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ORIGINAL ARTICLE

Sleep and school attendance in adolescence: Results from a large population-based study

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Abstract

Background: The aim of this study was to examine the link between adolescent sleep and non-attendance in school. *Methods*: A large population-based study from Norway conducted in 2012, the youth@hordaland study, surveyed 8,347 adolescents aged 16–19 years (54% girls). Self-reported sleep measures included bedtime, rise time, sleep duration, sleep efficiency, sleep onset latency (SOL), wake after sleep onset (WASO), insomnia symptoms, tiredness, and sleepiness. School attendance was obtained from national administrative registries. *Results*: Most sleep parameters were associated with increased risk of school non-attendance. After adjusting for gender and socioeconomic status, short sleep duration and sleep deficiency were the sleep measures with the highest odds of non-attendance (OR=4.61, CI 95% 3.29–6.46) and (OR=3.26, CI 95% 2.67–3.99), respectively). Also, large bedtime discrepancies in weekend versus weekdays were associated with non-attendance (OR=2.43, CI 95% 1.93–2.02), as well as insomnia (OR=2.25, CI % 1.89–2.67) and daytime tiredness (OR=2.09, CI 95% 1.70–2.57). The associations were somewhat reduced after additional adjustment for depression, but remained significant in the fully adjusted model. ***Conclusion*: The demonstrated relationship between sleep problems and school absence suggests that careful assessment of sleep is warranted when adolescents present with extensive school absence. Future studies on how the sleep–school absence relationship in adolescence may impact later work affiliation in adulthood are needed.**

Key Words: *adolescence, sleep, school, non-attendance, epidemiology*

Introduction

The average sleep duration decreases during adolescence, despite the sleep need remaining constant [1]. Consequently, a sleep deficit may be the result when later bedtimes and long sleep onset meet early morning rise time on school days in adolescence. Sleep problems are frequent in this age group, as reflected in a high prevalence of insomnia [2]. Sleep problems during adolescence constitute a public health concern in its own right, but they are also associated with several health-related problems, as well as increased use of health care services [3, 4]. The functional significance of sleep problems in adolescents may also be evident in their school attendance and school performance.

Among adults, sleep problems have consistently been linked to subsequent work absenteeism [5]. While little is known about this association in adolescence, there are some indications that sleep may also impact school attendance. A community study found high rates of sleep problems in children and adolescents with school absence behavior [6]. High rates of school absence has also been found in adolescents

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with Delayed Sleep Phase Syndrome [7]. Further, delaying school start times has been associated with both longer sleep duration and a reduction in tardiness in adolescence [8]. Tardiness may be one consequence of sleep problems leading to increased school absence. However if this association is restricted to single hours of absence, or also related to entire school days, remains unknown. A consistent association has been demonstrated between sleep and academic performance. In a meta-analysis of the association between sleep and school performance, daytime tiredness and sleepiness showed the strongest associations with performance, whereas short sleep duration showed the weakest association [9]. Such findings suggest that also the link between sleep and school *absence* should be assessed across specific sleep parameters, as they may represent distinct indicators and targets for sleep interventions.

An observed sleep and school absence association may also be explained by co-existing problems or symptoms. Depression is one such likely candidate due to the high prevalence in adolescence [10], and close link to school absenteeism [6]. The demonstrated overlap between insomnia and depressive symptoms may thus account for some of a potential link between sleep and school absence [11].

Based on the above considerations, the overall aim of the present study was to examine the association between a broad range of self-reported sleep parameters, and official register data on school absenteeism in 17–19-year-olds. Our hypothesis was that there would be a significant association between school absence and sleep duration, insomnia, sleep deficiency, tiredness, and sleepiness. The second aim was to investigate to what extent depression may explain some of these associations.

Methods

Procedure

In this population-based study, we used data from the youth@hordaland-survey, conducted in the county of Hordaland, Norway. The youth@hordaland survey is the fourth wave of the Bergen Child study, where children born 1993–1995 are followed from elementary to upper secondary school age. The main aim of the survey was to assess prevalence of mental health problems and service use in adolescence. The web-based questionnaire covered a broad range of mental health related issues, daily life functioning, use of health and social services, and demographics. Data were collected during spring 2012. Adolescents in upper secondary education received information per e-mail, and time during regular school hours was allocated for them to complete the questionnaire. A teacher was present to organize the data collection and to ensure confidentiality. Survey staff could be reached by phone, both by the respondents and school personnel.

