owens, & Carskadon, 1999) or the expression of the endogenous circadian pattern (that induces later sleeping and waking-up schedules) free of social pressures of school schedule (Hansen et al., 2005), or both.

Independent of cause, these modifications promote a reduction–extension sleep pattern between week and weekend days (Andrade et al., 1993; Carskadon, 1990; Hansen et al., 2005; Manber, Bootzin, Acebo, & Carskadon, 1996; Wolfson & Carskadon, 1998). This irregular pattern and the associated daily sleep loss are related to increased reports of diurnal sleepiness, tiredness, bad mood, concentration and attention difficulties, and reduction in school performance (Dahal, 1999; Manber et al., 1996; Wolfson & Carskadon, 1998). The frequency of tiredness symptoms in high school and university students is similar to that observed for hard-working adults (Oginska & Pokorski, 2006).

The effects of the school schedules are evidenced in studies that compare sleep–wake patterns in vacation and school days. During vacation, the adolescents sleep more and later (Crowley, Acebo, Fallone, & Carskadon, 2006; Hansen et al., 2005). When returning to school, the daily sleep loss during the week may be 2 hr, whereas on weekends, the sleep duration can increase about 30 min (Hansen et al., 2005).

Thus, adolescents show a sleep loss during school days and irregular sleep schedule transitions between school and weekend days. Despite the general recognition of harm due to these practices, studies evaluating the knowledge about sleep physiology and deprivation consequences are scarce (Cortesi, Giannotti, Sebastiani, Bruni, & Ottaviano, 2004; Mathias, Sanchez, & Andrade, 2006). In addition, these concepts are not explored in the school environment. A survey on Italian (Cortesi et al., 2004) and Brazilian (Mathias et al., 2006) high school students reported low knowledge about sleep physiology, although they also recognized the negative consequences of sleep deprivation on mental and physical welfare.

In this context, education is essential. Many authors emphasize the importance of education to improve the sleep habits in students (Brown, Walter, & Soper, 2002, Carskadon, 1990, 1999; Cortesi et al., 2004; Hansen et al., 2005; LeBourgeois, Giannotti, Cortesi, Wolfson, & Harsh, 2005; Mathias et al., 2006; Sousa, Araújo, & Azevedo, 2007). Hansen et al. suggested that people who deal with adolescents (pediatric doctors, parents, and teachers) and adolescents themselves need to be aware of sleep changes during adolescence and their relationship with lifestyle, school schedules, and potential health problems due to sleep deprivation. The evaluation of educational sleep programs brings positive results in some sleep–wake cycle parameters, such as reduction of irregular sleep schedules between school and weekend days and sleep latency (Sousa et al., 2007).

Program I: Teaching Chronobiology to High School Students in Natal, Brazil

A sleep education program was developed for high school Brazilian students, and this effect on sleep–wake habits and knowledge was evaluated when returning to school after the midyear vacation.

Participants and Procedures

Data were collected on 25 high school students (17 girls and 8 boys), with mean age of 16 ± 1.2 years. The participants and their parents signed consent forms with a description of the study that was approved by the Committee Research Ethics Board of Universidade Federal do Rio Grande do Norte. The study was performed in four stages, which are the following: (a) evaluation of sleep knowledge and habits on school days (baseline—1 week), (b) sleep education program (before midyear vacation), (c) evaluation of sleep habits during vacation (1 week), and (d) reevaluation of sleep knowledge and habits on the first school week after midyear vacation.

The sleep education program consisted of 12 daily 50-min activities during a month. The activities started with the presentation of banners in the classroom with questions about sleep: "What is sleep? Why do we sleep?" After that, a lesson about sleep physiology was conducted involving students in the discussion. This lesson dealt with characteristics, functions, and individual needs of sleep. Next, the changes of the sleep–wake cycle throughout ages were discussed through a construction of a sleep ontogeny map by students, emphasizing the changes of sleep duration and temporal pattern at adolescence. In this activity, each group characterized the sleep–wake schedules of an individual on an age indicated by the researcher. Thus, Group 1 described the schedules of a newborn, Group 2 of a child, Group 3 of an adolescent,

Group 4 of an adult, and Group 5 of an elderly person. Subsequently, sleep deprivation causes were discussed by a survey about sleepiness, tiredness, concentration and memorization difficulties, and bad moods among the students in the classroom. At this point, the conflict between physiological sleep needs and environmental influences, such as school schedules, was emphasized, besides the poor sleep habits of adolescents.

Afterward, the negative consequences of sleep deprivation on health and welfare were discussed with the students. Then, sleep hygiene statements were presented to students to help them avoid the sleep deprivation problems. Last, we held a quiz using sleep hygiene statements to evaluate students' knowledge. First, each group received equal cards with adequate and inadequate attitudes to be followed to get a sleep of good quality. Then, the students separated their cards depending on behaviors that must or must not improve their sleep quality. To conclude, each group fixed the posters to the picture. The group that made fewer mistakes gained a pillow to be chosen by lot among the group members. Also, all members received sleep hygiene pamphlets. Finally, the students made banners with the answers to the questions proposed at the first meeting, as a way to evaluate their knowledge.

The students' sleep habits and knowledge were evaluated by the questionnaire "Health and Sleep" adapted by Miriam Andrade from the sleep habits questionnaire used by Andrade (1997) and Louzada (2000) for Brazilian adolescents (Mathias et al., 2006). In addition, the students recorded their bedtime and wake-up schedules, as well as their nap schedules, in a sleep diary for 1 week at baseline, vacation, and the first school week after midyear vacation.

The answers to the questions concerning the sleep knowledge of the "Health and Sleep" questionnaire were compared between before and after the educational program using the chi-square test. To investigate the effects of the sleep education program, we compared nocturnal sleep schedules and latency, and nap schedules obtained from the sleep habit questionnaire at baseline and after the program by paired Student's *t* test. The same procedure was used to compare the index of irregularity of the sleep–wake cycle, calculated from the standard deviation of bedtime recorded in the sleep diary.

