



## Severe Sleep Problems and Psychopathic Features: A Study of Finnish Adolescents

 Heidi Backman<sup>1\*</sup>, Taina Laajasalo<sup>1,2</sup>, Suvi Saukkonen<sup>3</sup>, Venla Salmi<sup>4</sup>, Markus Jokela<sup>1</sup> and Eeva T Aronen<sup>3</sup>
<sup>1</sup>Institute of Behavioural Sciences, University of Helsinki, Finland

<sup>2</sup>Forensic Psychiatric Center for Children and Adolescents, Children's Hospital, Department of Child Psychiatry, Helsinki University Central Hospital, Finland

<sup>3</sup>University of Helsinki and Helsinki University Hospital, Children's Hospital and Pediatric Research Center, Child Psychiatry Unit, Laboratory of Developmental Psychiatry, Finland

<sup>4</sup>Criminological Unit, National Research Institute of Legal Policy, Helsinki, Finland

 \*Corresponding author: Heidi Backman, MA, Institute of Behavioural Sciences, University of Helsinki, PO Box 9, FI-00014 Helsinki, Finland, Tel: +358503304644; E-mail: [heidi.backman@helsinki.fi](mailto:heidi.backman@helsinki.fi)

Received date: May 30, 2016; Accepted date: June 23, 2016; Published date: June 28, 2016

Copyright: © 2016 Backman H, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

### Abstract

**Objective:** This study investigated sleep and psychopathic features in a population-based sample of 4855 Finnish adolescents.

**Method:** Sleep was evaluated by questions about the frequency and persistence of sleep problems and the amount of sleep on school and weekend nights. Psychopathic features were measured with Antisocial Process Screening Device-Self Report (APSD-SR).

**Results:** Frequent and persistent sleep problems was reported by 5% of the adolescents while 3.2% of adolescents had continuous short sleep, 7 hours or less on both school and weekend nights. Higher scores on the APSD-SR measure were associated with both sleep problems and short sleep.

**Conclusion:** We conclude that severe problems of sleep quality and quantity among adolescents may be associated with vulnerability to lack of behavioral control and prosocial behavior.

**Keywords:** Sleep problems; Short sleep; Sleep quality; Sleep quantity; Psychopathy; Impulsivity; Narcissism; Callous-unemotional; Adolescents

### Introduction

Sleep deprivation and sleep-related problems among youth are a growing concern worldwide [1,2]. There are several studies indicating that a great number of adolescents worldwide suffer from insufficient sleep, i.e. less than 8 hours per night [3]. For example, in a large population-based study of adolescents 14–18 years old, as much as 69% reported less than 8 hours of sleep on school nights [4], and in another study, only 1 in 5 obtained enough sleep ( $\geq 9$  hours) on school nights [5]. In addition to the alarming commonness of above mentioned sleep quantity problems among youth, qualitative sleep problems are not rare either: almost one quarter of adolescents report symptoms of chronic insomnia [6], and about one third of adolescents report difficulties falling asleep [5]. However, previous studies investigating adolescent sleep have failed to focus on youth who suffer from severe difficulties: frequent and persistent sleep problems or continuous short sleep duration on both week and weekend nights [7-10]. In addition, findings regarding percentage of poor sleep between boys and girls vary in literature [8,9,11-14] although principally, girls suffer from qualitative sleep problems more often than boys [8,9,13,14] but boys sleep less [11-13]. Given these shortcomings, more data on the severe qualitative or quantitative sleep problems in male and female adolescents are needed.

It is worth noting that adolescence marks a period of rapid brain development, especially in the prefrontal circuits of the brain responsible for regulation of emotion [15-17]. Thus the adolescent brain may be especially vulnerable to the effects of sleep alterations [18] causing even permanent changes in brain function [19]. In addition to being detrimental to adolescents' brain, physical health and cognitive functions, multiple other risk factors and consequences have been associated with poor sleep according to recent reviews [7,20]. For example, poor sleep is associated with many types of emotional and behavioral problems in community samples [1,5,6,14,21], and also with depression, anxiety disorders, disruptive behavioral disorders, and attention deficit hyperactivity disorder in clinical samples [20,22-25]. However, not only sleep problems itself but also the persistence and severity of problems count. Specifically, chronic insomnia has been linked to increased subsequent risk for health and psychological problems [6], and the most harmful consequences on functioning become from insufficient sleep amount that occurs on both school and weekend nights [1,25].

