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Original Article

Associations of self-reported sleep disturbance and duration with academic failure in community-dwelling Swedish adolescents: Sleep and academic performance at school

Olga E. Titova [a,*], Pleunie S. Hogenkamp [a], Josefin A. Jacobsson [a], Inna Feldman [b,c], Helgi B. Schiöth [a], Christian Benedict [a,**]

[a] Department of Neuroscience, Uppsala University, 751 24 Uppsala, Sweden
[b] Uppsala County Council, 751 25 Uppsala, Sweden
[c] Department of Women's and Children's Health, Uppsala University, 751 85 Uppsala, Sweden

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ABSTRACT

Objective: To examine associations of self-reported sleep disturbance and short sleep duration with the risk for academic failure.
Methods: A cohort of ~40,000 adolescents (age range: 12–19 years) who were attending high school grades 7, 9, and 2nd year of upper secondary school in the Swedish Uppsala County were invited to participate in the Life and Health Young Survey (conducted between 2005 and 2011 in Uppsala County, Sweden). In addition to the question how many subjects they failed during the school year (outcome variable), subsamples of adolescents also answered questions related to subjective sleep disturbance ($n = 20,026$) and habitual sleep duration ($n = 4736$) (exposure variables). Binary logistic regression analysis was utilized to explore if self-reported sleep disturbances and habitual short sleep duration (defined as less than 7–8 h sleep per night) increase the relative risk to fail subjects during the school year (controlled for possible confounders, e.g. body-mass-index).
Results: Adolescents with self-reported sleep disturbances had an increased risk for academic failure (i.e., they failed at least one subject during the school year; OR: boys, 1.68; girls, 2.05, both $P < 0.001$), compared to adolescents without self-reported sleep disturbances. In addition, adolescents who reported short sleep duration on both working and weekend days were more likely to fail at least one subject at school than those who slept at least 7–8 h per night (OR: boys, 4.1; girls, 5.0, both $P < 0.001$).
Conclusion: Our findings indicate that reports of sleep disturbance and short sleep duration are linked to academic failure in adolescents. Based on our data, causality cannot be established.

1. Introduction

Surveys in both Asian and European cohorts have recently shown that a significant proportion of school-aged children perceive the quality of their regular sleep to be insufficient [1–3]. This is alarming, as adolescents with sleep problems exhibit deficits in attention, a lack of concentration, reduced cognitive functioning, and signs of reduced capacity to cope with emotional stress [1,4–6]. As a consequence, adolescents with sleep problems may perform poorly in school. Supporting this assumption, previous studies have demonstrated that adolescents with insufficient sleep are at an increased risk for academic failure [3,5,7–9]. For instance, in a study involving 713 adolescents, self-reported sleep complaints were associated with overall impaired performance at school [10]. Another study demonstrated in children that experimental sleep restriction (i.e., 1 h less sleep each night over four consecutive nights) led to impaired math fluency and attentional deficits [5]. However, although fewer in number, there are also studies that did not find evidence for an association of insufficient sleep with academic performance [11,12]. For instance, in one study involving 1000 high school students and 200 middle school students, there was no correlation between sleep time and academic performance measured by students' self-reported grade point average. This finding was consistent from 7th through 12th grades [11]. In light of these contradictory findings, which may mainly be due to differences in sample sizes, large adolescent cohorts are needed to examine if reports of sleep disturbances and short sleep duration are linked to academic success in school. Thus, in the present study whose

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* Corresponding author. University of Uppsala, Department of Neuroscience, Box 593, Husargatan 3, Uppsala, Sweden. Tel.: +46 18 471 4136; fax: +46 18 51 1540.
E-mail address: olga.titova@neuro.uu.se (O.E. Titova).
** Corresponding author. University of Uppsala, Department of Neuroscience, Box 593, Husargatan 3, Uppsala, Sweden. Tel.: +46 18 471 4136; fax: +46 18 51 1540.
E-mail address: christian.benedict@neuro.uu.se (C. Benedict).

