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Brief Communication

The association between chronotype and sleep problems in preschool children

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ABSTRACT

Objective: Adolescents and adults who are evening-types exhibit shorter sleep duration and more sleep problems than individuals with an earlier chronotype. We hypothesized that already at a preschool age, evening-types would exhibit more sleep problems relative to children who are morning or intermediate chronotypes. The aim of this study was to examine the association between chronotype and sleep problems among preschool children.

Methods: We studied a subset of typically-developing 4.5-year-olds taking part in the Growing Up in Singapore Towards healthy Outcomes birth cohort study (n = 244). The Children's Chronotype Questionnaire (CCTQ) was used to categorize children into morning-, intermediate-, and evening-types. Sleep problems were measured using the Children's Sleep Habits Questionnaire (CSHQ), with higher scores corresponding to greater sleep problems. The relation between chronotype, sleep–wake timing, and nocturnal sleep time was also evaluated in a subsample of 117 children using actigraphy recordings with parent-reported sleep diaries.

Results: After controlling for potential confounders (maternal education, child's sex, birth order, and ethnicity), a significant main effect of chronotype on sleep problems was observed, in which evening-types exhibited greater CSHQ scores compared to morning- and intermediate-types (all $p < 0.001$). Actigraphy data in the subsample confirmed that evening-types had later bedtimes ($p < 0.001$) and get-up times ($p = 0.02$) during weekdays and weekends, but shorter nocturnal sleep time ($p = 0.034$) only during weekdays, compared to children who had earlier chronotypes.

Conclusions: In preschool children, sleep problems were greater in evening-types compared to morning- and intermediate-types, suggesting that chronotype could be a contributing factor to sleep disturbances in early childhood.

1. Introduction

Sleep problems that start in early childhood often persist across development [1–3], and have been associated with negative behavioral, cognitive, and emotional health consequences [2,4]. It is known that sleep problems are often caused by irregular sleep habits [5–7] and poorly enforced bedtime routines [5,6] such as irregular sleep–wake schedules. In adolescents and adults, chronotype is thought to be a stable trait that contributes to individual differences in sleep–wake timing [8,9]. A person's chronotype reflects his or her preferred timing of sleep and waking activities [7], which is linked to psychosocial behavior and specific properties of the circadian clock [8–10].

In children, chronotype is often divided into three different categories: “morning,” “intermediate,” and “evening” chronotypes.

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Evening-types exhibit later habitual bedtimes and sleep onset times independent of environmental factors (such as parenting), in comparison to morning-types, as evidenced by actigraphy [7,11]. However, little is known about whether individual differences in chronotype contribute to sleep problems in preschool children who have yet to be exposed to the formal education system and fixed school start times. In the present study, we therefore aimed to assess whether typically developing Singaporean preschoolers who are evening-types exhibit greater sleep problems than those who are morning- or intermediate-types.

2. Methods

2.1. Study design and sample

The present study was carried out as part of the Growing Up in Singapore Towards healthy Outcomes (GUSTO) birth cohort study, which recruited 1247 pregnant women aged ≥18 years during the first trimester of pregnancy. Socio-demographic information was collected upon enrollment. Women were recruited from two major public hospitals in Singapore: KK Women's and Children's Hospital, and the National University Hospital. All births occurred between 30 November 2009 and 1 May 2011. Further details about GUSTO study participants and research procedures have been described in a previous publication [12]. Written, informed consent was obtained from the caregiver of each child. The GUSTO study was approved by the National Health Care Group Domain Specific Review Board and the SingHealth Centralized Institutional Review Board.

2.2. Procedures

At 4.5 years of age (±2 months), mothers completed the Children's Chronotype Questionnaire (CCTQ) and Children's Sleep Habits Questionnaire (CSHQ) (n = 288) in English, Chinese, Malay, or Tamil, according to their dominant language during a center research visit. The CCTQ and CSHQ questionnaires were forward and backward translated to Chinese, Malay, and Tamil by accredited translation services specializing in East Asian and local languages (eg, ACTC Translation Centre). These forward and backward translations were independently checked by at least two native Chinese, Malay, and Tamil English-speaking persons. Following consensus discussions with all translators, single Chinese, Malay, and Tamil versions were obtained. Internal consistency of the English version as well as the combined English and language translations for CCTQ and CSHQ were assessed by Cronbach's α coefficients. We found that the Cronbach's α for both the English as well as the combined translations showed similar results. Sleep–wake behavior was examined in a subsample of 118 children using actigraphy recordings with parent-reported sleep diaries.