Though there is evidence on associations between poor sleep and several behavioral consequences and conduct problems in children and adolescents, a few studies have evaluated how poor sleep associates with impulsivity [4,21,26], emotional competence [14,27] and narcissism [28] captured with the term psychopathic features. However, studies of sleep and specifically psychopathic features are almost nonexistent. These features are now included in the DSM-5 nomenclature as a specifier for Conduct Disorder in children and

adolescents, which points out the importance of also studying associations between sleep and psychopathic traits in young people. Accordingly, recent neuroimaging studies suggest that sleep deprivation is associated with alterations in the normal functional activity and connectivity of brain regions associated with impulse control, reinforcement learning, risky decision-making, and emotional processing, namely in the prefrontal cortex, amygdala, and ventral striatum, in both adults and adolescents [14,27,29-31]. Dysfunction in these areas is also thought to underlie many of the core symptoms of psychopathy [32,33]. Psychopathy refers to a specific set of affective (callousness, poverty of emotions, lack of guilt), interpersonal (narcissism, interpersonal glibness), and behavioral (impulsivity, irresponsibility) features [34]. Investigating psychopathic traits among adolescents, studies have focused on impulsivity, narcissism and callous-unemotional traits. They have been found to be the factors of a widely used psychopathy scale for adolescents [35-37]. Psychopathic features are related to an increased risk for aggressive and delinquent behavior in adolescent community samples and to a more severe and persistent conduct disorder and antisocial behavior in clinical and forensic samples [38]. As mentioned earlier, sleep-deprived children and adolescents also show aggressive and hostile behavior [20-22], similar to individuals with psychopathic features. In addition to behavioral-level and neuroimaging findings, the neuropsychological deficits exhibited by individuals with altered sleep also resemble those found among persons with psychopathic features; both show diminished fear reactivity in fear conditioning experiments [39,40]. Further, in gambling tasks, sleep problems are associated with risk-related judgments favoring unrealistic expectations of gains and underestimating the consequences of losses [27,30]. A similar pattern is found when individuals with psychopathic features are faced with a gambling task [41]. In addition to these similarities, short sleep has been shown to decrease empathy towards others and the ability to delay gratification, and to increase unrealistically favorable self-description [42].

Considering that the association between altered sleep and psychopathy was proposed already in the 1970's [43], the paucity of empirical research in this area is surprising. We are aware of only four earlier studies concerning sleep and psychopathic features in adults [28,44-46] and no studies on adolescents. Salley et al. [46] and Harty et al. [44] found no associations between sleep and psychopathic features. However, both studies had considerable limitations; the first relied on projective personality test as a measure of psychopathy, and the second was conducted in a mostly male sample from a correctional institute. Recently, Jonason et al. [45] found a link between an evening-type orientation and Dark Triad traits (i.e., narcissism, psychopathy, and Machiavellianism) indicating that, on measures of psychopathy, those who tend to stay awake late get higher scores than those who go to bed earlier. Further, Sabouri et al. [28] found that psychopathy correlated positively with sleep disturbances among adults. The increasing prevalence of inadequate sleep in adolescents, the lack of studies on associations between sleep and psychopathic features in adolescent samples, and the above-mentioned findings of similarities between sleep-deprived individuals and individuals with psychopathic features emphasize the need for studies on the relationships between sleep and psychopathic features.

The present study aimed to address the prevalence of self-reported frequent and persistent sleep problems and continuous short sleep on all nights in a population-based sample of Finnish 15-16 year-old adolescents. Further, the aim of this study was to investigate how the severe qualitative and quantitative sleep problems are associated with scores on a self-reported psychopathy scale and its subfactors, which are impulsivity, narcissism and callous-unemotional traits. Based on the literature above, we assumed that sleep problems and low amount of sleep are associated with psychopathic features in these adolescents.

## Method

### Subjects and procedure

The sample comprises 4855 ninth-grade students with a mean age of 15.3 years (sd=0.55); 50.9% were female. Almost all (97.5%) of the students were of Finnish origin, and most (66.5%) came from a nuclear family. Statistics Finland was responsible for sampling and assuring that the sample represented the general population of 15-16-year-old adolescents in Finland in respect to family constellation and living conditions. In the last 12 months, 30.9% of the adolescents had received some form of special education (full- or part-time)<sup>1</sup>. The data were collected by the National Research Institute of Legal Policy's national representative Finnish Self-Report Delinquency Study (FSRD-2012) of juvenile delinquency [47]. FSRD-2012 was conducted randomly in 51 municipal comprehensive schools in spring 2012. Geographical area and community residential density were used as classification criteria. Of the targeted students (n=6089), 79.7% (n=4855) completed the questionnaire. The main reason for non-response was an absence for personal reasons (e.g. illness, athletic meets, special needs education, family vacation, or truancy). A poor net connection in schools, occurring randomly nationwide, was another reason for non-response. A more detailed description of the procedure is given elsewhere [36,47]. The survey was performed via computer during a regular class supervised by a teacher who had been briefed about the required practices [48]. Respondents' anonymity was guaranteed, and no harm to the participants could arise from the study. According to the guidelines of the Advisory Board on Research Integrity, formal consent from the parents was not required for this study [49].

### Measures

In the FSRD-12 survey, sleep problems, their frequency, their duration, and sleep amount on school and weekend nights were evaluated with four sleep questions which were modified from the Sleep Self-Report (SSR) [23] and the Sleep Disturbance Scale for Children (SDSC) [50]. The items were rated on a Likert-like scale. Of the four questions, two explored problems of sleep quality. All the respondents were asked firstly, Q1) "Do you think you have trouble sleeping" with the corresponding response categories 1=no sleep problems, 2=less than once a week, 3=1-2 nights per week, 4=3-5 nights per week and 5=every or almost every night, and secondly, Q2) "If you do, for how long have you had troubles sleeping?" with the response categories 1=no sleep problems, 2=less than for 4 weeks, 3=1-6 months, 4=6-12 months, 5=1-2 years and 6= over 2 years. Two other questions of the survey measured sleep quantity by questions

<sup>1</sup> Finnish comprehensive schools provide extensive special needs education and the threshold for additional support is very low, which explains the high percentage. All students receiving special education within comprehensive schools were included in the sample. Students with severe impairment study in special schools, which were not included in the sample.