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Fig. 1. Flow-chart illustrating the number of adolescents from the *Swedish Life and Health Young Study (Uppsala County)* who were available to investigate the association of self-reported sleep disturbance and short sleep duration with academic failure (i.e., all covariates, as well as exposure and outcome variables were available). *Abbreviations*: ID = subject code.

analysis was based on questionnaire data of ~20,000 community-dwelling Swedish adolescents in the age between 12 and 19 years (7th and 9th grades and 2nd year of upper secondary school), we aimed to examine associations of self-reported sleep disturbance (i.e. subjective appraisal of sleep quality) and duration with the risk for academic failure at school. All analyses were controlled for confounders that may impact adolescents' sleep (e.g. parents' ethnic identity, family household structure, parents' employment status, body mass index or BMI, and school location). It was hypothesized that adolescents with reports of sleep disturbance and short sleep duration (i.e. less than 7–8 h sleep per night) would have a higher risk to fail at least one subject during the school year, compared to those without sleep disturbances or sufficient sleep length. In light of previous findings where the adverse impact of chronic short sleep on school performance was more pronounced in girls than in boys [9], particular attention was paid to gender in the analysis. To our best knowledge, there is no other community-dwelling study with a similar sample size that has systematically investigated to which extent sleep quality and quantity are related to academic failure among Swedish boys and girls in the age between 12 and 19 years.

One possible lifestyle factor that could explain as to why sleep problems are so frequently found among adolescents Asian and European cohorts [1–3] might be the increasing use of information and communication technologies, comprising internet. Previous studies have demonstrated that the frequent use of information and communication technologies can lead to subjective sleep disturbances, later bedtimes, stress susceptibility, and depressive symptoms in children and adolescents [13–15]. According to the central statistical agency in Sweden in 2013, 91% of the Swedish population (16–85 years old) had a home internet access. This analysis also revealed that the time spent on the internet was highest among people in the age between 16 and 24 years, especially for females [16]. Against this background, we also investigated to which extent the use of internet at night was linked to sleep disturbances and short sleep duration in adolescents.

2. Methods

2.1. Study sample

Fig. 1 presents a flow chart of exclusions. A cohort of 39,399 adolescents who were attending high school grades 7, 9, and 2nd year of upper secondary school in the Swedish Uppsala County (typical school start times between 8 AM and 9 AM) were invited to participate anonymously in the *Life and Health Young Survey* (conducted between 2005 and 2011 in Uppsala County, Sweden). The survey was completed by adolescents at the end of the school year. In 2005, adolescents who participated in the survey were not asked about family structure (utilized as covariate in the present study). The question concerning habitual nocturnal sleep duration was only available from the survey conducted in 2011. As there were no missing variables (including covariates), for the final analysis, 20,026 questionnaires were considered eligible to examine the association between self-reported sleep disturbances and academic failure. In addition, 4736 questionnaires were considered eligible to investigate the association between self-reported habitual nocturnal sleep duration and academic failure. The data analysis was approved by the Ethical Committee of Uppsala (EPN).

2.2. Assessment of reports of sleep disturbances and duration

Self-reported sleep disturbances were assessed by three questions: How often during the last three months have you had the following problems: difficulty falling asleep/restless sleeps/had nightmares? The adolescent could answer those questions by using a 5-point ordinal scale (never – 1 point, seldom – 2 points, sometimes – 3 points, often – 4 points, and always – 5 points) (Cronbach's $\alpha = 0.76$). The answers were summed into a cumulative score spanning from 3 to 15. For the analysis, a dichotomized variable was created, contrasting the highest symptom quartile with the three lowest symptom quartiles.

Self-reported habitual sleep duration was measured by the question: *How many hours do you sleep on average per night during weekdays and Saturday/Sunday?* These were the possible answers: less than 5 hours, 5–6 hours, 7–8 hours, 9–10 hours, or more than 10 hours. Four sleep duration categories were built for the analysis: No curtailed sleep (i.e. sleep duration more than 7 h on both working days and weekend days); curtailed sleep on weekend days (i.e. <7–8 h/night on weekend days, >7–8 h/night on working days); curtailed sleep on working days (i.e. <7–8 h/night on working days, >7–8 h/night on weekend days); and curtailed sleep on both working and weekend days (i.e. <7–8 h/night on working days, <7–8 h/night on weekend days). In the present study, the proportion of adolescents who slept at least 9 h per night on working days – as it has earlier been recommended by the US Sleep Foundation for children in the age between 12 and 17 years [17] – was relatively low (~8%). Thus, in the present study, sleep duration of 7–8 h per night was used as cut-off-point. Importantly, questions related to sleep duration were only answered by adolescents who attended school grade 9 and 2nd year of upper secondary school in 2011 ($n = 4736$).

