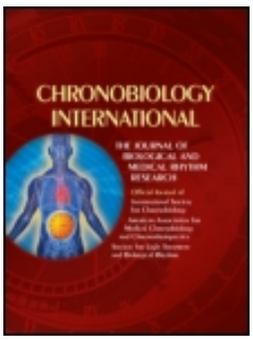

Taylor & Francis
Taylor & Francis Group

Chronobiology International

The Journal of Biological and Medical Rhythm Research

ISSN: 0742-0528 (Print) 1525-6073 (Online) Journal homepage: http://www.tandfonline.com/loi/icbi20

Fatigue and Mood Correlates of Sleep Length in Three Age-Social Groups: School Children, Students, and Employees

Halszka Oginska & Janusz Pokorski

To cite this article: Halszka Oginska & Janusz Pokorski (2006) Fatigue and Mood Correlates of Sleep Length in Three Age-Social Groups: School Children, Students, and Employees, Chronobiology International, 23:6, 1317-1328, DOI: 10.1080/07420520601089349

To link to this article: http://dx.doi.org/10.1080/07420520601089349

Chronobiology International, 23(6): 1317–1328, (2006)

ISSN 0742-0528 print/1525-6073 online
DOI: 10.1080/07420520601089349

informa
healthcare

FATIGUE AND MOOD CORRELATES OF SLEEP LENGTH IN THREE AGE-SOCIAL GROUPS: SCHOOL CHILDREN, STUDENTS, AND EMPLOYEES

Halszka Oginska and Janusz Pokorski

Department of Ergonomics and Effort Physiology, Jagiellonian University Medical College, Krakow, Poland

The aim of the study was to trace the consequences of insufficient sleep, in terms of chronic sleep reduction rather than acute sleep deprivation, on fatigue, mood, cognitive performance self-estimations, and daytime sleepiness in different age-social groups. The age group of the subjects reflects their social situation and their working time organization: adolescents (n = 191) obeyed the strict school schedules with starting times often before 08:00 h; university students (n = 115) had more flexible timetables; young employees (n = 126) were engaged in regular morning schedules or irregular daytime hours or day and night shifts. A questionnaire study determined the declared need of sleep, self-reported sleep length, chronic fatigue (using a scale comprised of eight fatigue symptoms and four mood and three cognitive items), and daytime sleepiness (Epworth Sleepiness Scale). The declared need for sleep decreased in subsequent age groups from 9 h 23 min in school children to 8 h 22 min in university students and to 7 h 37 min in young employees. Consequently, the discrepancy between preferred and real sleep length (sleep deficit) was the largest in adolescents: 106 min. Females showed a greater need of sleep than males ($p = .025$) and significantly more fatigue, mood, and cognitive problems; they also exhibited higher level of daytime sleepiness ($p < .000$). The sleep index (reported sleep length related to requirements) correlated significantly with all health issues in women ($p < .000$), while only with fatigue symptoms in men ($p = .013$). Actual sleep length was unrelated to mood and fatigue issues; the declared individual need of sleep and sleep index showed significant associations, especially in the group of adolescents. The most frequent complaints of adolescents included tiredness on awakening (46%), nervousness, and general weakness; university students reported excessive drowsiness (50%), tension, and nervousness; employees suffered mostly from negative moods, such as tension (49%), nervousness, and irritability. The findings of the study indicate that chronic sleep loss seems to affect females more severely than males. The associations of fatigue and mood with sleep need and sleep index were more pronounced in younger subjects. Surprisingly, fatigue symptoms in school children and university students were as frequent as in hard-working adults. Because the

Address correspondence to Halszka Oginska, Department of Ergonomics and Effort Physiology, Jagiellonian University Medical College, ul. Grzegorzecka 20, 31-531 Krakow, Poland. Tel./Fax: + 48 12 421 93 51; E-mail: mmoginsk@cyf-kr.edu.pl

problem of insufficient sleep is already present in youngsters, their work time organization needs more attention.

