

## Sleep in relation to psychiatric symptoms and perceived stress in Swedish adolescents aged 15 to 19 years

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### Abstract

**Background:** Sleep affects psychiatric health and perceived stress during adolescence.

**Objective:** The first aim of this study was to investigate the prevalence of poor sleep in a sample of Swedish adolescents aged 15 to 19 years. The second aim was to investigate correlations between: a) sleep and psychiatric symptoms and; b) sleep and perceived stress. The third aim was to examine possible sex differences in sleep.

**Method:** In 2011, a total of 185 Swedish adolescents (aged 15 to 19 years) from two upper secondary schools participated in this cross-sectional study. We used three different psychometric scales: Pittsburgh Sleep Quality Index (PSQI), Symptoms Checklist (SCL-90), and Perceived Stress Scale (PSS) to measure sleep, general psychiatric health and perceived stress.

**Results:** In total, 76% of the female students and 71% of the male students had poor overall sleep quality. A large majority, 93%, reported daytime dysfunction and 60% reported problems staying awake during daily activities. The correlation between sleep and general psychiatric health was 0.44 and the correlation between sleep quality and perceived stress was 0.48. Female students reported significantly more sleep disturbances than male students do.

**Conclusions:** Three out of four of the upper secondary school students presented with poor overall sleep that associated with psychiatric symptoms and perceived stress. These findings add to results from earlier studies and imply that interventions to improve sleep in adolescents, individually as well as on a societal level, should be considered as one way of trying to impact the observed rising numbers of psychiatric complaints. Such interventions may improve mental and somatic health in adolescents and prevent the development of psychiatric and stress-related symptoms. Further studies of possible methods, and their implementation, for improving sleep in adolescents should be of high priority.

**Keywords:** sleep; adolescence; stress

### Introduction

Good sleep is important for mental as well as somatic health in adolescents (1-6). In Sweden, studies have shown that people aged 16 to 24 years, especially females, have over time exhibited an increase in symptoms of anxiety, depression, and somatization (7, 8). Psychiatric disorders have, according to the World Health Organization (WHO), now become the second most common non-communicable health concern worldwide (cardiovascular disease being the leading concern) (9, 10). Furthermore, psychiatric disorders are soon expected to be the leading public health problem in Sweden according to the Swedish National Institute of Public Health (11).

Previous research has shown that adolescents with

depression exhibit significantly shorter sleep duration and poorer sleep quality than adolescents without depression (12). There is also a large overlap between insomnia and depression in both sexes in adolescence, and there is a bi-directional relationship between short sleep duration and development of anxiety and depressive symptoms in adolescents (13). A meta-analysis from 2011 showed high rates of sleep disturbances in adolescents worldwide (14). Parallel to the reported increases in anxiety, depressive symptoms, and somatization (7, 8), it has also been suggested that adolescent sleep deficit has increased over the past 20 years with an increase in sleep onset difficulties (15) and a decline in total sleeping time (16).

The American National Sleep Foundation recently recommended 8 to 10 hr of sleep per night for teenagers (14 to 17 years of age) (17) to allow for more individual needs, although, 9 to 10 hr of sleep per night was earlier considered needed for optimal functioning (18, 19). Previous studies focussing on sleep duration showed diverging results; 24 to 73% of adolescents were reported to sleep less than 7 hr per night on weekdays (20). Perhaps not very surprisingly, those with shorter sleep duration tended to have higher rates of daytime sleepiness (14). When analysing sex differences, girls generally had a longer sleep duration than boys (21) on weekdays, weekends, and during vacation (6).

Although sleep plays an important role in mental health, there are still very few studies using validated questionnaires to examine the prevalence of poor sleep among Swedish adolescents. Most previous studies, including those on a large-scale basis that report high rates of sleep disturbance in adolescents, are based on single questions, e.g. those only assessing “time in bed”. This is, however, only one aspect of sleep, not taking other important aspects into account, such as total sleep duration, difficulties falling asleep, daytime sleepiness, or the impact of sleep on general functioning (14).

The first aim of this study was to investigate the prevalence of poor sleep in a sample of Swedish adolescents aged 15 to 19 years. The second aim was to investigate the correlations between sleep and psychiatric symptoms, and sleep and perceived stress, in both sexes. The third aim was to examine possible sex differences in sleep.

