Sleep Medicine xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Sleep Medicine

journal homepage: www.elsevier.com/locate/sleep

Original Article

Hours of sleep in adolescents and its association with anxiety, emotional concerns, and suicidal ideation

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ARTICLE INFO

Article history:
Received 27 November 2012
Received in revised form 18 November 2013
Accepted 20 November 2013
Available online xxxx

Keywords:
SEYLE study
Sleep
Adolescents
Psychosocial difficulties
Anxiety
Suicidal ideation

ABSTRACT

Objectives: Anxiety and concerns in daily life may result in sleep problems and consistent evidence suggests that inadequate sleep has several negative consequences on cognitive performance, physical activity, and health. The aim of our study was to evaluate the association between mean hours of sleep per night, psychologic distress, and behavioral concerns.

Methods: A cross-sectional analysis of the correlation between the number of hours of sleep per night and the Zung Self-rating Anxiety Scale (Z-SAS), the Paykel Suicidal Scale (PSS), and the Strengths and Difficulties Questionnaire (SDQ), was performed on 11,788 pupils (mean age ± standard deviation [SD], 14.9 ± 0.9; 55.8% girls) from 11 different European countries enrolled in the SEYLE (Saving and Empowering Young Lives in Europe) project.

Results: The mean number of reported hours of sleep per night during school days was 7.7 (SD, ±1.3), with moderate differences across countries ($r = 0.06$; $P < .001$). A reduced number of sleeping hours (less than the average) was more common in girls ($\beta = 0.10$ controlling for age) and older pupils ($\beta = 0.10$ controlling for sex). Reduced sleep was found to be associated with increased scores on SDQ subscales of emotional ($\beta = -0.13$) and peer-related problems ($\beta = -0.06$), conduct ($\beta = -0.07$), total SDQ score ($\beta = -0.07$), anxiety (Z-SAS scores, $\beta = -10$), and suicidal ideation (PSS, $\beta = -0.16$). In a multivariate model including all significant variables, older age, emotional and peer-related problems, and suicidal ideation were the variables most strongly associated with reduced sleep hours, though female gender, conduct problems measured by the SDQ, and anxiety only showed modest effects ($\beta = 0.03$–0.04).

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1389-9457/$ - see front matter
http://dx.doi.org/10.1016/j.sleep.2013.11.780

Conclusions: Our study supports evidence that reduced hours of sleep are associated with potentially severe mental health problems in adolescents. Because sleep problems are common among adolescents partly due to maturational processes and changes in sleep patterns, parents, other adults, and adolescents should pay more attention to their sleep patterns and implement interventions, if needed.

1. Introduction

Adequate sleep is essential for good health and optimal physical and cognitive performance [1,2]. Insufficient sleep not only interferes with quality of life and general well-being, but it also may be hazardous to one's health and the well-being of the public. There is evidence that sleep loss may affect emotional function [3] and chronically disrupted sleep may increase the risk for developing affective symptoms [4,5]. In particular, high prevalence and comorbidity of anxiety and sleep problems suggest an important association between these two disorders. There is evidence of a bidirectional relationship in the course of disturbances (i.e., poor sleep increasing the risk for later anxiety disorder and primary anxiety developing into insomnia) [6]. Importantly, there is evidence that sleep complaints are more common in suicidal patients [7,8]. Indeed insufficient sleep and sleep disturbances are common in depressive disorders and other psychopathologic conditions potentially associated with suicidal risk. In a large community sample of 5692 adults in the United States, the presence of sleep problems (e.g., early morning waking, difficulty initiating or maintaining sleep) was significantly related to each measure of suicidality, including suicidal ideation, suicide planning, and suicide attempts [9].

Sleep problems in children and adolescents are common and sleep disruption is associated with a wide range of behavioral, cognitive, and mood impairments [10]. Biologic studies indicate considerable changes in sleep architecture during adolescence, such as changes in melatonin secretion and a need for greater total sleep time, possibly due to maturational changes in the neuronal connectivity [11,12]. Due to circadian changes, teenagers also have a delayed sleep pattern and prefer to go to sleep between 2:00 am and 6:00 am and wake up between 10:00 am and 1:00 pm [13]. However, despite a physiologic need for 9 h of sleep each night, teenagers on average only sleep 7 h per night [14] to meet the challenges of school, sports, part-time jobs, family, and friends [15].

