Sleep Behavior of South African Adolescents

Alison Reid BSc, Hons, Claudia C. Maldonado BSc, Hons, and Fiona C. Baker PhD

Wits Sleep Laboratory, Brain Function Research Unit, School of Physiology, University of the Witwatersrand, Johannesburg, South Africa

Study Objectives: To survey a large group of South African adolescents about their sleep behavior, daytime behaviors, and morning alertness as compared to those of other teenagers worldwide.
Design: Subjects completed a questionnaire about their sleep habits and daytime behaviors on the previous day, and subjective morning alertness at the time of completing the questionnaire.
Setting: Four secondary schools in Johannesburg, South Africa on mid-week mornings.
Participants: 825 secondary school students volunteered for this study.
Interventions: N/A
Measurements and Results: The students, (16±1 years), 61% female, reported significantly less time in bed ($p<0.001$) on a school night (453±70 minutes), compared to weekend nights (476± 128 minutes). On the school night, they reported a mean sleep onset latency of 17 minutes, with 45% of the sample falling asleep in less than ten minutes. Short sleep onset latency and short in-bed wakefulness both were positively related to a high sleep efficiency and subjective sleep quality. On the previous day, 72% of the adolescents had consumed caffeinated beverages and 56% had exercised, but these behaviors did not significantly influence their nighttime sleep. The majority (77%) of students had napped the previous day and 8% had taken medication to fall asleep that night. 40% of the students felt that they could fall asleep mid-morning, if given the chance, but their sleepiness was independent of their nighttime sleep quality or duration.
Conclusions: Similarly to teenagers around the world, South African adolescents get insufficient sleep during the week, which they attempt to compensate for on the weekends. A large proportion of the students are also sleepy during the school day, which may influence their academic performance.
Key words: Adolescent development; sleep debt; daytime sleepiness; sleep quality; caffeine; napping

INTRODUCTION

ADOLESCENCE IS CHARACTERIZED BY EXTENSIVE PSYCHOLOGICAL AND PHYSIOLOGICAL DEVELOPMENT IN WHICH SLEEP PLAYS AN ESSENTIAL ROLE.[1] It has consistently been shown in countries around the world, however, that as children get older they also get less sleep,[2-8] often resulting in adolescents being sleep deprived. Although they are purported to require between 8.25 hours and 9.2 hours of sleep per night for optimal daytime alertness,[9,10,11] adolescents in North America,[9] Israel,[6] and China[7] report a sleep duration of between only seven and 7.75 hours on school nights. Consequently, teenagers frequently exhibit excessive daytime sleepiness[12,13] and spontaneously sleep for longer when not restricted by set wake-up times. Studies from several countries, such as Poland,[14] Finland,[5] Italy,[4] Taiwan,[7] China,[8] and North America,[15] have shown that adolescents have up to two hours more sleep on a weekend night than on a week night, suggesting that that sleep loss incurred during the school week is being compensated for on the weekend.

Adolescents are exposed to demands from part-time jobs, academic pressures, sporting and social activities, as well as emotional turmoil, all of which all may contribute to a shortened sleep time.[1,7,16-18] In addition to socially driven changes in sleep habits, adolescents may experience a biologically mediated phase delay of their circadian rhythm that controls the timing of sleep within a 24-hour period. Teenagers prefer to go to bed later and wake up later than do younger children.[13,19] Despite this delay in sleep phase, many schools impose early school start times so that adolescents may be losing sleep due to progressively later bedtimes while wake times remain early.[1,13,15]

Biological and social factors may detrimentally affect males more than females. Outi et al.[5] found that males preferred to go to bed later and wake up later than did females. While some studies report no significant gender differences in sleep patterns,[2,9] others have reported more frequent night awakenings,[4,5] shorter sleep duration,[7,8,20] or lower sleep quality in female compared to male adolescents.[21] Regardless of gender, certain daytime behaviors also may influence the sleep habits of adolescents. Napping ranges widely from 2% in Australian teenagers[22] to 75%[6] in Israeli teenagers and caffeine, which is commonly consumed by teenagers in the form of soda, tea, and coffee, is associated with sleep fragmentation in adolescents.[1]