## Material and methods

### *Population*

This study is part of a larger project that aims to evaluate stress and psychiatric symptoms among adolescents. When choosing the study population, we opted for two schools that differ in terms of academic performance and urbanicity in order to obtain a broader sample. Gymnasieskolan Spyken in Lund is a large upper secondary school with educational programmes intended to prepare students for university studies. It is situated in the city of Lund that is a part of the Metropolitan Malmö region (662,941 inhabitants in 2011). Spyken has high academic performance. The second school, Bergska skolan is located in the town of Finspång, and has an average academic performance. Bergska skolan is the only upper secondary school in Finspång with national education programmes. Finspång is a small town (20,747 inhabitants in 2010) with heavy industry located in a rural area (22). An invitation to participate was sent by letter to all Swedish-speaking students aged 15 to 19 years.

### *Questionnaires and computer programmes*

We used the Pittsburgh Sleep Quality Index (PSQI) (23) to measure sleep. The widely used index consists of seven subscales: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medication, and daytime dysfunction. The score has a cut-off level for poor sleep of more than five points (23). This cut-off level has been widely used in clinical use as well as in research studies (24) (25-27). It was created by evaluating clinical and clinimetric properties over an 18-month period in healthy controls and in patients with depression and/or sleep-disorders in order to differentiate “poor” sleepers from “good” sleepers. A global PSQI score > 5 provided a sensitivity of 89.6% and a specificity of 86.5% in differentiating “poor” from “good” sleepers (28). The PSQI also has a good test–retest reliability and validity (29).

To evaluate psychiatric symptoms, we used the symptoms checklist 90, SCL-90 (30). It is based on 90 items where each item is given a score on a five-point Likert scale to assess overall psychiatric health. The SCL-90 has been used in many countries, including Sweden (31). It includes an overall Global Severity Index (GSI) consisting of nine subscales: Somatization, Obsessive compulsivity, Interpersonal sensitivity, Depression, Anxiety, Hostility, Phobic anxiety, Paranoid ideation, and Psychoticism. The SCL-90 is commonly used in psychiatric health evaluations and has high reliability and validity (30).

Perceived stress was measured with the widely used 14-item Perceived Stress Scale (PSS-14), constructed as a five-point Likert scale. The PSS has adequate test–retest reliability (32) and validity in adolescents (33).

The questionnaires were web-based and the students were allowed 10 consecutive days to provide their responses into the internet-based survey programme Inquisite Survey System (Inquisite Inc., Copenhagen, Denmark). Only one response per student and item was possible. Data were stored in a non-identifiable form to preserve anonymity.

### *Statistics*

All statistical analyses were conducted in Stata IC 12.1 (Stata Corp, Texas, USA). We used the Student’s *t*-test to determine the potential difference from a cut-off of 5 for the PSQI. A  $\chi^2$  test was used for comparing the proportion of female and male students with a PSQI score above 5 as well as the proportion of students getting less than 8 hr of sleep or having problems staying awake. To calculate correlations between sleep and perceived stress and sleep and psychiatric symptoms, we used Spearman’s rank correlation coefficient as the data were non-parametric.

## Results

A total of 283 students agreed to participate and gave written informed consent. Of the 283 students who agreed to participate in the study, 185 students responded to all the questions in the PSQI. As the total PSQI score only can be calculated if no response is missing, the response rate was 65%. Of these 185 students, which were equally distributed in the two participating schools, 130 were female and 45 were male. Ten students did not report their sex. The students represented 14% of the total number of students at Spyken and 12% of the total number of students at Bergska. With the exception of four students, all participants came from programmes intended to prepare the students for university studies. The mean age was 16.9 and the median age was 17 years (range: 15 to 19 years, data not shown in tables).

Table 1 shows the results from the overall PSQI scale for the 185 students who responded to all the questions in the PSQI scale. The mean score in both sexes was 6.70 (females: 6.72; males: 6.31), all significantly higher than the cut-off level of 5, indicating poor sleep. No significant sex difference was observed. In total, 140 students (76%) had a score over 5, i.e. the cut-off level for poor sleep. Figure 1 shows the distribution of the results from the overall PSQI scale by gender.