Many clinical studies in adolescents have consistently reported that reduced hours of sleep are associated with emotional problems such as depressive and anxiety symptoms [16,17], in addition to self-harm and suicidal ideation [18]. Poor sleep also has been correlated with increased aggression, irritability, and hostility in both adults and adolescents; conduct problems and bullying behavior in schoolchildren [19–21]; and habitual substance use [22], self-injurious behaviors [23], and suicide attempt overall [24–26]. It has been hypothesized that the relationship between sleep problems and aggression may be mediated by the negative effect of sleep loss on prefrontal cortical functioning, resulting in loss of control over emotions and regulation of aggressive impulses. Other potentially contributing mechanisms connecting sleep problems with aggression and violence have been linked to alterations in functioning of the central serotoninergic system and the hypothalamic–pituitary–adrenal-axis [5].

Given this evidence, our study was designed to investigate the effect of number of sleep hours on both emotional and behavioral problems in adolescents. Indeed we had a unique opportunity to analyze data collected on a large cohort of pupils (12,395 pupils from 11 European countries; average age, 15 years) extensively evaluated for emotional and behavioral problems, including anxiety, suicidal ideation and hyperactivity, together with information regarding average hours of sleep during school days. Because most studies mentioned above focused on clinical samples (i.e., adolescents with recognized emotional and behavioral problems), it was of interest to evaluate if the same association was present in adolescents recruited from community settings; this evaluation also enabled us to evaluate the potential benefit of widespread preventive interventions at the same time.

2. Methods

2.1. Description of study sample

The SEYLE study comprises a sample of 12,395 adolescents recruited from 179 randomly selected schools within 11 study sites in the following countries: Austria, Estonia, France, Germany, Hungary, Ireland, Israel, Italy, Romania, Slovenia, and Spain; Sweden served as the coordinating center [27]. All questionnaires were administered in the official languages of the respective countries. In each country, a list of all eligible schools within the study sites was generated according to specific inclusion and exclusion criteria to assure that representativeness and schools were then randomly selected [27]. Baseline evaluations were performed during the autumn of 2009 (eight countries) and spring of 2010 (three countries).

2.2. Participation rates

The overall rate of consent in the first eight countries was 76% (Estonia, Germany, Hungary, Ireland, Israel, Italy, Romania, and Spain). In the other three countries (Austria, France, and Slovenia) extended procedures for collection of the informed consent were imposed by the local ethics committees (i.e., multiple forms to be signed, pupil could only be enrolled only if both parents signed the form). This consent resulted in the postponement of pupil recruitment and a lower rate of consent in these countries (23%). When including these three countries in the analysis, the overall rate of consent decreased to 49%; however, the results of the study did not differ when analyzing the whole sample or when excluding the three countries with lower rates of consent. This finding suggests that the external validity of our sample was high.

2.3. Representativeness of the study sample

To assess the potential representativeness of the data from each study site key parameters, such as mean age, number of immigrants, population density, net income, and sex proportion, were compared to the corresponding national data. Data at the national and local levels were extracted from Eurostat (http://epp.eurostat.ec.europa.eu). According to our previous analysis, the adolescents participating in the SEYLE study were reasonably representative of their respective country [28].

2.4. Measures

A structured questionnaire was administered to adolescents to collect a large number of demographic, psychosocial, and behav-

