

RESEARCH ARTICLE

Sleep Duration and Internalizing Symptoms in Children

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Abstract

Objective: Emotional problems such as anxiety and low mood have been associated with sleep problems in children. The study's objectives were to 1) assess the association between sleep duration and internalizing symptoms (anxiety and low mood) in children aged 5-12 years (y), and 2) evaluate whether insufficient sleep according to the National Sleep Foundation (NSF) guidelines is associated with internalizing symptoms. **Methods:** A cross-sectional study of N =796 children aged 5-12y, recruited from primary care physicians' offices in Toronto, Canada was conducted through the TARGET Kids! research network. Using linear regression, we investigated 1) the cross-sectional association between parent reported 24-hour sleep duration (hours) and parent reported symptoms using the Strengths and Difficulties Questionnaire (SDQ), controlling for child age, sex, family income, maternal education, family composition, and standardized body-mass index (zBMI). The analysis was repeated using insufficient sleep per NSF guideline as the independent variable. **Results:** Sleep duration was inversely associated with internalizing symptoms, B estimate = -0.33 (95%CI -0.57, -0.07), p=0.012. Twenty-eight (14%) children aged 5 y, and 36 (6%) of those aged 6-12y, experienced insufficient sleep. There was a trend toward association between insufficient sleep and internalizing symptoms, B estimate = 0.64 (-0.09, 1.38), p=0.086. **Conclusion:** The relationship between insufficient sleep and internalizing symptoms among children requires further elucidation. Children who show internalizing symptoms may benefit from interventions supporting sleep.

Key Words: sleep, mental health, child, internalizing symptoms

Résumé

Objectif: Les problèmes émotionnels comme l'anxiété et l'humeur sombre ont été associés à des problèmes de sommeil chez les enfants. Les objectifs de la présente étude étaient de 1) évaluer l'association entre la durée du sommeil et les symptômes d'internalisation (anxiété et humeur sombre) chez les enfants de 5 à 12 ans (a), et 2) évaluer si le sommeil insuffisant selon les lignes directrices de la Fondation nationale du sommeil (FNS) est associé aux symptômes internalisants. **Méthodes:** Une étude transversale de N =796 enfants de 5 à 12 ans recrutés dans les bureaux de

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médecins de soins de première ligne à Toronto, Canada, a été menée dans le réseau de recherche TARGet Kids! À l'aide de la régression linéaire, nous avons investigué 1) l'association transversale entre la durée du sommeil (en heures) sur 24 heures rapportée par les parents et les symptômes rapportés par les parents à l'aide du questionnaire des forces et difficultés (QFD), en contrôlant pour l'âge de l'enfant, le sexe, le revenu familial, l'éducation maternelle, la composition de la famille et l'indice de masse corporelle normalisé (IMCn). L'analyse a été répétée avec le sommeil insuffisant selon les lignes directrices de la (FNS) comme variable indépendante. **Résultats:** La durée du sommeil était inversement associée à des symptômes d'internalisation, estimation $B = -0,33$ (IC à 95 % $-0,57$ à $-0,07$), $p = 0,012$. Vingt-huit (14 %) enfants âgés de 5 ans, et 36 (6 %) de ceux âgés de 6 à 12 ans avaient un sommeil insuffisant. Il y avait une tendance à l'association entre le sommeil insuffisant et les symptômes d'internalisation; estimation $B = 0,64$ ($-0,09$, $1,38$), $p = 0,086$. **Conclusion:** La relation entre le sommeil insuffisant et les symptômes d'internalisation chez les enfants nécessite des éclaircissements. Les enfants souffrant de symptômes d'internalisation peuvent bénéficier d'interventions favorisant le sommeil.

Mots clés: sommeil, santé mentale, enfant, symptômes d'internalisation

Introduction

Sleep problems in children are a major source of public health concern and are often characterized by difficulty initiating and/or maintaining sleep, nightmares, and refusal to sleep independently (1). Insufficient sleep has become increasingly common, with studies reporting significant declines in sleep duration in children and adolescents compared to previous decades (2, 3). A substantial body of literature suggests that a lack of adequate sleep is associated with daytime fatigue, poor functioning, and safety problems (4, 5). Indeed, poor sleep during childhood can persist for extended periods, resulting in long-term problems in academic performance, poor impulse control, and impaired social functioning (6,7,8). This relationship often occurs at an early age and may continue into adolescence and adulthood (9, 10).