Q3) “How many hours of sleep do you get on school nights?” and Q4) “How many hours of sleep do you get on weekend nights?”. The corresponding response alternatives were 1=9–11 hours, 2=8–9 hours, 3=7–8 hours, 4=5–7 hours and 5=less than 5 hours. After the data collection, two dichotomous sleep variables were formed to indicate sleep quality and sleep quantity in a following way. Respondents who answered to Q1) 4=3–5 nights per week or 5=every or almost every night and to Q2) 4=1–2 years or 5=over 2 years, were classified as having frequent (3 or more times per week) and persistent (persisting for 1 year or more) sleep problems. Accordingly, all the other respondents were treated as not having frequent and persistent sleep problems. These categories were defined as such because they are comparable to those used in previous studies [6,8,9]. Likewise, respondents who answered to both of the latter questions Q3–Q4) 3=5–7 hours and/or 4=less than 5 hours were categorized as having continuous short sleep duration (less than 7 hours) on both school and weekend nights. Respondents who answered something else to the questions, belonged to a group not having continuous short sleep. The need to focus on school and weekend nights together has been recognized [10,25] although in large meta-analytic reviews, Bartel et al. [7] listed only five studies that have examined combined sleep time of week and weekend nights and Gradisar et al. [3] did not find any studies that have considered insufficient sleep time on weekends. Dichotomous sleep variables indicating sleep quality and quantity are shown in Table 1.

	All	Boys	Girls
	n (%)	n (%)	n (%)
Frequent and persistent sleep problems: adolescent reports having trouble sleeping 3 to 5 times per week for 1 or more years			
No	4610 (95.0)	2280 (95.9)	2330 (94.1)
Yes	245 (5.0)	98 (4.1)	147 (5.9)
$\chi^2(1)=8.33^{**}$ $\phi=-0.041$			
Continuous short sleep duration: adolescent reports sleeping less than 7 hours on both school and weekend nights			
No	4700 (96.8)	2281 (96.0)	2419 (97.6)
Yes	155 (3.2)	96 (4.0)	59 (2.4)
$\chi^2(1)=10.77^{***}$ $\phi=0.047$			
Note. Comparisons in prevalence between genders using $\chi^2$ tests; $\phi$ =Phi, effect size; * $p<0.05$ ; ** $p<0.01$ ; *** $p<0.001$ .			

**Table 1:** Prevalence of sleep quality and quantity problems among boys and girls (n=4855).

Psychopathic traits were assessed with the Antisocial Process Screening Device-Self-Report (APSD-SR) [51], which is a 20-item questionnaire based on the Psychopathy Checklist-Revised (PCL-R) [52]. The APSD-SR includes items reflecting impulsive behavior, such as “Acts without thinking”, narcissistic features, such as “Thinks he is more important”, and callous-unemotional traits, such as “Concerned about feelings of others [reversely scored]”. Items do not refer to a specific period of time. Items are scored on a 3-point scale (0=not at all true, 1=sometimes true, 2=definitely true), with a higher score representing a higher level of the trait. The total score and the subscale scores (impulsivity, narcissism, callous-unemotional) are obtained by

adding the respective items. The APSD-SR was translated into Finnish and included in the FSRD-12 survey. The factorial validity of the instrument among Finnish adolescents was described in a recent study [36]. A three-factor model comprising impulsivity, narcissism, and callous-unemotional features was found to fit the data from Finnish adolescents the best, consistent with several earlier studies of the instrument in other populations [35,37]. Accordingly, the variables interesting us were both the APSD-SR total score examining the psychopathy features among adolescents and the three subscale variables indicating impulsivity, narcissism and callous-unemotional features.

### Data analysis

The data were analyzed using SPSS<sup>®</sup> 21.0 (IBM Corporation, Armonk NY, USA). Appropriate sample weights were used to ensure that the sample was representative for Finnish youth [36]. The analyses were conducted in five stages. First, we investigated prevalence of qualitative and quantitative sleep problems among boys and girls using Chi-square tests. Then, the point-biserial correlation was applied to assess the correlation between the nominal sleep items and the APSD-SR total score and subscale scores. In the third stage, a factorial analysis of variance (ANOVA) was conducted to compare the main effects of sleep quality and sleep quantity and to examine interaction effect between frequent and persistent sleep problems and continuous short sleep with gender variable on APSD-SR total score. Gender was included in the analysis as a fixed factor to distinguish the effect between boys and girls on psychopathic features among the groups with and without qualitative and quantitative sleep problems. Fourth, a multivariate analysis of variance (MANOVA) was used to find out if there were associations between sleep variables and APSD-SR subscale scores (i.e. impulsivity, narcissism and callous-unemotional scores) among boys and girls. Correlating moderately with each other, no multicollinearity problems with the subscales were detected. In the final fifth stage, multiple two-way ANOVAs were run for both levels of gender. By splitting the data into two groups (boys and girls), and investigating the groups separately, we could see the two-way interaction effects of sleep separately among boys and girls on APSD-SR total score as well as on impulsivity, narcissism and callous-unemotional scores. The assumption of normal distribution was valid for the APSD-SR total and subscale scores. Also, the homogeneity of variances for each combination of the groups of the three independent variables (sleep quality, sleep quantity and gender) was valid.