Sample

All adolescents born between 1993 and 1995 were invited (N=19,430) to participate in the current study that took place during the first months of 2012, of which 10,220 agreed, yielding a participation rate of 53%. Sleep variables were checked for validity of answers based on preliminary data analysis, resulting in 374 adolescents being omitted due to obvious invalid responses (e.g., negative sleep duration or sleep efficiency). Among the 9,846 remaining adolescents, 1,499 did not give consent to data linkage to the official register on school absence, yielding a sample size of 8,347 for the linked dataset.

Sleep measures

Sleep duration. Self-reported bedtime and rise time were indicated in hours and minutes using a scroll down menu with five minutes interval and were reported separately for weekdays and weekend. Time in bed (TIB) was calculated by subtracting bedtime from rise time. Sleep onset latency (SOL) and wake after sleep onset (WASO) were indicated in hours and minutes using an equal scroll down menu, and sleep duration was defined as TIB minus SOL and WASO. For analyses purposes, sleep duration was also split into the following three categories using deviation from the mean (1 SD) as the cut-off: (1) *short sleep duration* (< 4:50), (2) *medium sleep duration* (4:50 to 8:00), and (3) *long sleep duration* (> 8:00).

Sleep efficiency was calculated as sleep duration divided by TIB multiplied by 100 (reported as percentage).

Subjective sleep need was reported in hours and minutes, and sleep deficiency was calculated separately for weekends and weekdays, and was defined as the difference between each participant´s subjective sleep need, and his/her actual sleep duration.

Insomnia. Difficulties initiating and maintaining sleep (DIMS) were rated on a 3-point Likert scale with response options "not true," "somewhat true" and "certainly true." Given a positive response ("somewhat true" or "certainly true"), participants were then asked how many days per week they experienced problems either initiating or maintaining sleep. Duration of DIMS was rated in weeks (up to three weeks) months (up to 12 months) and a last category of more than a year. Tiredness/sleepiness was rated on a joint

question on a three point Likert scale with response options "not true," "somewhat true," and "certainly true." If confirmed ("somewhat true" or "certainly true") follow-up questions were presented, where participants reported the number of days per week they experienced sleepiness and tiredness separately. Frequency of napping and oversleeping were assessed separately, with the response options: "never," "seldom (a couple of times a year)," "sometimes (a couple of times a month)," "often (many times a week)," and "always (every day)." Insomnia was operationalized according to Lichstein et al.'s [12] quantitative criteria for insomnia: self-reported DIMS at least three times a week, with a duration of six months or more, in addition to reporting SOL and/or WASO of more than 30 minutes, as well as tiredness or sleepiness at least three days per week. For more information on insomnia and sleep pattern see [2].

Depression

Symptoms of depression were assessed by using a short version of the Mood and Feelings Questionnaire (SMFQ) [13]. The SMFQ comprises 13 items assessing depressive symptoms rated on a 3-point Likert scale ("correct," "sometimes correct," and "not correct"). The total score on the SFMQ was used in the present study. A high internal consistency between the items and a strong unidimensionality was shown in previous population-based studies [14], and was also recently confirmed in a publication based on the same dataset as the present study [10].

School attendance

Official register-based data on non-attendance were provided by Hordaland County Council, and included both days and school hours of absence the last semester (6 months). In the present study we used both the mean of days and hours, as well as dichotomous variables using the 90th percentile as the cutoff (cutoffs: ≥10 days and ≥19 hours, respectively) defining "substantial school absence."

Ethics

The study was approved by the Regional Committee for Medical and Health Research Ethics, Region West. Informed consent was obtained after complete description of the study to the adolescents.

Data analysis

IBM SPSS Statistics 22 for Mac (SPSS Inc., Chicago, Ill) was used for all analyses. Independent sample t-tests and χ^2-tests were used to examine the association between school non-attendance and the demographical and sleep variables. Logistic regression analyses were used to assess the association between sleep variables and school non-attendance (dichotomized on the 90th percentiles of *days* and *hours* of non-attendance). We calculated both crude odds-ratios (OR) and adjusted for the following covariates entered simultaneously: age, gender, parental education, and income level. Finally, we examined a fully adjusted model in which we in addition controlled for depressive symptoms.

