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ORIGINAL RESEARCH

Persistent Short Sleep from Childhood to Adolescence: Child, Parent and Peer Predictors

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Bror M Ranum[1]
Lars Wichstrøm[1,2]
Ståle Pallesen[3,4]
Jonas Falch-Madsen[1]
Silje Steinsbekk[1]

[1]Department of Psychology, Norwegian University of Science and Technology, Trondheim, Norway; [2]Department of Child and Adolescent Psychiatry, St. Olavs Hospital, Trondheim, Norway; [3]Department of Psychosocial Science, University of Bergen, Bergen, Norway; [4]Norwegian Competence Center for Sleep Disorders, Haukeland University Hospital, Bergen, Norway

Purpose: Many children have periods when they sleep too little, with widely recognized detrimental effects. Less is known about persistent short sleep during childhood. Therefore, the present study aimed to investigate the prevalence of persistent short sleep in school-aged children and identify a set of child, parent, and peer predictors thereof.

Participants and Methods: Objectively measured sleep duration (hip-held accelerometer) was biennially assessed in a community sample followed from 6 to 14 years (n=801). A latent profile analysis was applied to assess whether a subgroup of children slept consistently short across time and predictors of persistent short sleep were determined through regression analysis.

Results: A subgroup of children (n=160; 20.2%) was identified as having persistent short sleep across time. Temperamental negative affectivity (β=0.08; 95% CI=0.01, 0.15; p=0.03) and low observer-assessed parental emotional availability (β=−.09; 95% CI=−.18, −.01; p=0.04) predicted membership to that group. Teacher ratings of victimization from bullying were not associated with persistent short sleep (β=0.01; 95% CI: −.10, 11; p=0.88).

Conclusion: High child temperamental negative affectivity and low parental emotional availability may be involved in the development of persistent short sleep through childhood.

Keywords: actigraphy, childhood, early adolescence, parental emotional availability, prospective cohort study, negative affectivity, sleep duration, insufficient sleep, victimization from bullying

Introduction

Short sleep is associated with negative health outcomes in children, such as cardiometabolic risk,[1] symptoms of psychiatric disorders,[2] and cognitive and behavioral problems.[3] Sleep duration among children and adolescents has declined significantly during the past century,[4] and many parents (6[5] –50%[6]) report that their children sleep insufficiently on a regular basis, underscoring the potential gravity of this historic trend for children's health and development. For adults, sleep curtailment has been shown to produce adverse long-term effects.[7] Whether this is also true of children is unknown because of the paucity of prospective studies. Notably, a systematic review of emerging evidence suggests that shortened sleep is associated with reduced brain function in children and adolescents in the short term.[8] Experimental evidence moreover indicates that children take longer to recover from sleep curtailment than adults,[9] adding to this concern. It is plausible that the negative outcomes seen after such relatively brief periods of sleep deprivation would be even more pronounced if shortened sleep continues for longer periods. Interventions and treatment efforts toward persistent short sleep in children

Correspondence: Bror M Ranum
Department of Psychology, Norwegian University of Science and Technology, Trondheim 7049, Norway
Tel +4795156994
Email bror.ranum@ntnu.no

would benefit from knowledge of its predictors. At present, such predictors are not sufficiently explored.

Even though the stability of sleep duration from one assessment point to the next is only modest to moderate in childhood,[10–12] indicating that most children will outgrow short sleep, a sub-group of children characterized by curtailed sleep over longer time-periods during development may still exist. However, which children this encompass, how many are affected, and predictors thereof are currently unknown.

Identifying a valid cut-off point for insufficient sleep duration at any one point in development is associated with many complexities and remains difficult to pinpoint.[13] Defining persistent insufficient sleep carries additional challenges because some children may fluctuate slightly above or below a predefined cut-point during development, thereby not being defined as persistent short sleepers through childhood according to such criteria (eg, less than 7 hours), even though they sleep consistently less than others. Therefore, it is timely to ask whether a class of children consistently sleeping little—and less than others—throughout childhood can be identified.

If such a class of children can be identified, its predictors should be determined. Theoretical models of insomnia[14] and results from experimental[15] and cross-sectional research[16] converge in underscoring that downregulation of arousal is needed for sleep initiation and maintenance and thus sleeping adequately. According to ecological[17] and transactional[18] models of development, impaired downregulation abilities may stem from endogenous child (eg, temperament), parent (eg, parenting style) or environmental factors (eg, school environment and peer relations), including their interactions. In the present inquiry, and as outlined in detail below, we focus on temperamental negative affectivity, parents' emotional availability and bullying from peers as potential predictors.