2.3. Assessment of academic failure at school

Academic failure was measured by one question: *Have you failed any subject during the school year?* Possible answers were as follows: no, 1–2 subjects, 3–4 subjects, ≥5 subjects. Based on the answers, two categories were formed: failed no subject at school during the school year vs. failed at least one subject at school during the school year. Importantly, no data were lost when converting the 4-point-Likert-scale into a dichotomous variable.

2.4. Assessment of internet use at night

Self-reported internet use at night was measured by one question: *Are you usually active in the internet at night?* Possible answers were either yes or no.

2.5. Assessment of covariates

Parents' ethnic identity was defined as Swedish, mixed, or foreign (ternary). Family household structure was defined as follows: Living in a household with both parents vs. Single-adult household/other household structure (dichotomized). Parents' employment status was measured by the question: *What does your father/mother do for work?* The responses were dichotomized, i.e., *at least*

Table 1
Descriptive statistics of students (split by gender) from the *Life and Health Young Study (Uppsala County, Sweden)* who were available to examine the association of self-reported sleep disturbance and duration with academic failure.

Variable		Boys	Girls	*P*-value[a]
N (% group)		9963 (49.8)	10,063 (50.2)	
Age, years (SD)		15.9 (1.5)	15.9 (1.5)	0.41
Grade, *n* (% group)	Grade 7 (mean age = 13 years)	1516 (15.2)	1490 (14.8)	0.59
	Grade 9 (mean age = 15 years)	4448 (44.6)	4473 (44.4)	
	2nd year of upper secondary school (mean age = 17 years)	3999 (40.1)	4100 (40.7)	
BMI, kg/m^2 (SD)		21.74 (3.78)	20.76 (3.39)	0.000
Parents ethnic identity, *n* (% group)	Swedish	7714 (77.4)	7702 (76.5)	0.33
	Mixed	1126 (11.3)	1183 (11.8)	
	Foreign	1123 (11.3)	1178 (11.7)	
Parent's employment, *n* (% group)	At least one parent is employed	9645 (96.8)	9698 (96.4)	0.09
	Unemployed/students/on sick leave/on disability pension/on parental leave/other	318 (3.2)	365 (3.6)	
Household structure, *n* (% group)	Living with both parents	6592 (66.2)	6494 (64.5)	0.015
	Another family structure	3371 (33.8)	3569 (35.5)	
School location, *n* (% group)	Urban	6068 (60.9)	6402 (63.6)	0.000
	Rural	3895 (39.1)	3661 (36.4)	
Academic failure (% group)	Failed one or more subjects	2801 (28.1)	2162 (21.5)	0.000
	Passed all subjects	7162 (71.9)	7901 (78.5)	
Sleep duration on working days, $n = 4736$ (% group)	≥7–8 h/night	1722 (72.7)	1606 (67.8)	0.000
	<7–8 h/night	647 (27.3)	761 (32.2)	
Sleep duration on weekend days, $n = 4736$ (% group)	≥7–8 h/night	2065 (87.2)	2086 (88.1)	0.32
	<7–8 h/night	304 (12.8)	281 (11.9)	

[a] Chi-square tests or *t*-test. A detailed description of all variables can be found in the methods section.

one parent was employed vs. *unemployed/students/on sick leave/on disability pension/on parental leave/other*. School location was defined either as urban or rural. BMI was calculated as body weight (kg) divided by squared height (m^2) and used as a continuous variable.