Sleep loss, which may be incurred as a result of these social, biological, and behavioral factors, may have serious consequences for adolescents, which have also been well documented in other countries. Insufficient sleep is associated with poor school achievement,[4,15,23] lower grades,[20] and decreased school attendance,[24] as well as problems with attention, memory, and concentration[4,6,25] and higher rates of depression and anxiety.[15,20,21]

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Address correspondence to: Alison Reid, School of Physiology, University of the Witwatersrand Medical School, 7 York Road, Parktown, 2193, Johannesburg, South Africa; Tel: +2711/717-2506; Fax: +2711/643-2765; E-mail: 057mreid@chiron.wits.ac.za

Table 1—Mean (SD) for sleep and daytime behaviors in South African adolescents (age: 16±1 yr)

Variable*	Mean (SD)
Bedtime	22:30 (60min)
Wake time	06:07 (42min)
Time in bed (minutes)	453 (70)
Sleep onset latency (minutes)	17 (15)
Number of awakenings	7 (11)
Total sleep time (minutes)	432 (70)
Sleep efficiency (percentage)	96 (4)
Sleep quality (mm)	59 (21)
Weekend time in bed(minutes)	476 (128)
Nap duration (minutes)	14 (36)
Exercise duration (minutes)	24 (39)
Caffeinated beverages (cups)	2 (2)

*n ranges from 713-801 for each variable

Although the sleep patterns of adolescents have been investigated in many countries, the sleep behavior of South African adolescents has never been studied. South African adolescents, however, also are exposed to early school start times, and probably other social and academic pressures, which predispose teenagers to sleep deprivation in other countries. We therefore investigated the sleep behavior of a large group of adolescents in South Africa to assess whether they have sleep deficits similar to those of teenagers in other countries.

METHODS

Verbal consent was obtained from 825 students from four schools in Johannesburg, South Africa to participate in our study. Our study was approved by the ethics committee of the University of the Witwatersrand (protocol # M990202), which adheres to the principles of the Declaration of Helsinki. We administered a one-page questionnaire to the students at the four schools between 08:00 and 13:00 on different school mornings over a two-week period in March 1999, and in the mid-term when there were no scheduled examinations. Since all classes were conducted in English at these schools, an English questionnaire was given to the students. The start time of all the schools was 07:45. Eight-hundred and twenty three (99.7%) questionnaires were returned. However, not all the students answered every question so that the response rate for each question ranged from 87% to 97%.

Standard questions used at the University of Witwatersrand Sleep Laboratory were included in the questionnaire. Information about the ethnicity, social activities, and academic performance of the students was not obtained, primarily because time constraints limited the length of the questionnaire. Specifically, the students were asked at what times they had gone to bed and woken up, to estimate how long they had taken to fall asleep (subjective sleep onset latency; SOLs), how many times they had woken up and for how long they had remained awake (wake after sleep onset; WASO) on the previous night. The students also were asked whether they had taken any medication to help them to get to sleep and whether an alarm or wake-up call was used to wake them that morning. Students assessed the quality of the preceding night's sleep on a 100mm visual analog scale with anchor points of "worst ever sleep" and "best ever sleep." Students from three of the four schools (n=502) also were asked to report how many hours of sleep they usually got per night on weekends. This question had not yet been included in the questionnaire when the first school was assessed. Actual bedtimes and wake up times were not asked for weekend sleep.

Questions about daytime behaviors were also included in the questionnaire. Students were asked if they had taken a nap on the previous day, and for how long they had napped, as well as whether they had exercised, and the duration of the exercise. In addition, students were asked how many cups of caffeinated beverages (tea, coffee, or cola drinks) they had consumed on the previous day. As an accepted indicator of subjective daytime alertness,[26] we asked students from three of the four schools (n=476) whether or not they thought that they would be able to fall asleep within five minutes if given the chance, at the time of completing the questionnaire (this question also had not yet been included in the questionnaire when the first school was assessed). We chose to ask the adolescents only about their previous night of sleep to obtain a more accurate description of sleep as opposed to more retrospective information about sleep, which becomes more inaccurate when averaged over several days or weeks.