Table 2 shows the results from the single items "Minutes of sleep per night", included in the subscale Sleep duration, and "Problems staying awake" (last month), included in the subscale Daytime dysfunction. The rationale for presenting the results from the specific items is that previous research has had a main focus on these items. The "n" varied slightly as the response rate varied between the different items and subscales. The mean sleep duration was 495 min (8 hr 15 min) per night for the

female students and 483 min (8 hr 3 min) per night for the male students. The difference of 12 min in mean Sleep duration between females and males was not significant. In total, 25% of the female students and 35% of the male students slept for less than the lowest recommended sleep duration of 8 hr/night. The single item "Problems staying awake" during activities (such as school) at least once during the past month was reported by 60% of the students (200/79/200). "Problems staying awake" during activities at least once a week was reported by 28% (56/200) of the students. There were no significant sex differences in "Problems staying awake" during activities at least once a week.

Table 3 shows the correlations between overall sleep quality (PSQI) and psychiatric symptoms (GSI) as well as perceived stress (PSS), by sex. There were moderate correlations between overall sleep (PSQI) and psychiatric symptoms (GSI) ( $\rho = 0.44$ ) as well as between overall sleep quality and perceived stress (PSS) ( $\rho = 0.48$ ). The highest correlation ( $\rho = 0.60$ ) was observed between overall sleep (PSQI) and perceived stress in male students.

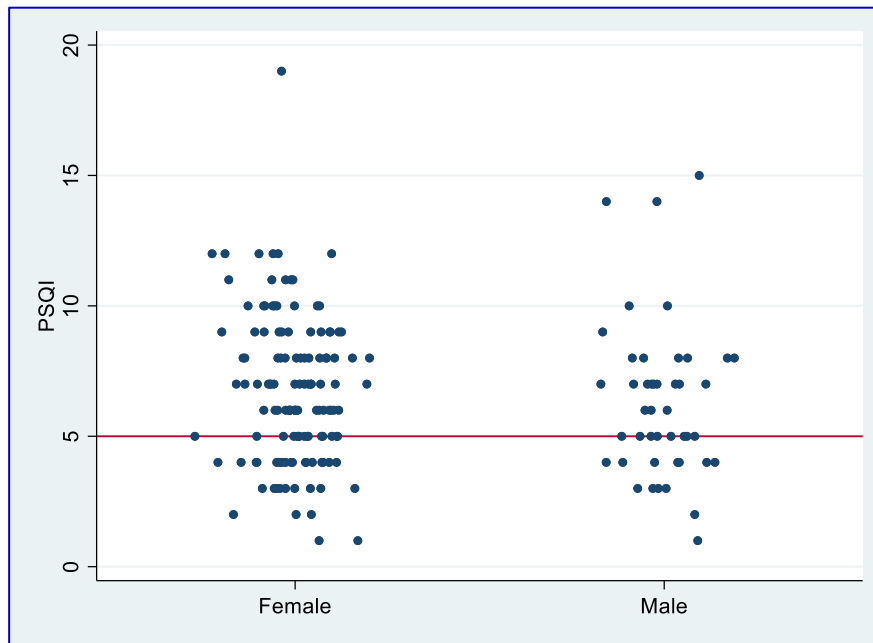
Table 4 shows the results for the seven subscales from the PSQI, each with a possible range of 0 to 3. The only significant sex difference was found for the subscale Sleep disturbance. Females had more sleep disturbances than males ( $p = 0.002$ ). In total, 13 students (6.5%) used sleeping medication.

Table 5 shows the 10 different items in the subscale Sleep disturbance for females and males. The female students had significantly higher scores than male students on the following six items: "Nightly waking", "Toilet visits", "Feeling cold", "Feeling hot", "Unpleasant dreams", and "Ache". No sex differences were found for the items "No sleep in 30 min", "Breathing difficulties", "Snoring/coughing" or "Other".