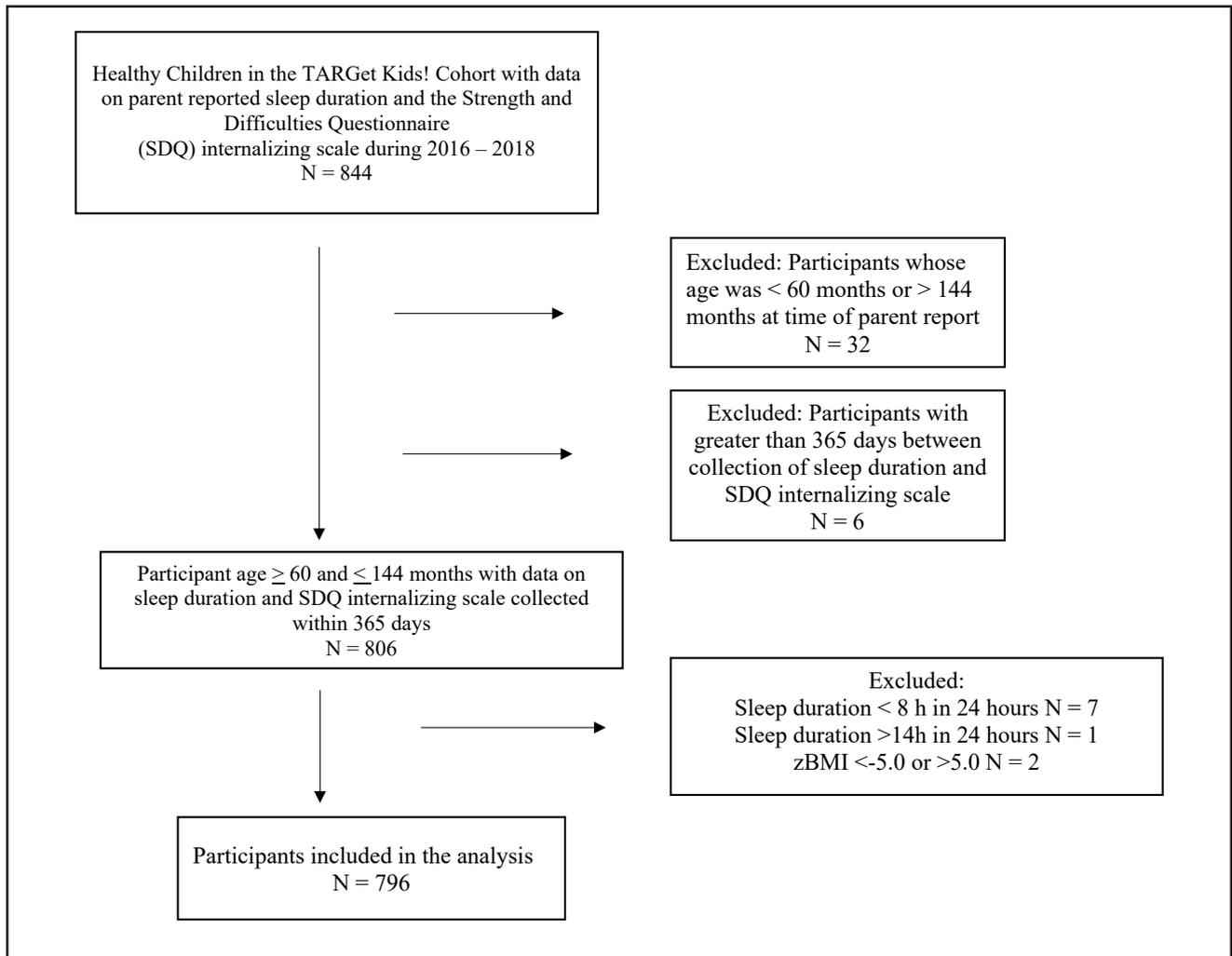
Sleep is a key component of healthy growth and is required for adequate physical and mental health. Children benefit from the restorative effects of sleep including improved brain function, development, working memory, and emotion regulation (11,12,13). Correspondingly, sleep problems are generally associated with emotional problems for children of all ages, including depression (14, 15, 16, 17), anxiety (1, 18,15), and behavioral problems (19, 20). About 90% of children with anxiety disorders report at least one sleep-related problem, including refusal or reluctance to sleep alone, difficulty initiating or maintaining sleep, and talking or walking during sleep (1, 21). While restricted sleep is associated with internalizing symptoms among clinical populations of youth (1, 22, 23, 24, 25), examinations of the relationship between sleep duration and internalizing symptoms in non-clinical samples of young children are lacking.