We calculated the total time that the students spent in bed (TIB) during the school night as the time between reported bedtimes and wake-up times. We estimated the total sleep time (TST) for each student by subtracting the students' SOL_s and WASO from TIB. Sleep efficiency was calculated as TST/TIB and expressed as a percentage.

Analyses

Measurements on the sleep quality visual analog scale were normalized with the arcsine transformation before statistical analysis and then computed as parametric data. Sleep behavior was first compared between students from the four different schools using an analysis of variance. Since no significant differences were found, the data was pooled for further analysis.

To assess the relationships between sleep, daytime, and demographic factors, five separate multiple linear regression analyses were performed with bed time, wake time, TST, sleep quality, and sleep efficiency as the five dependent variables. A multiple logistic regression analysis was performed to evaluate the independent effects of sleep behavior, daytime behaviors, and demographic characteristics on the adolescents' perceived alertness the following morning. Finally, a paired t-test was used to compare TIB on the school and weekend nights. Because of the number of comparisons performed, the minimum statistical significance level for all analyses was set at $p<0.01$.

RESULTS

Table 1 shows means and standard deviations for demographic, sleep and daytime behavior variables. The students, of whom 61% were female, were between 14 and 20 years old, although 90% of the sample was between 15 and 17 years old. They went to bed at 22:30 and woke up at 06:07, therefore spending 453 minutes in bed on the school night. Once they were in bed, the students estimated SOL_s of 17 minutes, with 45% of them reporting SOL_s of less than 10 minutes and 3% of the students report-

Table 2—Regression summaries for bedtime, wake up time, total sleep time, and sleep quality in South African adolescents

Dependent variable	Independent variable	Beta (standard error)	Partial correlation
Bedtime	Gender	-0.11 (0.04) *	-0.1
	Age	-0.02 (0.04)	-0.02
	Medication	0.11 (0.04) *	0.1
	Napping	0.15 (0.04) **	0.15
	Caffeine	0.08 (0.04)	0.08
	Exercise	0.07 (0.04)	0.08
Wake up time	Gender	-0.003 (0.03)	-0.005
	Age	-0.05 (0.02)	-0.08
	Bedtime	1.11 (0.04) **	0.78
	Sleep onset latency	0.26 (0.03) **	0.39
	Number awakenings	0.02 (0.03)	0.02
	Time spent awake	0.18 (0.03) **	0.21
	Total sleep time	1.18 (0.04) **	0.8
	Medication	-0.02 (0.02)	-0.03
	Napping	-0.02 (0.02)	-0.03
	Caffeine	0.1 (0.02) **	0.16
	Exercise	-0.04 (0.02)	-0.07
Total Sleep Time	Gender	0.02 (0.04)	0.02
	Age	-0.06 (0.04)	-0.06
	Medication	-0.03 (0.04)	-0.03
	Sleep quality	0.1 (0.04)	0.1
	Napping	-0.15 (0.04) **	-0.15
	Caffeine	-0.18 (0.04)	-0.08
	Exercise	-0.04 (0.04)	-0.04
Sleep Quality	Gender	-0.02 (0.04)	-0.02
	Age	-0.05 (0.04)	-0.05
	Bedtime	-0.07 (0.1)	-0.03
	Sleep onset latency	-0.6 (0.18) *	-0.14
	Number awakenings	-0.2 (0.06) **	-0.14
	Time spent awake	-0.12 (0.06)	-0.08
	Total sleep time	0.04 (0.12)	0.01
	Medication	-0.11 (0.04) *	-0.12
	Wake up time	0.03 (0.07)	0.02
	Napping	0.02 (0.04)	0.02
	Caffeine	0.01 (0.04)	0.01
	Exercise	0.1 (0.04)	0.1
	Sleep efficiency	-0.43 (0.2)	-0.1

* p<0.01; ** p< 0.001

ing taking at least one hour to fall asleep. Just over half (52%) of the sample estimated that they had woken up at least once during the night. Fifty students (6%) estimated that they were awake for at least 30 minutes that night.