Keywords Sleep deficit, Fatigue, Mood, Daytime sleepiness, Students, Adolescence, Shift work

INTRODUCTION

Good sleep in humans is the condition of appropriate functioning and quality of life; it enhances the immune system, helps to consolidate memory, and improves mood. Consequently, a lack of sleep is often linked with lowered mood, irritability, and problems with concentration, judgment, and memory. Laboratory studies have proven that sleep deprivation results in performance impairments (Taylor & McFatter, 2002), while adequate sleep length improves learning and problem solving (Wagner et al., 2004). Extended sleep leads to substantial improvements in daytime alertness, reaction time, and mood (Kamdar et al., 2004).

The effects of chronic sleep reduction have not been studied as often as those of total sleep deprivation, but it seems that both conditions lead to similar physiological (Spiegel et al., 1999; Van Cauter et al., 2005), affective, and cognitive consequences (Alapin et al., 2000; Dinges et. al., 1997), though of different intensity. Certainly, chronic sleep loss is one of the common plagues of modern societies, affecting a large part of the population (Fischer et al., 2004). According to a recent poll of the National Sleep Foundation (2005), adult Americans sleep on average 6.8 h on weeknights, more than 1 h less than they need. Over the past several years, there has been a downward trend in the proportion of respondents who reported sleeping $\geq$8 h/night on weekdays, from 38% in 2001 to 30% in 2002 and 26% in 2005. The study on a nationally representative British sample showed similar average sleep duration (7.04 h), with 18% of the respondents complaining of insufficient sleep (Groeger et al., 2004). A sample of Japanese white-collar workers showed even shorter sleep on weekdays, 6.5 h, and an average sleep debt of 45 min (Kageyama et al., 2001).

Apart from the quantity of sleep, the timing of sleep has also changed. Millions of people work night shifts and obtain only $\sim$5 h sleep on working days and then try to catch up by sleeping longer, $\sim$9 h, on days off. The phenomenon of so-called "binge sleeping" may be observed not only in shift working populations: inadequate sleep on weeknights and make up sleep on weekends seems to be a routine way of life both for students and employees, especially in the case of early start times of school and work.

The most obvious result of sleep deficit is daytime sleepiness. Symptoms of chronic fatigue, including physical complaints, negative moods, and cognitive impairments, may also be expected. This interaction

with subjective health is probably mediated by some situational (workload characteristics, including working time organization) and individual factors, such as gender, age, and traits of temperament. The question arises whether the affective and cognitive consequences of sleep deficit are the same in individuals of different ages. Most studies comprise either an adult or student population; thus, the comparative research is lacking. It seems that adolescence is a difficult time from the standpoint of sleep. A number of biological, behavioral, and environmental factors influence the sleep patterns of adolescents. On the one hand, they show a noticeable tendency to circadian phase delay, which is associated with later melatonin secretion onset in the night (Carskadon et al., 1998). Meanwhile, the entire teen culture favors an evening model of activity, while educational schedules demand early start times. On the other hand, their sleep need remains unchanged from that of the pre-pubertal stage. Taken together, all this puts adolescents at the higher risk of chronic sleep loss.

This study aimed to assess the effects of insufficient sleep, in terms of chronic sleep reduction rather than acute sleep deprivation, on subjective health estimations (mood, cognitive performance, and fatigue) in three different age-social groups: school children, university students, and young employees. The choice of groups was based on previous studies showing major discrepancies between the required and actual sleep length of adolescents and young adults, in comparison to a diminishing difference in older aged individuals (Oginska, 2005). As sleep is particularly important in young subjects, and adolescents are a population at risk of its deficit, it was hypothesized that subjective health consequences of insufficient sleep would be more pronounced in teenagers than in older groups. Because students are subjected to the most flexible time schedules, their sleep deficit and fatigue level was expected to be lower than in the younger and older age groups.