It is important to understand whether children and adolescents are getting enough sleep. Previous studies suggest a

lack of consensus regarding what can be properly defined as “adequate” sleep (26). Sleep recommendations for children are largely based on expert opinion and lack clarity on how they were formulated (26). Experts from National Sleep Foundation (NSF) as well as the American Academy of Sleep Medicine (AASM) developed recommendations for children in regard to sufficient daily sleep duration. The two sets of guidelines are similar. For children ages 3-5 years, NSF and AASM recommend 10-13 hours of sleep per day; for children ages 6-13 years, NSF recommends 9-11 hours while AASM recommends 9-12 hours of sleep per day (27, 28). Neither set of guidelines had robust observational evidence to support their assessment of what is considered adequate sleep duration for child health and development. Bruni and colleagues (29) argue for establishing standardized protocols to describe and evaluate optimal sleep across pediatric age groups, as almost 20-30% of children in their first 10 years of life, are described as sleep deprived based on AASM 2016 and NSF 2015 guidelines.

We investigated sleep duration and mental health in a community sample of young children recruited from primary care pediatric practices. A previous TARGetKids! Study did not find a strong association between parent reported sleep duration and total mental health difficulties; however, this study was conducted in three-year-old children (30), and less is known about whether such a relationship may be present in school-age children, and among those with internalizing symptoms. The primary objective of this exploratory study was to assess the association between parent reported sleep duration in 24 hours and internalizing symptoms in children ages 5-12 years, controlling for child age, sex, family income, maternal education, family composition, and standardized body-mass index(zBMI). The secondary objective of this study was to evaluate whether

Figure 1



meeting the National Sleep Foundation's guidelines for sufficient sleep is associated with internalizing symptoms.

Methods

Participants

This was a cross-sectional study of 796 children who presented for care at well-child visits at pediatric or family medicine primary care practices and participated in The Applied Research Group for Kids (TARGeT Kids!) between 2016 and 2018. TARGeT Kids! is a practice-based research network in a large urban center, Toronto, Canada (31). Children from birth to age five, are enrolled in the TARGeT Kids! research registry through their pediatrician's or family doctor's offices and may be followed over time. Parents answer surveys about their child and family. Anthropometric measures are also collected at office visits.

TARGeT Kids! exclusion criteria at enrollment include genetic or chronic health conditions (except asthma), severe developmental delay, gestational age less than 32 weeks, acute illness, and parents unable to communicate in English (32). For this study, children were included if they were five to 12 years old at the time of measurement collection and had complete responses on parent-reported sleep duration and parent reported internalizing symptoms. For sleep duration, children whose parents reported fewer than 8 hours or greater than 14 hours of sleep were excluded due to concerns the values might be reporting errors, based on NSF sleep duration guidelines (27). The mean and standard deviation of number of days between collection of measures was 6.04 ± 26.03 , with the majority (60.6%) of reports of sleep duration collected simultaneously with reports of internalizing symptom. See Figure 1 (Sample Flow Chart). Consent was obtained from participating families, and ethics approval was granted by the Research Ethics Boards at