Results and Discussion

The baseline frequency of right answers about sleep knowledge was higher on questions about sleep deprivation consequences. On the other hand, the questions about sleep temporal organization, individual differences on sleep patterns, use of substances, and activities before sleep showed a lower frequency of correctness (Figure 1). After the program, the frequency of correct answers increased in questions about sleep temporal organization, activities and food habits before sleep, nap function and schedule, and sleep compensation. However, the frequency of correct answers decreased in questions about alcohol ingestion effects on sleep. Also, decreased frequencies were observed on the question "we are more productive when we wake up early," which showed lower levels of rightness at baseline.

Sleep is a subject that raises the students' interest. Thus, the adolescents were visibly motivated during the "Sleep Hygiene Month," relating sleep experiences of themselves or family members during lectures. The most common reports are the following: "I wake up so tired when I sleep too much" or "I fall a sleep only when watching TV." During the program, sleepiness was reported by more than 70% of students (77.77%), followed by tiredness (55.55%) and bad mood (51.85%). Concentration and memorization difficulties were reported by almost 30% of students (33.33% and 25.92%, respectively). The contents

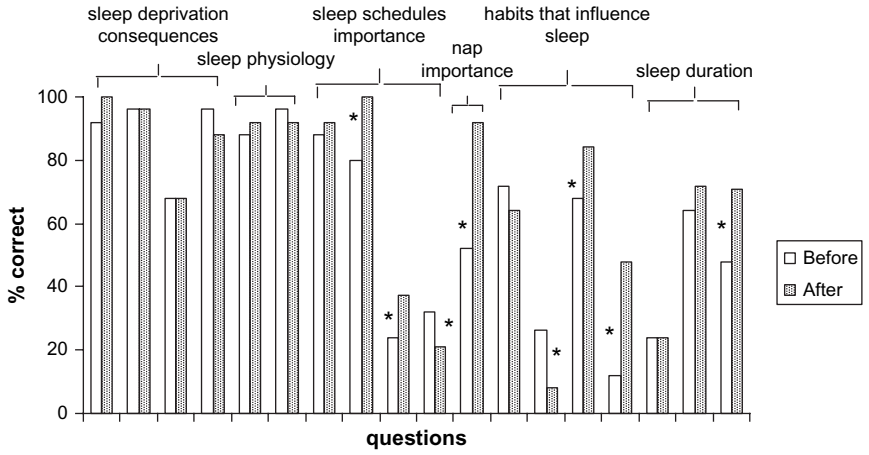

Fig. 1. Percentage of students answering correctly the sleep concepts before and after the sleep education program (*$p < .05$, chi-square test).

were introduced by means of dynamic student participation in lectures and activities. We did not evaluate the students' opinion about the program; nevertheless the motivated participation of students expressed their satisfaction. The quiz is one of the most important activities because it allows the evaluation of students' impressions about behaviors that favor sleep or make sleep difficult. The students' interest in sleep was indicative of the importance of this behavior on people's lives and welfare. It emphasizes the importance of the discussion of this subject with adolescents throughout social and physical changes that influence the sleep–wake cycle and its relationship with environment.

Despite the positive receptiveness, on the first school week after midyear vacation, the students maintained an irregular sleep pattern between school and weekend days, with later bedtimes and wake-up times on weekends (Table 1). Also, they present short nocturnal sleep duration at school days, even though the irregularity of bedtime became reduced after the education program (Table 2).

The motivations of students to bedtime and wake-up time are different between school and weekend days (Figure 2). On school days, watching TV is the most frequent motivation to bedtime, followed by feeling sleepy. Beyond this, at weekends, they present elevated reports of computer use before sleep. On weekdays, school is the main contributor for waking-up time and on weekends, by not being sleepy anymore. After the program, bedtime reports ascribed to feeling sleepy and to waking-up feeling refreshed increased on school and weekend days. Besides, there was an increase in frequencies of watching TV and using computers on school days and mainly computers on weekends.

After the program, the increase in correct answers about nap function and duration was followed by a decrease in nap frequency on the first school week after midyear vacation (Table 1). Also, the naps tended to finish earlier and be of shorter duration.

Table 1
Adolescent Sleep Characteristics Before and After the Sleep Education Program ($n = 25$; $p < .05$, t test)

Characteristic (hr:min ± min)	*Before sleep education program (M ± SD)*	*After sleep education program (M ± SD)*	*p*
Weekdays (hr:min ± min)			
Bedtime	22:21 ± 21	22:13 ± 64	ns
Wake-up time	6:15 ± 39	6:25 ± 63	ns
Time in bed	8:03 ± 69	8:13 ± 53	ns
Weekends (hr:min ± min)			
Bedtime	24:10 ± 110	24:45 ± 137	ns
Wake-up time	8:54 ± 106	9:42 ± 120	ns
Time in bed	9:09 ± 145	9:06 ± 113	ns
Naps			
Frequency (%)	32	16	<.05
Start (hr:min ± min)	13:40 ± 40	13:08 ± 113	ns
End (hr:min ± min)	15:55 ± 83	14:57 ± 130	<.10
Length (hr:min ± min)	2:15 ± 68	1:48 ± 50	<.10

Table 2
Irregularity Indexes (IR) (Bedtime *SD* [min]) of Seven Students (S) According to the Sleep Diary ($p < .05$, t test)

Students	*School days*	*Vacation*	*Return to school*
S1	59	69	22
S2	121	49	83
S3	92	10	7
S4	61	66	86
S5	60	30	70
S6	83	80	71
S7	131	60	54
IR (mm)	86.71 ± 29.78	52 ± 24.46[a]	56.14 ± 30.58[b]

[a]School days and vacation, $p = .06$.
[b]School days and back to school, $p = .09$.