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ioral data within the context of the SEYLE project [27]. The employed questionnaire used a process translation and cultural adaptation. All the scales included in the questionnaire were included in the officially translated and validated version in the respective language when available. If the scale was not available in the required language, it was translated (and back-translated) using the same procedure as the other study materials. Internal reliability for all scales used in SEYLE was assessed using Cronbach α. The questionnaire included the question, "On average, how many hours per night do you sleep (Monday–Friday) (Answer in hours)?" The note in brackets (Monday–Friday) was specifically incorporated in the question to focus on sleep during school days. The questionnaire also included scales for the evaluation of anxiety symptoms (Zung Self-rating Anxiety Scale [Z-SAS] [29]), suicidal ideation (Paykel Suicidal Scale [PSS]) [30], and emotional and behavioral disturbances (Strengths and Difficulties Questionnaire [SDQ]) [31]. The Z-SAS is a 20-item self-report assessment instrument, which includes measures of state and trait anxiety based on scoring in four groups of manifestations: cognitive, autonomic, motor, and central nervous system symptoms. The PSS is a 5-item scale that assesses thoughts of death ("Have you felt that life was not worth living?" "Have you wished that you were dead?"), suicide ideation ("Have you thought of taking your life, even if you would not really do it?" "Have you reached the point where you seriously considered taking your life or perhaps made plans how you would go about doing it?"), and suicide attempt ("Have you tried to take your own life?") in the past 2 weeks. The SDQ is a brief behavioral screening questionnaire comprising 25 items divided in five subscales: (1) emotional symptoms (i.e., "I worry a lot," "I am often unhappy, down-hearted, or tearful"); (2) conduct problems (i.e., "I am constantly fidgeting or squirming," "I am often accused of lying or cheating"); (3) hyperactivity/inattention (i.e., "I am restless and I cannot stay still for long," "I am easily distracted or I find it difficult to concentrate"); (4) peer relationship problems (i.e., "I am usually on my own," I generally play alone or keep to myself," "I get on better with adults than with people my own age"); and (5) prosocial behavior (i.e., "I try to be nice to other people," I care about their feelings," "I usually share with others [food, games, pens etc.]"). A total SDQ score is derived from the sum of scores of the first four scales summarizing emotional, behavioral, and interpersonal problems. These scales showed adequate internal consistency in each country [27] and in the overall sample (Z-SAS, = 0.81; PSS, = 0.76; SDQ, = 0.74).

2.5. Statistical analyses

All analyses were performed using the Statistical Package for the Social Sciences (SPSS) software [32]. Descriptive statistics, such as mean, standard deviation (SD), and percentages (%) were calculated. Normal distribution of hours of sleep in the whole sample n addition to other continuous variables, were tested by the Kolmogorov–Smirnov (K–S) test. The variable age was transformed in an ordinal variable at 3 levels ($\leqslant$14, 15, $\geqslant$16), as less than 8% of pupils were younger than the age 14 years or older than 16 years. Because the distribution of hours slept per night was skewed to the left (K–S, $d = 0.18$; $P < .01$ [skewness, 0.13; standard error, 0.02]), nonparametric tests, such as the Mann–Whitney U test, the Kruskal–Wallis analysis of variance, the nonparametric χ^2 test, and the Spearman rank correlation test were utilized. The Cronbach α coefficient for each scale in each language in which the scale was administered was calculated to test its internal consistency (i.e., reliability of the scale) in our sample of pupils. Significant associations were further controlled for age and sex by regression analysis (all effects). A further regression (all effects) was performed to test the strength of association of significant variables in the same model with the average number of hours of sleep in adolescents.

The variance inflation factor was calculated to test for collinearity. For significant associations, effect sizes in r coefficients, and standardized β coefficients for regression analyses also were calculated to have an estimate of the strength of associations. In our sample, we had a high power of 0.95 to detect small effect sizes of $r = 0.005$ when comparing two groups by a nonparametric test on a continuous variable; for example, we corresponded variables to a difference of 0.12 points when comparing boys and girls on the number of hours of sleep, with an α value as small as 0.001. However, only medium–large differences ($r > 0.06$ or standardized $\beta > 0.05$ in regression analysis) were considered as relevant.

3. Results

There were 11,788 pupils who provided data on their number of sleep hours per night during school days (Monday–Friday). The main sociodemographic and psychopathologic features of the responding pupils stratified for countries are summarized in Table 1. Remarkable differences were observed in the number of sleep hours, conduct problems at the SDQ self-evaluation, and age.

Overall, adolescents reported sleeping an average of 7.7 ± 1.3 h per night (Monday–Friday). As reported in Table 1, the Kruskal–Wallis analysis of variance test (H) revealed that number of hours of sleep per night was moderately different across countries ($P < .001$; $r = 0.06$) (Fig. 1). Further mean hours of sleep tended to slightly decrease with age ($r = 0.015$) and to be lower among girls ($r = 0.015$) (see Table 2 for details).

Controlling for age and sex, the mean number of hours of sleep per night was inversely correlated to emotional problems, conduct problems, peer problems, and total SDQ scores. A negative correlation also was found with Z-SAS scores (anxiety symptoms) and PSS scores (suicidal ideation) (Table 3).

We finally performed a regression model in which we simultaneously entered all significant variables as independent variables and the average number of hours of sleep during school days in adolescents' dependent variable to test the independent impact of each variable. Results are reported in Table 4. Variables maintaining significant a association with hours of sleep per night were older age, emotional and peer problems at the SDQ, and suicidal ideation as measured by the PSS. Female gender, conduct problems at the SDQ, and high anxiety at the Z-SAS showed small–medium associations with hours of sleep per night.

