Sleep-related factors: associations with poor attention and depressive symptoms

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Abstract

Background Sleep duration is known to be associated with depression and attention deficits in children, though the majority of studies have focused on adolescents. Attention problems and depressive symptoms related to sleep factors have not been studied simultaneously in the non-clinical child population before.

Methods Sleep quantity, adverse bedtime behaviour, daytime sleepiness, poor attention and symptoms of depression were assessed using self-report measures. The participants were 11 years old (n = 439).

Results Short sleep duration during the school week is related to poor attention and high depression. It is not a significant predictor of low attention and high depression symptoms in logistic regression analyses. Instead, adverse bedtime behaviour and daytime sleepiness predict them highly significantly.

Conclusions Short sleep duration is related to poor attention and depressive symptoms as suggested by previous work. However, the significant role of other sleep-related factors calls for further research.

Introduction

In general, sleep problems are of considerable significance to children’s well-being. One of the most studied issues in sleep research is the effect of sleep duration. Concern about school-aged children’s sleep deprivation has been raised in many countries (e.g. Tynjälä et al. 1993; Smaldone et al. 2007). Much less attention has been paid to other aspects of sleep.

Sleep loss is connected to several problems. It seems evident that it impairs the capacity to learn (Curcio et al. 2006; Gomez et al. 2011) and has a negative effect on academic performance (Fallone et al. 2005; Taras & Potts-Datema 2005; Curcio et al. 2006; Dewald et al. 2010). Several studies have suggested that short sleep duration is related to attention problems (e.g. Dahl 1996; Paavonen et al. 2009) and depression (Wolfson & Carskadon 1998; Giannotti et al. 2002; Fredriksen et al. 2004; Gangwisch et al. 2010). Many of these studies have focused on adolescents, and attention and depression have seldom been studied within the framework of the same research. The present article aims to fill the gap in the research of children’s sleep-related problems and co-occurring emotional and behavioural disturbances.

There is mounting evidence showing that children with ADHD (Attention Deficit Hyperactivity Disorder) have sleep problems (Cortese et al. 2009). There is also evidence suggesting that the symptoms of ADHD are related to sleep factors in children with no diagnosis of true ADHD (Aronen et al. 2000; Stein et al. 2001; Paavonen et al. 2009). For instance, Paavonen and colleagues (2009) observed that the group of healthy 7- to 8-year-old children who slept least (<7.7 h) scored higher on hyperactivity/impulsivity and total-ADHD measures than the other groups. There were no group differences in inattention.
Thus, the literature may suggest that children who sleep chronically short hours exhibit externalizing and hyperactive/impulsive behaviour.

Several studies (e.g. Liu et al. 2007; Ivanenko & Johnson 2008) on children with a major depression disorder have found that sleep disorders are also typical. Studies of children and adolescents with no diagnosis of depression have also suggested the co-occurrence of emotional and sleep problems (e.g. Wolfson & Carskadon 1998; Johnson et al. 2000; Giannotti et al. 2002; Fredriksen et al. 2004; Smaldone et al. 2007; Alfano et al. 2009). The specific relationship between short sleep duration and depression has mostly been studied in adolescents (Wolfson & Carskadon 1998; Giannotti et al. 2002). Perhaps the most influential investigation in the field is that of Gangwisch and colleagues (2010). They found in their large population-based study that when parents set adolescent bedtimes relatively early (10:00 pm or earlier), the participants gained more sleep than those participants who went to bed late (see also Short et al. 2011). The longer time asleep consequently led to a lowered level of depression and to diminished suicidal ideation. However, there is little research on the relationship between sleep quantity and depressive symptoms in children (see, however, Fredriksen et al. 2004). In addition to sleep duration, adverse bedtime behaviour (e.g. Owens et al. 2000a,b) and daytime sleepiness were investigated in the present study. Very little, if anything, is known about the role of bedtime behaviour in attention and depressive symptoms in non-clinical child populations.

Daytime sleepiness is evidently the result of an inadequate amount of sleep and/or poor sleep quality (e.g. Fava 2004; Gainsa et al. 2007; Short et al. 2011), but other issues, such as alcohol and irregular breakfasts, may also be related to the phenomenon in adolescents (Saarenpää-Heikkilä et al. 2001). Thus far, the evidence for suggesting that daytime sleepiness might be linked to children’s poor attention and symptoms of depression is scarce (see, however, Stein et al. 2001).