2.6. Statistical analysis

The statistical software package for social science (SPSS, version 19.0.0; SPSS, Chicago, IL, USA) was used for statistical testing. Student's two-independent-sample *t* test and Chi-square test were used to compare groups (e.g. girls vs. boys). A binary logistic regression analysis was utilized to examine the association of academic failure (outcome variable) with sleep disturbance and duration (exposure variables). In light of previous findings where the adverse impact of chronic short sleep on school performance was more pronounced in girls than in boys [9], particular attention was paid to gender in the analysis. All results deriving from binary logistic regression were adjusted for adolescents' age, parents' ethnic identity, family household structure, parents' employment status, adolescents' BMI, and school location. For all the statistics, a *P*-value smaller than 0.05 was considered as significant.

3. Results

3.1. Descriptive

Cohort characteristics, stratified by gender, are shown in Table 1. Academic failure was more prevalent among boys compared with girls ($\chi^2 = 118.03$, d$f = 1$, $P < 0.001$). The proportion of self-reported sleep disturbances was 27%. In general, the relative number of sleep disturbances was higher in girls, and increased by ascending grade ($P < 0.001$ for analyses; Fig. 2A). On working but not weekend days, girls reported more frequently to sleep less than 7–8 h per night than boys (32% vs. 27%, $\chi^2 = 13.27$, d$f = 1$, $P < 0.001$) (Table 1). Proportions of students in each sleep duration category, split by gender, are shown in Fig. 2B.

3.2. Self-reported sleep disturbance and short sleep duration increase the risk for academic failure at school

Adolescents' age, parents' ethnic identity, family household structure, parents' employment status, adolescents' BMI, and school location were significant independent correlates of academic failure ($P \leq 0.001$ for all covariates).