4. Discussion

The major finding of our study was the correlation between reduced number of hours of sleep per night during school days and emotional problems, as well as the risk for suicidal ideation in adolescents. Due to the large sample size and the fact that the SEYLE sites have been shown to be representative of their respective countries [28], the findings reported here, which focused on the effect of sleep on adolescents' emotional and behavioral adjustment, can be considered valid within each of the 11 participating countries. Our results indicate that pupils between the ages of 14–16 years generally sleep approximately 8 h per night during school days. Hours of sleep tended to decrease with age and girls generally slept less than boys. Although this amount of sleep is not strikingly low, it is of considerable interest to examine if there is any association between hours of sleep and psychologic and behavioral problems, respectively.

The association between emotional problems (SDQ) and reduced sleep is in line with established evidence that inadequate sleep affects emotional symptoms [3] and increases risk for devel-

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Table 1
Main sociodemographic and psychopathologic features of the sample stratified across countries.

	Country of pupil																						χ^2 test	P value	Effect (φ)*
	Austria (N = 932)		Estonia (N = 1033)		France (N = 1004)		Germany (N = 1439)		Hungary (N = 985)		Ireland (N = 963)		Israel (N = 1183)		Italy (N = 1188)		Romania (N = 1127)		Slovenia (N = 1162)		Spain (N = 1025)				
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%			
Sex (boys)	341	38	453	46	312	31	676	48	364	41	528	54	882	81	379	32	389	35	331	30	526	52	950.62	<.001	0.28
Living with biological parents	814	87	812	82	884	89	1188	84	749	85	868	88	852	79	1122	95	1039	93	1024	92	867	85	227.40	<.001	0.14
	Med	L-UQ	Med	L-UQ	Med	L-UQ	Med	L-UQ	Med	L-UQ	Med	L-UQ	Med	L-UQ	Med	L-UQ	Med	L-UQ	Med	L-UQ	Med	L-UQ	H	P value	r**
Sleep (h)	7	7–9	7	7–9	7	7–9	8	7–10	7	7–9	8	8–10	8	7–11	8	7–9	8	7–10	7	7–9	8	7–10	749.09	<.001	0.06
Age (y)	15	15–16	14	14–15	15	15–16	15	14–16	15	15–16	14	13–15	16	15–17	15	15–16	15	15–16	15	15–16	14	14–16	4892.74	<.001	0.40
SDQ subscales																									
Emotional problems	2	1–7	2	1–7	3	1–8	3	1–7	2	1–7	2	1–7	3	1–7	2	1–7	2	1–7	3	2–7	3	2–7	259.10	<.001	0.02
Hyperactivity	5	4–7	4	3–6	4	3–7	4	3–7	4	3–7	4	4–7	4	3–7	4	3–7	4	4–7	4	3–7	5	4–8	350.40	<.001	0.03
Prosocial	8	7–10	7	6–10	8	7–10	8	6–10	7	6–10	8	6–10	7	5–10	7	6–9	8	6–10	8	7–10	8	7–10	626.51	<.001	0.05
Z-SAS	35	32–44	33	31–42	34	31–45	35	32–45	34	31–42	33	30–42	32	29–46	35	32–48	34	31–44	35	32–45	34	30–43	366.61	<.001	0.03
PSS	0	0–7	0	0–6	0	0–9	0	0–9	0	0–5	0	0–5	0	0–11	0	0–6	0	0–5	0	0–8	0	0–7	252.59	<.001	0.03

Abbreviations: Med, median; L-UQ, lower–upper quartiles; h, hours; y, years; SDQ, Strengths and Difficulty Questionnaire; Z-SAS, Zung Self-rating Anxiety Scale in grey medium-large effects; PSS, Paykel Suicidal ideation Scale.
* Cramer φ effect: small, 0.1; medium, 0.3; large, 0.50.
** r effect: small, 0.01; medium, 0.06; large, 0.14.

oping affective symptoms [4,5]. Association between reduced number of sleep hours and suicidal ideation (PSS) also is in line with previous reports [23–26]. We did not control for depressive symptoms in our study, but the study by Lee et al. [18] reported a strong association between reduced sleep (<7 h) and suicidal ideation, independent of depressive symptoms. However, we did control for anxiety symptoms at the Z-SAS and emotional problems at the SDQ. Controlling for these variables, the association between reduced sleep per night and suicidal ideation was independently maintained. This finding is noteworthy and confirms the results by Lee et al. [18], who suggested that suicidal ideation may not be fully explained by depression or emotional problems alone. In these data, emotional problems were strongly correlated with suicidal ideation ($r = 0.41$; $P < .001$). Anxiety also was found to be associated with sleep hours per night in adolescents, though the association was small. This finding is in line with previous evidence [4,5].

