Somnological Aspects of Puberty

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Abstract: The characteristics of sleep during puberty are discussed from the physiological aspect of hormone secretion and from the social aspect of reduced sleep time. Many types of hormones show an increased rate of secretion during sleep at night. Thus, sleep cannot simply be said to represent a stoppage of activities, and rather it comprises another form of ‘activity.’ During puberty, in particular, the secretion of sexual hormones increases during sleep. Sleep is therefore assumed to play a role in promoting the maturation of sexual function. However, in Japan, the amount of sleep time that junior-high school students get has been on the decline. One of the factors contributing to this decline is that students are going to bed at increasingly later times. Students who go to sleep at late hours at night show a high incidence of problems, such as feeling unwell when they awake in the morning, being unable to consume breakfast, having irregular bowel movements, feeling drowsy during the day, and physically feeling they didn’t get a sufficient amount of sleep at night, as well as other problems. Because the same group tends to show similar symptoms even during summer vacation when the number of hours of sleep increases, it is clear that this is not simply due to reduced sleep time. Accordingly, the increasingly later times at which they go to sleep must be recognized as a major problem.

Key words: Puberty; Sleep-awake rhythm; Sleep health; Growth hormones; Gonadotropic hormones
academic system for the science.

For the newly proposed field of somnology, the areas in which sleep-related studies are conducted comprise three major realms. The first is “sleep science” in which basic studies are implemented involving molecular biology and genetic studies. The second is “sleep medicine” which attempts to clinically treat sleeplessness and hypersomnia. Because dentistry and pharmacology are related to this area, this field is also called “sleep medicine-dentistry-pharmacology.” And the third is “sleep sociology” which attempts to treat social problems related to sleep, such as those regarding the so-called ‘night-based society,’ shift work, and accidents resulting from shift work. The above represents the content of the proposal by the SCJ in which these three major study fields are integrated under the main theme of “sleep,” and based on which an academic system is structured. The purpose of this proposal is: to further promote sleep studies in a way that transcends each specific field, to apply and reflect the results of such studies in society, to protect the nation from sleep disorders, to improve people’s overall health, to prevent accidents such as those caused by drowsiness, and to eventually increase relevant economic effects produced by better sleep habits.

In this paper, various characteristics observed during puberty are listed from the viewpoint of somnology, and two matters are described in particular. First, the results of a survey on ‘actual sleep-related conditions’ are presented which show that a major problem is occurring in terms of the sleep patterns of junior-high school students, a key pubescent age group. Secondly, the increased rate of hormone secretion as an ‘activity’ during sleep in the vital organs is discussed in terms of the relationship between specific sleep patterns during puberty and the secretion of hormones.

Problems Regarding Sleep Time

An epidemiological survey conducted extensively in Japan in 1996 revealed that one out of five adults in the country suffers from some forms of sleep disorder.2) Meanwhile, according to one hypothesis, the lifestyle habits of adults are formed mostly during puberty. Therefore, in order to eliminate the problem of sleep disorders, people must begin to take care of their sleep hygiene during puberty. It is also known that one pattern of sleep disorder called ‘sleep-wake rhythm disorder’ begins to appear when people are in their mid-teens, or a certain time from the onset of puberty to the beginning of young adulthood.3) In light of the above, people’s lifestyle behaviors during puberty are very important.

1. Survey studies regarding the sleep habits of junior-high school students

Regarding the sleep problems seen among junior-high school students, a survey was conducted recently by a research organization at the National Institute of Mental Health of the National Center of Neurology and Psychiatry, and this survey is discussed herein.4) The organization implemented a survey on the sleep habits of students at two junior high schools in Okinawa Prefecture during summer vacation. The survey targeted a total of 527 male and female students. The reason summer vacation was selected was because there were no restrictions regarding what time the students had to wake up, in contrast to during the school term, and the survey could thus be conducted under relatively less restrictive conditions. They implemented a questionnaire-type survey which asked what time the students went to bed, what time they got up, their amount of daytime drowsiness, their level of concentration ability, and others questions over a period that lasted for about two months.