Attention problems and symptoms of depression may not be independent. Daviss (2008) states in his review that ADHD and a major depression disorder are often co-morbid in clinically diagnosed children. Daviss goes on to state that this co-morbidity ‘is not an artifact of rater biases, overlapping symptoms, or other methodological artifacts’ (p. 565). The close connection between self-reported poor attention and depression symptoms has even been demonstrated in the non-clinical child population (Muris et al. 2008).

In conclusion, this study aimed to explore the relationships among children’s sleep duration, bedtime behaviour, daytime sleepiness, attention and symptoms of depression. We also were interested in discovering how sleep-related factors predict a high level of depressive symptoms and poor attention.

Methods

Sample

The target group consisted of all 5th grade students (mean age 11.51 years, SD = 0.54) in a town of 44 500 inhabitants in southern Finland. Students in Swedish-speaking and special education classes (47 students) were excluded. The size of the target population was 481 students. Of these, 439 students (50.8% girls) completed the study.

Procedure

The educational authorities of the town gave permission for the study and delivered questionnaires to every public elementary school in the town. They also evaluated the ethical validity of the study. Parents were thoroughly informed about the study. Classroom teachers received training on how to collect in a 45-minute lesson in May 2010. They were instructed to answer the students’ questions when necessary. The participants were able to discontinue answering the questions if they so wished. The teachers also informed the participants that if question caused anxiety or worry in the child, he or she should talk about it with a parent, the teacher or the school nurse.

The children anonymously completed several inventories about sleep duration during the school week and weekend, bedtime behaviour, feelings of daytime sleepiness, depression and attention. The participants’ age and gender were recorded as background variables.

Instruments

Sleep duration during the school week was inquired about using four questions: ‘When did you go to sleep yesterday?’, ‘When did you wake up today?’, ‘When are you going to go to sleep today?’ and ‘When are you going to wake up tomorrow?’ The options for bedtime in the evening ranged in half-hour intervals from before half-past-eight (before 8:30 pm) to one o’clock or later (1:00 AM or later). The options for waking in the morning ranged in 15-minute intervals from before half-past-five (before 5:30 AM) to nine o’clock or later (9:00 AM or later). All the options were indicated both in words and numbers. These data were then used to calculate sleep durations for the previous and coming night. The two sleep duration figures were then
averaged to form an indication of sleep quantity during the school week. Indices for the internal consistency of all measures are given in Table 1.

Sleep duration at the weekend was assessed using two open-ended questions: 'When do you usually go to sleep on Friday and Saturday evenings?' and 'When do you usually wake up on Saturday and Sunday mornings?' From the answers, an estimation of the children’s weekend sleep duration was computed.

The Sleep Self-Report (Owens et al. 2000a) is a questionnaire including 26 retrospective sleep items from the past week of a child’s sleep. The options for each item are ‘usually’ (5–7 times a week, value 3), ‘sometimes’ (2–4 times a week, value 2) and ‘rarely’ (0–1 time a week, value 1). The questionnaire includes scales for bedtime behaviour (12 items), sleep behaviour (7 items), daytime sleepiness (4 items) and background variables (3 items). For the purposes of the present study, the scales for bedtime behaviour and daytime sleepiness were translated into Finnish and piloted on a group of fifth graders. Care was taken to retain the original content and readability of the items. Both scales were shortened to obtain the best possible internal consistency.

Adverse bedtime behaviour was investigated using six items: ‘Do you go to bed at the same time every night on school nights?’ (reverse-coded), ‘Do you fall asleep in about 20 min?’ (reverse-coded), ‘Do you fight with your parents about going to bed?, ’Is it hard for you to go to bed?, ’Are you ready for bed at your usual bedtime?’ (reverse-coded), and ‘Do you stay up late when your parents think you are asleep?’. An average over these six items was computed. A high average value indicated adverse bedtime behaviour.

Daytime sleepiness was assessed with the help of three questions: ‘Do you have trouble waking up in the morning?’, ‘Do you feel sleepy during the day?’ and ‘Do you feel rested after a night’s sleep?’ (reverse-coded). A high average over these items indicated high daytime sleepiness.