Coming back to school after midyear vacation is associated with almost 2 hr sleep loss in adolescents (Hansen et al., 2005), which is characterized by later sleep schedules (Andrade et al., 1993; Carskadon et al., 1993) and poor sleep habits (Cortesi et al., 2004). Thus, the development of a sleep education program in school before midyear vacation can contribute to awareness about sleep, favoring behavioral changes that help adolescents returning to school.

The educational program promoted positive changes on some aspects of students' sleep knowledge, which were translated into practice, such as nap frequency and bedtime irregularity. In addition, the reports of going to bed as a consequence of feeling sleepy and of waking-up time due to not being sleepy increased. Despite the reduction of irregularity in bedtime after the program, the sleep schedules did not change between school and weekend days.

The increase in sleep knowledge can contribute to sleep–wake changes, such as those observed by Brown et al. (2002) in university students and by Gallash and Gradisar (2007) in adults. The practice of good sleep habits may be enhanced because it is related to good sleep quality (Brown et al., 2002; LeBourgeois et al., 2005). In the current study, the sleep knowledge increased as indicated by questions concerning sleep temporal organization and compensation, activities and habits before sleep, and nap function and schedule. This promoted positive changes in some sleep parameters, such as the reduction of nap frequency and sleep irregularity between school and weekend days. Both behaviors were discussed during the program and seem to be subjected to changes as observed by Brown et al. (2002) and Sousa et al. (2007).

Furthermore, the increase in reports of bedtime motivated for feeling sleepy and wake-up time for not being sleepy may be due to students' recognition and respect of their physiological needs. In addition, the decrease in nap frequency

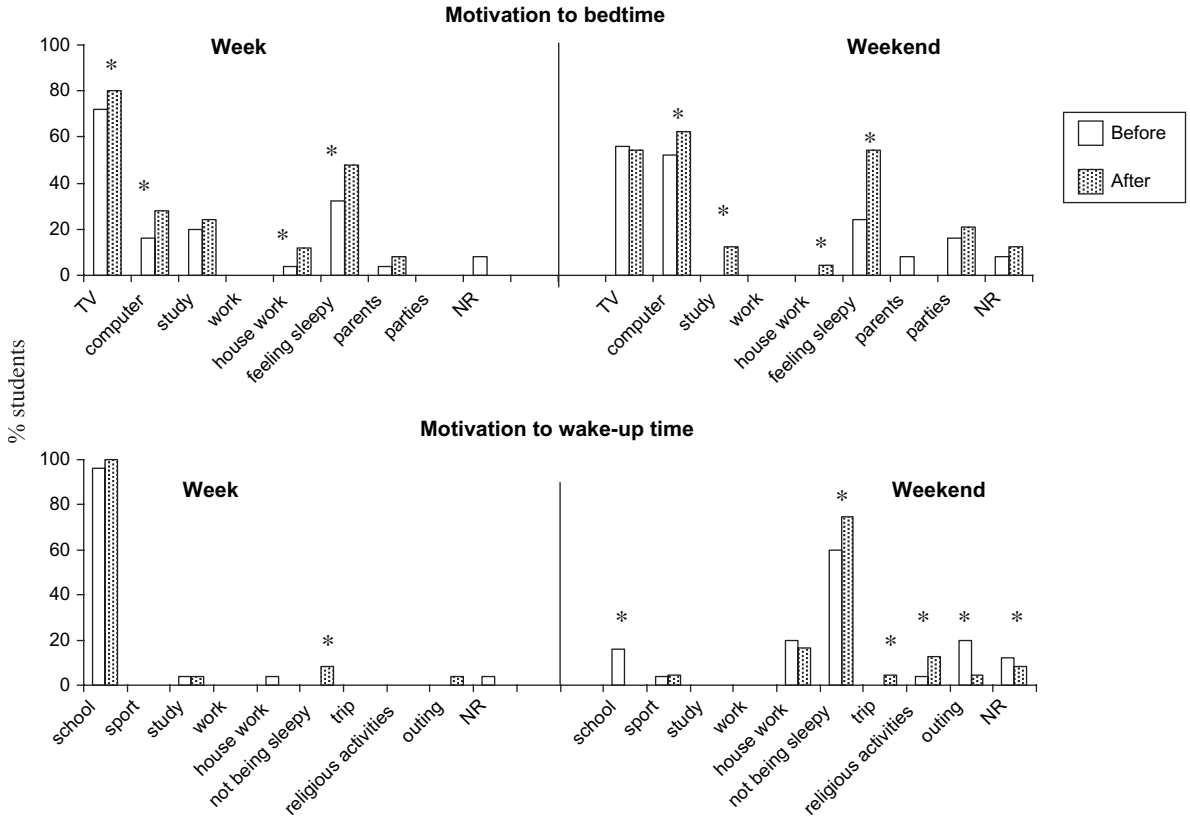

Fig. 2. Percentage of students answering the reasons for the habitual bedtime and wake-up time on week and weekend days before and after the program (*$p < .05$, chi-square test).

could contribute to increased sleepiness at bedtime because short naps in the afternoon may reduce subjective sleepiness (Takahashi, Fukuda, & Arito, 1998).

Despite the reduction in bedtime irregularity after the program, the sleep schedules did not change between school and weekend days, as observed by Sousa et al. (2007) in a previous educational sleep program with adolescents. Thus, the school schedule is a social factor that determines the students' sleep–wake cycle, and the sleep knowledge developed during the program was not sufficient to promote significant changes in behavior. In addition, this may be a consequence of maintenance of pleasurable activities in the home routines of adolescents. For example, the frequency of computer use and watching TV before sleep increased during weekdays. After all, chats at night and talking about later TV programs are part of social context. As proposed by Mathias et al. (2006), one of the main challenges of the educators is to translate the theoretical knowledge to behavioral changes.