The results were as follows. The time at which the students went to bed ranged from 9:30 pm to 3:00 am, and the percentage of stu-
dents who went to bed after midnight was 12.8% for the first-grade students, 19.8% for the second-grade students, and 38.6% for the third-grade students. On the other hand, the times that they woke up ranged from 4:00 am to 3:00 pm and the average was 8:00 am. Their wakeup times correlated positively with the times at which they went to bed, and 7% of all students regularly got a short amount of sleep lasting six hours or less. Students who went to bed late woke up at later times with a longer amount of sleep time.

A comparison of “sleep health risk” was conducted among three different sets of students: 1) Those who went to bed by midnight (‘non-delayed sleep group’) and those who went to bed at the latest times [25%] (‘delayed sleep group’); 2) those who got up before 9:00 am (‘non-delayed wakeup group’) and those who got up after 9:00 am (‘delayed wakeup group’); and 3) those who got six or less hours of sleep (‘reduced sleep-time group’) and those who got six or more hours of sleep (‘normal sleep-time group’). Consequently, the results shown in Table 1 were obtained. The ‘sleep health risk’ comprises a score which results from the integrated evaluation of various factors, including disorders related to maintaining sleep function, such as frequent awakening, excessively deep sleep, waking up too early, parasomnia, sleep apnea, difficulty in waking up, and hypnagogic disorder.

The ‘delayed sleep group’ tended to feel unwell when they woke up and consumed breakfast irregularly, and they manifested many sleep problems such as physically feeling they didn’t get a sufficient amount of sleep at night and experiencing daytime drowsiness. A similar tendency was seen in the ‘reduced sleep-time group.’ Meanwhile, the ‘delayed wakeup group’ who were thought to have gotten longer hours of sleep also said they felt unwell when they woke up and were often unable to eat breakfast and felt they didn’t get a sufficient amount of sleep. The group who slept irregularly showed a higher level of sleep health risk and were unable to fall asleep easily and could not get up early in the morning, in comparison with the group who slept regularly.

As mentioned earlier, this survey was carried out during summer vacation when there were no restrictions in place as to what time the students had to wake up. In other words, they could sleep as much as they wanted. Even under such conditions, differences were still seen regarding the time they went to sleep and the regularity of their sleep. Thus, an increase in sleep health risk and ‘feeling poorly'
During the daytime’ are assumed to result from lowered sleep quality. In the group who went to bed at later times at night, there were many students who slept and got up at irregular times.

The same research organization also conducted another study which examined sleep health risks of junior-high school students and then compared the level of such risks during summer vacation and the school term. In summer vacation, students went to bed and woke up at later times and their sleep health risk was significantly higher.\(^5\) The students who manifested a high level of sleep health risk during the school term and during summer vacation tended to have irregular sleep habits and they went to bed at later times. Moreover, a subsequent survey conducted which targeted an increased number of subjects during the school term confirmed that later times of going to sleep caused a reduction in the amount of sleep time and consequently caused a deterioration in overall sleep health (Fig. 1).\(^6\)

Taking these findings into consideration, it can be said that going to sleep at later times, irregular sleep habits, and not consuming breakfast are associated strongly with a deterioration of sleep health. Thus, it is important for people to acquire regular sleeping and eating habits on a routine basis. Students’ sleep time is restricted by the time at which they have to be at school the following morning, and the time they must go to bed is almost fixed. It is therefore necessary for students to receive appropriate and adequate instruction regarding the importance of going to bed at an earlier time.

### 2. The effects of nap-taking

Another study pointed out that the reason why students go to sleep at later times was because they often slept for short periods during the day, i.e. they took naps.\(^7\) According to this study, about half of all junior and senior-high school students surveyed said they often take naps. Because they take brief naps at
3. Night-shifted lifestyles and reduction of sleep time