Attention

Raili Kukkonen (unpubl. obs.) developed a self-report measure of attention by adopting the technique pioneered by Klimkeit and colleagues (2006) where a child is presented with questions about himself or herself and after each question is shown a line marked with a scale of 0–10. At the positive end of the line there is a smiling face and at the negative end a frowning face. The participant is asked to mark a cross on that point of the line which best describes himself or herself (for details of the technique see Klimkeit et al. 2006, appendix). Kukkonen (unpubl. obs.) adapted some items from Klimkeit and colleagues (2006) and created several novel ones.

Based on the highest attainable internal consistency, 16 items from the measure of attention were used in this study. Four were drawn directly from Klimkeit and colleagues (2006): ‘Do you get into trouble at home?, ’Do you get into trouble at school?, ’Do you find it hard to concentrate?’ and ‘Do you find it hard to sit still?’ Some examples of the remaining questions are: ‘Do you give up easily when you are supposed to think things through?, ’Is it difficult to follow the rules at school?, ’Do you get bored in lessons when you should be listening?’ and ‘Do you often leave your work and tasks unfinished?’ The 16 items were averaged.

The students were split into two categories: the students in the lowest quartile (n = 111) in terms of their attention score were regarded as the Low-attention group whilst the other students (n = 323) were considered the High-attention group.

The Children’s Depression Inventory (CDI) is a very widely used, reliable and well-validated self-report measure of depressive symptoms in children aged 7 to 17 years (Kovacs 1985, Almqvist et al. 1991). Because two items of the CDI (‘I have trouble sleeping almost every night’ and ‘I am tired all the time’) probe tiredness and sleeping problems, they were dismissed from the results of the present study to avoid overlap. Hence, symptoms of depression were assessed with the help of only 25 CDI items. The average of these variables was used to indicate depression. The children were divided into two groups, so that roughly the highest scoring quartile on CDI-25 were labelled to the High-depression group (n = 99). The other three quartiles comprised the Low-depression group (n = 338). ‘High’ in this context is only used as to denote the highest quartile on the depression scale continuum.

Table 1. Descriptive statistics for sleep measures, attention and symptoms of depression

<table>
<thead>
<tr>
<th>Measure</th>
<th>Cronbach’s α</th>
<th>Skewness</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep duration/night during the school week</td>
<td>0.76</td>
<td>–0.64</td>
<td>9 h 5 min</td>
<td>52 min</td>
</tr>
<tr>
<td>Sleep duration/night at the weekend</td>
<td>NA</td>
<td>–0.38</td>
<td>10 h 18 min</td>
<td>1 h 22 min</td>
</tr>
<tr>
<td>Adverse bedtime behaviour (1–3)</td>
<td>0.68</td>
<td>0.90</td>
<td>1.46</td>
<td>0.37</td>
</tr>
<tr>
<td>Daytime sleepiness (1–3)</td>
<td>0.67</td>
<td>0.63</td>
<td>1.63</td>
<td>0.50</td>
</tr>
<tr>
<td>Attention (0–10)</td>
<td>0.92</td>
<td>–1.02</td>
<td>7.89</td>
<td>1.58</td>
</tr>
<tr>
<td>Depression (CDI-25, 0–2)</td>
<td>0.89</td>
<td>1.71</td>
<td>0.26</td>
<td>0.24</td>
</tr>
</tbody>
</table>

n = 431–439.
Results

Descriptive results of the main variables are given in Table 1. On average, the students slept 9 h 5 min during the school week. They reported that they slept 1 h 14 min longer nights at the weekend than during the school week ($Z = -14.78$, $P < 0.001$). The distributions of attention and CDI scores were not normal: the former was skewed to the left and the latter to the right. Thus, the majority of the children showed a high level of attention (median = 8.31, range 0–10) and a low level of depressive symptoms (median = 0.20, range 0–2).

Spearman correlations among the measures are given in Table 2. Somewhat surprisingly, daytime sleepiness was only very weakly related to sleep duration during the school week ($r_s = 0.12$, $P < 0.05$). Sleep durations during the school week and weekend correlated significantly, probably reflecting an individual need for sleep irrespective of the day. Long sleep duration during the school week was clearly associated with positive bedtime behaviour, a low level of depressive symptoms and good attention capacity. Daytime sleepiness was relatively strongly negatively related to the level of attention and positively related to the level of depressive symptoms. Finally, as expected, a high level of depressive symptoms was strongly correlated to poor attention. Generally, the correlational patterns could be regarded as hypothesized.