SUBJECTS AND METHODS

The study comprised three groups of subjects. Age group in this context reflected the social situation of subjects and was strictly connected with their working time organization. Adolescents (school children) were subjected to tough school schedules with early start times, often before 08:00 h. This group included 191 boys and girls of 14–16 years of age. The university students (n = 119, 20–27 years of age) had much more flexible schedules and more free time; however, some had part-time jobs for economic reasons, sometimes including evening or late evening activity, which could result in reduced sleep. Then young adult employees (n = 126, 30–45 years of age) did not constitute a homogenous group: they were engaged in various work systems that may be roughly classified

as regular morning schedules (n = 40, "office hours") or irregular daytime hours (n = 59, many self-employed), or irregular day and night shifts (n = 27, mainly healthcare).

The analysis was based on several subjective measures:

1. a declared need for sleep, assessed on the basis of two questions, "How much sleep do you need to feel fresh and rested the next day?," and "At what time would you go to bed and wake up, if you were totally free to plan your day and had no commitments?." The average of both answers (in min) was taken into account because the authors had not been able to judge which approach provided a more reliable estimate of sleep need;
2. self-reported sleep length, calculated from usual bedtime and wake-up time on an average weekday (regular workday);
3. sleep index, the ratio of actual sleep length on the average day to declared individual sleep need (both in min);
4. chronic fatigue scale (CFS), a list of 15 symptoms of fatigue (on a four-options scale: "almost never," "seldom," "often," and "almost always") developed by the team of physicians and psychologists, used in the authors' laboratory for more than 15 years, and showing satisfactory psychometric features (in this data set Cronbach's alpha was 0.87). The CFS consists of: fatigue symptoms (headaches, general weakness, excessive drowsiness, feeling tired on awaking, lack of appetite, reluctance to do any effort, heart palpitations, and easily fatigued), negative mood items (apathy, irritability, tension, and nervousness), and cognitive items (problems with attention, decision taking, and memory);
5. additionally, daytime sleepiness by the Epworth Sleepiness Scale (ESS; Johns, 1991) was assessed. Only items 1–7 were counted: the last item regarding falling asleep at the wheel was omitted because it was not relevant in most cases (i.e., young subjects).

The questionnaire study was anonymous and conformed to the ethical principles established by the journal for the conduct of human research (Touitou et al., 2004).

RESULTS

Table 1 presents the main results of the study. The declared need of sleep decreased significantly in subsequent age groups, from 9 h 23 min in secondary school pupils to 8 h 22 min in university students and to 7 h 37 min in young employees. Also, actual sleep length in employees (7 h 02 min) was ~40 min shorter than in younger subjects. Students slept the longest (7 h 48 min).

TABLE 1 Sleep and Fatigue Symptoms in Three Age-social Groups—Means and S.D.

	School children (n = 191)	Students (n = 115)	Employees (n = 126)	ANOVA results (p)
Age (years)	14.8 ± 0.5	21.5 ± 1.7	38.0 ± 5.3	—
Sleep need (min)	563 ± 114	502 ± 83	457 ± 65	.000
Sleep length (min)	457 ± 63	468 ± 73	422 ± 52	.000
Sleep index	0.84 ± 0.20	0.95 ± 0.18	0.94 ± 0.16	.000
Fatigue symptoms (8–32 pts.)	15.6 ± 4.1	16.6 ± 3.7	15.5 ± 3.7	.039
Negative mood (4–16 pts.)	8.5 ± 3.0	9.2 ± 2.2	9.1 ± 2.8	.051
Cognitive problems (3–12 pts.)	5.7 ± 2.2	6.4 ± 1.9	5.8 ± 1.7	.008
ESS (items 1–7; 0–21 pts.)	6.5 ± 3.7	8.0 ± 3.6	7.6 ± 3.9	.002

The average discrepancy between the preferred and actual sleep length (sleep deficit) was the largest in adolescents, 106 min; in the older groups, it amounted to 35 min. The same trend was seen in the individual sleep index; there was a 16% deficit in younger subjects and only a 5–6% one in older ones.