Negative Affectivity and Sleep

Temperamental negative affectivity refers to the tendency to experience negative emotions (eg, sadness, fear, anger, and discomfort) more often, more intensely, and for a longer duration than others.[19] Physiological-emotional reactivity—corresponding to temperamental negative affectivity—is theorized to be one of the most important endogenous child factors influencing sleep.[20] Empirical evidence from early childhood studies supports this claim. Infants and preschool children with high negative affectivity are perceived by their mothers to have more difficulties falling asleep,[21] which is associated with shorter sleep.[22] However, less is known about the role of negative affectivity in school-aged children and adolescents' sleep. A cross-sectional study revealed that 6–13-year-olds who expressed their emotions more frequently and intensely than their peers also slept shorter[23] but prospective studies and evidence for the direction of influence are scarce. Only two studies seem to exist,[24] both showing that short sleep (parent report by questionnaire[25] and time diaries[6]) at age 6 was predicted by difficult temperament (closely related to high negative affectivity). The conclusions that can be drawn from these studies are limited for two methodological reasons: sleep duration and temperament were both parent-reported; thus, their association may be confounded by common method bias.[26] Moreover, the correspondence between parent- or self-reported sleep and objectively measured sleep is modest[27] and varies according to the sleep parameters assessed, the recall period, whether schooldays are distinguished from days off from school, as well as respondent- and data collection method.[28] Furthermore, findings from infants and young children do not necessarily apply to older children and adolescents. Consequently, it is not known whether negative affectivity is involved in the etiology of objectively measured short sleep in school-aged children and adolescents.

Parental Emotional Availability

Parental emotional availability refers to the ability of parents to demonstrate warmth, consistency, understanding, support, and positive communication. According to Biringen,[29] parental emotional availability comprises the following factors: 1) Sensitivity: Parent's ability to develop and maintain a positive and healthy emotional connection with the child—promoting engaging, joyous, and creative play; 2) structuring: Parent's contribution in structuring activities and how effectively the parent limit unwanted behavior in the child that may reduce the emotional connection; 3) nonintrusiveness: Parents ability to facilitate child autonomy by not taking too much control, helping too much, or overprotecting the child; and 4) nonhostility: not displaying behavior that can be frightening or threatening to the child—such as showing dissatisfaction, impatience, boredom, anger or raising one's voice. Typically, parents are children's most salient and important regulatory scaffold and thus constitute the environmental factor which impacts children's sleep the most. Emotionally available parents may help protect against

sleeping too little along two pathways. First – external regulation; effective and consistent parent practices may help to soothe and downregulate the child at bedtime or at night if the child awakens. Indeed, parental emotional availability works as a buffer against the hypothalamic-pituitary-adrenocortical (HPA) axis response.[30] Given the reciprocal relationship between sleep and the secretory activity of the HPA-axis,[31] it seems conceivable that helping the child downregulate arousal both directly and through skill acquisition can improve sleep. Consequently, parents who are emotionally available to the child may protect against curtailed sleep. Supporting this notion, high-quality parent–child interactions at 12–18 months have been prospectively associated with better sleep 2–3 years later.[32] Second – internal regulation; developmental theory[33] suggests that emotionally available parents are better at promoting the acquisition of self-regulation capacities in the child. The child may then take responsibility for the needed downregulation and consistent bed-time routines itself as she or he ages. Such theorizing is supported by findings[34] suggesting that parents' emotional availability indeed fosters self-regulation, which predicts fewer sleep problems.[35] Of note, most theoretical and empirical work on parental emotional availability focus on infants, toddlers and preschoolers. Even though parents continue to be an important source of external (down)-regulation and facilitate the learning of self-regulation throughout childhood, the proposition that parental emotional availability continues to be of importance —also for school-aged children and adolescents' sleep duration—has never previously been investigated. Furthermore, most studies examining the relationship between the parent–child interaction and sleep have relied on subjective reports,[36] risking inflating associations due to common method effects. To reduce this impact, using observer ratings of the parent–child interaction and measuring sleep by objective methods, would advance this field.

Victimization from Bullying

Peers become increasingly important and impactful throughout childhood, to the better or worse. Bullying and victimization is a widespread phenomenon in childhood.[37] Victimization from bullying by peers is strongly associated with psychosocial stress (low psychological well-being and poor social adjustment) in children.[38] Psychosocial stress is related to episodes of impaired sleep,[39] and this also seems to be the case for victimization from bullying—specifically—in children[40] and adolescents.[41] Fortunately, bullying can be reduced by a range of interventions.[37] Thus, victimization from bullying may be one of the most important malleable exogenous factors that affect children's sleep. However, it remains unknown whether victimization from bullying is predictive of prospective persistent short sleep.

Interactive Effects

Environmental factors may impact some children, for genetic or other organismic reasons, more than other—more impervious—children. Indeed, temperamental traits, including negative affectivity, have repeatedly been found to interact with environmental factors in shaping children's development.[42–45] Such interactive effects may be operative with respect to short sleep as well: One may speculate that highly reactive children struggle the most with downregulating (and thus sleep less) from the aftermath of victimization from bullying or insensitive, harsh or intrusive parents (ie, low emotional availability), whereas children less dominated by negative affectivity would be less afflicted.

The Present Study

Based on the aforementioned theoretical notions and existing research, the following hypotheses will be tested: Can a subgroup of children with shortened sleep throughout childhood and adolescence be identified (H1)?; Can such persistent short sleep be predicted from higher negative affectivity (H2), low parental emotional availability (H3), victimization from bullying (H4)? Moreover, we hypothesize that the negative environmental effects of parents' emotional unavailability and victimization from bullying are stronger for children with high negative affectivity (H5). Because socioeconomic status,[46] male gender,[46] and emotional and behavioral problems[47] have been associated with shorter sleep duration and may be associated with the predictors, we included socioeconomic status, gender and emotional and behavioral problems as covariates.