2.3. Measures

2.3.1. Children's Chronotype Questionnaire (CCTQ)

The CCTQ includes a multi-item morningness/eveningness (ME) scale score that has been validated for use in 4- to 11-year-old children across Asian and Caucasian/white populations, where children with scores ≤23 are classified as morning-types, scores of 24–32 as intermediate-types, and scores of ≥33 as evening-types [7,11,13]. The ME scale score is derived by summing the scores from the responses to items 17–26 of the original questionnaire [7] (a = 1, b = 2, c = 3, d = 4, e = 5), except for items 17, 18, 24, and 25, for which scoring is reversed (a = 5, b = 4, c = 3, d = 2, e = 1). Cronbach's α for the 10 items was 0.72 and ranged from 0.66 to 0.75.

2.3.2. Children's Sleep Habits Questionnaire (CSHQ)

The CSHQ has been validated to assess sleep problems in 4- to 10-year-old children across different ethnic groups [14–16]. It comprises eight subscales, grouped according to the following sleep domains: Bedtime Resistance, Sleep Onset Delay, Sleep Duration, Sleep Anxiety, Night Wakings, Parasomnias, Sleep Disordered Breathing, and Daytime Sleepiness. The CSHQ total score is determined by summing the scores from individual subscales, in which a higher CSHQ score indicates greater sleep problems. Cronbach's α for the eight subscales was 0.50 and ranged from 0.37 to 0.52.

2.3.3. Actigraphy

Sleep–wake behavior was monitored in a subsample of 4.5-year-old children (n = 117) for ≥4 days using actigraphy (Actiwatch 2; Philips Respironics, Murrysville, PA), including at least one day of the weekend. Data were collected in one-minute intervals and scored with Actiware software version 6.0.2 (Philips Respironics, Murrysville, PA) using the automatic sensitivity threshold for sleep–wake staging. Similar to existing studies using infant and toddler actigraphy [13,17], concurrent parent-reported child sleep diaries were used to confirm and to demarcate bedtimes, get-up times, and nocturnal sleep time in the actigraphy record. Only those actigraphy recordings in which bedtimes and get-up times aligned with parent-reported sleep diaries were included in the analyses. In all, 4.88% (n = 6) of our actigraphy data was not used for analyses due to either mismatched or missing sleep diaries.

2.4. Statistical analyses

We included only those children who were born ≥37 to ≤41 weeks of gestation, with birth weights of ≥2500 g to ≤4000 g and Apgar scores of ≥9 at either 5 or 10 min (latest recorded) (n = 244). Of the 244 mother–offspring pairs who met the inclusion criteria (84.7% of 288 participants), 6 had missing data for either maternal education (n = 2) or the CSHQ (n = 4). For each analysis in this study, we used the maximum number of mother–offspring pairs that were available.

Pearson correlations and paired-samples *t* tests were used to assess the association and differences between sleep–wake timing and nocturnal sleep time on chronotype for weekdays and weekends using actigraphy. Previous studies have shown that male sex, lower maternal education, being non-Caucasian/nonwhite, and being a first-born were associated with greater child sleep problems [3,18,19]. We therefore assessed the associations between socio-demographic characteristics (child's sex, ethnicity, maternal education, and birth order) with CSHQ scores and Children's ChronoType Questionnaire – Morningsness/Eveningness Scale (CCTQ-ME) scores using Pearson correlations and Kruskal–Wallis tests (Table 1). A one-way analysis of variance (ANOVA) was used to investigate the main and covariate effects of chronotype on CSHQ scores with Bonferroni-adjusted post hoc pairwise comparisons. All analyses were conducted using IBM SPSS version 22 (IBM SPSS, Armonk, NY).

3. Results

3.1. Sleep–wake timing

The actigraphy-estimated average (standard deviation [SD] in hours) bedtime and get-up time based on mother-reported child sleep diaries were respectively 23:01 (0:59) and 08:02 (01:00). Average bedtimes for morning-, intermediate-, and evening-types during weekdays were respectively 21:55 (01:00), 22:44 (0:48), 23:02 (0:58), and during weekends were respectively 22:21 (01:23), 23:12 (01:03), and 23:34 (01:15). Average wake for