When considering the percentage of subjects reporting sleep length $\leq$6.5 h, twice as many adult employees obtained insufficient sleep compared to the youngest group (17.8% of school children, 13.9% of university students, and 34.1% of employees). But if the sleep index of 0.81 is taken into account (equivalent to $\sim$90 min sleep debt with regard to the individual sleep need of 8 h), the situation is quite the opposite: 47.6% of adolescents, 22.6% of students, and 19.8% of older subjects show sleep deficit on weeknights.

A reduced level of sleepiness was reported in the youngest group, and no difference was observed in fatigue, mood, and cognitive symptoms between pupils and employees. More complaints were found in the university student group. It was somewhat surprising that fatigue symptoms in school children and university students were as frequent as in hard-working adults (see Figure 1).

The comparison of different work schedules (day regular, day irregular, day, and night shifts) within the employees group did not reveal significant differences. This may be due to relatively small subgroups. Night workers expressed the lowest fatigue, perhaps suggesting a "healthy worker effect."

The most frequently reported health complaints in adolescents included feeling tired on awaking (46% of subjects reported it "often" or "almost always"), nervousness (39%), and general weakness (37%). The most frequent problems of the university students were excessive drowsiness (50%), tension (49%), and nervousness (46%). Employees complained mostly of tension (49%), nervousness (47%), and irritability (42%). Among workers employed in various schedules, those engaged in night work exhibited excessive somnolence, in addition to negative moods characteristic of this age group. In general, negative moods were among the most

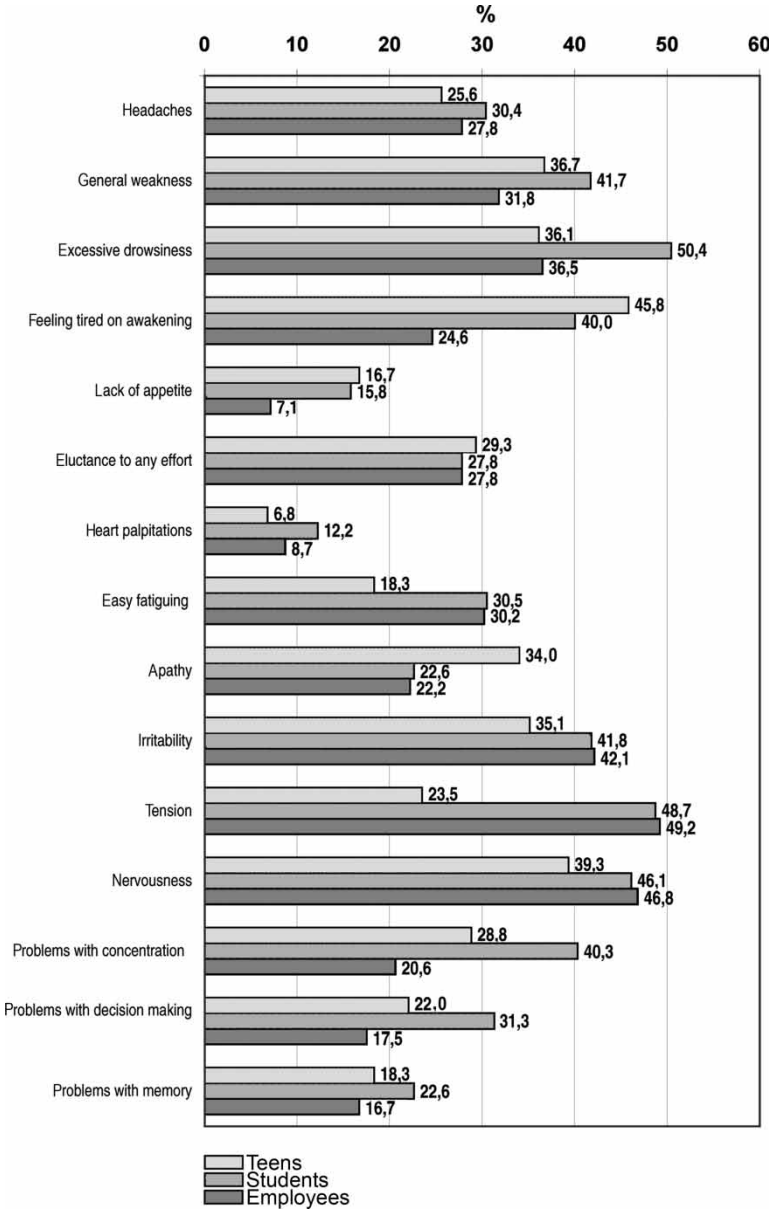

FIGURE 1 Percentage of subjects reporting particular health problems "often" or "almost always" in consecutive age groups.