Methods

Participants and Procedure

The data were derived from the Trondheim Early Secure Study (TESS).[48] Together with the appointment for an age-4 routine health check-up (N=3456), an invitation letter was sent to the parents of all children in the 2003

and 2004 birth cohorts in Trondheim, Norway, together with a screening questionnaire for emotional and behavioral problems, the Strengths and Difficulties Questionnaire (SDQ) 4–16 version.[49] The health nurse informed parents about TESS and collected written consent. All the procedures used in TESS have been reviewed and approved by the Regional Committee for Medical and Health Research Ethics, Mid-Norway. A flow-chart of recruitment and attrition is depicted in Figure 1.

Because one of the main aims of TESS is to study mental health, children with emotional or behavioral problems were oversampled to increase statistical power. To

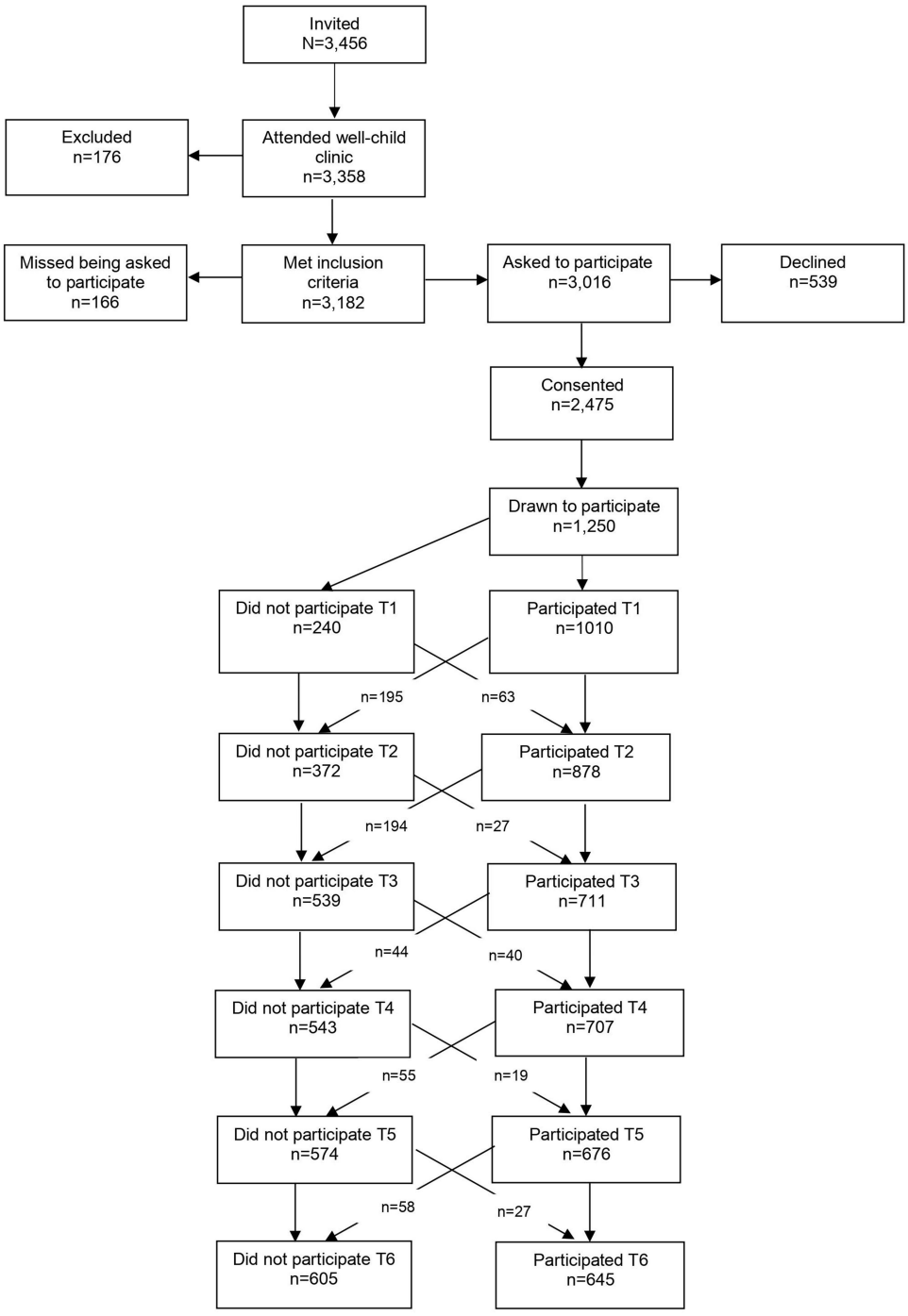

Figure 1 Flow chart of recruitment and follow-up.
Notes: Number of participants at the various assessment points is based on the number of participants invited to participate (n=1250) minus those who did not participate at the respective measurement points (i.e., T1, T2).