## Results

### Descriptive statistics of sleep

Frequent (3 or more times per week) and persistent (persisting for 1 year or more) sleep problems were reported by 5.0% of subjects. On both school and weekend nights 3.2% of adolescents reported sleeping 7 hours or less. As shown in Table 1, the responses of males and females differed in sleep items. Overall, girls had more frequent and persistent sleep problems than boys. Conversely, boys were more prone to suffer from continuous short sleep duration on all nights (Table 1).

### Sleep and psychopathic features

As shown in Table 2, APSD-SR total score as well as all of the APSD-SR subscale scores were associated with variables of sleep quality and quantity. Thus, adolescents who had frequent and

persistent sleep problems or continuous short sleep, i.e. had slept 7 hours or less all week, had higher APSD-SR total scores and higher subscale scores than other adolescents (Table 2).

	APSD-SR	Impulsivity	Narcissism	CU traits
Frequent and persistent sleep problems	0.12**	0.14**	0.08**	0.05**
Continuous short sleep duration	0.14**	0.12**	0.08**	0.11**

Note. Correlations calculated with Point-biserial correlation coefficient; APSD-SR=Antisocial Process Screening Device-Self-Report total score; CU=Callous-unemotional traits; \*p<0.05; \*\*p<0.01; \*\*\*p<0.001.

**Table 2:** Correlations between the sleep quality and quantity variables and APSD-SR total score and subscale scores (n=4855).

A factorial analysis of variance was conducted on the influence of three independent variables (sleep quality, sleep quantity, gender) on the APSD total score. Both sleep variables included two levels (yes, no) and gender consisted of two groups (boys, girls).

The cell means and standard deviations of the sleep and gender variables on APSD-SR are shown in Table 3. Girls having both qualitative and quantitative sleep problems scored highest on the APSD-SR scale. However compared to girls, boys who had either short sleep or frequent and persistent sleep problems got higher scores on APSD-SR scale (Table 3).

Both frequent and persistent sleep problems and continuous short sleep on school and weekend nights were associated independently with significantly higher APSD-SR total score and subscale scores even though analyses included gender effects. The main effect for gender was not significant.

In addition, we found a statistically significant three-way interaction between the sleep variables and the gender variable which means that a two-way interaction between variables of sleep quality and quantity varied across boys and girls as shown in Figure 1. In the multivariate analysis, the main effects of both sleep variables were significant on all of the subscales of APSD-SR. Significant three-way interactions for qualitative sleep problems, sleep quantity and gender were detected on

IV	APSD-SR		Impulsivity		Narcissism		CU traits	
	F(1, 5472)	$\eta^2$	F(1, 5472)	$\eta^2$	F(1, 5472)	$\eta^2$	F(1, 5472)	$\eta^2$
Sleep quality	39.58***	0.007	20.57***	0.004	27.50***	0.005	9.09**	0.002
Sleep quantity	57.38***	0.01	19.83***	0.004	30.77***	0.006	41.23***	0.007
Gender	0.22	0	5.61*	0.001	0.49	0	35.89***	0.007
Sleep quality x Sleep quantity x Gender	9.07**	0.002	7.54**	0.001	7.42**	0.001	0.37	0

Note: Results are from ANOVA and MANOVA; ASPD-SR=Antisocial Process Screening Device- Self Report; CU traits=Callous-unemotional traits; IV=Independent variable;  $\eta^2$ =Partial Eta squared statistics indicating effect sizes; \*p<0.05; \*\*p<0.01; \*\*\*p<0.001.

**Table 4:** The main effects and the three-way interaction between frequent and persistent sleep problems, continuous short sleep on all week, and gender on psychopathic, impulsive, narcissistic and callous-unemotional traits among adolescents.

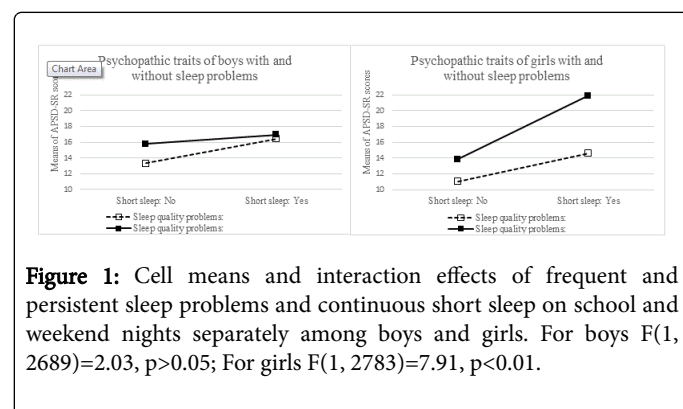
Finally, the two-way analyses of variances showed a significant interaction effects among girls on APSD-SR scale (Figure 1) yielding

impulsivity and narcissism but not on callous-unemotional traits. The results of the three-way ANOVAs and MANOVA are shown in Table 4.