**TABLE 1.** The results of Pittsburgh Sleep Quality Index (PSQI) in 185 Swedish adolescents by sex

PSQI	Total <sup>a</sup>	Female <sup>b</sup>	Male <sup>b</sup>	Missing data on sex	<i>p</i> -value between sexes
n	185	130	45	10	
Mean score CI 95%	6.70 (6.30-7.20)	6.72 (6.23-7.21)	6.31 (5.41-7.21)		<i>p</i> = 0.20
<i>n</i> > score 5	140	99	32		<i>p</i> = 0.50
% > score 5	76%	76%	71%		
<i>p</i> -value mean score > score 5	<b><i>p</i> &lt; 0.0001</b>	<b><i>p</i> &lt; 0.0001</b>	<b><i>p</i> = 0.0026</b>		

Note. <sup>a</sup>The total PSQI can only be calculated if the answers are complete and no answer is missing; <sup>b</sup>all participants did not share their data on gender and/or school. Significant *p*-values in **bold**



**FIGURE 1.** Distribution of PSQI global scores for female and male students. The horizontal line indicates the cut-off score of 5

**TABLE 2.** The results from the single items “Minutes of sleep per night”, part of the subscale Sleep duration, and “Problems staying awake last month”, part of the subscale Daytime dysfunction, divided by sex

		Total	Female	Male	Missing data on sex	p-value between sexes
Minutes of sleep per night	mean (CI 95%)	492 (484-500)	495 (485-505)	483 (467-498)		0.11
	SD	57.4	59.2	54.5		
	range	330-810	330-810	385-615		
	n	198	139	49	10	
	n < 8h	54	35	17	2	0.2
	% < 8h	27%	25%	35%		
Problems staying awake	n never	79	55	22	2	
	n less than 1 time/week	65	46	15	4	
	n 1 to 2 times/week	38	26	9	3	
	n 3 or more times/week	18	14	3	1	
	n > 1 to 2 times/week	56	40	12	4	0.6
	n total	200	141	49	10	
	% > 1 to 2 times/week	28%	28.4%	24.5%		

**TABLE 3.** Spearman correlations between overall sleep quality (Pittsburgh Sleep Quality Index [PSQI]) and general mental health (Global Severity Index from Symptoms Checklist 90 [GSI]) as well as perceived stress (Perceived Stress Scale [PSS]), by sex

Scales	All			Female			Male		
	$\rho$	n	p-value	$\rho$	n	p-value	$\rho$	n	p-value
PSQI–GSI	0.4393	179	< <b>0.0001</b>	0.4137	129	< <b>0.0001</b>	0.4375	44	<b>0.0030</b>
PSQI–PSS	0.4802	166	< <b>0.0001</b>	0.4437	122	< <b>0.0001</b>	0.6032	40	< <b>0.0001</b>

Note. Significant p-values in bold

**TABLE 4.** The results of the subscales from the Pittsburgh Sleep Quality Index in Swedish adolescents by sex

Subscales of PSQI		Total	Female	Male	Missing data on sex	<i>p</i> -value between sexes
Sleep quality	mean	1.27	1.28	1.18		<i>p</i> = 0.20
	CI 95%	(1.17-1.37)	(1.17-1.40)	(0.96-1.41)		
	<i>n</i>	200	141	49	10	
Sleep latency	mean	1.5	1.53	1.37		<i>p</i> = 0.17
	CI 95%	(1.35-1.65)	(1.35-1.71)	(1.10-1.63)		
	<i>n</i>	200	141	49	10	
Sleep duration	mean	0.82	0.8	0.82		<i>p</i> = 0.55
	CI 95%	(0.72-0.92)	(0.68-0.92)	(0.59-1.04)		
	<i>n</i>	202	141	49	12	
Habitual sleep efficiency	mean	0.39	0.36	0.42		<i>p</i> = 0.68
	CI 95%	(0.28-0.49)	(0.24-0.48)	(0.2-0.63)		
	<i>n</i>	199	139	48	12	
Sleep disturbance	mean	1.08	1.14	0.91		<b><i>p</i> = 0.0020</b>
	CI 95%	(1.01-1.15)	(1.06-1.22)	(0.79-1.04)		
	<i>n</i>	188	132	46	10	
Use of sleeping medication	mean	0.11	0.09	0.1		<i>p</i> = 0.55
	CI 95%	(0.05-0.18)	(0.02-0.16)	(-0.02-0.22)		
	<i>n</i>	200	141	49	10	
	<i>n</i> using	13	8	3	2	
Daytime dysfunction	mean	1.54	1.54	1.43		<i>p</i> = 0.19
	CI 95%	(1.43-1.64)	(1.41-1.66)	(1.21-1.65)		
	<i>n</i>	200	141	49	10	
	<i>n</i> affected	187	133	44		
	% affected	93.5%	94.3%	89.8%		