accomplish this, the participants were allocated to four strata according to their SDQ scores (cut-offs: 0–4, 5–8, 9–11, 12–40). The probability of selection increased with increasing SDQ-scores—0.37, 0.48, 0.70, and 0.89 in the four strata, respectively. Population weights were applied in the analyses to provide corrected population estimates. The dropout rate after consenting to participate did not vary by SDQ score (t=0.17, df=1, p=0.86) or gender (Cramer's v2=1.02, df=1, p=0.31) at the age-4 assessment. The accelerometer assessment of sleep was implemented from 6 years of age (49% boys) onwards; therefore, the data from the first assessment (4 years) were not included in the present analyses. Accelerometer measurement and interview were conducted biennially at the ages of 6 (n=685, Mage=6.6 years, SD=0.52), 8 (n=618; Mage=8.8 years, SD=0.23), 10 (n=617, Mage=10.5 years, SD=0.15), 12 (n=557, Mage=12.5, SD=0.14), and 14 years (n=557, Mage=14.3, SD=0.63). Participants with valid accelerometer data on at least one occasion comprised the analytical sample (n=801). At age 6 years 52% completed all 7 days of accelerometer measurement. The corresponding numbers for the subsequent measurement points were as follows: 45% at age 8 years; 48% at age 10 years; 37% at age 12 years; and 36% at age 14 years. None of the sample characteristics in Table 1 predicted selection to the analytic sample from the main TESS sample. Within the analytical sample, short-sleep duration at 8 years of age predicted attrition at 10 years (standardized beta β= −.13; 95% confidence interval [CI]: −.25, −.01; p=0.02) but explained a negligible part of the variance in drop-out (proxy R2=0.02). Similarly, sleep duration at 12 years of age-predicted attrition at 14 years (β= −.12; 95% CI: −.23, −.01; p=0.04) but explained virtually none of the variance in drop-out (proxy R2=0.01). Boys (β=0.17; 95% CI: 0.-05–0.28; p=0.005), and children with higher negative affectivity (β=0.16; 95% CI: 0.05–0.27; p=0.003) were more likely to drop out at 10 years (proxy R2=0.03 for each predictor). Table 1 displays the sample characteristics of the analytic sample at 6 years of age.

Table 1 Sample Characteristics of Analytic Sample at T2 (Age 6)

Characteristics		%
Gender of child	Male	48.2
	Female	51.8
Gender of parent informant	Male	17.9
	Female	82.1
Ethnic origin of biological mother	Norwegian	93.5
	Western Countries	6.0
	Other Countries	0.5
Ethnic origin of biological father	Norwegian	93.3
	Western Countries	6.0
	Other Countries	0.7
Biological parents' marital status	Married	59.4
	Cohabitating	26.6
	Divorced/Separated	12.3
	Other	1.7
Informant parents' socioeconomic status	Leaders	7.1
	Higher professionals	27.4
	Lower professionals	40.4
	Skilled workers	22.4
	Farmers/fishermen	0.2
	Unskilled workers	2.5
Household gross annual income	0–225′ NOK (0–26,500 USD)	2.2
	225′ – 525′ NOK (26,500–62′ USD)	11.6
	525′ – 900′ NOK (62′ – 106′ USD)	45.4
	> 900′ NOK (> 106′ USD)	40.8

Measures

Sleep Duration

Was assessed using a triaxial ActiGraph GT3X accelerometer (Manufacturing Technology Incorporated, Fort Walton Beach, Florida, USA). The accelerometer is a small hip-strapped device measuring acceleration in three dimensions. Children were instructed to wear the accelerometer for seven consecutive days, 24 hours a day, only taking it off when bathing or showering. Sleep diaries were not administered. Bedtime and rise time were manually scored by a bachelor level student of psychology (instructed by an expert in accelerometry) inspecting each individual actogram. The inter-scorer reliability (ICC = intraclass correlation coefficient) between the student and the expert was ICC=0.90 at age 6, ICC=0.86 at age 8, ICC=0.84 at age 10, ICC=0.88 at age 12. Age 14 accelerometer data were not coded by both raters. Human visual scoring has been shown to have superior correlation with polysomnography compared to autodetection by computer[50] and is closely aligned with sleep diary entries, with the resulting difference in sleep duration being minuscule (0.7 minutes).[51] Sleep duration (minutes scored as asleep between bedtime and rise time, excluding minutes awake) was derived using Sadeh's sleep algorithm[52] and was based on 60-second epochs (time-blocks).[53] Sadeh's algorithm scores an epoch as asleep

or awake depending on activity during the current epoch considering activity in the previous and subsequent five minutes. For the best possible measure of individual differences in sleep duration and to reduce the influence of measurement error, we created a latent variable for each measurement occasion loading on sleep duration at each night of the week (illustrated in Figure 2). Only nocturnal sleep was considered.

Child Negative Affectivity

Was assessed using the Children's Behavior Questionnaire,[19] a caregiver report measure designed to provide a detailed assessment of temperament in children 3 to 7 years of age. We calculated a composite score reflecting negative affectivity from five domains (anger, discomfort, fear, sadness, and reversed soothability) with