Frequent and persistent sleep problems		Continuous short sleep on school and weekend nights		
		No	Yes	Row Mean
Boys	No	13.33 (5.14)	16.42 (6.72)	12.26 (5.02)
	Yes	15.76 (5.04)	16.96 (7.56)	15.08 (5.91)
	Mean for boys	13.41 (5.16)	16.54 (6.88)	13.54 (5.28)
Girls	No	11.04 (4.48)	14.61 (5.48)	11.11 (4.52)
	Yes	13.93 (4.98)	21.91 (12.31)	14.45 (6.01)
	Mean for girls	11.20 (4.56)	15.90 (7.58)	11.31 (4.69)
Column Mean		12.28 (4.98)	16.31 (7.12)	12.41 (5.11)

Note. ASPD-SR=Antisocial Process Screening DeviceSelf Report.

**Table 3:** APSD-SR total score means and standard deviations for frequent and persistent sleep problems and continuous short sleep duration among boys and girls. Continuous short sleep on school and weekend nights.



**Figure 1:** Cell means and interaction effects of frequent and persistent sleep problems and continuous short sleep on school and weekend nights separately among boys and girls. For boys  $F(1, 2689)=2.03, p>0.05$ ; For girls  $F(1, 2783)=7.91, p<0.01$ .

was significant on impulsivity scale ( $F(1, 2689) = 11.76, p < 0.01$ ). In brief, analyses with the split file addressed stronger effects of sleep variables among girls on APSD-SR total score and narcissism but conversely on impulsivity among boys.

## Discussion

This study is the first one to evaluate the association between sleep and psychopathic features in a large, representative community sample of adolescents. This study shows that youth with frequent and persistent sleep problems as well as continuous short sleep duration had significantly higher scores on APSD-SR measure reflecting psychopathic behaviors than other adolescents. Interestingly, in our study girls who had both qualitative and quantitative sleep problems scored highest on the APSD-SR scale. However, boys having either short sleep or frequent and persistent sleep problems reported higher psychopathic features than girls. This might indicate that girls who have severe qualitative and quantitative sleep problems are a special subgroup that needs closer inspection in the context of psychopathic-like behaviour.

This study also investigated severe qualitative and quantitative sleep problems among boys and girls. In our population-based sample of 15-16-year-olds, we found that more than 3% of adolescents sleep too little on all nights and 5% subjectively reported having sleep problems at least three times per week for one or more years. Previous studies have yielded greater proportions of sleep problems among adolescents than we reported [3-5,9] which is not surprising, because we focused on a special group of youth: those who have severe qualitative and quantitative sleep problems. Girls had more frequent and persistent sleep problems than boys but boys reported shorter sleep duration with 7 or less hours of sleep on school and weekend nights. The results are in line with previous studies reporting that girls have more sleep problems [8,9,13] and boys insufficient sleep amount [11-13] compared to the other sex, as we hypothesized.

Two earlier studies [44,46] reported no associations between psychopathy and sleep problems, but these studies had considerable limitations and both used adult samples. Thus, it is not possible to compare our results with these studies. However, a study of evening type orientation and Dark Triad traits [45] found an association between psychopathic features and eveningness which in turn has been linked to poor sleep and shorter sleep length on week nights [11,12]. Although the study of Jonason et al. [45] does not show causality of eveningness and psychopathy, it might give some hint of underlying biological mechanisms from an evolutionary perspective; they suggest that dark personalities may tend to be awake late at night because it is the time when other people are usually less active and so weak regarding their cognitive capacity. Another novel study [28] found that psychopathy correlated positively with sleep disturbances among adults. Our findings are novel in a western sample of adolescents and in respect of studying both qualitative and quantitative aspects of sleep. Our results are supported by the adult study findings of Sabouri et al. [28].

Regarding impulsivity, our study supports previous reports describing a relationship between sleep problems and impulsivity [1,4,26]. Many previous studies have reported on associations between aggressive or violent behavior and sleep problems or reduced sleep amount in adolescents [4,13,21]. Our results are in line with these findings as impulsivity is often associated with aggression and violent behavior in adolescents. More detailed examination revealed that the

effect of qualitative or quantitative sleep problems on impulsivity was stronger for boys than for girls. This finding may suggest that boys are more vulnerable to the effects of poor sleep related to impulsivity or violent behavior as other studies have also reported [4,21]. Besides impulsivity, our results indicate that qualitative and quantitative sleep problems are associated also with changes within the interpersonal-affective domain among adolescents. No earlier studies were found to report on the effects of sleep on narcissistic and callous-unemotional features in adolescents. However, Brand et al. [14] studied emotional competence among adolescents and found a link between emotional control of one's own emotions and sleep problems. The associations between sleep variables and APSD-SR total score and narcissism subscale were stronger in girls than in boys. This suggests that adolescent girls are even more susceptible to the effects of severe sleep problems, with respect to narcissistic behaviors such as bragging or blaming others for one's own mistakes.