Results

Demographical characteristics

In all, 8,347 adolescents provided valid responses on the relevant sleep items in the linked sample. The mean age was 17 years, and the sample included more girls (53.5%) than boys (46.5%).

School absenteeism

Girls had significantly more days of registered school absenteeism than boys (4.5 days vs. 3.6 days, respectively, $p < 0.001$), while there were no gender differences in hours of school absence (7.7 vs. 7.5, respectively) during the last 6 months. Age was significantly associated with school absence, with increased absence among older adolescents compared to their younger peers (19 year-olds: 5.4 days, 18 year-olds: 3.9 days, and 17 year-olds: 3.5 days; $p < 0.001$). Parental education was unrelated to school absence, but adolescents with lower family income showed increased absence compared to families with good or average family economy ($p < 0.001$).

Sleep duration, sleep deficiency and school absence

Adolescents with substantial school absence (days) had significantly shorter sleep duration on week days (mean 5:36 SD 1:52) compared to adolescents with normal absence (mean 6:30 SD 1:34, $p < .001$). Similar patterns were observed on weekends, and for *hours* of school absence (data not shown). As depicted in Figure 1, sleep duration was significantly associated with school absence across all the six categories in a dose-response manner. It should also be noted that sleeping > 9 hours was associated with more *hours* of school absence, whereas a similar curvilinear trend was not observed for *days* of school absence (see Figure 1 for details). When sleep duration was split into three categories according to standard deviations, a similar pattern emerged; Adolescents with

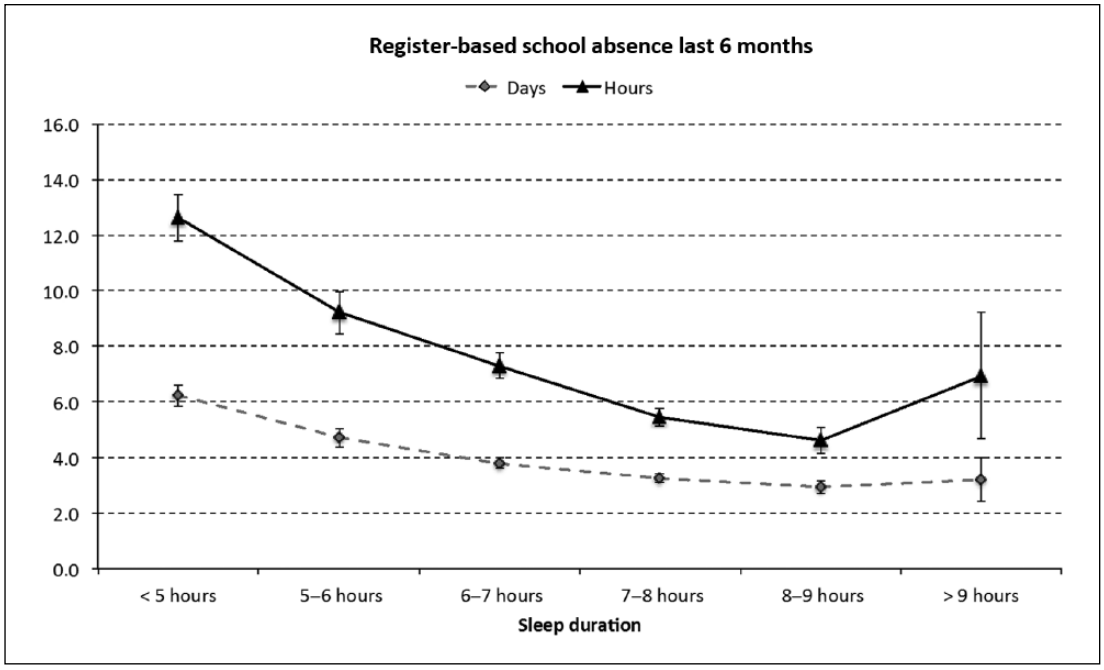

Figure 1. Sleep duration and school absence among adolescents in the youth@hordaland study (n=8347). Error bars indicate 95% confidence intervals.