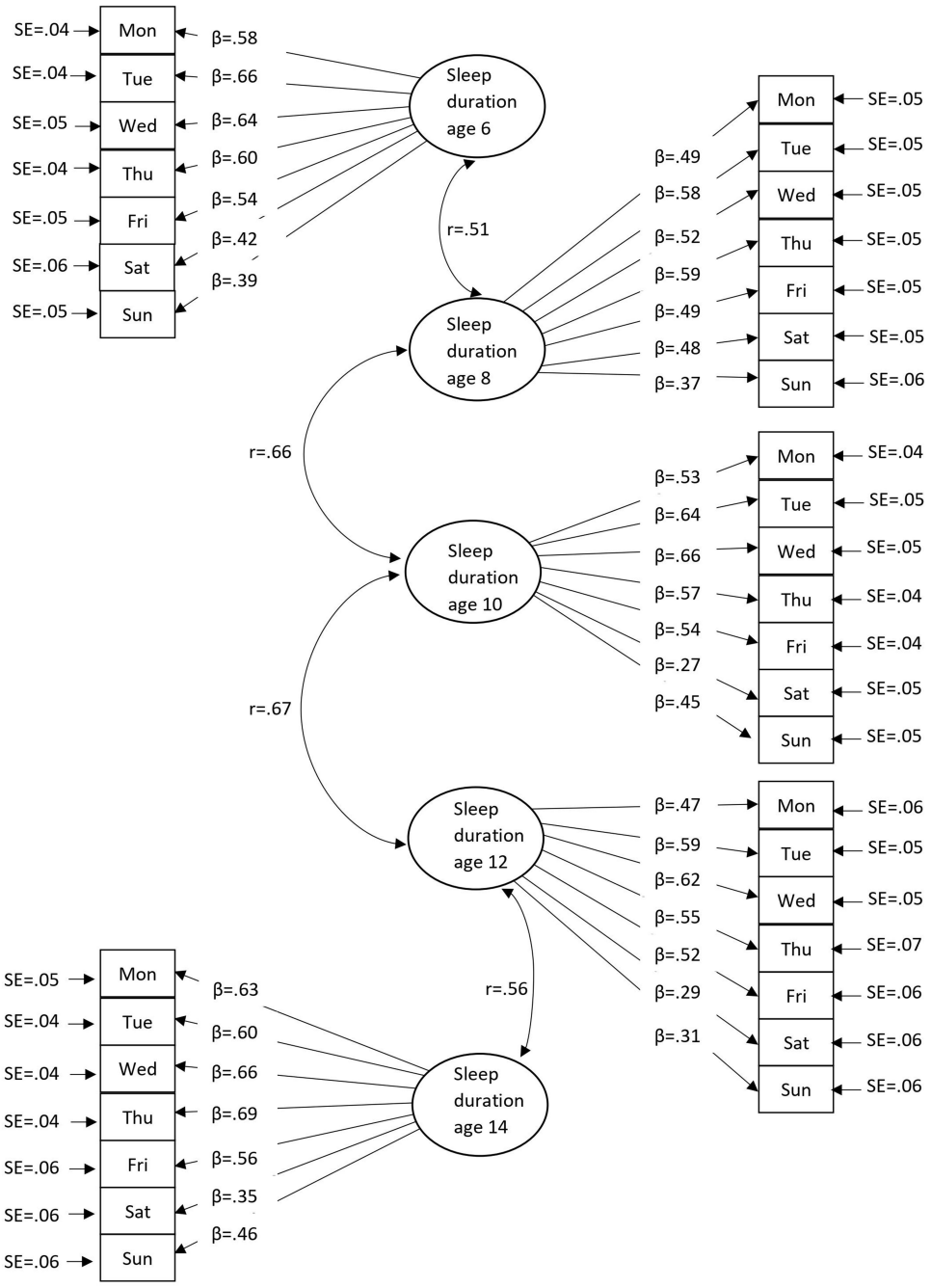

Figure 2 Factor analysis of sleep duration with standardized beta coefficients (β), standard errors (SE) and correlations (r).
Notes: All coefficients and correlations are significant at p<0.001 level. Correlations between sleep duration age 6 and sleep duration age 10, etc., are left out for parsimonious reasons.

a total of 31 items, which had a good internal consistency (Cronbach' alpha [α]=.82).

Parent Emotional Availability Scales (EAS)

Is a measure of the quality of parent–child interactions and was assessed through the coding of parent–child interaction. Parents and children were observed through video recording of four consecutive 5-min sequences of play (free play, child lead play, parent-led play, and a clean-up task). Videotapes of the interactions were scored according to the EAS 3rd ed.[54] The Emotional Availability Scale was administered to rate four parental dimensions (sensitivity, structuring, nonintrusiveness, and nonhostility) of emotional availability. We used a composite score of the four dimensions as a measure of the quality of the parent–child interaction. The four parent ratings yielded an acceptable internally consistent score (α=0.74). All the raters were trained and certified as reliable by Zeynep Biringen, who developed the EAS. The interrater reliability between multiple blinded coders on a random 10% of the sample of the videotapes for the total parent scale, assessed using the interclass correlation coefficient (ICC),[55] was ICC=0.71.

Victimization from Bullying

Was assessed by teacher report using five questions from the Olweus Bully/Victim Questionnaire,[56] which had an acceptable internal consistency (α=0.77). The questions covered victimization from direct bullying such as physical assault, verbal assault and breaking/hiding toys and indirect bullying in the form of social exclusion.

Socioeconomic Status (SES)

Was measured in terms of parental occupation coded according to the International Standard Classifications of Occupations.[57] If parents were living together, the parent with the highest socioeconomic status was chosen. Socioeconomic status was ranked from high to low as follows: leaders, higher level professionals, lower level professionals, formally skilled workers, farmers/fishermen, and unskilled workers.

Emotional and Behavioral Problems

Was assessed by teacher report using the Teacher Report Form (TRF) from the Achenbach System of Empirically Based Assessment (ASEBA) scales.[58] The Teacher Report Form consists of 120 items and is used to rate children between ages 4 and 18 years. The TRF has scales for anxious/depressed, withdrawn/depressed, somatic complaints, social problems, thought problems, attention problems, rule-breaking behavior, and aggressive behavior. The two aggregate categories of internalizing and externalizing problems were used to measure emotional and behavioral problems, respectively.