There are indications from adult samples that sleep-deprived individuals appear to be both more self-focused and less empathic than when fully rested [42]. On the contrary to the other subscales (impulsivity and narcissism) our results showed that there was not an interaction effect of sleep quality and quantity on callous-unemotional traits: only direct effects of sleep variables were found. In other words, associations between callous-unemotional traits and qualitative sleep problems did not depend on sleep amount or gender. Callous-unemotional traits have gained a lot of attention in the past 20 years and in fact, studies have started to focus on those youth who are callous and unemotional without other characteristics of antisocial behavior [53]. Also according to this study, callous-unemotional features seem to be a special component of psychopathic traits and might deserve more attention in a context of adolescent poor sleep.

Our results suggest that especially high frequency and persistence of both sleep problems and sleep deprivation may increase the risk of psychopathic-type behaviors emerging. Accordingly, continuous sleep problems may change brain functioning [19] or alternatively, psychopathic features may be a risk factor for sleep alterations among adolescents. It is important to recognize that several mechanisms may account for the association between poor sleep and psychopathy and the causes and consequences might be intertwined or bidirectional as in other associations between sleep and psychopathology [1,7,20]. Based on the literature, the mechanism behind the associations found between poor sleep and increased psychopathic features may possibly be attributed to changes in the functioning of brain regions responsible for impulse control, risk-taking behaviors, reinforcement learning, and emotional processing. As pointed out by Killgore [27], the functioning of emotion-regulating regions of the medial prefrontal cortex and the emotionally responsive regions of the limbic system, including the amygdala, appears to be altered in both sleep-deprived individuals and individuals with psychopathic features. It is also worth considering that sleep problems and psychopathy might share a third common etiological factor such as compromised function of the autonomic nervous system, a biological chronotype [45] or a mediating factor like home environment. Because of the cross-sectional nature of the study, no causal interpretations can be made. Future studies are needed to examine whether sleep related problems are associated with increased scores on measures investigating psychopathic tendencies, and whether in some individuals deprived sleep instead of a psychopathic temperamental trait may underlie the behavioral phenotype of psychopathic features, and also to determine whether improving sleep quality or increasing sleep amount might decrease impulsivity and increase prosocial behavior in adolescents.

The study has some limitations. The first is the lack of objective measures; as in other large-scale community surveys, both sleep and psychopathy were measured by self-report. The operationalization of sleep problems also varies between studies, making comparisons difficult, and only few studies have investigated a group of youth with severe sleep problems. Future studies on this topic using parental reports and objective measures (e.g. actigraphy or polysomnography) of sleep as well as measures of psychopathy not relying solely on self-report are needed. Second, our sample was homogeneous with regard to age; the findings thus may not be generalizable to adults or younger children. Third, because the study was cross-sectional, causal interpretations cannot be made. However, we did ask about the persistence of sleep problems and found that especially self-reported persistent and frequent sleep problems were associated with an increased amount of psychopathic features. Studying the associations between sleep and psychopathic traits, we included gender in the analyses, and there was no need to control for the age as the sample was homogeneous in respect to age. However, because of the restricted nature of the study (cross sectional self-report study evaluating associations between sleep and psychopathic traits) we were unable to control for such factors as the effects of somatic illnesses, mental health problems or criminal history of the responders or their parents, or recent stressful life events, which may have influenced scores on both sleep and psychopathy measures. Further studies are needed to evaluate what is the role of sleep in respect to other factors associated with psychopathic features in adolescents.

Our results emphasize the importance of addressing sleep among adolescents since it might be linked to their psychosocial functioning in behavioral and social domains. Especially adolescents with frequent and persistent sleep problems or those with continuous short sleep on all week nights had higher self-reported impulsivity, narcissistic, and callous-unemotional features, increasing the risk for lower behavioral control and lack of concern for others. As adolescents with sleep problems may exhibit psychopathic-like symptoms, it is important to include a detailed assessment of sleep habits and sleep alterations when assessing conduct problems and psychopathic features. Treating sleep problems may potentially diminish these symptoms, which would be of practical importance.

## Acknowledgement

This study was supported by Helsinki University Central Hospital Research Grants (EVO) TYH 2012139 and 2013207. Special thanks to D.Soc.Sc. Janne Kivivuori for his collaboration.