Seventy-two percent of the students reported that they had consumed caffeinated beverages on the day before the questionnaire had been administered and 8% of the students reported taking some form of medication on the school night to help them to get to sleep. The amount and type of medication used by these students was not assessed. The majority (77%) of the students had taken a nap on the previous day and just over half of the students (56%) reported exercising the previous day. 62% of the students (n=764), reported that they had relied on an alarm clock or wake-up call to wake up that morning. Finally, at the time of completing the questionnaire, 40% of the students felt that they would fall asleep within five minutes if they were given the chance.

From multiple linear regression analysis, later bedtime was significantly related to use of medication, napping, and the male gender (Table 2). A later wakeup time, however, was significantly related to a later bedtime, longer SOL_s, greater WASO, longer TST, and more caffeine consumption on the previous day (Table 2). TST was negatively associated with napping the previous day, and tended to be associated with higher perceived sleep quality, independent of gender, age, use of medication, and exercise (Table 2). Longer SOLs, more awakenings, and use of medication were also independently associated with a lower perceived quality of sleep whereas participation in exercise tended to be associated with a higher sleep quality (Table 2). Sleep efficiency was significantly associated with perceived quality of sleep

[F(10,335)=4,89;Beta=0.31, partial correlation =0.31 , p<0.001], but was not related to any other measured variable.

From logistic regression analysis, none of the variables examined was found to be a significant, independent predictor of morning alertness of the students, based on whether they would fall asleep within five minutes. Perceived quality of sleep, however, tended to be a weak predictor of morning alertness of the students (chi-square=5.34, p= 0.02). Finally, the students spent a significantly longer time in bed (paired t-test, t(417)=-6.4, p<0.001) on weekend nights (476±128minutes) compared to a school night.

DISCUSSION

Our study provides the first information about sleep behavior of South African adolescents on a typical school night. The majority of students reported that they slept well with a relatively high sleep quality. Their total sleep time of just over seven hours, however, may have been insufficient; the majority of students did not wake up spontaneously in the morning, took a nap during the day and spent more time in bed on weekend nights, possibly to recover sleep lost during the school week. Also, almost half of the students reported that they fell asleep in less than 10 minutes suggesting that they had a high sleep drive. The mean sleep efficiency of 96% was also, therefore, relatively high for these students. Finally our measure of daytime alertness indicates that 40% of the students felt that they would fall asleep almost immediately, at school in the mid-morning, if given the chance, regardless of the previous night's sleep.

This study was a questionnaire-based study that therefore had the limitations inherent in a retrospective survey. We used a short questionnaire that relied on the accuracy of subjective reports, but allowed us to assess the basic sleep behavior of a large student population. Although, we were able to assess only one night of sleep, we attempted to obtain data from a typical school night by distributing the questionnaires in mid-term, when the students were settled in their new classes and were not writing examinations. We cannot, however, speculate about the long-term, habitual sleep patterns of South African adolescents based on the findings from one night of sleep. Future research should evaluate the sleep habits of South African adolescents over a longer period of time and assess the consequences of these sleep habits for their general well being. We also were not able to assess whether there were any ethnic differences in sleep habit in our subjects, or whether other social factors influenced the adolescents' sleep. Further studies could evaluate the influence of ethnicity; social activities and academic performance on sleep habits in South African teenagers.

Our findings indicate that South African adolescents have a similar TIB and TST on a school night to that of adolescents in other countries.[2,6,7,9] Since adolescents are reported to require at least 8.25 hours per night for optimal daytime alertness and ideally should get about 9.2 hours of sleep per night[9,10,11] South African adolescents, like those worldwide, are getting at least one hour less sleep than they should.