Table 1. Descriptive Characteristics (N =796)		
Characteristic	Mean (SD)	% (n)
SDQ Internalizing Score	2.84 (2.6)	
> 90th %tile		14.0 (112)
Sleep Duration (hours) at 5y	10.4 (0.8)	
below guidelines 5y		14.0 (28)
Sleep Duration (hours) at 6-12y	9.9 (0.8)	
below guidelines 6-12y		6.0 (36)
Age, months	91.84 (22.9)	
Age 5y (60-70 months)		24.0 (195)
Age 6-12y (71-144 months)		75.6 (602)
Sex, male		54.0 (429)
Family income, <\$60,000 ^a		7.5 (57)
Maternal Education level,		
Completed high school or less ^b		4.3 (34)
Family composition ^c		
Two parent household		91.0 (721)
Single parent household ^d		8.9 (71)
zBMI	0.053(1.1)	
zBMI indicates standardized body mass index score		
^a 35 participants did not provide family income		
^b 10 participants did not provide maternal education level		
^c 4 participants did not provide family composition		
^d Includes other non-traditional family arrangements		

the Hospital for Sick Children and St Michael's Hospital. This report followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline (33).

Independent Variables

For the primary objective, parent-reported sleep duration (hours), parents completed a standardized questionnaire based on the Canadian Community Health Survey addressing child and family characteristics, health behaviours and nutrition. This questionnaire included a question regarding child's 24-hour sleep duration. For the second objective, insufficient sleep is defined as 10 or fewer hours per day for 5-year-old children, and 9 or fewer hours per day for 6-12-year-old children by the NSF guidelines (27).

Dependent Variables

Parents completed the Strength and Difficulties Questionnaire (SDQ), a 25-item screening tool developed to assess behaviors and emotions in children and adolescents (34).

Internalizing symptoms were defined by a two-factor solution (internalizing scale includes emotional problems and peer problems subscales; externalizing scale includes conduct problems and hyperactivity subscales) for the measure as recommended by Goodman et al. (35). For describing the sample, high levels of internalizing symptoms are defined as a score > 6 on the SDQ internalizing scale, which identifies children ranked above the 90th percentile of the population, on published norms (36).

This is an exploratory, hypothesis-generating study where the model and covariate selection were identified after data collection and prior to data analysis. Demographic variables were collected at baseline. Family income was dichotomized at \$60,000 (Canadian dollars), low maternal education was defined as completed high school or less, family composition was dichotomized as two parent household or single parent household/other. Body mass index (BMI) z score (standardized values by age and sex based on World Health Organization (WHO) Growth Standards and Reference (37)) was also considered a covariate for internalizing

Table 2. Correlation Matrix for all variables of interest (N=796)

Variables	1	2	3	4	5	6	7	8
1. Internalizing score	1							
2. Sleep Duration	-.095**	1						
3. Age	.036	-.385**	1					
4. Sex	-.046	.073*	.017	1				
5. Family Income	-.136**	.095**	.001	.027	1			
6. Maternal Education	-.033	.062	-.005	.019	.233**	1		
7. Family Composition	-.001	.122**	-.059	.024	.241**	.019	1	
8. zBMI	-.069*	-.117**	-.020	-.005	-.011**	-.051	-.066	1
* p<0.05								
** p<0.01								

symptoms as a recent study conducted by Carsley and colleagues (38) suggests increased weight status in children ages 0 to 18 years is associated with mental health related outpatient visits and emergency department visits.

Statistical Analysis

Descriptive statistics were calculated for the entire sample. To investigate objective 1, a hierarchical linear regression (HLR) model was used to evaluate the association for parent reported 24-hour sleep duration and internalizing symptoms. The minimal adjustments included child age and sex; the fully adjusted model included all covariates, child age, sex, family income, maternal education, family composition, and zBMI. Likewise for objective 2, an HLR model evaluated the association between insufficient sleep, and internalizing symptoms. The minimally adjusted model included child age and sex; the fully adjusted model included child age, sex, family income, maternal education, family composition, and zBMI. A sensitivity analysis was completed including the additional 8 participants whose parents reported fewer than 8 hours or greater than 14 hours of sleep and results were essentially the same. Therefore, we report only the primary analyses with exclusion and inclusion criteria as described. Results from HLR models are reported as adjusted regression coefficients B (non-standardized). No adjustments have been made for multiple tests, all raw p-values are reported and should be interpreted at a type-1 error rate per test, not as a family-wise type-1 error rate.