To find out how sleep-related factors predicted the participants’ presence in the Low-attention group and the High-depression group, logistic regression analyses were carried out. The High-attention group and Low-depression group served as reference groups.

The children’s inclusion in the Low-attention group is predicted in Table 3. Sleep duration during the school week had no effect on whether a child belonged to the High- or Low-attention group. Particularly, adverse bedtime behaviour (OR = 11.74) and daytime sleepiness (OR = 3.62) were powerful predictors of poor attention.

Table 4 presents the results of the logistic regression analysis in which the sleep-related measures predicted a child’s inclusion in the High-depression group. Sleep duration had no effect on being in the highest scoring quartile of the depression scale. Adverse bedtime behaviour (OR = 3.80) and daytime sleepiness (OR = 4.34) proved again to be statistically significant predictors of depressive symptoms.

Discussion

There is not much work on how sleep and symptoms of attention and depression are linked in the healthy, non-clinical child population. Previous work has most commonly concerned adolescents, while relatively little corresponding research has been carried out on participants as young as 11 years old. Earlier research into adolescent sleep has not investigated attention and depressive symptoms within the same research designs. The present study aimed to fill these gaps. We were interested in

### Table 2. Correlations (Spearman’s rhos) among the main measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sleep duration/night during the school week</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Sleep duration/night at the weekend</td>
<td>0.34***</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Adverse bedtime behaviour</td>
<td>–0.30***</td>
<td>–0.19***</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Daytime sleepiness</td>
<td>–0.12*</td>
<td>–0.00</td>
<td>0.44***</td>
<td>–</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Attention</td>
<td>0.27***</td>
<td>0.18***</td>
<td>–0.53***</td>
<td>–0.49***</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>6. Depression (CDI-25)</td>
<td>–0.23**</td>
<td>–0.14**</td>
<td>0.48***</td>
<td>0.52***</td>
<td>–0.64***</td>
<td>–</td>
</tr>
</tbody>
</table>

$n = 427–438$.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

### Table 3. Logistic regression analysis predicting children’s low attention as a function of sleep measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>B</th>
<th>Wald $\chi^2$-test</th>
<th>$P$</th>
<th>Odds ratio</th>
<th>95% confidence interval for odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Sleep duration/night during the school week</td>
<td>–0.00</td>
<td>1.58</td>
<td>0.209</td>
<td>1.00</td>
<td>0.99 – 1.00</td>
</tr>
<tr>
<td>Adverse bedtime behaviour</td>
<td>2.46</td>
<td>33.61</td>
<td>0.000</td>
<td>11.74</td>
<td>5.11 – 27.00</td>
</tr>
<tr>
<td>Daytime sleepiness</td>
<td>1.29</td>
<td>20.20</td>
<td>0.000</td>
<td>3.62</td>
<td>2.07 – 6.34</td>
</tr>
</tbody>
</table>

$n = 434$. $\chi^2(3) = 121.51$, $P < 0.001$.

The model predicted correctly 91.6% of the High-attention group and 44.1% of the Low-attention group. The overall percentage for correct predictions was 79.5%. The goodness-of-fit indices were tolerable. Nagelkerke’s pseudo $R^2$ was 0.36.
exploring the relationship between sleep duration, adverse bedtime behaviour, daytime sleepiness, attention and depressive symptoms in Finnish fifth graders. The extended sleep quantity at the weekend in our sample, along with previous work (Tynjälä et al. 1993), supports the notion that Finnish children suffer from sleep deprivation during the school week.

The present results concerning sleep duration in relation to attention confirm previous findings. Low sleep duration on school week nights was correlated to poor attention ($r_c = 0.27$, $P < 0.001$). This finding is in line with previous non-experimental work in which short sleep duration has been linked to poor attention in healthy participants (Aronen et al. 2000; Paavonen et al. 2009). For instance, our findings confirmed those of Paavonen and colleagues (2009) with the exception of our self-report measure, which was unable to distinguish different types of attention impairment.

Several studies have demonstrated the association between short sleep duration and depressive symptoms in non-clinical samples of adolescents (Wolfson & Carskadon 1998; Giannotti et al. 2002; Fredriksen et al. 2004; Gangwisch et al. 2010). In our 11-year-old children, the correlation between the length of sleep during the school week and the frequency of depression symptoms was of the same magnitude as in a study by Fredriksen and colleagues (2004). Thus, the present results on sleep quantity and symptoms of depression are consistent with previous research.