Overall it is not possible to determine if reduced sleep results in emotional disturbances or if emotional problems increase the risk for reduced sleep from these cross-sectional data. It has been reported that there may be a bidirectional relation in the course of these disturbances (i.e., poor sleep increases the risk for a later emotional disorder and primary emotional problems increasing the risk for later insomnia) [6]. Although cross-sectional data are not able to determine causality, it is well-known that sleep is essential for recovery of central nervous system injury, optimal physical and cognitive performance, quality of life, and general well-being [3]. A reduced number of sleep hours also may be associated with a number of other explanations apart from emotional distress (i.e., primary insomnia, sleep disturbance induced by a medical condition, familial or individual lifestyles, and natural individual need of sleep). In our study we were unable to check for these variables, with the exception of an extra sleep during weekend days, as we specifically asked for the average number of sleep hours during school days (Monday–Friday). However, it is reasonable to think that specific conditions did not have an impact on the overall significance of the results obtained from such a large sample.

We also found that reduced sleep correlated with behavioral problems such as conduct and peer problems. These observations may support the hypothesis that sleep problems may be associated with deviant behavior and interpersonal problems [20,21]. The major strength of our study was its large sample size allowing for a robust picture of adolescents regarding their sleep patterns and associated indicators of their psychosocial well-being. Because the adolescents participating in the SEYLE study were reasonably representative of their respective country [28], these findings are most likely to be valid for all European adolescents.

A limitation of our study is that all data collected were derived from a self-administered questionnaire, including measurement of the individual mean number of hours of sleep. Self-evaluation tools are unfortunately at risk for being affected by cognitive biases, including recall bias, erroneous self-perception, as well as the desire to please or displease, or to provoke, particularly in adolescents. In particular, some variables such as overcommitment, low level of social support, and poor self-rated health have been shown to be associated with overreporting of sleep difficulties and underestimation of sleep efficiency regarding sleep in working adults. Therefore, self-reported evaluations among adolescents of hours of sleep also may be influenced by psychosocial characteristics to some extent [33]. Furthermore concerning participation rates, it should be noted that there were slightly more girls (55.8%) than boys in our study. We may hypothesize that girls may be more collaborative and sensitive to psychologic and emotional factors than boys overall, leading to a higher consent rate in girls and participation rate; we also can hypothesize that sex-related cultural factors