Statistical Analysis

All statistical analyses were performed using Mplus, version 7.4.[59] Missing data were handled by applying the full information maximum likelihood (FIML).[60] Because we oversampled children with high SDQ scores, the data were weighted proportional to the number of children in a specific stratum in the population divided by the number of participating children in that specific stratum. A robust maximum likelihood estimator was used that does not presuppose multivariate normality.

A much-used approach to identify clusters of developmental trajectories is latent growth-mixture modeling.[61] However, such an approach examines individual growth or decline over time (ie, change). Because our hypotheses concerned the level of sleep over time, and not linear (or curvilinear) changes over time, we applied latent profile analysis (LPA).[62] By this approach, classes with specific characteristics are identified and each child is given a probability of belonging to the emerging classes. All available datapoints on sleep duration were included in the Latent Profile Analysis (age 6, 8, 10, 12, 14 years). To determine the number of classes, we applied the Voung–Lo–Mendell–Rubin test,[63] along with entropy and class size as indicators.[64]

To test our hypotheses concerning predictors, the probability of belonging to a subgroup of children sleeping persistently shorter than others was regressed on age 6 measures of child negative affectivity, emotional availability of the parent, and victimization from bullying. Parental socioeconomic status, gender, and emotional and behavioral problems were included as covariates. The assumption that children high in negative affectivity would be more affected was tested by adding multiplicative terms between negative affectivity and emotional availability and victimization, respectively, to the regression analysis.

Results

Bivariate correlations between the study variables are displayed in Table 2. Factor loadings, correlations and standard errors for the latent variable sleep duration are presented in Figure 2.

The results of the latent profile analysis revealed that the length of sleep throughout childhood was not evenly

Table 2 Mean, Standard Deviation (SD) and Correlations of Study Variables

		Mean	SD	2	3	4	5	6	7	8	9	10	11	12
1	Sleep duration age 6	9.67	0.58	0.37***	0.37***	0.27***	0.20***	0.01	0.03	−0.07	0.03	−0.14**	−0.04	−0.10
2	Sleep duration age 8	9.26	0.58	–	0.45***	0.35***	0.29***	−0.12**	0.07	−0.06	0.00	−0.12**	0.02	0.00
3	Sleep duration age 10	9.03	0.57	–	–	0.43***	0.34***	−0.10*	0.12*	−0.03	0.01	−0.15***	−0.02	−0.03
4	Sleep duration age 12	8.69	0.62	–	–	–	0.42***	−0.06	0.16**	−06	0.11*	−0.17***	−0.02	−0.04
5	Sleep duration age 14	8.48	0.82	–	–	–	–	−0.02	0.07	0.03	0.00	−0.11*	−0.05	−0.07
6	Negative affectivity of child age 6	3.73	0.55	–	–	–	–	–	−0.04	0.03	0.03	−0.07	0.10*	−0.07
7	Emotional availability of parent age 6	25.16	2.86	–	–	–	–	–	–	−0.08*	0.09	−0.06	0.00	−0.04
8	Victimization from bullying age 6	6.97	2.06	–	–	–	–	–	–	–	−0.10*	0.06	0.35*	0.73***
9	Socioeconomic status	4.60	0.90	–	–	–	–	–	–	–	–	0.04	0.02	−0.01
10	Boy	0.48	0.50	–	–	–	–	–	–	–	–	–	−0.02	0.04
11	Emotional problems age 6	2.86	1.02	–	–	–	–	–	–	–	–	–	–	0.93***
12	Behavioral problems age 6	1.91	0.70	–	–	–	–	–	–	–	–	–	–	–

Notes: *p<0.05, **p<0.01, ***p<0.001.

distributed between participants, but rather tended to cluster in a group-wise fashion. A solution with three classes of sleep duration showed a better fit to the data (Table 3) compared to two, four and five classes, and this solution also had acceptable entropy. The largest class comprised children with moderately long sleep throughout childhood and early adolescence, and the second-largest class slept comparatively longer than the others, about half an hour longer each night than the "moderate" class. Importantly, a smaller—albeit sizable (n=160; 20.2%)—class slept less than the others at all time-points; about half an hour shorter than the moderate class and an hour shorter each day than the long-sleeping class. This subgroup of children characterized by persistent short sleep was the focus of the remaining hypothesis testing. Table 4 provides data on the percentage of children in each class and the mean sleep duration with standard deviation for the three classes at all ages. This is graphically illustrated in Figure 3.

Displaying higher levels of negative affectivity and having a less emotionally available parent predicted an increased probability of belonging to the class characterized by persistent short sleep (Table 5). No interactions emerged between the predictors. Note that socioeconomic status, gender, and emotional and behavioral problems were included as covariates. Boys were more likely than girls to belong to the short-sleep class.