One question that called attention to the consequence of a worse result is "we are more productive when we wake up early." This result demonstrates the strong social–cultural influence on sleep needs perception (Owens, 2004). Despite the fact that sleep chronobiology discussions have been included in program activities, such as the variation of mental and physical performance according to the time of day and chronotype, the adolescents think that waking up early improves their productivity. This can be observed in school registration and parents meetings, when most parents and teenagers expressed their preferences for morning schedules, even when the afternoon schedule was less expensive. Also, when questioned about the schedule that they prefer to go to school, the adolescents frequently answered, "in the morning, because if I study in the afternoon I will sleep all morning and I will not have time for sports practice, extracurricular courses, and studying." In spite of adolescent claims that they are not willing in the morning, they prefer to study in the morning. The parents reported similar reasons.

Thus, the educational program improved individual sleep knowledge, but did not necessarily promote behavioral changes or daily habits. Some behaviors are easier to change, such as sleep irregularity and nap frequency. But the sleep schedules that already suffer an advance on weekdays as a consequence of early school schedules are more difficult to modify due to endogenous pressures and later schedules associated with pleasurable activities that are part of the day by day of adolescence, as computer use and TV. Therefore, the

familiar environment must be involved in programs with adolescents because their habits are influenced by the routine of the home, friends, and society. Moreover, the development of sleep educational programs exerts an important role on school environment. Teacher participation is essential, detecting disturbances associated with sleep loss and irregularity, such as tiredness and poor motivation in classes, and guiding about the aspects that may influence their students' behavior. Also, they might be prepared to introduce this theme in their classroom lessons to adolescents, contributing to improved adolescent quality of life. This may promote long-term benefits in adulthood, including the establishment of good family sleep habits.

Program II. Parent–Teacher Discussions on Sleep in Adolescents in Dekalb County, GA

MSM, in collaboration with the NSBRI Education and Outreach Team, strives to promote understanding of and support for sleep research and education by working across the educational continuum to share the new discoveries resulting from NSBRI-led research. Through teacher professional development, innovative curricular materials and university courses, and use of various media, we are undertaking three primary goals, which are the following: (a) develop inquiry/problem-based middle and high school curricular materials that promote understanding of and appreciation for sleep hygiene during adolescence and reproductive development; (b) engage teachers in sustained professional development programs that broaden their science knowledge base and infuse their classroom lessons with sleep and circadian-based supplements; and (c) increase public awareness of the real-life impacts of sleep research through media, informal science activities, and professional activities (MacLeish et al., 2007).

Teacher Workshop

We opened the 2006/2007 school year with a workshop for middle school science and math instructors in Dekalb County, GA, to begin to benchmark for the goals described above. This workshop would also set the foundation for a longer term partnership with the school system in which the Circadian Rhythms and Sleep Disorders Program at MSM would develop educational materials and exercises to be used by the middle school teachers. The initial lecture was entitled "Sleep for Life and Health," and its goal was to introduce basic and clinical sleep research to the middle school teachers. The theme of the talk was sleep as a vital behavior and physiological function that is necessary for cognitive abilities as well as physical health.

Following the talk, the teachers broke into teams, and we reviewed questionnaires and surveys that the teachers could share with their students. During the team sessions, the teachers began to express interest in teaching middle school students about the need to sleep for better scholastic performance. As a result, during the workshop, we presented a second impromptu talk about the importance of sleep during adolescence. During this talk, we highlighted that (a) poor academic performance is correlated with sleep loss and insomnia (Wolfson & Carskadon, 2003); (b) rapid growth during puberty requires that adolescents obtain at least 9 hr of daily sleep (Anders, Carskadon, & Dement, 1980; Carskadon et al., 1993); and (c) during adolescence, bedtimes and rise times generally become later, sleep amount decreases during school days, and the weekday/weekend sleep discrepancy increases (Carskadon et al., 1980).

The teachers suggested that educating parents and teachers about sleep may be a tool to improve scholastic performance in the Dekalb County schools that primarily serves a working class population and the parents. The teachers felt defenseless in their ability to teach adolescents about sleep, particularly when their parents were ambivalent about its importance for health and cognitive performance.

Parent–Teacher Education

In February 2007, we gave a presentation at the quarterly parent–teacher conference at Miller Grove High School in Dekalb County. The theme of the talk was to educate teachers and parents about the importance of sleep for physical, mental, and emotional development during adolescence. The 2-hr lecture highlighted the research that suggests that sleep deprivation impairs mental acuity needed for acceptable school performance. The parents were receptive to suggestions on how to prioritize sleep hygiene and ensure that their adolescent children achieved adequate daily amounts of sleep. The nine primary suggestions (Carskadon et al., 2004; Fallone, Seifer, Acebo, & Carskadon, 2002; Wolfson & Carskadon, 2003) were to:

1. Maintain consistent bedtimes and rising times
2. Be aware of your personal circadian rhythm
3. Limit caffeine and nicotine intake after 14:00 hr.
4. Limit arousal activities 1–2 hr before bedtime
5. Limit light intake an hour before retiring
6. Keep your sleeping area for sleep, not rousing activity
7. An hour before retiring, engage in calming or relaxation activities
8. Avoid jobs that require late hours
9. Expose yourself to bright light in the morning that stimulates waking.

During the remainder of the school year, we attended two student workshops at Miller Grove whose goals were to expose students to sleep research as a tool to increase their exposure to practical science and to emphasize the importance of sleep health and hygiene in their daily routines. During these workshops, we reinforced the concepts presented at the Parent Teacher Association (PTA) meeting and

described our research program to the students. Since that time, several students from Miller Grove High School have visited the Sleep Laboratory at MSM.

Radio Outreach

In August 2007, the radio show "The Importance of Sleep for Kids" premiered on Atlanta Public Broadcasting station WABE during National Public Radio's "All Things Considered." This program featured interviews with Judith Owens, PhD, at Brown University, and Ketema N. Paul, PhD, at MSM, and consisted of descriptions of the harmful influences of poor sleep habits on adolescents and its negative impact on school performance. The radio piece asks the question: Are kids too busy to sleep? The piece highlights a study by Dr. Owens that found that 37% of parents report that their children have problems sleeping and that the source or those problems stem from developmental changes, social and academic pressures, and sleep disorders such as apnea. Dr. Paul's piece highlighted the necessity to sleep to complete mature pubertal development. This program also reviewed the outreach work at Miller Grove and with Dekalb County middle school teachers.