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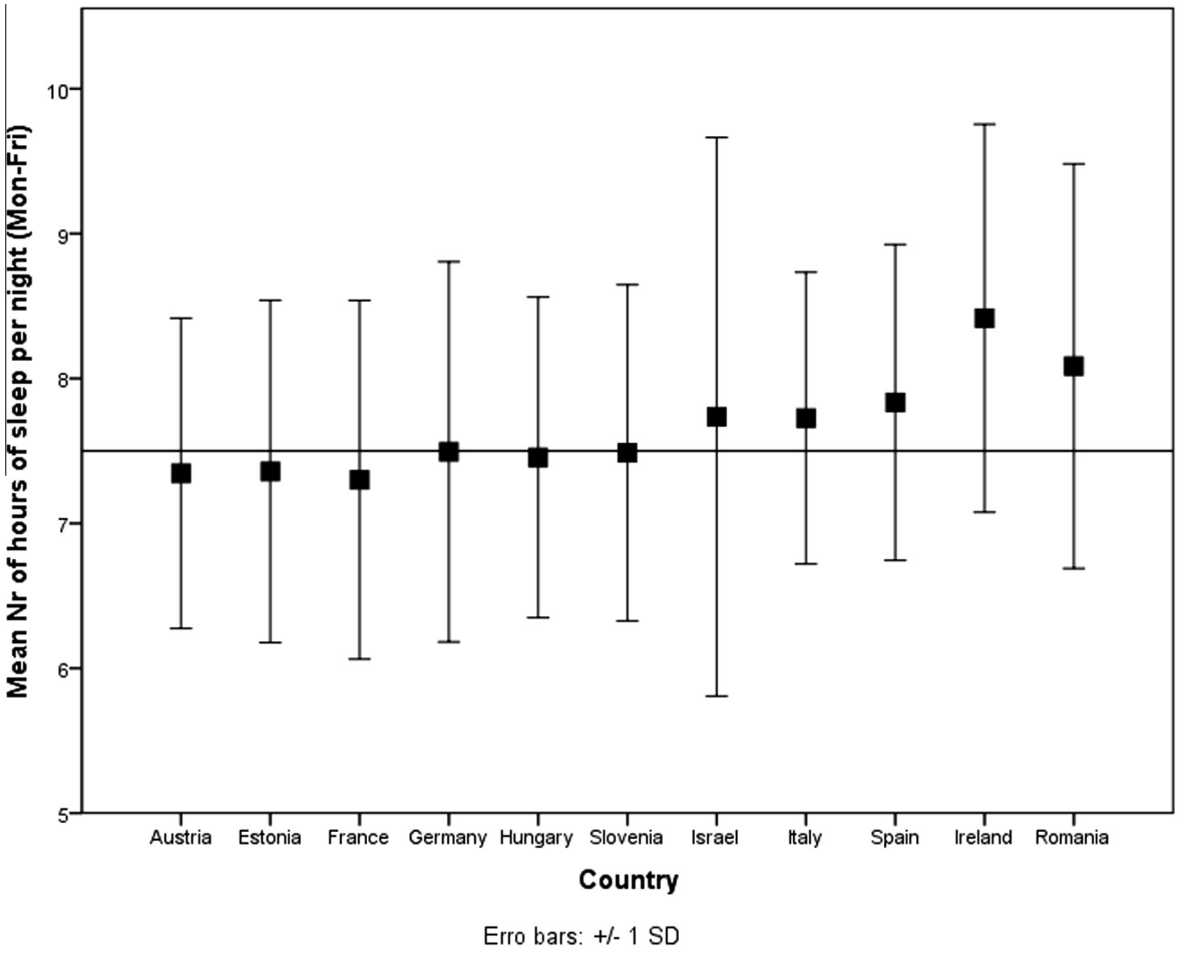

Fig. 1. Mean hours of sleep stratified by country.

Table 2
Mean hours of sleep stratified for sex and age cohorts.

Sex	Mann–Whitney test[§]					
	n	Median	Lower–upper quartiles	*z* score	*P* values	Effect size (*r*)
Boys	5181	8	7–9	−10.54	<.001[§]	0.10
Girls	6552	8	7–8			
	11,733	(missing *n* = 55)				
Age (y)[*]	Kruskal–Wallis ANOVA[§§]					
	N	Median	Lower–upper quartiles	*H*	*P* value	Effect size (*r*)
⩽14	3809	8	7–9	197.42	<.001	0.015
15	5134	8	7–8			
⩾16	2776	7	7–8			
	12,313	(missing = 82)				

Abbreviations: y, years; ANOVA, analysis of variance.
[*] Adolescents aged 12 or 19 years or older were removed from the analysis due to insufficient data.
[§§] Controlling for sex, the difference among age cohorts remained significant ($\beta = 0.10$; $P < .001$).
[§] Controlling for age, the difference between sexes remained significant ($\beta = 0.10$; $P < .001$).

may have had an impact on consent to participate. Finally, the cross-sectional design of our study cannot account for causality of relationships, as previously noted.

Our study supports previous evidence that reduced sleep may have consequences on the psychosocial adjustment of adolescents, particularly on negative emotions and suicidal risk. Because sleep problems are common among young individuals [10] and are at least partially the result of significant changes in sleep architecture during adolescence due to maturational changes in neuronal connectivity [11,12], individuals who deal with this age population should consider sleep problems as an important factor and implement necessary interventions to help adolescents better engage in healthy lifestyles and habits. Parents and adolescents should be advised about the importance of adequate hours of sleep.

Funding sources

The SEYLE project is supported through Coordination Theme 1 (Health) of the European Union Seventh Framework Program

Table 3
Correlations between hours of sleep per night (Monday–Friday), Strengths and Difficulty Questionnaire subscales, Zung Self-rating Anxiety Scale, Paykel Suicidal ideation Scale scores.