Note. Significant *p*-values in bold

**TABLE 5.** The items in the subscale Sleep disturbance from Pittsburgh Sleep Quality Index (PSQI) by sex

Item from PSQI Subscale		Female	Male	<i>p</i> -value between sexes
Sleep Disturbance	mean			
	CI 95 %			
	<i>n</i>			
No sleep in 30 min	mean	1.47	1.27	0.143
	CI 95 %	(1.27-1.66)	(0.97-1.56)	
	<i>n</i>	141	49	
Nightly waking	<i>n</i>	141	49	
	mean	1.10	0.53	<b>0.0003</b>
	CI 95 %	(0.93-1.27)	(0.3-0.76)	
Toilet visits	mean	0.65	0.41	<b>0.0491</b>
	CI 95 %	(0.50-0.81)	(0.2-0.62)	
	<i>n</i>	141	49	
Breathing difficulties	mean	0.2	0.22	0.6116
	CI 95 %	(0.11-0.28)	(0.03-0.42)	
	<i>n</i>	141	49	
Snoring/coughing	mean	0.25	0.14	0.1394
	CI 95 %	(0.15-0.35)	(-0.01-0.3)	
	<i>n</i>	141	49	
Feeling cold	mean	1.0	0.5	<b>0.0006</b>
	CI 95 %	(0.88-1.23)	(0.28-0.74)	
	<i>n</i>	140	49	
Feeling hot	<i>n</i>	139	48	
	mean	0.93	0.63	<b>0.0297</b>
	CI 95 %	(0.76-1.09)	(0.38-0.87)	
Unpleasant dreams	mean	0.81	0.23	<b>&lt;0.001</b>
	CI 95 %	(0.66-0.97)	(0.08-0.38)	
	<i>n</i>	139	48	
Ache	mean	0.33	0.1	<b>0.0241</b>
	CI 95 %	(0.21-0.45)	(0.01-0.23)	
	<i>n</i>	139	49	
Other	mean	0.59	0.5	0.2781
	CI 95 %	(0.44-0.75)	(0.21-0.79)	
	<i>n</i>	138	48	

Note. Significant *p*-values in bold

## Discussion

The main findings of the present study were that 76% of the female students and 71% of the male students participating in the study had a PSQI score of more than 5. Significant correlations were found between overall sleep quality and psychiatric symptoms (GSI,  $\rho = 0.44$ ) as well as between overall sleep quality and perceived stress (PSS,  $\rho = 0.48$ ). The only statistically significant difference between the sexes was found in one of the seven subscales in the PSQI scale, i.e. the subscale Sleep disturbance, where the female students had significantly higher scores than the male students in 6 of the 10 components.

There is still a shortage of studies on sleep using detailed and validated questionnaires in Swedish adolescents. Our findings that three out of four Swedish adolescents reported poor sleep adds to previous research based only on a single or a few questions (14, 34, 35) by supporting that poor sleep amongst adolescents is also common when using a well-validated scale.

The mean sleep duration per night was 8 hr 12 min, thus within the interval of the current recommendations of 8 to 10 hr/night (17) albeit in the lower end. A total of 25% of the female students and 35% of the male students slept for less than the lowest recommended duration of 8 hr/night. These findings correspond well with earlier studies. In the Healthy Lifestyle in Europe by Nutrition in Adolescence Study, with a sample of 3,311 European adolescents, the mean total sleep duration was 8 hr per night (36). In the Swedish Life Health and Young Study (data collected between 2005 and 2011 in Uppsala,  $n = 4,736$ ), 32.2% of girls and 27.3% of boys reported sleeping less than 7 to 8 hr per night on school days (35).

In the present study, the subscale Daytime dysfunction had the highest scores for both female and male students, with 94.3% of the female students and 89.8% of the male students reporting daytime dysfunction.

There were significant correlations between overall sleep quality and psychiatric symptoms as well as between overall sleep quality and perceived stress. In adults, stress is considered to be a very important cause of primary insomnia (37) and the correlation between stress and poor sleep quality is well established in adults. Objective sleep recordings in adults show that stress is also associated with shortened sleep duration, sleep fragmentation, and reduction in deep sleep. Impaired sleep quality may also cause increased levels of stress-related biomarkers (e.g. cortisol) and increase the negative effects of stress (38). In adolescents, there are fewer studies on the correlation between increased stress and poor sleep quality (39). A recent study from Sweden showed that a sleep duration of less than 7

hr was associated with stress at home (younger adolescents) and stress at school (older adolescents) (20). Stress during school examination periods has been shown to reduce sleep duration and sleep quality, which negatively affects academic functioning and results (40).