MSM and NSBRI are supporting the mission to engage teachers, students, scientists, and the general public in a concerted effort to promote sleep research in its relationship to space travel and technology (MacLeish et al., 2007). This expansion ushered in a comprehensive educational public outreach program with the potential to contribute significantly to the U.S. science workforce and to the quest for knowledge about the universe and the solar system. The program is embedded in a 7-year commitment to using best science education practices and science content to improve learning opportunities for students and teachers at all stages of the educational spectrum. In Dekalb County, GA, we have partnered with middle and high school teachers as well as the PTA of Miller Grove High School to encourage teachers to infuse sleep education in their curricula and encourage parents and students to place a larger emphasis on healthy sleep habits. This has served not only to support the goals of NSBRI Education and Public Outreach Program (MacLeish et al. 2007) but also to educate teachers, students, and parents about the value of sleep research and the potential benefits of prioritizing sleep hygiene.

SLEEP HABITS IN UNIVERSITY

It is widely documented that adolescence is related to important modifications in sleeping behavior consisting in a trend to sleep less, decrease in the regularity of lifestyle, and phase delay (Carskadon et al., 2001; Gibson et al., 2006). However, these tendencies persist after this growing-up period and remain present also during the first courses of university (Veldi, Aluoja, & Vasar, 2005). The consequences of this altered sleep behavior are numerous: daytime sleepiness, mood and behavioral problems, and high level of unatendance to morning classes. However, this general pattern is highly dependent on the individual morning–evening orientation, which depends on sociocultural influences, age, and geographical latitude and is under the control of the endogenous circadian pacemaker (Kerkhof & van Vianen, 1999; Smith, Reilly, & Midkiff, 1989). A percentage of the population exhibits a marked preference for waking and going to bed at early hours, they are the so-called morning types (M-types), whereas others, the evening types (E-types), show a preference for sleeping at later hours and find it difficult to get up in the morning; however, between these two extreme situations, a continuous gradient can be found (neither types [N-types]) (Smith et al., 1989). Human chronotypes differ also in daily rhythms of many physiological and behavioral variables, such as core body temperature, heart rate, blood pressure, and cortisol and melatonin secretion (Andrade, Benedito-Silva, & Menna-Barreto, 1992; Kudielka, Bellingrath, & Hellhammer, 2007; Otsuka et al., 1993).

Sleep disorders are common among all age groups; however, they are rarely diagnosed. Lack of teaching time and the limited number of medical schools with expertise in sleep medicine have been considered as major barriers for sleep medicine instruction. In addition, medical students and junior doctors complain themselves about sleep deprivation and poor sleep quality, which lead to impaired mood and sleepiness prevalence during the day (Veldi et al., 2005).

Program III. Teaching Chronobiology to Undergraduate Medical Students in Murcia, Spain

A practical exercise was developed to improve the education of undergraduate medical students in the chronobiology of sleep. This exercise consisted of a self-evaluation of sleep patterns and the influence of gender and circadian preference.

Participants and Procedures

Data were collected from a representative sample obtained from those students attending a chronobiology course at the University of Murcia Medical School from the 2003/2004 to the 2006/2007 terms. Chronobiology is a one-term optional course taught in the second year. The volunteer students included 81 females (56%) and 64 males (44%), 19–24 years of age.

Data were recorded during a complete week, in October, through a sleep and feeding time log, including items about sleep onset, nocturnal awakenings, sleep offset, naps, and the main meal times. In addition, to assess the preference for daily activity pattern, the participants completed the Morningness–Eveningness

Questionnaire (Horne & Östberg, 1976). The original score can range from 70–86 (extreme morningness) to 16–30 (extreme evening); however, because the Spanish population is shifted to eveningness because our highest score for morningness was 51, we decided to establish a classification based in 25–75 percentiles. Morning types were defined as those individuals with scores between 64 and 51, intermediate type were those presenting scores between 50 and 34, and the evening types were those with scores from 33 to 18.

Sleep diaries and questionnaires were collected by teachers, and once data were filtered, they were posted in a worksheet in our intranet to be analyzed by students themselves as part of a practical exercise about sleep chronobiology. Interdaily sleep variability was determined as standard deviation of the midsleep time along the recording week.

Sleep data were analyzed by a two-way analysis of variance with repeated measures considering gender and chronotype as independent factors. All the variables were tested for normality. Regression analysis between morningness–eveningness score and bedtime, rise time, and interdaily sleep variability was performed using the SPSS® statistical package.

All students signed an informed consent before their inclusion in the study. The data stored in the database were alphanumeric and no personal identifiers were recorded. The study received research ethics approval from the Research Ethics Board of the University of Murcia.

Results and Discussion

Sleep habits in the second-year medical students (Table 3) are characterized by the following: (a) a tendency to increase interdaily sleep variability during weekends when compared to weekdays, with lectures scheduled in the morning (from Monday to Thursday), delayed sleep phase (the usual bedtime occurring after midnight in all groups) specially during weekends; (b) low values of time in bed during the night (average during weeknights 422 ± 48 min); and (c) high variability, in terms of frequency, timing, and duration of nape (Figures 3A, C). Although this general temporal pattern is similar between men and women, women exhibited more regularity in their sleep patterns, particularly in the time of naps, and showed a slight phase advance with respect to men (Figures 3A, C).

These general trends are more evident in E-types (Table 3), characterized by higher interdaily sleep variability, reduced sleep during weekdays, and phase delays with respect to M-types. It is noteworthy that E-types remained in bed during weekday nights an average of 420 ± 55 min because they went to bed late and usually attend morning classes at 08:30 hr; however, during weekends, they increase their sleep time to 492 ± 67 min. In addition, the time, frequency, and duration of siesta are highly variable. This E-types pattern is less marked in women than in men, exhibiting a significant early bedtime than men (00:59 hr in men vs. 00:23 hr in women) (Figures 3B, D; Table 3).