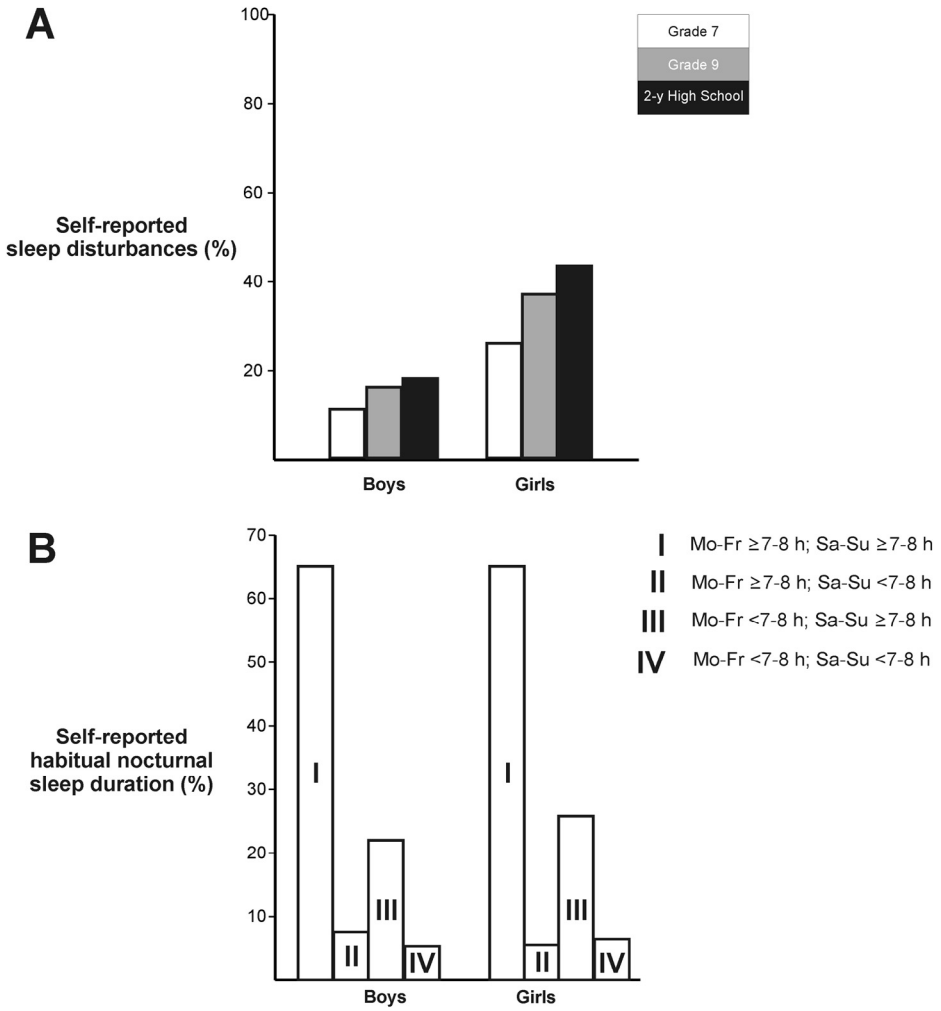

Fig. 2. (A) Proportion of students from the *Swedish Life and Health Young Study (Uppsala County)* who reported sleep disturbances, split by gender and grade. (B) Proportion of students in each sleep duration category, split by gender (I = no curtailed sleep at all, II = curtailed sleep on weekend days, III = curtailed sleep on working days, IV = curtailed sleep on both working and weekend days). Note that data on sleep duration were only collected at grade 9 and 2nd year of upper secondary school.

Multivariate binary logistic regression demonstrated that adolescents with reports of sleep disturbances had an approximately twofold higher relative risk to fail at least one subject during the school year. Although in the same direction, the strength of this association slightly differed between gender ($P = 0.020$ for the interaction term *Gender*Sleep disturbance*, Table 2). School grade did not influence the observed associations.

Multivariate binary logistic regression demonstrated that self-reported short sleep duration increased the risk to fail one or more subjects during the school year, with highest odds for adolescents who reported to sleep less than 7–8 h on both working and weekend days (Table 2). No significant interaction of sleep duration with gender or grade was found. Importantly, when using 9 h per night as cut-off-point for sleep duration – as it has earlier been recommended by the US Sleep Foundation [17] – no significant association was found between sleep duration and academic success ($P \geq 0.05$ for all odds ratios).

3.3. *Internet use at night is more prevalent among adolescents with reports of sleep disturbance and short sleep duration*

As demonstrated by Chi-square testing, adolescents with reports of sleep disturbances were more active in the internet at night, compared to those without self-reported sleep disturbances ($\chi^2 = 42.5$, d$f = 1$, $P < 0.001$, Fig. 3, left panel). Similar observations were made on both weekdays and weekend days when the Internet use of adolescents who slept less than 7 h per night was compared with that of adolescents who slept at least 7 h per night ($\chi^2 = 241.2$, d$f = 1$, $P < 0.001$ and $\chi^2 = 95.1$, d$f = 1$, $P < 0.001$ respectively; Fig. 3, middle and right panels).

4. Discussion

We hypothesized that both reports of sleep disturbances and short sleep duration (defined as <7–8 h sleep per night in the present study) would increase the risk for academic failure at school in adolescents. Supporting our assumption, our main logistic regression analysis demonstrated that both subjective sleep measures were linked to an increased risk for academic failure at school. These associations were independent of school grade. The analysis also revealed that girls who reported sleep disturbances had a greater relative risk to fail one or more subjects during the school year than boys with self-reported sleep disturbances. One explanation for the observed gender difference in our study could be that skills that are relevant to perform well at school – e.g. consolidation of facts and events and gain of insight – are more affected by sleep disturbances in girls compared to boys. Another explanation could be that boys, compared to girls, are less complaining about sleep disturbances because of their social roles, which may have weakened the observed association in boys. Thus, studies where sleep is measured more objectively (e.g. by means of a sleep EEG) are needed to ascertain further the role of gender for the association between reports of sleep disturbances and academic failure in adolescents. Nevertheless, in light of previous studies that have shown that sleep plays an important role in cognitive capabilities in children [18,19], our results suggest that sleep may play an important role for adolescents' performance in school.

Another important finding of our study is that ~30% of the adolescents reported sleep problems (i.e. either sleep disturbances or short sleep duration). Similar observations have been made in other adolescent cohorts [1–3], indicating that sleep problems among adolescents have reached an epidemic level in our modern societies. One common behavior among adolescents that may compromise their regular good night's sleep is the use of the Internet in periods when adolescents should sleep, i.e. during the night.Supporting this view, we demonstrate that adolescents with

Table 2
Association of self-reported sleep disturbance and short sleep duration with academic failure.