common complaints, being reported "often" or "almost always" by 37% of the subjects, while about one-fourth complained of fatigue symptoms (27%) and cognitive problems (24%).

Although gender was not the main issue in this study, significant gender differences were detected, confirming a higher susceptibility to

fatigue and sleepiness in females (see Table 2). Females showed a greater need of sleep than males but did not differ as to the length of the average weeknight sleep and sleep deficit (sleep index). Women revealed significantly higher scores (that is, more health problems) in all the fatigue, mood, and cognitive subscales. They also exhibited more daytime sleepiness. Correlation analysis showed a weak association between sleep index and fatigue symptoms in men ($r = -.19$), while in women these relationships were significant: fatigue symptoms ($r = -.30$), negative mood ($r = -.28$), cognitive problems ($r = -.28$), and daytime sleepiness ($r = -.27$), suggesting higher vulnerability of females to sleep loss.

In the entire study group ($n = 432$), sleep deficit, as measured by the sleep index, was associated with the most obvious effects of insufficient sleep, such as feeling tired upon awaking ($r = .32$) and excessive drowsiness ($r = 26$); however, apathy, reluctance to extend effort, problems with concentration, and general weakness was related to low sleep index as well.

If analyzed separately by the age group, tiredness on awaking ($r = .39$), excessive drowsiness, and apathy (both $r = .31$) are the strongest correlates of sleep loss in school children, while in students reluctance to extend any effort ($r = .37$), excessive drowsiness ($r = .36$) and problems with concentration ($r = .28$) show the highest correlation coefficients. In the employee group, correlations are lower, although significant; problems with memory ($r = .26$) and decision-making ($r = .22$), as well as excessive drowsiness, are the strongest correlates of the low sleep index (insufficient sleep). The findings of the more general analysis are summarized in Table 3.

Self-reported length of sleep did not show strong relationships with either the mood- or fatigue-related items, while individual sleep need in younger groups showed several significant associations; long sleepers reported more fatigue symptoms as well as affective and cognitive problems. The sleep index showed the strongest relationships, proving to be a better indicator than sleep need; both were better than actual sleep length. The relationships of the sleep variables with mood and fatigue

TABLE 2 Sleep and Fatigue Symptoms in Males and Females—Mean ± S.D. and ANOVA Results

	Males ($n = 168$)	Females ($n = 264$)	ANOVA F value	ANOVA *p*
Age (years)	23.3 ± 11.0	23.4 ± 9.8	0.005	n.s.
Sleep need (min)	502 ± 101	525 ± 104	5.082	.025
Sleep length (min)	444 ± 59	453 ± 69	2.012	n.s.
Sleep index	0.91 ± 0.20	0.89 ± 0.18	1.915	n.s.
Fatigue symptoms (8–32 pts.)	14.5 ± 3.6	16.7 ± 3.9	31.833	.000
Negative mood (4–16 pts.)	8.1 ± 2.3	9.3 ± 2.9	22.051	.000
Cognitive problems (3–12 pts.)	5.4 ± 1.9	6.1 ± 2.0	13.184	.000
ESS (items 1–7; 0–21 pts.)	6.4 ± 3.7	7.7 ± 3.8	12.513	.000

TABLE 3 Correlation Coefficients of Sleep Variables and Fatigue Symptoms in Three Consecutive Age Groups: School Children, University Students, and Employees