Results

The mean (\pm SD) age of children included in this study (n=796) was 91.8 (\pm 22.9) months or approximately 7.7 years and 54% were male. Overall, 14% (95% CI 0.12, 0.17) of participants were rated as high, for internalizing symptoms. Sample characteristics are presented in Table 1. Correlations among variables are documented in Table 2.

On average, children 5 years old slept 10.4 hours daily (\pm SD=0.8), and children 6-12 years old slept 9.9 hours daily (\pm SD=0.8). Of children aged 5 years, 14% did not meet guidelines for sufficient sleep, whereas among children aged 6-12 years, 6% did not meet guidelines. The majority of participants came from well-educated and financially secure families, as 91% of participants reported living in a two-parent household, 95.7% of mothers had a college/university degree, and 92% reported an annual household income >\$60,000 CAD.

Parent-reported sleep duration was inversely associated with internalizing symptoms, adjusting for child age, sex, family income, maternal education, family composition, and zBMI with B estimate = -0.33, [95% CI -0.57, -0.07], p=0.012. See Table 3. Results from the HLR model are reported as adjusted regression coefficients B (non-standardized).

When we examined the relationship between insufficient sleep according to NSF guidelines and internalizing symptoms, the minimally adjusted (adjusted for age and sex only) model, showed that insufficient sleep per guideline was associated with internalizing symptoms (B estimate = 0.70, [95% CI 0.016, 1.38], p=0.044). However, the association was no longer statistically significant, after adjusting

Table 3. Association between sleep duration and internalizing score among children 5 to 12 years of age N = 796

	Minimally adjusted ^a			Adjusted ^b		
	B Estimate	95%CI	p-value	B Estimate	95%CI	p-value
Sleep Duration	-0.29	-0.52, -0.05	0.017*	-0.33	-0.57, -0.07	0.012*
Age, months	0.0001	-0.01, 0.01	0.967	-0.001	-0.01, 0.01	0.959
Sex, male	0.20	-0.16, 0.58	0.270	0.21	-0.17, 0.59	0.281
Family income, <\$60,000	---	---	---	1.52	0.76, 2.28	0.001**
Maternal Education, high school or less	---	---	---	0.064	-0.9, 1.02	0.895
Family composition, single parent household ^c	---	---	---	-0.40	-1.08, 0.28	0.249
zBMI	---	---	---	-0.24	-0.43, -0.06	0.008**

CI, confidence interval; and zBMI, body mass index z-score
^aAdjusted for age and sex
^bAdjusted for age, sex, family income, maternal education, family composition and zBMI
^cIncludes other non-traditional family arrangements

Minimally Adjusted:
Multiple R-squared: 0.01
Adjusted R-squared: 0.006

Adjusted:
Multiple R-squared: .039
Adjusted R-squared: .030

for all covariates, B estimate = 0.64, [95% CI -0.09, 1.38], $p=0.084$. See Table 4.

Discussion

This study documents an inverse association between parent reported 24-hour sleep duration and parent reported internalizing symptoms in a community sample of 796 children ages 5-12 years old, while adjusting for child age, sex, family income, family composition, maternal education and zBMI. The subsequent examination of insufficient sleep per NSF guidelines, identified a trend, but not a clear association between insufficient sleep and internalizing symptoms, once adjusted for covariates.

The current study extends the evidence about sleep duration and internalizing problems to children under 6 years, where recent literature indicates sleep problems are early markers of severity for young children with anxiety disorders and major depression (39), and can precede internalizing problems more often than externalizing problems (40). The model also documented the anticipated association between low family income and internalizing symptoms, as previously identified (41). However, we document an inverse association between zBMI and internalizing symptoms. This appears to be inconsistent with a recent report that children

with higher zBMI are more likely to have an outpatient mental health visit (38).