Discussion

Given the lack of knowledge about the persistence of short sleep in childhood, we investigated whether a class of children with enduring short sleep could be identified and, if so, investigated the proposition that temperamental negative affectivity, low emotional availability from parents and victimization from bullying by peers predicted persistent short sleep. Using latent profile analysis, we identified three classes differentiated by the duration of sleep: 1) short-sleep duration; 2) intermediate sleep duration 3) long sleep duration. The class characterized by short-sleep duration manifested comparatively short sleep —ie, 0.5 and 1 hour shorter than the two other classes—at all ages from 6 to 14 years. Higher negative affectivity and reduced emotional availability from parents at 6 years of age-predicted likelihood of belonging to the persistent short-sleep group. Contrary to our hypothesis, victimization from bullying was unrelated to persistent short sleep and negative affectivity did not moderate the effect of parental emotional availability or victimization from

Table 3 Fit Statistics of Latent Profile Analysis (LPA)

Classes	AIC	BIC	LMRT	Entropy (0–1)
1	37,779.85	37,826.71	–	–
2	36,349.96	36,424.93	p<0.001	0.836
3	**35,731.88**	**35,834.97**	**p=0.012**	**0.852**
4	35,446.03	35,577.23	p=0.691	0.846
5	35,250.68	35,410.00	p=0.234	0.862

Notes: Data in bold formatting indicates the best fitting model relative to the other models tested.
Abbreviation: LMRT, Lo–Mendell–Rubin Test.

bullying. Gender and socioeconomic status were included as covariates, and the results showed that boys were more likely to have persistent short sleep, whereas socioeconomic status was unrelated to the risk of persistent short sleep.

A Class of Children with Persistent Short Sleep

Our results are in line with, and extend, previous prospective studies finding that 6% of children had persistent short sleep as reported by parents (both from age 2 to 6[5] and from age 2 to 10[65]); and that 15% of preadolescents (age 10–13) had persistent short sleep (parent reported).[66] The present study adds to previous knowledge by showing that persistent short sleep in children is also evident when objective measures of sleep are applied, and not merely reflected by persistence in parent report. Please note that we identified a somewhat larger portion of children (20.2%) had persistent short sleep compared to former research. The different proportion of children having short sleep across studies might reflect differences in measurement methods, age spans captured, cultural differences in sleep practices, or other factors not identified. Recall that the correlation between reported sleep duration and objectively measured sleep duration varies considerably, ranging from 0.29[67] to 0.64[68] in 6–10 year olds.

The mean sleep duration at age 6 years in the persistent short-sleep class was 9.1 hours, which is in the lower end of recommended sleep duration (9–11 hours) for this age group (6–14 years) by the National Sleep Foundation.[69] However, due to the yearly decline in sleep duration by approximately 10 minutes, from the age of 8 years onward, the short-sleep group fell below recommendations, indicating that we accurately identified a group sleeping too little throughout most of childhood and into adolescence. Hip-held actigraphy (used in this study) is prone to overestimate sleep duration compared with polysomnography.[70] Thus, it is likely that a share of the short-sleeping group also slept too little at the age of 6 years, adding confidence to the construct validity of this group.

Roughly half an hour separated the three classes identified in the present inquiry. The clinical significance of this is hard to determine. Still, experimental research indicates that restricting sleep by one hour compared to the habitual amount impair neurocognitive performance.[71] Further, sleep curtailment has demonstrated negative effects in natural contexts,

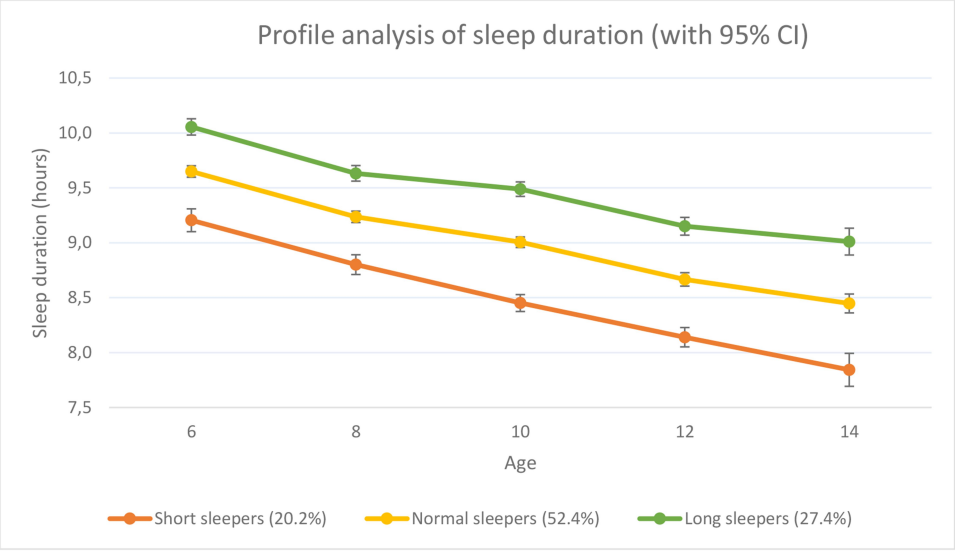

Figure 3 Profile analysis of sleep duration (with 95% CI).

Table 4 Mean Sleep Duration (Hours) with Standard Deviation for Three Classes by Age

Age	Persistent Short Sleep (n= 160; 20.2%)	Medium Sleep Duration (n=422; 52.4%)	Long Sleep (n=219; 27.4%)
6	9.14 (0.59)	9.64 (0.46)	10.08 (0.47)
8	8.69 (0.50)	9.23 (0.44)	9.72 (0.44)
10	8.41 (0.42)	8.99 (0.40)	9.54 (0.41)
12	8.08 (0.46)	8.67 (0.47)	9.18 (0.48)
14	7.78 (0.73)	8.42 (0.66)	9.00 (0.73)

such as poor school functioning.3 Because individual sleep need is unknown, such comparisons are difficult though.