	School children			Students			Employees		
	Sleep need	Sleep length	Sleep index	Sleep need	Sleep length	Sleep index	Sleep need	Sleep length	Sleep index
Fatigue symptoms	**.37** $p < .000$	.01 n.s.	**−.36** $p < .000$	**.20** $p = .030$	−.18 n.s.	**−.34** $p < .000$	.07 n.s.	−.12 n.s.	−.12 n.s.
Mood complaints	**.27** $p < .000$	−.09 n.s.	**−.30** $p < .000$	.08 n.s.	−.12 n.s.	**−.21** $p = .028$	−.01 n.s.	−.17 n.s.	−.07 n.s.
Cognitive problems	**.28** $p < .000$	−.01 n.s.	**−.23** $p = .001$	−.05 n.s.	**−.21** $p = .027$	−.16 n.s.	.17 n.s.	−.14 n.s.	**−.25** $p = .005$
Daytime sleepiness	**.29** $p < .000$	−.06 n.s.	**−.27** $p < .000$	**.25** $p = .007$	**−.18** $p = .050$	**−.36** $p < .000$	.09 n.s.	−.08 n.s.	−.15 n.s.

were the strongest in the group of adolescents. This may indicate their higher susceptibility to sleep deficit, although the effect of other factors not analyzed here cannot be excluded.

The findings of the correlation analysis of data of workers employed in various work schedules differed. In the group of regular day workers, no associations between sleep variables and mood/fatigue symptoms were detected; however, the sleep index correlated significantly with daytime sleepiness ($r = -.43$; $p = .006$). In the group of "flexible" workers (i.e., those engaged in irregular daytime schedules), the sleep index correlated significantly and negatively with cognitive problems ($r = -42$; $p = .001$). In the group of day and night workers, no significant associations were found, although this might have been a result of the small number of subjects and "healthy worker effect."

DISCUSSION

The interpretation of the above results requires the consideration of many limitations of a cross-sectional study based on self-reports; it is strongly marked by the subjectivity of measures. Both mood and fatigue are undoubtedly subjective issues, and the same is true of ratings of sleep need.

The average length of sleep in the present sample did not differ from the regular sleep of healthy people, as estimated, for example, in the diary study by Monk et al. (2000); weeknight time spent in bed amounted to 7 h 35 min (7 h 27 min in the 20–50 year old U.S. sample). This is, however, the absolute value; as far as the individual satisfactory sleep length is considered, the mean sleep index amounted to 0.84–0.95 in three subgroups, which equals the mean sleep debt of 77 min in adolescents and 24 min in adults. Excessive drowsiness was reported by 36% of school children, and this was exactly the same as in the group of adult workers. The ESS score was lower in adolescents than in the older subjects. These results were a bit astonishing, as one might have expected a higher incidence of somnolence in the younger group. Other studies (e.g., Gibson et al., 2006) showed that sleep deprivation and excessive sleepiness were common in two large Canadian high school samples and associated with a decrease in academic achievement and extracurricular activity. Yet, drowsiness remained the strong correlate of sleep index in both younger and older subjects in our study.

No significant gender differences emerged in actual sleep length, and this is in accordance with the findings of some other studies (Monk et al., 2000; Ursin et al., 2005). One cannot, however, ignore the apparent differences between men and women in sleep need and daytime sleepiness. Average subjective sleep need in females was 23 min longer than in males (8 h 45 min vs. 8 h 22 min). The same tendency may be observed

in older populations, e.g., 7 h 48 min vs. 7 h 04 min in Polish physicians aged 29–68 years (Oginska et al., 2005) and 7 h 45 min vs. 7 h 16 min in 40–45 year old Norwegians (Ursin et al., 2005).

The sleep index and sleep need show strong relationships with health outcomes, while actual sleep length is not as useful as an indicator. It is difficult to discern between cause and effect in studies of sleep length/requirements and health or longevity (Kripke et al., 2002). Also, the theoretical relationship between individual sleep need and fatigue is not obvious. Two explanations are justified:

1. subjects who need more sleep than others (long sleepers) more easily develop fatigue syndrome in everyday circumstances, as they are chronically sleep deprived, and
2. those who are over-fatigued need more sleep to recover.