Poor sleep quality, such as short sleep duration and/or increased sleep fragmentation, is associated with poor somatic and psychosocial health, low school performance, and risk-taking behaviour (41) and decreased cognitive functioning (42). Baudacco et al studied total sleep duration and concluded that adolescents who slept for less than 7 hr per night had more behavioural and emotional problems (20). A previous study of adolescents found that those who reported short sleep duration on school and weekend days, as well as sleep disturbances, were more likely to fail in at least one subject at school (35). Low academic performance has been associated with daytime sleepiness, overall poor sleep quality and short sleep duration (1) and poor sleep quality negatively affects learning, memory processes and academic achievement (43, 44).

The female students slept on average 12 min more than the male students did, although the difference was not significant ( $p = 0.11$ ). This is in accordance with earlier studies that have shown that girls sleep 11 min per night more than boys on school days and 29 min more on non-school days (6). Laberge et al noticed that girls spent more time in bed than boys in earlier adolescence (10 to 13 years), which they mainly attributed to the girls' earlier puberty (45). In exploratory analyses of pubertal development and insomnia, onset of menses was associated with a 2.75-fold increased risk for insomnia for girls. In contrast, maturational development was not associated with insomnia in boys (46). We found no differences between the sexes in the items "No sleep in 30 min", "Breathing difficulties", "Snoring/coughing", or "Other". However, despite longer sleep duration, the female students reported significantly more sleep disturbances than the male students do. The female students had significantly higher scores than male students on the following six items in the subscale Sleep disturbance: "Nightly awakening", "Toilet visits", "Feeling cold", "Feeling hot", "Unpleasant dreams", and "Ache" in our study. In the earlier mentioned Swedish study by Titova et al, the relative number of reported sleep disturbances was higher in girls and increased by ascending grade in school (35).

Various factors may contribute to overall sleep quality. Higher cognitive and emotional arousal around bedtime has consistently been associated with poor and borderline total sleep duration (47). Increased "screen time" and use of technological devices have been suggested to have an impact on

sleep quality and are related to shortened sleep duration, mainly due to later bedtimes (41). However, little-to-no negative causal effects of pre-bed technology on sleep quality have been observed in controlled laboratory experiments (47). A negative family environment has also been associated with poor sleep quality (47), and parenting style seems to be of importance. Adverse parenting styles, with restriction, reproach, and inconsistency, were highly correlated with low sleep quality, increased daytime sleepiness, and with negative mood as well as increased symptoms of anxiety and depression. This was observed as a general pattern, irrespective of whether the parenting style referred to mothers or fathers (48). Adolescents with parents expressing higher levels of support and commendation reported better mood, better concentration, and lower levels of daytime sleepiness (48). A meta-analytic review from 2015 states that computers, evening light, a negative family environment, caffeine, tobacco, and pre-sleep worry are negatively associated with measures of sleep quality, whereas physical activity, good sleep hygiene, and parent-set bedtimes were positively associated with sleep quality (47).

Early school start times have been suggested as a major contributing factor to short sleep duration during weekdays, sleep deprivation, and daytime sleepiness and this relationship seems to increase with higher age, i.e. from early to late adolescence (41). In a recent systematic review focussing on the effects of later school start times on adolescent sleep duration, total sleep duration increased from 25 to 77 min per night during weekdays when school start times were delayed 25 to 60 min. Some studies in that review also reported reduced daytime sleepiness, less problems staying awake, fewer depressive symptoms, and lower consumption of caffeine (49) in relation to later school start times.

Good sleep can be achieved by a variety of factors, such as physical activity, which is associated with earlier bedtimes, longer sleep duration, and possibly shorter sleep onset latency (47). Athletes report better sleep quality, shortened sleep onset latency, and fewer awakenings after sleep onset, as well as less tiredness and increased concentration during the day compared with controls. They also report significantly fewer anxiety and depressive symptoms (50), which highlights the bi-directional relationships between sleep quality and psychiatric symptoms. Since physical activity has been shown to affect circadian timing, adolescents should, however, be encouraged to limit physical activity in the evening, and instead try to shift their physical activity to the morning hours (51).