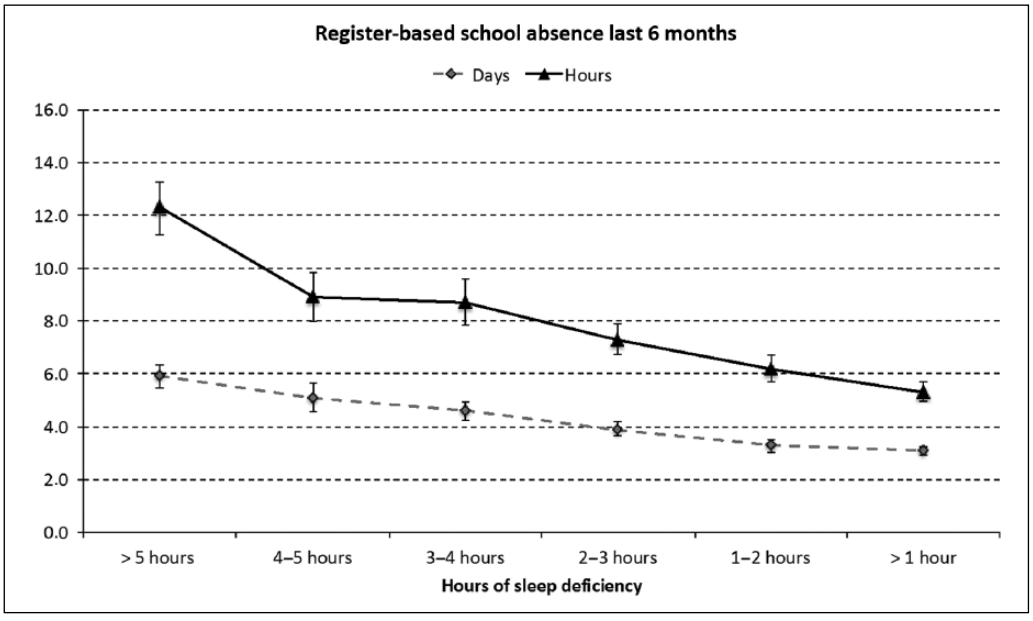

Figure 2. Sleep deficiency and school absence among adolescents in the youth@hordaland study (n=8347). Error bars indicate 95% confidence intervals.

short duration (one or more standard deviations below average) had increased odds of substantial school absence (OR= 4.61, 95% CI 3.29–6.46). Sleep deficiency, calculated by subtracting actual sleep time from subjective perceived sleep need, showed a similarly graded association (Figure 2). Sleep deficiency exceeding two hours was significantly associated with increased odds for substantial school absence, with more than four hours of average sleep debt yielding an OR of 3.26 (95% CI 2.67–3.99) after adjusting for gender and socioeconomic status. Difference in bedtime between weekdays and weekends was also related to school absence. As detailed in Table 1, a difference between weekdays and weekends of 4+ hours more

Table 1. Sleep characteristics as risk factors for substantial school absence, defined as register-based number of days last 6 months (dichotomized at the 90th percentile: 10 days or more).