## References

- Owens J; Adolescent Sleep Working Group; Committee on Adolescence (2014) Insufficient sleep in adolescents and young adults: an update on causes and consequences. *Pediatrics* 134: e921-932.
- Sarchiapone M, Mandelli L, Carli V, Iosue M, Wasserman C, et al. (2014) Hours of sleep in adolescents and its association with anxiety, emotional concerns, and suicidal ideation. *Sleep Med* 15: 248-254.
- Gradisar M, Gardner G, Dohnt H (2011) Recent worldwide sleep patterns and problems during adolescence: a review and meta-analysis of age, region, and sleep. *Sleep Med* 12: 110-118.
- Hildenbrand AK, Daly BP, Nicholls E, Brooks-Holliday S, Kloss JD (2013) Increased risk for school violence-related behaviors among adolescents with insufficient sleep. *J Sch Health* 83: 408-414.
- Short MA, Gradisar M, Lack LC, Wright HR, Dohnt H (2013) The sleep patterns and well-being of Australian adolescents. *J Adolesc* 36: 103-110.
- Roberts RE, Roberts CR, Duong HT (2008) Chronic insomnia and its negative consequences for health and functioning of adolescents: a 12-month prospective study. *J Adolesc Health* 42: 294-302.
- Bartel KA, Gradisar M, Williamson P (2015) Protective and risk factors for adolescent sleep: a meta-analytic review. *Sleep Med Rev* 21: 72-85.
- Ohayon MM (2002) Epidemiology of insomnia: what we know and what we still need to learn. *Sleep Med Rev* 6: 97-111.
- Patten CA, Choi WS, Gillin JC, Pierce JP (2000) Depressive symptoms and cigarette smoking predict development and persistence of sleep problems in US adolescents. *Pediatrics* 106: E23.
- Roberts RE, Duong HT (2015) Is there an association between adolescent sleep restriction and obesity. *J Psychosom Res* 79: 651-656.
- Giannotti F, Cortesi F, Sebastiani T, Ottaviano S (2002) Circadian preference, sleep and daytime behaviour in adolescence. *J Sleep Res* 11: 191-199.
- Collado Mateo MJ, Díaz-Morales JF, Escribano Barreno C, Delgado Prieto P, Randler C (2012) Morningness-eveningness and sleep habits among adolescents: age and gender differences. *Psicothema* 24: 410-415.
- Meijer AM, Reitz E, Deković M, van den Wittenboer GL, Stoel RD (2010) Longitudinal relations between sleep quality, time in bed and adolescent problem behaviour. *J Child Psychol Psychiatry* 51: 1278-1286.
- Brand S, Kirov R, Kalak N, Gerber M, Schmidt NB, et al. (2015) Poor Sleep Is Related to Lower Emotional Competence Among Adolescents. *Behav Sleep Med* .
- McRae K, Gross JJ, Weber J, Robertson ER, Sokol-Hessner P, et al. (2012) The development of emotion regulation: an fMRI study of cognitive reappraisal in children, adolescents and young adults. *Soc Cogn Affect Neurosci* 7: 11-22.
- Colrain IM, Baker FC (2011) Changes in sleep as a function of adolescent development. *Neuropsychol Rev* 21: 5-21.
- Giedd JN, Blumenthal J, Jeffries NO, Castellanos FX, Liu H, et al. (1999) Brain development during childhood and adolescence: a longitudinal MRI study. *Nat Neurosci* 2: 861-863.
- Steinberg L, Dahl R, Keating D, Kupfer D, Masten A, et al. (2006) Psychopathology in adolescence: Integrating affective neuroscience with the study of context. In: Cicchetti D, Cohen D (eds.) *Dev Neurosci-Basel*, Wiley, New York pp: 2: 710-741.
- Beebe DW (2011) Cognitive, behavioral, and functional consequences of inadequate sleep in children and adolescents. *Pediatr Clin North Am* 58: 649-665.
- Shochat T, Cohen-Zion M, Tzischinsky O (2014) Functional consequences of inadequate sleep in adolescents: a systematic review. *Sleep Med Rev* 18: 75-87.
- Backman H, Laajasalo T, Saukkonen S, Salmi V, Kivivuori J, et al. (2015) Are qualitative and quantitative sleep problems associated with delinquency when controlling for psychopathic features and parental supervision?. *J Sleep Res* 24: 543-548.
- Aronen ET, Lampenius T, Fontell T, Simola P (2014) Sleep in children with disruptive behavioral disorders. *Behav Sleep Med* 12: 373-388.
- Owens JA, Maxim R, Nobile C, McGuinn M, Msall M (2000) Parental and self-report of sleep in children with attention-deficit/hyperactivity disorder. *Arch Pediatr Adolesc Med* 154: 549-555.
- Reigstad B, Jørgensen K, Sund AM, Wichstrøm L (2010) Prevalences and correlates of sleep problems among adolescents in specialty mental health services and in the community: what differs? *Nord J Psychiatry* 64: 172-180.
- Roberts RE, Roberts CR, Duong HT (2009) Sleepless in adolescence: prospective data on sleep deprivation, health and functioning. *J Adolesc* 32: 1045-1057.
- Kamphuis J, Meerlo P, Koolhaas JM, Lancel M (2012) Poor sleep as a potential causal factor in aggression and violence. *Sleep Med* 13: 327-334.
- Killgore WD (2013) Self-reported sleep correlates with prefrontal-amygdala functional connectivity and emotional functioning. *Sleep* 36: 1597-1608.