In experimental studies on performance impairments induced by different doses of sleep debt, Van Dongen et al. (2003) observed significant effects of individual variability of sleep need, as well as of "substantial trait-like interindividual differences in vulnerability to sleep loss." The results of the authors' field study on fatigue and mood correlates of actual sleep length and individual sleep index suggest that both individual variables (sleep need and vulnerability to sleep loss) may vary considerably with age. This finding calls for further exploration by means of laboratory-controlled investigations.

The hypothesis that the health consequences of insufficient sleep are more pronounced in younger than in older subjects was confirmed. At least three explanations of this finding are suggested:

1. younger subjects are indeed more fragile and susceptible to chronic sleep loss,
2. in older subjects, the relationships between sleep and fatigue issues are not so distinct, as many other stress factors stemming from professional or personal life play a masking role, or
3. the educational system does not allow for choice, so "natural selection" or "healthy student effect" cannot be observed in younger groups (no drop-outs); as a result, the health effects of unfavorable working time organization are more visible.

The hypothesis concerning a lower fatigue level in university student groups, as a result of their most flexible work schedules and lesser sleep deficit, was not confirmed. As their workload profile is dominated by cognitive challenges, they are probably particularly sensitive to and aware of their vigilance, attention, and memory deficits, and thus report more often than others cognitive problems and excessive drowsiness.

The very probable "healthy worker effect" did not allow the possibility of drawing any conclusions regarding the impact of work schedule in young employees; shift workers did not exhibit health consequences of their shortened sleep.

New social-economic conditions in Poland have led to more autonomy in employment—that is, more self-employment, especially in the service sector. This has resulted also in more flexible work systems, which means more hours spent at work and more irregular schedules, adapted to the customers' requirements and needs. In those "flexible" workers, cognitive complaints (i.e., problems with concentration, memory, and decision-making) were associated with sleep deficit.

It may be concluded that insufficient sleep causes more severe effects in females than in males, and the associations of fatigue and mood with sleep need and sleep index are more pronounced in younger subjects. It was somewhat surprising that fatigue symptoms in school children and university students were as frequent as in hard-working adults. Because the problem of chronic sleep loss emerges in adolescence, their time organization needs more consideration (see Teixeira et al., 2004). Thus far, too little attention has been paid to the time budget and timing problems of adolescents, as school duties are not considered as to be the equivalent of work in adulthood. As Dement (1997) pointed out, although people get a great deal of information about two other health basics, nutrition and physical fitness, the society "remains a vast reservoir of ignorance about sleep deprivation and sleep disorders," and "we must realize that we cannot be healthy unless our sleep is healthy."

ACKNOWLEDGMENTS

This research was partially carried out in frame of the Jagiellonian University Medical College program, no. 501/PKL/146/L (H. Oginska).

REFERENCES

Alapin, I., Fichten, C.S., Libman, E., Creti, L., Bailes, S., Wright, J. (2000). How is good and poor sleep in older adults and college students related to daytime sleepiness, fatigue, and ability to concentrate? *J. Psych. Res.* 49(5):381–390.

Carskadon, M.A., Wolfson, A.R., Acebo, C., Tzischinsky, O., Seifer, R. (1998). Adolescent sleep patterns, circadian timing, and sleepiness at a transition to early school days. *Sleep* 21(8):871–881.

Dement, W. (1997). What all undergraduates should know about how their sleeping lives affect their waking lives. Stanford University Center of Excellence for the Diagnosis and Treatment of Sleep Disorders. Available at: http://www.stanford.edu/~dement/sleepless.html. Accessed: August 2006.

Dinges, D.F., Pack, F., Williams, K., Gillen, K.A., Powell, J.W., Ott, G.E., Aptowicz, C., Pack, A.I. (1997). Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4–5 hours per night. *Sleep* 20(4):267–277.

Fischer, F.M., Rotenberg, L., de Castro Moreno, C.R. (2004). Equity and working time: A challenge to achieve. *Chronobiol. Int.* 21:813–829.