	%	Crude model		Adjusted model*		Fully adjusted model§	
		OR	95% CI	OR	95% CI	OR	95% CI
Sleep duration							
Long sleep duration	14.6%	1.00	–	1.00	–	1.00	–
Medium sleep duration	75.1%	1.69	1.23–2.32	1.69	1.23–2.32	1.57	1.14–2.17
Short sleep duration	10.2%	4.71	3.37–6.58	4.61	3.29–6.46	3.70	2.62–5.22
Sleep deficiency							
< 2 hours	19.2%	1.00	–	1.00	–	1.00	–
2–3 hours	11.1%	1.61	1.27–2.04	1.58	1.24–2.01	1.52	1.19–1.94
3–4 hours	16.5%	2.44	1.91–3.11	2.41	1.88–3.08	2.25	1.75–2.89
>4 hours	53.1%	3.22	2.64–3.91	3.26	2.67–3.99	2.79	2.26–3.45
Difference in bedtime (weekdays versus weekends)							
< 2 hours	38.3%	1.00	–	1.00	–	1.00	–
2–3 hours	40.4%	1.02	0.86–1.20	1.05	0.89–1.26	1.05	0.88–1.25
3–4 hours	13.5%	1.49	1.21–1.85	1.62	1.30–2.01	1.56	1.25–1.94
>4 hours	7.8%	2.26	1.80–2.85	2.43	1.92–3.09	2.20	1.72–2.81
Insomnia							
No	86.4%	1.00	–	1.00	–	1.00	–
Yes	13.6%	2.55	2.16–3.03	2.25	1.89–2.67	1.83	1.52–2.20
Tiredness							
≤ 2 days/wk	29.0%	1.00	–	1.00	–	1.00	–
3–4 days/wk	35.0%	1.59	1.28–1.96	1.48	1.18–1.82	1.39	1.19–1.73
> 4 days/wk	36.0%	2.34	1.91–2.86	2.09	1.70–2.57	1.74	1.40–2.16
Sleepiness							
≤ 2 days/wk	59.9%	1.00	–	1.00	–	1.00	–
3–4 days/wk	21.7%	1.40	1.17–1.69	1.30	1.07–1.57	1.20	0.99–1.46
> 4 days/wk	18.4%	1.72	1.43–2.07	1.55	1.28–1.87	1.25	1.02–1.53
Oversleeping							
Never	37.3%	1.00	–	1.00	–	1.00	–
Seldom/sometimes	57.2%	2.75	2.28–3.31	2.64	2.19–3.19	2.53	2.09–3.06
Often/always	5.5%	7.50	5.73–9.81	6.84	5.21–8.98	5.82	4.40–7.71

*Adjusted for age, gender, parental education and income level.
$Adjusted for age, gender, parental education and income level, and depressive symptoms (SMFQ total score).

than doubled the odds of substantial school absence (OR=2.43, 95% CI 1.93–2.02).

Insomnia and school absence

Insomnia significantly increased the odds of substantial school absence (OR=2.25, 95% CI 1.89–2.67) after adjusting for gender and socioeconomic status. The association was only slightly attenuated after adjusting for depression (OR=1.83, 95% CI 1.52–2.20).

Tiredness, sleepiness, oversleeping, and school absence

Tiredness showed a graded relationship with register-based school absence. Being tired more than four days per week significantly increased the odds of substantial school absence after adjusting for gender and socioeconomic status (OR=2.09, 95% CI 1.70–2.57). Sleepiness more than four days per week was also related to increased odds of school absence (OR=1.52, 95% CI 1.28–1.87). The results showed that 5.5% of the adolescents reported oversleeping often or always, and this behavior showed a large increase in the odds for substantial school absence (OR=6.84, 95% CI 5.21–8.98).

Discussion

This population-based study demonstrates dose-response association between several sleep parameters and register-based school absence. Adolescents with short sleep duration, sleep deficiency, large weekdays–weekends bedtime discrepancy and insomnia had significantly higher odds of substantial school absence. Depression accounted for some of these associations, but the results showed that most sleep parameters were independently associated with school absence in the fully adjusted model.

In line with our hypothesis, adolescent sleep problems were related to an important functional

outcome; school absence. This mirrors the functional significance of sleep in adults, with sick leave and work absence as commonly studied outcomes [5]. In agreement with studies among adults, short sleep duration was the most potent sleep variable in relation to functional impairment. Adolescents with short sleep duration had a fourfold increased odds of substantial school absence in the present study. This association held true both when sleep duration was calculated as standard deviations from the mean, and sleep deficiency calculated as the discrepancy between actual and subjective sleep need. There was consistent relation between sleep problems and both hours and days of absence.

Although there are established gender differences in the point prevalence of the different sleep problems, the relation between sleep and school absence seems to hold true for both genders. This was shown by the associations between sleep and school absence being only marginally attenuated when controlling for gender and socioeconomic status. However, the relative importance of sleep behavior may differ across gender [15], e.g., due to insomnia being more prevalent among girls, whereas boys more often have short sleep duration and larger weekdays-weekend discrepancies.

The demonstrated sleep-school absence relation could also be a general risk indicator, co-occurring with health problems linked to school absence. The transdiagnostic perspective of sleep problems across mental and somatic disorders would support this view [15]. The fact that mental health problems may account for some of the relationship between sleep and school attendance, was partly supported when adjusting for depression in the analysis, as depression seemed to account for some, but not all of the association. However, inspection of the 95% confidence intervals showed that adjusting for depression did not constitute a statistically significant difference. This is in line with the notion of sleep and depression as distinct and commonly co-existing disorders [11]. In addition, a range of other factors may be related to both sleep and school absence, but it was beyond the scope of the present study to assess these factors. Sleep problems and school absence may for example be related to chronic illness [16], and to what extent sleep may influence the relationship between these and other factors awaits further study. The interrelation between sleep, school performance and school absence is an important avenue for future research. In particular to explore if the demonstrated school absence–sleep association may be one of the potential pathways between sleep and school performance.