Good sleep hygiene can be beneficial in order to achieve quality sleep and includes factors related to the sleep environment, sleep stability, daytime sleep

and addressing cognitive, emotional and physiological arousal (47).

Since sleep quality plays such an essential role in mental and somatic health outcomes in adolescents (1-6), methods to improve sleep are highly important to prioritise in public health policies among adolescents in order to prevent the development of psychiatric and stress-related symptoms. For this purpose, multiple factors need to be considered. Supportive parents, who raise their children with support and commendation and create a more positive family environment is important. Physical activity should also be encouraged, particularly in the morning (47, 50, 51). Creating a window of time allowing the individual enough sleep duration, whether by parent-set earlier bedtimes (47), later school start times (41, 49) or other measures, is an option. Teaching methods to improve sleep habits also seem to be of vital importance (47). This includes addressing ruminating thoughts, which can be achieved by reducing arousal around bedtime and at night awakenings (47). Mindfulness-interventions can be used to cope with ruminating thoughts and have shown some potential to improve sleep quality in healthy students (52, 53) but need to be more closely evaluated in adolescents. There have been some promising results with interventions focussing on gradually prolonging sleep in combination with sleep hygiene advice that seem to have beneficial effects on sleep, self-reported sleep problems and depressive symptoms of adolescents with chronic sleep reduction (54).

### Limitations and strengths

The major limitation with the present study is whether the results from the 185 students that participated could be generalised to a broader population. It is possible that the high percentage reporting poor sleep and associated with general psychiatric symptoms and perceived stress depended on particular characteristics of the students that participated in the study (e.g. those who were more stressed and thus more motivated to take part in the study). Previous data have suggested that students from programmes intended to prepare students for university studies may have higher levels of perceived stress (55) and most of the students participating in our study were indeed in such programmes. However, there was no difference in results when comparing the two schools with different academic performance and urbanicity (22), and the 185 participating students still represents 12 to 14% of the total number of students; a figure high enough to be concerned about considering the possible consequences.

The higher proportion of female students might have affected the results, and a more even sex

distribution could possibly have allowed the sex difference of 12 min sleep duration to reach significance.

All instruments for measuring sleep, general psychiatric symptoms and perceived stress were based on self-report rather than objective measures. In addition, none of the instruments included data from parental report. However, a good correlation has been found between objective sleep recordings (polysomnography) and the self-reported sleep questionnaire PSQI (29). An Australian study also reported that the subjects overestimated, rather than underestimated, their total sleep duration by approximately 10% (56), which indicates that the use of self-reported questionnaires does at least not seem to overestimate the sleep problems in adolescents. Other limitations with the study include lack of clinical diagnoses on obstructive sleep apnoea, periodic limb movement or restless legs that may be affected by psychotropic medications used to treat concurrent psychiatric disorders. Although the PSQI scale includes symptoms of potential clinical diagnoses such as sleep apnoea and restless legs as well as symptoms that are related to psychiatric disorders (e.g. anxiety and depression), the PSQI does not differentiate between different diagnoses as possible causes behind poor sleep.

There is still a lack of studies conducted among Swedish adolescents 15 to 19 years of age using validated scales; this study serves as an important contribution to previous studies. Finally, when selecting the study population, we opted for two schools that differed in terms of socioeconomic status, academic proficiency profile, urbanicity, and geographic location with the aim of obtaining a sample as representative as possible. This has been requested in previous studies (22, 33, 57).

### Conclusion

Three out of four of the upper secondary school students participating in this study presented with poor overall sleep that associated with psychiatric symptoms and perceived stress.

### Clinical significance

These findings add to results from earlier studies and imply that interventions to improve sleep in adolescents, individually as well as on a societal level, should be considered as one way of trying to impact the observed rising numbers of psychiatric complaints. Such interventions may improve mental and somatic health in adolescents and prevent the development of psychiatric and stress-related symptoms. Further studies of possible methods, and their implementation, for improving sleep in adolescents should be of high priority.

### Ethical standards

We acquired the required permission for the study from the local ethics committee (Etikprövningsnämnden) in Lund (reference no. 2011/345). The complete study was registered at [www.clinicaltrials.gov](http://www.clinicaltrials.gov) (reference NCT01457222) before it was started. All participants gave written informed consent.

### Conflicts of interest

The authors declare no conflicts of interest.

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