28. Sabouri S, Gerber M, Lemola S, Becker SP, Shamsi M, et al. (2016) Examining Dark Triad traits in relation to sleep disturbances, anxiety sensitivity and intolerance of uncertainty in young adults. *Compr Psychiatry* 68: 103-110.
29. Mullin BC, Phillips ML, Siegle GJ, Buysse DJ, Forbes EE, et al. (2013) Sleep deprivation amplifies striatal activation to monetary reward. *Psychol Med* 43: 2215-2225.
30. Venkatraman V, Chuah YM, Huettel SA, Chee MW (2007) Sleep deprivation elevates expectation of gains and attenuates response to losses following risky decisions. *Sleep* 30: 603-609.
31. Yoo SS, Gujar N, Hu P, Jolesz FA, Walker MP (2007) The human emotional brain without sleep—a prefrontal amygdala disconnect. *Curr Biol* 17: R877-878.
32. Blair RJ (2013) The neurobiology of psychopathic traits in youths. *Nat Rev Neurosci* 14: 786-799.
33. Hyde LW, Shaw DS, Hariri AR (2013) Understanding Youth Antisocial Behavior Using Neuroscience through a Developmental Psychopathology Lens: Review, Integration, and Directions for Research. *Dev Rev* 33.
34. Hare RD (1991) *Hare Psychopathy Checklist-Revised*. Multi-Health Systems, North Tonawanda, New York.
35. Frick P, Bodin S, Barry C (2000) Psychopathic traits and conduct problems in community and clinic-referred samples of children. Further development of the Psychopathy Screening Device. *Psychol Assessment* 12: 382-393.
36. Laajasalo T, Saukkonen S, Kivivuori J, Salmi V, Lipsanen J, et al. (2014) Brief report: self-reported psychopathic-like features among Finnish community youth: investigation of the factor structure of the Antisocial Personality Screening Device. *J Adolesc* 37: 1185-1188.
37. Vitacco MJ, Rogers R, Neumann CS (2003) The antisocial process screening device: an examination of its construct and criterion-related validity. *Assessment* 10: 143-150.
38. Frick PJ, Ray JV, Thornton LC, Kahn RE (2014) Can callous-unemotional traits enhance the understanding, diagnosis, and treatment of serious conduct problems in children and adolescents? A comprehensive review. *Psychol Bulletin* 140: 1-57.
39. Dawel A, O'Kearney R, McKone E, Palermo R (2012) Not just fear and sadness: meta-analytic evidence of pervasive emotion recognition deficits for facial and vocal expressions in psychopathy. *Neurosci Biobehav Rev* 36: 2288-2304.
40. Marsh AA, Finger EC, Mitchell DG, Reid ME, Sims C, et al. (2008) Reduced amygdala response to fearful expressions in children and adolescents with callous-unemotional traits and disruptive behavior disorders. *Am J Psychiatry* 165: 712-720.
41. Mitchell D, Colledge E, Leonard A, Blair R (2002) Risky decisions and response reversal: is there evidence of orbitofrontal cortex dysfunction in psychopathic individuals? *Neuropsychologia* 40: 2013-2022.
42. Killgore WD, Kahn-Greene ET, Lipizzi EL, Newman RA, Kamimori GH, et al. (2008) Sleep deprivation reduces perceived emotional intelligence and constructive thinking skills. *Sleep Med* 9: 517-526.
43. Hare RD (1970) *Psychopathy: Theory and Research*. Wiley, New York.
44. Harty L, Forkner RD, Thompson A, Stuewig J, Tangney JP (2010) Are inmates' subjective sleep problems associated with borderline personality, psychopathy, and antisocial personality independent of depression and substance dependence? *J Foren Psychi Psych* 21: 23-39.
45. Jonason PK, Jones A, Lyons M (2013) Creatures of the night: Chronotypes and the Dark Triad traits. *Pers Individ Differ* 55: 538-541.
46. Salley RD, Khanna P, Byrum W, Hutt LD (1980) REM sleep and EEG abnormalities in criminal psychopaths. *Percept Mot Skills* 51: 715-722.
47. Kivivuori J, Bernburg JG (2011) Delinquency Research in the Nordic Countries, in: *Crime and Justice in Scandinavia. Crime Justice-A Review of Research*, University of Chicago Press, Chicago pp: 405-478.
48. Kivivuori J, Salmi V, Walser S (2013) Supervision mode effects in computerized delinquency surveys at school: Finnish replication of a Swiss experiment. *J Exp Criminology* 9: 91-107.
49. Finnish Advisory Board on Research Integrity (2009) Ethical principles of research in the humanities and social and behavioural sciences and proposals for ethical review.
50. Bruni O, Ottaviano S, Guidetti V, Romoli M, Innocenzi M, et al. (1996) The Sleep Disturbance Scale for Children (SDSC). Construction and validation of an instrument to evaluate sleep disturbances in childhood and adolescence. *J Sleep Res* 5: 251-261.
51. Frick PJ, Hare RD (2001) *Antisocial Process Screening Device (APSD)*. (1stedn), Multi-Health Systems Inc., Canada.
52. Hare RD (2003) *The Psychopathy Checklist-Revised*. (2ndedn), Multi-Health Systems Inc., Toronto.
53. Frick PJ, Cornell AH, Barry CT, Bodin SD, Dane HE (2003) Callous-unemotional traits and conduct problems in the prediction of conduct problem severity, aggression, and self-report of delinquency. *J Abnorm Child Psych* 31: 457-470.