Strengths and limitations

The present study is based on a broad and detailed assessment of sleep. While the definition of insomnia was based on published quantitative criteria, it was not based on a structured interview, which of course is difficult to employ in a population-based study. The use of both SOL and WASO to estimate exact sleep duration was a significant strength of the current study, as population-based studies on sleep rarely provide such detailed measures. Although self-reported sleep parameters, including SOL and WASO typically differ from those obtained from objective assessment, [17] recent studies have showed that such self-report sleep assessments can be recommended for the characterization of sleep parameters in both clinical and population-based research [18]. Also, the accuracy of self-reported SOL and WASO is generally better in adolescents than in adults [19], and a study of young adolescents in Hong Kong recently found good agreement between actigraphy-measured and questionnaire-reported sleep durations [20]. The use of the Quantitative Research Criteria for Insomnia [12] is also a major strength of the study, and does not limit sleep problems to self-reported single items of initiating and maintaining sleep as has been used in previous studies. It should be noted that all data in the present study were based on self-reports, which renders the results susceptible to influence from the common method bias [21]. When defining sleep deficiency we used the respondents' perceived sleep need as the norm. On average, this variable was in accordance with expert recommended sleep duration (28), suggesting that normative sleep data would have given comparable results. A major strength of the study is the use of data from administrative registries on school absence, reducing the risk of mono-informant bias. There are some limitations that should be noted. Data stem from one county in Norway, and although the distribution of its population between urban and rural areas reflects Norway as a whole, the possible limited generalizability must be taken into account. Also, attrition from the study could affect generalizability, with a response rate of about 53% and with adolescents in schools overrepresented. The problem with non-participation in survey research seems unfortunately to be on the rise [22]. In light of that the response rate may be regarded as acceptable. Official data show that in 2012, 92% of all adolescents in Norway aged 16–18 attended high school, compared to 98% in the current study. Based on previous research from the former waves of the Bergen Child Study (the same population as the current study), non-participants have also been shown to have more psychological

problems than participants [23], and it is therefore likely that the prevalence of mental health problems may be underestimated.

In the analysis sleep was treated as an exposure variable. However, the study is cross-sectional and causal inferences cannot be drawn. School absence may be related to a less organized life style and lead to erratic sleep schedules. Most likely, there is a reciprocal relationship, where sleep problems increase school absenteeism, and days out of school can further consolidate these sleep patterns. Longitudinal studies are therefore needed to give more insight into the temporal relation between these variables.

Implications

The demonstrated relationships between sleep and school attendance calls for increased awareness of the importance of sleep in adolescence. For schools and health personnel, absenteeism should be considered an important marker of both poor sleep habits and sleep disorders. A non-optimal sleep pattern and short sleep duration may show stability into adult life, and serve as a predictor of later work absenteeism [24]. There are several possible points for intervention to promote adequate sleep in adolescence, both at the individual, parental, and societal level. In the present study the perceived sleep need was in accordance with experts' recommendations [25]. These findings suggest that the respondents were aware of their sleep debt, and that educating the adolescents on sleep need will probably not be sufficient to change behavior. One approach to improve sleep in adolescence is preventive programs targeting adolescent sleep in schools. While some sleep educational programs have shown promising results in improving both knowledge of sleep and increased sleep duration in adolescence [26] other studies with more rigorous designs have failed to demonstrate significant changes (for review see [27]). Parental involvement in bedtimes seems to promote good sleep habits in adolescence [28]. On a societal level, postponing school starting times may be one avenue for increasing sleep duration and reduce school absenteeism [29]. The co-occurrence and mutual impact on school absence suggest that intervention could target both sleep and depression. For the adolescents in mental health care, the inclusion of assessment and treatment of sleep problems should be an integral part of the treatment in line with current recommendations [30].

Conflict of interest

None declared.

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