Hours of sleep per night (Monday–Friday)					
	N	Spearman Rho	*P* value	β coefficients* (95% CI)	*P* value*
Emotional problems (SDQ)	11,768	−0.17	<.001	−0.13 (−0.34 to 0.09)	<.001
Hyperactivity (SDQ)	11,768	−0.05	<.001	−0.05 (−0.07 to −0.03)	<.001
Prosocial (SDQ)	11,768	−0.01	.20	0.03 (0.01 to 0.05)	<.001
Z-SAS	11,532	−0.10	<.001	0.14 (−0.06 to 0.34)	<.001
PSS	11,397	−0.16	<.001	−0.11 (−0.15 to −0.07)	<.001

Abbreviations: CI, confidence interval; SDQ, Strengths and Difficulty Questionnaire; Z-SAS, Zung Self-rating Anziety Scale; PSS, Paykel Suicidal ideation Scale in grey medium-large effects.
* Controlling for age and sex by regression analysis.

Table 4
Emotional problems, anxiety and Suicidal ideation regressed on nr. of hours of Sleep.

Hours of sleep	Standardized β (95% CI)	*P* value	Collinearity test (VIF value)
Age	−0.07 (−0.10 to −0.03)	<.001	1.00
Sex	0.03 (−0.001 to 0.07)	.05	1.13
Emotional problems (SDQ)	−0.09 (−0.13 to −0.05)	<.001	1.48
Hyperactivity (SDQ)	−0.04 (−0.07 to −0.002)	.04	1.04
Anxiety (Z-SAS)	−0.04 (−0.08 to −0.002)	.04	1.29
Suicidal ideation (PSS)	−0.08 (−0.12 to −0.04)	<.001	1.26

Abbreviations: CI, confidence interval; VIF, Variance Inflation Factor; SDQ, Strengths and Difficulty Questionnaire; Z-SAS, Zung Self-rating Anziety Scale; PSS, Paykel Suicidal ideation Scale in grey medium-large effects.

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2013.11.780.

Acknowledgements

The SEYLE project is supported through Coordination Theme 1 (Health) of the European Union Seventh Framework Program (FP7), Grant agreement nr. HEALTH-F2-2009-223091.

The authors were independent of the funders in all aspects of study design, data analysis, and writing of this manuscript. The Project Leader and Coordinator of the SEYLE project is Professor in Psychiatry and Suicidology Danuta Wasserman, Karolinska Institute (KI), Head of the National Centre for Suicide Research and Prevention of Mental Ill-Health and Suicide (NASP), at KI, Stockholm, Sweden. Other members of the Executive Committee are Professor Marco Sarchiapone, Department of Health Sciences, University of Molise, Campobasso, Italy; Vladimir Carli, National Centre for Suicide Research and Prevention of Mental Ill-Health (NASP), Karolinska Institute, Stockholm, Sweden; Professor Christina W. Hoven and Anthropologist Camilla Wasserman, Department of Child and Adolescent Psychiatry, New York State Psychiatric Institute, Columbia University, New York, USA. The SEYLE Consortium comprises of centers in 12 European countries. Site leaders for each respective center and country are: Danuta Wasserman (NASP, Karolinska Institute, Sweden, Coordinating Centre), Christian Haring (University for Medical Information Technology, Austria), Airi Varnik (Estonian-Swedish Mental Health & Suicidology Institute, Estonia), Jean-Pierre Kahn (University of Nancy, France), Romuald Brunner (University of Heidelberg, Germany), Judit Balazs (Vadaskert Child and Adolescent Psychiatric Hospital, Hungary), Paul Corcoran (National Suicide Research Foundation, Ireland), Alan Apter (Schneider Children's Medical Centre of Israel, Tel-Aviv University, Tel Aviv, Israel), Marco Sarchiapone (University of Molise, Italy), Doina Cosman (Iuliu Hatieganu University of Medicine and Pharmacy, Romania), Vita Postuvan (University of Primorska, Slovenia) and Julio Bobes (University of Oviedo, Spain).

Support for "Ethical Issues in Research with Minors and other Vulnerable Groups" was obtained by a grant from the Botnar Foundation, Basel, for Professor of Ethics, Dr. Stella Reiter-Theil, from the Psychiatric Clinic of the University Basel, who served as the consultant to the SEYLE project.

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Please cite this article in press as: Sarchiapone M et al. Hours of sleep in adolescents and its association with anxiety, emotional concerns, and suicidal ideation. Sleep Med (2014), http://dx.doi.org/10.1016/j.sleep.2013.11.780