Morningness score is significantly inversely correlated with bedtime, with this relationship more closely related in men than in women (Figure 4A). Similarly, a statistically significant inverse relationship between morningness and rise time was observed in both sexes (Figure 4B). Interdaily sleep variability is also inversely correlated with morningness score, with M-types being more regular in their sleep habits than E-types (Figure 4C).

This study points out that second-year university medical students are characterized by an adolescent-like sleep pattern with short sleep duration, irregularity, and phase delay. In addition, this practical exercise on sleep chronobiology contributes to medical doctors' education in a topic usually not included in their education.

The existence of different environmental and sociocultural characteristics among countries and even regions in the same country makes using the morningness score very difficult, as defined by Horne and Östberg, to establish comparisons between studies performed in different countries. Using the original criteria of Horne and Östberg, most Spanish students, particularly in the south, should be considered as intermediate or even evening types, with very few morning types. To avoid this shift, we decided to divide our population to define the three chronotypes, morning, intermediate, and evening type, according to quartiles.

One of the most striking features of the university students' sleep patterns is the irregularity in their behavior among different weekdays; thus, differences up to 4 hr for the bedtime in the same week are frequently found. Interdaily sleep irregularity tends to be higher in men and E-types, with women of M-types characterized by the most regular pattern. Sleep–wake cycle is not only a variable under the control of the central pacemaker, the suprachiasmatic nucleus, but regular sleep–wake pattern is also used as an internal zeitgeber by the human circadian system, improving the amplitude and robustness of many others' circadian rhythms (Elmore, Betrus, & Burr, 1994). Irregular zeitgeber exposure are associated with impaired health problems, such as cardiovascular disease, insulin resistance, metabolic syndrome, digestive diseases, poor sleep quality, and, recently, aging (Erren, Reiter, & Piekarski, 2003).

Although daytime sleepiness was not measured in our study, most students were mildly to severely sleep deprived during weekdays, with less than 422 min of nocturnal bedtime, a value far from the 510 min of sleep recommended by Carskadon et al. (2001) for adolescents. This sleep deprivation can be a consequence of the natural tendency of youngsters to go to bed late together with the usual academic activities scheduled early in the morning. The students, because of their leisure activities, also go to bed later on the weekends, reinforcing their natural sleep phase delay.

Table 3

Sleep Pattern Variables During Weeknights and Weekends in Undergraduate Medical Students

				Morning type			*Intermediate type*			*Evening type*		
	All	*Males*	*Females*	*All*	*Males*	*Females*	*All*	*Males*	*Females*	*All*	*Males*	*Females*
Weeknights												
Bedtime (hh:mm)	00:30[A]	00:43	00:20	00:09[ab]	00:14	00:05	00:35[a]	00:46	00:27	00:41[b]	00:59[1]	00:23[1]
SD (min)	54	57	50	46	60	37	54	56	52	57	51	58
Rise time (hh:mm)	07:35[A]	07:33	07:37	07:26	07:35	07:19	07:33	07:33	07:34	07:41	07:37	07:46
SD (min)	39	37	41	38	42	34	41	38	43	36	35	39
Sleep duration (min)	422[A]	411	432	437	441	434	417	406	426	420	397[1]	442[1]
SD (min)	48	51	44	39	42	38	47	49	44	55	53	50
Interdaily sleep variability	0.78	0.82	0.76	0.65	0.77[a]	0.57	0.79	0.78	0.80	0.90	0.91[1a]	0.88[1]
SD	0.76	0.78	0.74	0.62	0.74	0.53	0.81	0.84	0.81	0.76	0.74	0.81
Weekend												
Bedtime (hh:mm)	01:50[A]	02:00	01:41	01:06[ab]	01:09	01:05	01:58[a]	02:17	01:43	02:13[a]	02:06	02:20
SD (min)	87	79	92	73	68	78	91	82	95	78	70	88
Rise time (hh:mm)	09:49[A]	10:07[1]	9:34[1]	09:03[ab]	9:10	08:58	09:53[a]	10:16[1]	09:34[1]	10:25[b]	10:33	10:17
SD (min)	83	86	76	65	73	61	86	88	80	73	75	71
Sleep duration (min)	479[A]	487	473	476	480	473	474	478	471	492	507	477
SD (min)	71	70	72	56	48	61	79	72	84	67	77	53
Interdaily sleep variability	0.96	1.00	0.93	0.87	0.92	0.84	0.89	0.96	0.83	1.19	1.11	1.26
SD	0.84	0.79	0.87	0.69	0.77	0.66	0.75	0.81	0.70	1.08	0.81	1.31

Note. Same letters or numbers indicate significant differences, $p < .05$ (two-way analysis of variance). Capital letters indicate differences between weeknights and weekends, lowercase letters indicate differences between chronotypes, and numbers indicate significant differences by sex.