Surprisingly, insufficient sleep according to the NSF guidelines was not clearly associated with internalizing symptoms. This may be due to methodological factors, such as, the sample was not fully representative of the 6- 12 age bracket, or the sample size was not large enough to observe the effect. However, the guidelines themselves are not yet based on robust observational data (29) and likely will require further refinement when additional evidence is available.

The primary limitations of this study are the cross-sectional design and the use of parent report for obtaining information about sleep duration and about mental health. This study's data structure presumes that parent-reported sleep duration and parent-reported internalizing symptoms represent actual concurrent state of participants. Indeed 60% of reports were collected at the same time. In addition, due to its cross-sectional design, the study cannot provide information about the direction of effect, that is, whether sleep difficulties precede anxious behaviours or if they are a product of emotional distress. Moreover, we have not examined sleep quality in parallel with sleep duration, an aspect of sleep that also is important (42). In terms of using parent reported measures, parent subjective report of sleep may

Table 4. Association between insufficient sleep according to NSF Guidelines and internalizing symptoms among children 5 to 12 years of age N = 796

	Minimally adjusted ^a			Adjusted ^b		
	B Estimate	95%CI	p-value	B Estimate	95%CI	p-value
Insufficient sleep	0.70	0.016, 1.38	0.044*	0.64	-0.09, 1.38	0.086
Age, months	0.005	-0.004, 0.01	0.266	0.005	-0.004, 0.01	0.280
Sex, male	0.24	-0.13, 0.60	0.212	0.25	-0.13, 0.63	0.202
Family income, <\$60,000	---	---	---	1.47	0.69, 2.25	0.0002**
Maternal Education, high school or less	---	---	---	0.09	-0.87, 1.05	0.859
Family composition, single parent household ^c	---	---	---	-0.34	-1.02, 0.34	0.328
zBMI	---	---	---	-0.24	-0.43, -0.06	0.010*

CI, confidence interval; and zBMI, body mass index z-score
Sufficient sleep for children age 5 is ≥ 10 hrs p/night; sufficient sleep for children age 6-12 is ≥ 9 hrs p/night
^aAdjusted for age and sex
^bAdjusted for age, sex, family income, maternal education, family composition and zBMI
^cIncludes other non-traditional family arrangements
Minimally Adjusted:
Multiple R-squared: .009
Adjusted R-squared: .004
Adjusted:
Multiple R-squared: 0.034
Adjusted R-squared: 0.025

not translate to objective measures as a parent may not be a good judge of their child's sleep duration. Indeed, parents tend to overestimate the nightly sleep duration by ~24 min per night for children 4-9 years old (43). Therefore, using parent-reported sleep duration may have weakened the measured association between sleep duration and internalizing symptoms in this study. As for parent report of internalizing symptoms, it is well known that parents may underestimate their child's internalizing symptoms (44,45) however we are using a validated questionnaire frequently used to capture information about children's behaviour and emotions in community samples (34). Also, our community sample included 14% of participants with high levels of internalizing symptoms, consistent with published samples among children seen in the community or those recruited through primary care (46, 47). It is possible that using two parent reported measures, both obtained at the same time, may contribute to common method variance (CMV)(48). However, parent report of both child attributes is easier to obtain, often used in research despite its limitations, and is meaningful, as this is often the way clinicians collect information about the child.

Directions for future research should include longitudinal research that investigates directionality of the effect of sleep

duration and internalizing symptoms in children. Additionally, studies that use objective measures of sleep quality and duration such as actigraphy, and observe timing of sleep onset and wakening would improve the understanding of how sleep behaviors and emotional disorders are associated in children. (49). Future research should also examine how family characteristics and parent factors impact the relationship between child sleep and mental health outcomes (50).

Sleep is gaining increased recognition as an indicator of overall health, and sufficient sleep is presumed to be important for child development and emotion regulation (51). Findings add to the evidence that young children may experience both sleep difficulties and internalizing problems at the same time. Health providers should be knowledgeable about how to assist families with improving their child's sleep habits as a routine part of mental health care.

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Conflicts of Interest

The authors have no financial relationships or other ties to disclose.

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