Exposure variable: Self-reported sleep disturbance ($n = 20,026$)								
	Boys ($n = 9963$)				Girls ($n = 10,063$)			
Sleep condition	Passed all subjects, *n* (% group)	Failed 1 subject or more, *n* (% group)	OR (95% CI)	*P*-value	Passed all subjects, *n* (% group)	Failed 1 subject or more, *n* (% group)	OR (95% CI)	*P*-value
No sleep disturbance	6184 (86.3)	2151 (76.8)	1		5219 (66.1)	1002 (46.3)	1	
Sleep disturbance	978 (13.7)	650 (23.2)	1.681 (1.500–1.885)	0.000	2682 (33.9)	1160 (53.7)	2.047 (1.855–2.260)	0.000
Exposure variable: Self-reported sleep duration ($n = 4736$)								
	Boys ($n = 2369$)				Girls ($n = 2367$)			
Normal sleep (at least 7–8 h/night on both working and weekend days)	1214 (71)	330 (50.2)	1		1266 (67.6)	210 (42.5)	1	
Short sleep (i.e. <7–8 h/night) on weekend days	113 (6.6)	65 (9.9)	2.183 (1.554–3.065)	0.000	97 (5.2)	33 (6.7)	1.785 (1.155–2.759)	0.009
Short sleep on working days	328 (19.2)	193 (29.3)	1.819 (1.454–2.275)	0.000	432 (23.1)	178 (36)	2.359 (1.865–2.982)	0.000
Short sleep on both working and weekend days	56 (3.3)	70 (10.6)	4.143 (2.822–6.083)	0.000	78 (4.2)	73 (14.8)	5.030 (3.504–7.223)	0.000

Results derive from binary logistic regression (outcome variable: academic failure, defined as failure to pass at least one subject during the school year). All analyses were controlled for adolescent's age, parents' ethnic identity, family household structure, parents' employment status, adolescent's BMI, and school location (urban or rural). A detailed description of all variables can be found in the Methods section.

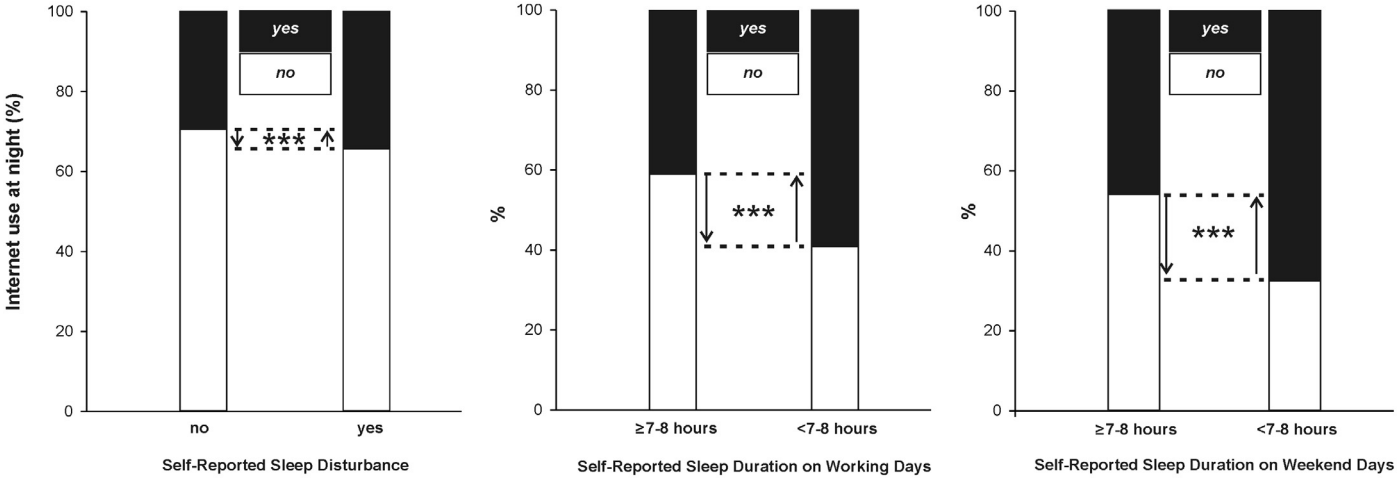

Fig. 3. Internet use at night among adolescents with or without reports of sleep disturbance (left panel, $n = 19{,}502$) and short sleep duration (middle and right panel, $n = 4674$). $^{***}P < 0.001$ (based on Chi-square testing).