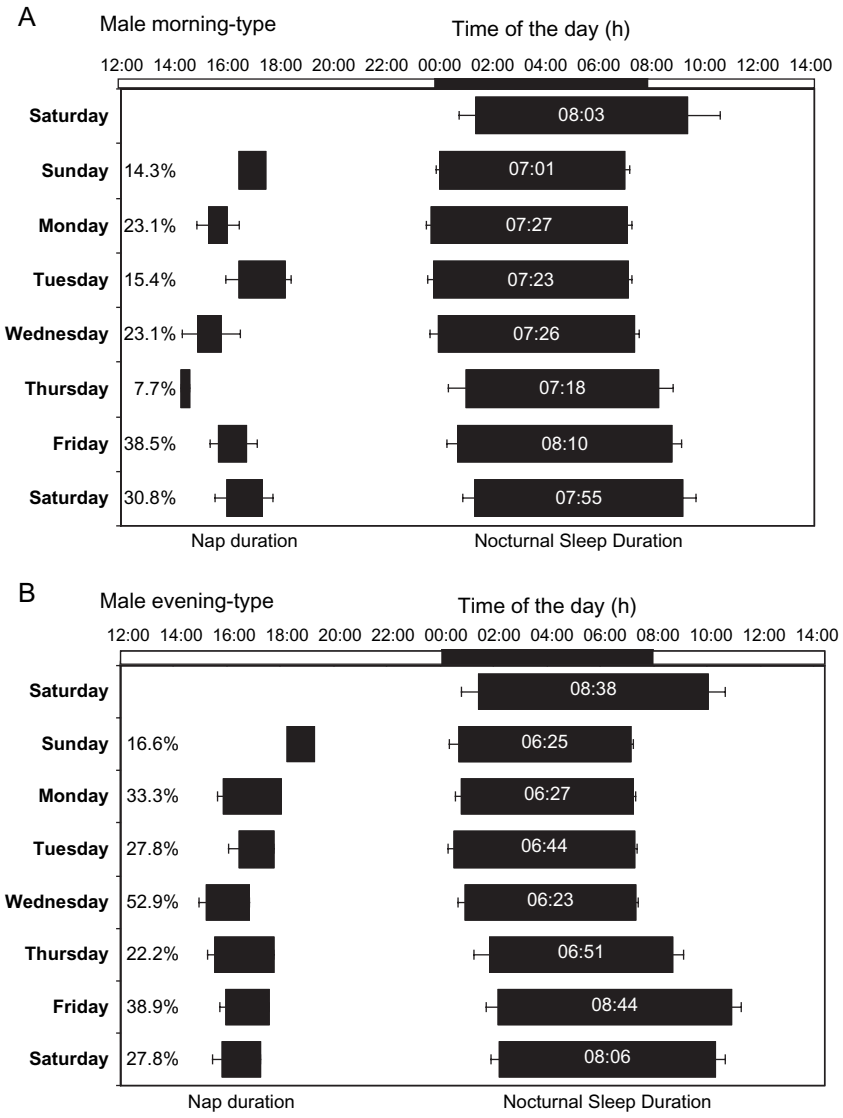

Fig. 3. Averaged actograms of sleep–wake cycle in (A) male morning type, (B) male evening type, (C) female morning type, and (D) female evening type. Values are expressed as mean ± standard error of mean. Numbers on nocturnal sleep indicate sleep duration and percentages on the left of the diurnal sleep are the proportion of individuals having naps.

The sleep loss seems to be more pronounced in E-types and men than in other group. The insufficient nocturnal sleep may interfere negatively with daytime functions with increasing risk of accidents, injuries, and poor school attendance and performance (Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002).

As was expected, our study confirms once more the results of other researchers who pointed out the presence of irregularity of the sleep–wake cycle in E-types (Monk, Petrie, Hayes, & Kupfer, 1994) and sleep loss (Giannotti et al., 2002).

It is noteworthy that educators and physicians continue failing to recognize poor academic performance and mood altered students as severe sleep loss sufferers. Owens (2001) found that 44% of pediatricians did not routinely screen for sleep disorders in adolescents, and sleep problem underdiagnosis has been noted by several authors (BaHamman, 2000; Haponik et al., 1996; Kapur et al., 1999, 2002; Kryger, Walid, & Manfreda, 2002; Meissner et al., 1998). Our study seems to be a good way of introducing sleep chronobiology to medical students, taking care of their own sleep patterns.

In conclusion, our study pointed out that young university students shared most of the characteristics of adolescents in their sleep patterns, that is, interdaily sleep variability, sleep loss, and phase delay, which are more extreme in E-types and men. This practical exercise that requires medical students to record their own sleep patterns improves their academic education in sleep chronobiology and makes them conscious of their problematic sleeping habits.