Gibson, E.S., Powles, P., Thabane, L., O'Brien, S., Molnar, D., Trajanovic, N., Ogilvie, R., Shapiro, C., Yan, M., Tanser, L. (2006). "Sleepiness" is serious in adolescence: two surveys of 3235 Canadian students. *BMC Public Health* 6(1):116 (Epub).

Groeger, J.A., Zijlstra, F.R., Dijk, D.J. (2004). Sleep quantity, sleep difficulties and their perceived consequences in a representative sample of some 2000 British adults. *J. Sleep Res.* 13(4):359–371.

Johns, M.W. (1991). A new method for measuring daytime sleepiness: The Epworth Sleepiness Scale. *Sleep* 14(6):540–545.

Kageyama, T., Nishikido, N., Kobayashi, T., Kawagoe, H. (2001). Estimated sleep debt and work stress in Japanese white-collars workers. *Psych. Clin. Neurosci.* 55:217–219.

Kamdar, R.B., Kaplan, K.A., Kezirian, E.J., Dement, W.C. (2004). The impact of extended sleep on daytime alertness, vigilance, and mood. *Sleep Med.* 5(5):441–448.

Kripke, D.F., Garfinkel, L., Wingard, D.L., Klauber, M.R., Marler, M.R. (2002). Mortality associated with sleep duration and insomnia. *Arch. Gen. Psych.* 59:131–136.

Monk, T.H., Buysse, D.J., Rose, L.R., Hall, J.A., Kupfer, D.J. (2000). The sleep of healthy people—a diary study. *Chronobiol. Int.* 17(1):49–60.

National Sleep Foundation (2005). "Sleep in America" Poll. Available at: http://www.sleepfoundation.org/_content/hottopics/2005_summary_of_findings.pdf. Accessed: August 2006.

Oginska, H. (2005). Hypersomnia and drowsiness at work. Seasonal aspects. Report 501/PKL/146/L, Krakow, Poland: Collegium Medicum UJ.

Oginska, H., Pokorski, J., Pokorska, J., Nitecka, E. (2005). Chronoergonomics and WAI in Polish physicians. In: Costa, G., Goedhard, W.J.A., Ilmarinen, J., eds. *Assessment and Promotion of Work Ability, Health and Well-being of Ageing Workers*. Elsevier, ICS 1280, pp. 118–123.

Spiegel, K., Leproult, R., Van Cauter, E. (1999). Impact of sleep debt on metabolic and endocrine function. *Lancet* 354(9188):1435–1439.

Taylor, D.J., McFatter, R.M. (2002). Cognitive performance after sleep deprivation: does personality make a difference? *Pers. Ind. Diff.* 34(7):1179–1193.

Teixeira, L.R., Fischer, F.M., Nagai, R., Turte, S.L. (2004). Teen at work: The burden of a double shift on daily activities. *Chronobiol. Int.* 21:845–858.

Touitou, Y., Portaluppi, F., Smolensky, M.H., Resning, L. (2004). Ethical principles and standards for the conduct of human and animal biological rhythm research. *Chronobiol. Int.* 21:161–170.

Ursin, R., Bjorvatn, B., Holsten, F. (2005). Sleep duration, subjective sleep need, and sleep habits of 40- to 45-years olds in the Hordaland Health Study. *Sleep* 28(10):1260–1269.

Van Cauter, E., Knutson, K., Leproult, R., Spiegel, K. (2005). The impact of sleep deprivation on hormones and metabolism. *Med. Neurol. Neurosurg.* 7(1). Available at: http://www.medscape.com/viewarticle/502825. Accessed: August 2006.

Van Dongen, H.P., Rogers, N.L., Dinges, D.F. (2003). Sleep debt: theoretical and empirical issues. *Sleep Biol. Rhythms* 1:5–13.

Wagner, U., Gais, S., Haider, H., Verleger, R., Born, J. (2004). Sleep inspires insight. *Nature* 427: 352–355.