either reports of sleep disturbances or short sleep duration were more active in the Internet at night. In addition to its time-consuming effect that may shorten available sleep time, the exposure to electronic devices to access the Internet (e.g. tablet, smartphone, and LED-screens) near to sleep onset may also cause sleep problems, as they can emit blue light, which has been shown to suppress the release of the sleep-promoting hormone melatonin [20].

4.1. Comparison with the literature

In the present study, both reports of sleep disturbances and short sleep duration were linked to academic failure at school in adolescents, with greater odds ratios for sleep duration. Our findings based on a large community-dwelling adolescent cohort add to the growing body of literature linking sleep with academic performance in adolescents [3,5,7–9]. However, in contrast to our results, previous studies have shown that poor sleep quality rather than short sleep duration increases the risk of adolescents for academic failure at school [1,10]. Possible reasons for those discrepancies between our study and others may be explained by differences in the sample size, gender distribution, utilized covariates, and how academic performance and sleep problems were defined.

4.2. Potential mechanisms

Our observational study is limited as we cannot yet establish causality. However, there are several potential mechanisms that may explain the association between poor sleep patterns and the risk to perform worse at school. A regular good night's sleep benefits skills that may help children to perform well in school. For instance, it has been shown that nocturnal sleep promotes the formation of long-term memory, particularly that of future relevance [21]. In addition, it has been demonstrated that sleep facilitates extraction of explicit knowledge and insightful behavior [22]. Finally, when sleep is inadequate, children exhibit deficits in attention, a lack of concentration, reduced cognitive functioning, and signs of reduced capacity to cope with emotional stress [1,4–6]. At this point, it is important to note that the observed association could be bidirectional, ie, it could also be that poor academic performance may lead to sleep problems, eg, by emotional stress.

4.3. Strengths and limitations

The major strength of our study is its sample size. Moreover, we control for confounding variables that are known to influence adolescents' sleep (as reviewed in Ref. 4), eg, BMI. However, there are also several limitations that apply to our study findings. Both sleep disturbance and duration were based on adolescents' reports. Another limitation of our study is that we used sleep duration of 7–8 h per night as cut-off to stratify students' sleep duration into sufficient and short sleep duration. That said, it must be borne in mind that the association between habitual sleep duration and academic failure at school may differ in its strength, or even fail to reach significance – when using another cut-off-point for sleep duration (eg, 9–10 h per night). In the present study, adolescents' failure to pass one or more subjects during the school year was defined as academic failure. There are, however, no data on whether adolescents had to repeat the school year or not. Furthermore, we have no data to specify in which school subject they failed (eg, math vs. physical education). Therefore the reader should be cautious in the interpretation of our results. Finally, confound by factors (eg, pubertal status) not considered in the analysis of the present study cannot be excluded.

4.4. Conclusion

Our findings indicate that reports of sleep disturbance and short sleep duration are linked to academic failure in adolescents. This could suggest that screening for sleep habits among adolescent students may represent a useful tool to identify a significant proportion of children who are at an increased risk to perform worse in school. On the other hand, it may indicate that those who perform poorly in school are at an increased risk to develop sleep problems.

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2014.09.004.