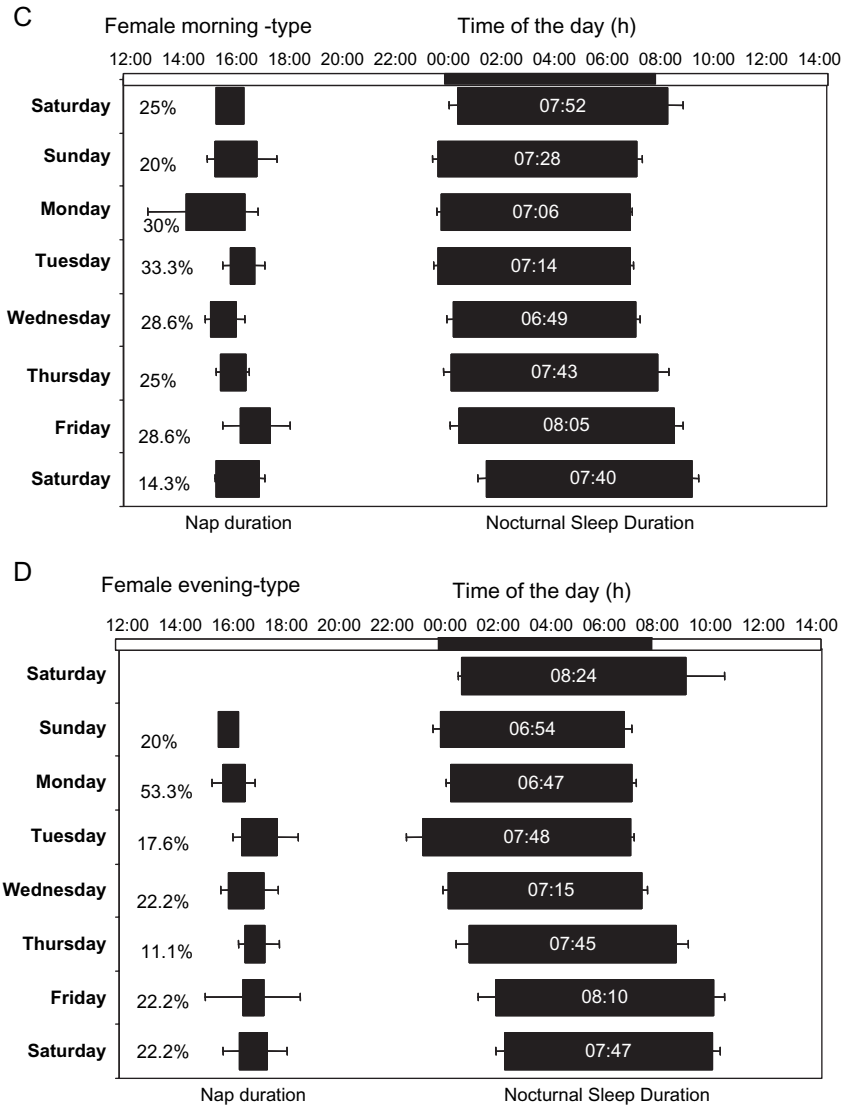

Fig. 3. Continued

CONCLUSIONS

Adolescents and young adult students show a delay in sleep schedules, irregular sleep patterns, and sleep loss associated with school and university schedules. In spite of the strong effect of school schedule on sleep–wake cycle, chronobiological educational experiences with adolescent students reduced sleep irregularity and nap frequency and increased sleep knowledge. Thus, the development of sleep educational programs plays an important role in the school environment. Teacher participation is essential, detecting sleep-related problems and guiding about the aspects that may influence their students' sleep. Also, they might be prepared to introduce this theme in their classroom lessons to adolescents. As a consequence, initiatives for development of didactic materials are essential. During workshops, it was observed that teachers are conscious about the importance of sleep education. They also suggest that their and parents' education about sleep may contribute to improved scholastic performance. Therefore, activities were developed with parents, such as discussions about sleep in school meetings and media (radio programs). The extension of these educational experiences to the familial context may promote more effective changes. The experiences with undergraduate medical students are a good way to introduce sleep chronobiology to future doctors, making them aware of the importance of sleep to themselves and their future patients, improving sleep patterns. Educational chronobiological experiences about sleep with high school students, parents, teachers and undergraduate medical students are essential to develop healthy sleep habits in the general population, particularly in students. Some individuals may learn some concepts.

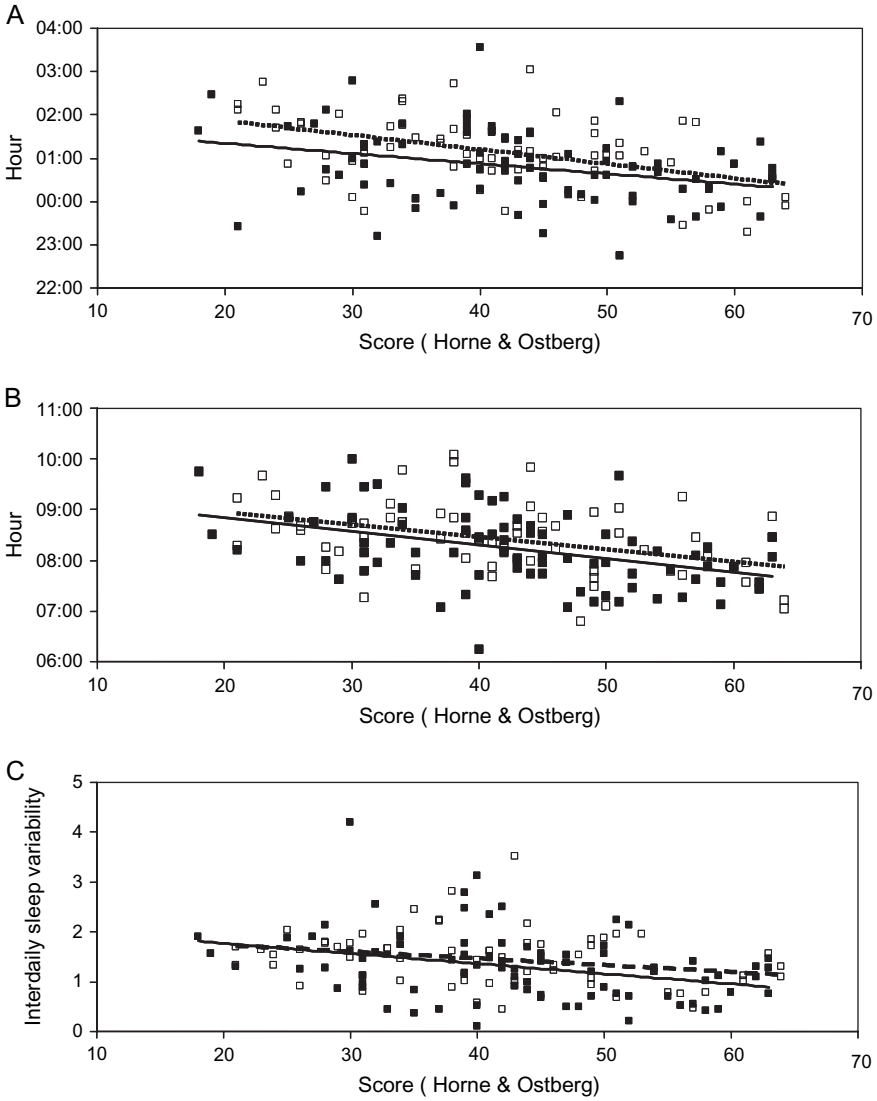

Fig. 4. Correlation between morningness score and (A) bedtime, (B) rise time, and (C) interdaily sleep variability, in males (white squares and dotted line) and females (black squares and solid line). Significant correlation coefficients for bedtime were .46 ($p < .01$) and .31 ($p < .01$) for males and females, respectively; for rise time, .39 ($p < .01$) and .4 ($p < .01$) for males and females, respectively; and for interdaily sleep variability, .27 ($p < .05$) and .32 ($p < .01$) for males and females, respectively.

Some of them may apply these concepts to a healthy sleep routine and others may retain their poor sleep habits.

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