The “National Time Use Survey” implemented by the NHK Broadcasting Culture Research Institute every five years since 1969 shows clearly that the lifestyles of Japanese people have shifted more and more towards nighttime-focused activities. In 1960, about 90% of the population went to bed at 11:00 pm, yet this figure decreased to around 51% by the year 2000. Also, in 1960 about 60% of the people in Japan got up at 6:00 am, while in 2000 approx. 60% of people were still asleep at this hour. Although a reduction in sleep time was seen across the board for all age groups, this tendency was shown most significantly in the generation aged 16–19 (from the latter half of puberty to early young adulthood). Compared with other countries, young people in Japan sleep a shorter amount of hours, and young Japanese in the pubescent years (including junior-high school students) get 30 minutes less sleep each night than their counterparts in America, and one hour and 30 minutes less sleep than youngsters in European countries. The optimal situation is to make sure that pubescent children, who represent the future generation, get a sufficient amount of good-quality sleep each night so that they can mature into mentally and physically healthy adults.

Fig. 2  The relationship between taking brief naps and experiencing irritation during the day

The junior-high school students were divided into three groups according to how often they take brief naps and their degree of irritation. In all groups, the degree of irritation increased when they went to sleep later at night. (Reprinted from Fukuda, K.: Proposal Regarding the Establishment of the Scientific Field of Somnology in Japan and Promotion of Its Study. Japan Science Council, 2002; pp. 69–96.)

Hormonal Secretion during Sleep

The relationship between sleep and endocrine function is another characteristic that can be discussed regarding puberty. Although various hormonal secretions increase, one of the most prominent of these is the growth hormone. It is known that secretion of this hormone increases corresponding with the period of deep sleep that occurs at the initial stage of nocturnal sleep. On the other hand, its secretion is prevented when a person suffers from sleep deprivation. That is, the growth hormone
is secreted during sleep and this is thus the reason why it is said “a child who sleeps well grows well.” Secretion of the growth hormone related to sleep continues until adulthood or later. This hormone affects growth and has a function which synthesizes proteins, and is assumed to play a role in repairing the vital organs at night.

Meanwhile, the secretion of adrenocorticotropic hormone (ACTH) decreases during the early stages of sleep and then increases during the latter part. The peak occurs at the time near dawn. Unlike the growth hormone, the secretion pattern is not changed by the reversal of day and night, for example in cases where people sleep during the daytime and not at night. That is, while the growth hormone is secreted in association with sleep, ACTH has a secretion pattern that is associated with time.

Among the hormones which are secreted in association with sleep, there is prolactin promoting the production of breast milk, galactorrhea.10) Moreover, there is also gonadotropin (luteinizing hormone (LH), etc.) which is secreted in association with sleep only during puberty. The secretion of this hormone begins to increase during pre-puberty and increases...
when day and night are reversed, i.e. when people sleep during the daytime (lower section), LH secretion occurs in the daytime, which is not seen usually (upper section). (Reprinted from the original / Kapen, S. et al.: J Clin Endocrinol Metab 1974; 39: 293–299 / Yamanaka, H. et al.: Clinical Examinations 1986; 30: 831–834.)

**Fig. 4  Sleep dependency on the secretion of gonadotrophic hormone (LH)**

When day and night are reversed, i.e. when people sleep during the daytime (lower section), LH secretion occurs in the daytime, which is not seen usually (upper section). (Reprinted from the original = Kapen, S. et al.: J Clin Endocrinol Metab 1974; 39: 293–299 / Yamanaka, H. et al.: Clinical Examinations 1986; 30: 831–834.)

**Conclusion**

In this paper, sleep characteristics during puberty were discussed from the social aspect of reduction of sleep time as well as the aspect of hormone secretion during sleep. Although sleep is often considered a stoppage of activities, it is in fact not, and instead it activates the secretion of hormones at night. It would be better to say that the reason why people sleep is so that they can produce hormones. According to recent sleep studies, it has been shown that the specific sleep pattern called REM sleep is necessary for memory. Thus, sleep is not a complete stoppage of activities, and rather it is another condition of ‘activity.’ Such recognition is considered especially important for puberty. That is, puberty represents an important growth stage in which sexual maturation is promoted by sleep. It is also shown that the reduction of sleep and sleep quality affects the overall quality of a person’s ordinary life significantly. It is important that the whole society including teachers and parents recognize these matters sufficiently.

**REFERENCES**

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