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References

[1] Dewald JF, Meijer AM, Oort FJ, Kerkhof GA, Bogels SM. The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: a meta-analytic review. Sleep Med Rev 2010;14:179–89.
[2] Sivertsen B, Harvey AG, Lundervold AJ, Hysing M. Sleep problems and depression in adolescence: results from a large population-based study of Norwegian adolescents aged 16–18 years. Eur Child Adolesc Psychiatry 2014;23:681–9.
[3] Li S, Arguelles L, Jiang F, Chen W, Jin X, Yan C, et al. Sleep, school performance, and a school-based intervention among school-aged children: a sleep series study in China. PLoS ONE 2013;8:e67928.
[4] Curcio G, Ferrara M, De Gennaro L. Sleep loss, learning capacity and academic performance. Sleep Med Rev 2006;10:323–37.
[5] Vriend JL, Davidson FD, Corkum PV, Rusak B, Chambers CT, McLaughlin EN. Manipulating sleep duration alters emotional functioning and cognitive performance in children. J Pediatr Psychol 2013;38:1058–69.
[6] Gruber R, Wiebe S, Montecalvo L, Brunetti B, Amsel R, Carrier J. Impact of sleep restriction on neurobehavioral functioning of children with attention deficit hyperactivity disorder. Sleep 2011;34:315–23.
[7] Pagel JF, Forister N, Kwiatkowki C. Adolescent sleep disturbance and school performance: the confounding variable of socioeconomics. J Clin Sleep Med 2007;3:19–23.
[8] Bruni O, Ferini-Strambi L, Russo PM, Antignani M, Innocenzi M, Ottaviano P, et al. Sleep disturbances and teacher ratings of school achievement and temperament in children. Sleep Med 2006;7:43–8.
[9] Meijer AM. Chronic sleep reduction, functioning at school and school achievement in preadolescents. J Sleep Res 2008;17:395–405.
[10] Lazaratou H, Dikeos DG, Anagnostopoulos DC, Sbokou O, Soldatos CR. Sleep problems in adolescence. A study of senior high school students in Greece. Eur Child Adolesc Psychiatry 2005;14:237–43.
[11] Eliasson A, King J, Gould B. Association of sleep and academic performance. Sleep Breath 2002;6:45–8.
[12] Loessl B, Valerius G, Kopasz M, Hornyak M, Riemann D, Voderholzer U. Are adolescents chronically sleep-deprived? An investigation of sleep habits of adolescents in the Southwest of Germany. Child Care Health Dev 2008;34:549–56.
[13] Thomee S, Harenstam A, Hagberg M. Computer use and stress, sleep disturbances, and symptoms of depression among young adults – a prospective cohort study. BMC Psychiatry 2012;12:176.
[14] Ononogbu S, Wallenius M, Punamaki RL, Saarni L, Lindholm H, Nygard CH. Association between information and communication technology usage and the quality of sleep among school-aged children during a school week. Sleep Disord 2014;2014:315808.
[15] Van den Bulck J. Television viewing, computer game playing, and Internet use and self-reported time to bed and time out of bed in secondary-school children. Sleep 2004;27:101–4.
[16] Statistics Sweden. Use of computers and the Internet by private persons in 2013 [In Swedish and parts in English], <http://www.scb.se>; 2013 [cited 2014.05.13].
[17] Matricciani LA, Olds TS, Blunden S, Rigney G, Williams MT. Never enough sleep: a brief history of sleep recommendations for children. Pediatrics 2012;129:548–56.
[18] Wilhelm I, Rose M, Imhof KI, Rasch B, Buchel C, Born J. The sleeping child outplays the adult's capacity to convert implicit into explicit knowledge. Nat Neurosci 2013;16:391–3.
[19] Wilhelm I, Diekelmann S, Born J. Sleep in children improves memory performance on declarative but not procedural tasks. Learn Mem 2008;15:373–7.
[20] West KE, Jablonski MR, Warfield B, Cecil KS, James M, Ayers MA, et al. Blue light from light-emitting diodes elicits a dose-dependent suppression of melatonin in humans. J Appl Physiol (1985) 2011;110:619–26.
[21] Wilhelm I, Diekelmann S, Molzow I, Ayoub A, Molle M, Born J. Sleep selectively enhances memory expected to be of future relevance. J Neurosci 2011;31:1563–9.
[22] Wagner U, Gais S, Haider H, Verleger R, Born J. Sleep inspires insight. Nature 2004;427:352–5.