Negative Affectivity Predicts Persistent Short Sleep

Previous findings in infants[22] and children[6] concerning the potential impact of temperament on parent proxy-reports of short sleep were supported by the present findings. We also extended this by showing that childhood negative affectivity is associated with persistent short sleep across childhood. In terms of potential mechanisms, children high in negative affectivity are more easily emotionally activated (eg, anger and frustration) and have poorer emotional regulation abilities.[72] They display more bedtime resistance,[73] which is linked to later sleep onset. Thus, these children may fall asleep later at night than less reactive children, typically resulting in curtailed sleep.[74] Additionally, negative affectivity is associated with a more easily exited nervous system that might prolong sleep onset latency and increase the number and duration of nocturnal awakenings,[75] explaining the results of this study.

Parental Emotional Availability May Protect Against Persistent Short Sleep

Although a sparse number of former studies on infants and toddlers have hinted at the quality of the parent–child relationship being important for sleep,[32,76] we here show that high emotional availability of parents reduces the risk of persistent short sleep in also older offspring. This finding concurs with the conclusion from a meta-analytic evidence that, broadly speaking, a negative family environment is associated with short-sleep duration among adolescents.[78] Our results extend this research by pointing to parental emotional availability as a specific factor. Future research should determine whether different aspects of parental emotional availability—such as sensitivity, structuring, nonintrusiveness, and nonhostility—are of particular importance. One common explanation for why parental emotional availability may affect sleep duration is that it buffers against hyperarousal (eg, prevents children from becoming very upset) and/or facilitates children's own emotion regulation (ie, promotes the development of downregulating skills) thus reducing the risk for problems with initiating and maintaining sleep when exposed to stressors. Emotional availability also comprises successful limit setting by the parent, which may contribute to longer sleep duration through parent-set bedtimes[77] and consistent bedtime routines[78] as well as less bedtime resistance,[73] all promoting longer sleep duration. Moreover, parental overinvolvement (an aspect of low emotional availability) may interfere with the sleep initiation process by impeding the development of self-soothing and by reinforcing behavior counteracting sleep initiation (eg, overresponding to signaling behavior).[79] Future research may clarify to what degree and under which circumstances each of these mechanisms are involved.

Table 5 Predictors of Probability of Belonging to a Class of Short Sleepers. Linear Regression Model Testing Association Between Covariates and Probability of Being a Short Sleeper

	Standardized Regression Coefficient β	95% CI	P-value
Negative affectivity of child	0.08	0.01, 0.15	0.03
Emotional availability of parent	−0.09	−0.18, −0.01	0.04
Victimization from bullying	0.01	−0.10, 11	0.88
Socioeconomic status	−0.01	−0.09, 0.07	0.90
Boy	0.09	0.02, 0.17	0.01
Emotional problems	−0.03	−0.27, 0.20	0.77
Behavioral problems	−0.09	−0.18, 0.35	0.52

Clinical Implications

The present findings indicate that interventions aimed at reducing negative affectivity may reduce the risk of persistent short sleep. Cognitive-behavioral therapy for youth (aged 9–13 years) with anxiety disorders have been shown to counteract self-reported negative affectivity.[80] Likewise, a few studies examining interventions targeting emotional availability or the attachment between the child and parent have shown beneficial effects on parental emotional availability.[29] In sum, the factors identified to predict persistent short sleep in the current study do seem to be modifiable and thus could be addressed in preventive efforts.

Limitations

Although the present study had several strengths, including involving a representative community sample followed repeatedly from childhood to adolescence, objectively recorded sleep and independent measures of predictors, thereby minimizing common method bias (ie, observations, parent, and teacher reports), we acknowledge some limitations. First, the study captures sleep duration only, thus other important aspects of sleep such as quality, timing, night-to-night variability in sleep duration, sleep architecture, and sleep problems were not accounted for. Although negative affectivity, parental emotional availability and victimization from bullying were not associated with persistent short sleep, these variables may still be associated with other aspects (eg, timing, architecture, problems) of sleep. As such, the specific focus on sleep duration limit generalizations to other sleep variables. Second, the short persistent sleep class may include children with less need for sleep than others (then being inconsequential), and it may contain children that get inadequate sleep on a regular basis.

Third, predictors were measured at one time point only and may thus not fully capture the developmental sequelae of continued parent, child, and peer interactions over time. Hence, predictors might differ over developmental periods. Fourth, although gender and socioeconomic status were controlled for, other confounding variables could potentially explain the results, such as behavioral sleep problems, insomnia or genes common to both parental emotional availability and offspring sleep.

Fifth, as there are cultural differences in sleep duration among children,[81] generalization of the present findings to cultures with other sleep practices should be made with caution.

Conclusions

A subgroup of 20% of children display persistent short sleep across the ages of 6 to 14 years. The probability of having persistent short sleep is higher for children high in temperamental negative affectivity and for those whose parents are less emotionally available. Interventions to promote healthy sleep should consider mitigating the impact of temperamental negative affectivity and targeting parent–child interactions.

Disclosure

The authors report no conflicts of interest in this work.

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