Almost half of the students reported a SOLs of less than 10 minutes. Their mean SOLs and WASO were also relatively short, compared to alert young adults[27] and US adolescents,[11] which is suggestive of a need for more sleep.[27,29] The short SOL_s and WASO are reflected in the high sleep efficiency of the students in our study, which also is considered to indicate a sleep shortfall.[29]

We also found a significant increase in reported time in bed on weekend nights compared to on a school night, which suggests that South African adolescents, similar to those in many other countries,[4,5,7,8,14] may build up a sleep debt during the school week and attempt to compensate for this sleep loss on the weekends. The difference in TIB between school and weekend nights of 23 minutes, reported by our subjects, was less than that reported by adolescents in other countries, which ranges between one and more than two hours.[4,5,7,8,14] South African students therefore may either accumulate comparatively less of a sleep debt during the school week or perhaps don't recover sleep on weekends to the same extent as do adolescents in other countries. Future research needs to be conducted to further examine sleep and daytime activities of South African adolescents on weekends.

Similar to Israeli high school children,[6] a high proportion of adolescents in our study also reported daytime napping, which may suggest insufficient nighttime sleep. Since napping was significantly associated with a later bedtime and less total sleep time, the high incidence of napping in our students may, however, also reflect a natural diurnal sleepiness that is reported to be associated with adolescent development.[30]

Our finding that 40% of the students felt that they could fall asleep almost immediately during the school morning, if given the chance, suggests that, like adolescents in other countries, South African teenagers may experience daytime sleepiness.[12,13] Our daytime alertness measure, however, was not significantly associated with any of the other variables assessed in our study, and therefore may not only depend on the previous night's sleep, but also may be related to other factors not assessed in this study. The weak association between morning alertness and sleep quality suggests that subjective alertness, as assessed in our study, may relate more to perceptions about the quality of the previous night of sleep, than to sleep time.

While the adolescents in our study may be getting too little sleep, the majority of students rated this sleep as being of relatively good quality. Better sleep quality was significantly associated with shorter SOL_s and WASO. Since sleep efficiency is calculated from SOL and WASO values, it was therefore, not surprisingly, also related to sleep quality. Sleep quality, however, was not dependent on TST, as is reported in other studies.[32] South African adolescents' subjective evaluations of their sleep quality in our study, therefore, appeared to be related more to ease of initiating, and continuity of sleep, than to sleep duration.

Not all of the students perceived that they slept well; small proportions of the students reported SOL_s of longer than half an hour (6%) and longer than an hour (3%), which may be indications of difficulty initiating sleep in these students. Also, the students who reported taking medication to help them to get to sleep ironically reported significantly later bed times, and a poorer sleep quality than those who did not take any medication. The use of sleep-promoting medication in South African adolescents is much higher than that reported for both Chinese[2] and Italian[18] adolescents, possibly because we did not ask about amount and type of medication taken to aid sleep. Sleep disorders and general health were also not assessed in this study, and could have accounted for poor sleep quality in sub-samples of our students, such as those who reported using medication to get to sleep and those who reported a very long SOL_s. Further research should be

conducted with South African adolescents to investigate the use of sleep-promoting medications, and the incidence of sleep disorders. Although there was a high frequency of caffeine use by the adolescents in our study, similar to those in other countries, the average amount consumed was not excessive and did not appear to influence bedtime, TST, or sleep quality that night.

Apart from going to bed later, the male adolescents reported similar sleep to that of the females in our study, which supports the findings of many others.[3,5,9,15] Some studies, however, have found that adolescent girls sleep less,[7,8,20] report more sleeping difficulties,[18] or have a poorer sleep quality than do males.[21] Possibly different study protocols, measurements of sleep quality, and social constraints in different countries may influence findings of gender differences. Certainly, as women get older, they report longer sleep times, longer SOL, and poorer sleep quality as well as greater number of awakenings, than do men.[32,33] In our study of a large group of male and female adolescents, however, we found no evidence of such gender differences being apparent at this age.

Most other studies have found changes in sleep behavior with increasing age in adolescents, which we did not find. The substantial majority (90%) of the adolescents in our study fell within a narrow age range of between 15 and 17 years, during which period sleep may not change significantly.

In conclusion, South African male and female adolescents have similar sleep behavior to teenagers in other countries; they do not get the recommended adequate amount of sleep and are sleepy in the morning at school. The consequences of sleep loss in South African children remain to be investigated.

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