Adverse bedtime behaviour is common among primary school children (Blader et al. 1997), and it is known that children with ADHD show bedtime resistance (Cortese et al. 2009), although this finding is not conclusive (Hansen et al. 2011). We observed in that in our non-clinical sample of children, adverse bedtime behaviour was clearly negatively related to attention capacity. Adverse bedtime behaviour was also closely linked to symptoms of depression. Emotional problems may be linked to sleep-onset and perhaps lead to adverse bedtime behaviour (Chorney et al. 2007). To our knowledge, there is no research linking children’s adverse bedtime behaviour directly to symptoms of depression.

In our study, sleep duration during the school week was only weakly related to daytime sleepiness. Daytime tiredness is indeed related to short sleep duration (Saarenpää-Heikkilä et al. 2000, 2001; Short et al. 2011), but many other factors, such as sleep disorders (sleepwalking, night waking, sleep talking, long sleep-onset etc.) and timing of meals also have an effect on it (Saarenpää-Heikkilä et al. 2000, 2001; Gaina et al. 2007). Gaina and colleagues (2007) observed in 12-year-old students that sleep duration affects daytime sleepiness only if it is 7.5 h or less. In our data only 4.6 percent of students fell into this category, which may explain the observed weak association between sleep duration during the school week and daytime sleepiness. Evidently, the daytime sleepiness in our study must be explained by other factors than low sleep quantity.

Sleep duration during the school week was totally unable to predict low attention and high depression in the logistic regression models. The result was unexpected, given that an abundance of literature has linked a low amount of sleep to these symptoms. In our data the strongest predictor of low attention was adverse bedtime behaviour, which was intuitively expected, because the scale for adverse bedtime behaviour included items that could also describe the symptoms of attention disorders. Adverse bedtime behaviour predicted depressive symptoms. Daytime sleepiness was a significant predictor of both low attention and high depression.

One of the limitations of the present study was the lack of measures probing sleep quality. Furthermore, our cross-sectional study did not reveal causality. It has been suggested that the causal associations between sleep and attention/depression are bidirectional (e.g. Dahl & Lewin 2002).

### Table 4. Logistic regression analysis predicting children’s high depression as a function of sleep measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>B</th>
<th>Wald χ²-test</th>
<th>$P$</th>
<th>Odds ratio</th>
<th>95% confidence interval for odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep duration/night during the school week</td>
<td>-0.01</td>
<td>3.54</td>
<td>0.060</td>
<td>1.00</td>
<td>[0.99, 1.00]</td>
</tr>
<tr>
<td>Adverse bedtime behaviour</td>
<td>1.34</td>
<td>11.60</td>
<td>0.001</td>
<td>3.80</td>
<td>[1.76, 8.19]</td>
</tr>
<tr>
<td>Daytime sleepiness</td>
<td>1.47</td>
<td>26.43</td>
<td>0.000</td>
<td>4.34</td>
<td>[2.48, 7.60]</td>
</tr>
</tbody>
</table>

$n = 437, \chi^2(3) = 87.03, P < 0.001$. The model predicted correctly 93.5% of the Low-depression group and 30.3% of the High-depression group. The overall percentage for correct predictions was 79.2%. The goodness-of-fit indices were tolerable. Nagelkerke’s pseudo $R^2$ was 0.28.
phenomena is perhaps neglected. For instance, there are a number of studies concerning the prevalence of daytime sleepiness and adverse bedtime behaviour (e.g. Saarenpää-Heikkilä et al. 1995; Tynjälä et al. 1997; Owens et al. 2000a,b; Petersen et al. 2003; Amschler & McKenzie 2005; Gaina et al. 2007; Simola et al. 2010), but very little is known about how they might interact with attention and depressive symptoms, particularly in non-clinical populations. Our results rather solidly suggest that their role may be more important than it is previously known. Further research in the field is needed.

Key messages

• Small sleep quantity is related to poor attention and depressive symptoms in 11-year-old participants.
• Poor attention and a high level of depressive symptoms are predicted by adverse bedtime behaviour and daytime sleepiness rather than sleep duration.
• In addition to sleep length, other aspects of sleep should be investigated in relation to poor attention and depressive symptoms in non-clinical child populations.

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References


