Later Emotional and Behavioral Problems Associated With Sleep Problems in Toddlers
A Longitudinal Study

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IMPORTANCE Childhood sleep problems have been linked to a range of adverse health outcomes, but there is limited knowledge as to the temporal association between sleep problems and subsequent emotional and behavioral problems in young children.

OBJECTIVE To examine whether sleep problems in toddlers aged 18 months are related to both concurrent and subsequent emotional and behavioral problems in preschool children aged 5 years.

DESIGN, SETTING, AND PARTICIPANTS A large population-based longitudinal study was conducted in September 2014 using data from the Norwegian Mother and Child Cohort Study conducted at the Norwegian Institute of Public Health from June 1, 1999, to December 31, 2008. A total of 32 662 children or pregnancies were included.

EXPOSURES Sleep was assessed by mother-reported child sleep duration and nocturnal awakenings.

MAIN OUTCOMES AND MEASURES Emotional and behavioral problems were measured with items from the Child Behavior Checklist and operationalized according to recommended clinical cutoffs, corresponding to T scores of greater than 65 (93rd percentile). Risk ratios (RRs) were calculated using negative binomial regression, controlling for emotional and behavioral problems at 18 months and other relevant covariates.

RESULTS Short sleep duration (≤10 hours) in 556 children (1.7%) and frequent nocturnal awakenings (≥3 times) in 1033 children (3.2%) at 18 months significantly predicted both concurrent and later incidence of emotional and behavioral problems at 5 years. The longitudinal RRs were generally larger for internalizing problems, with adjusted RRs of 1.59 (95% CI, 1.23-2.08) for both short sleep duration and 1.57 (95% CI, 1.28-1.93) for nocturnal awakenings; RRs for externalizing problems were 1.77 (95% CI, 1.37-2.30) and 1.25 (95% CI, 1.00-1.58), respectively. Additional adjustment for emotional and behavioral problems at 18 months slightly reduced the strength of these associations, and all RRs remained significant in the fully adjusted models.

CONCLUSIONS AND RELEVANCE Early sleep problems predict later development of emotional and behavioral problems. Intervention studies are needed to examine whether sleep programs targeting early childhood may avert the onset of later adverse outcomes.
Sleep problems are frequent in early childhood. Indicators of sleep problems, such as short sleep duration and nighttime awakenings, have been linked to a range of adverse health outcomes. The coexistence of sleep problems with both emotional (internalizing) and behavioral (externalizing) problems is well established, and the importance of sleep for children's emotional regulation has been emphasized.

Sleep problems may also constitute risk factors for emotional and behavioral problems. The authors of a review of the association between sleep and emotional and behavioral problems in children and adolescents provided evidence of a complex and possibly bidirectional link between sleep and emotional and behavioral problems in older children. The authors also noted a paucity of studies on toddlers and very young children. There are a few notable exceptions to the association noted in that review. In a study monitoring 490 US children aged 4 years to midadolescence, early sleep problems predicted the development of subsequent emotional and behavioral problems even after controlling for the stability of emotional and behavioral problems. These results showed a nonspecific association, with early sleep problems serving as an equally strong risk factor for both internalizing and externalizing problems. In a meta-analysis of prospective studies on emotional regulation problems in infancy and later behavioral outcomes, sleep problems were linked to later problems, although the magnitude of the associations differed across outcomes; the effect sizes ranged from $d = 0.24$ for internalizing problems and $d = 0.42$ for general behavioral problems to $d = 1.30$ for attention-deficit/hyperactivity disorder. The review was also restricted by the small number of studies included and by the sleep assessments being limited to general sleep problems rather than specific sleep problems, such as short sleep duration. More recent studies have examined specific aspects of both sleep and emotional and behavioral problems in childhood and showed that general sleep problems predicted persistent internalizing problems, whereas short sleep duration predicted hyperactivity from age 18 months to 5 years. Similarly, early sleep problems have been found to predict later attention problems. One reason for such disparate findings may be that the association between sleep and emotional and behavioral problems may be developmentally specific and differ across age groups. This hypothesis was suggested in a longitudinal study monitoring children from preschool to midadolescence in which the association between sleep and emotional and behavioral problems became stronger over time.

Although there is convincing evidence of the concomitant occurrence of sleep and emotional and behavioral problems, there is a lack of prospective research, particularly in young children, thereby limiting our knowledge of the temporal association between these problems. It also remains unclear whether the association is linked to both externalizing and internalizing problems. The overall aim of the present study was to investigate whether specific sleep problems in toddlers are related to both concurrent and subsequent emotional and behavioral problems in preschool children. Two hypotheses were tested: (1) there is a high concomitant occurrence of sleep problems and emotional problems at age 18 months, and (2) both nocturnal awakenings and short sleep duration predict development of later emotional and behavioral problems, also after controlling for internalizing and externalizing problems at age 18 months.

### At a Glance
- Longitudinal study of 32,662 Norwegian mother-infant pairs.
- Short sleep duration of 10 hours or less and frequent nocturnal awakenings ($\geq 3$ times each night) at 18 months was significantly associated with both concurrent and later incidence of emotional and behavioral problems at 5 years.
- Longitudinally, nocturnal awakenings were most strongly associated with internalizing problems, while short sleep duration was equally associated with internalizing and externalizing problems.
- Intervention studies are needed to examine whether sleep programs targeting early childhood may avert the onset of later adverse outcomes.

### Methods

#### Population

**Norwegian Mother and Child Cohort Study**

The present study draws from the Norwegian Mother and Child Cohort Study (MoBa) (http://www.fhi.no/morogbarn). In brief, MoBa is a prospective, population-based pregnancy cohort study conducted by the Norwegian Institute of Public Health. Participants were recruited from throughout Norway between June 1, 1999, and December 31, 2008, and 38.5% of the invited women consented to participate. The cohort included 108,000 children and 90,700 mothers. Follow-up is ongoing by the administration of questionnaires at regular intervals. Using data from the Medical Birth Registry of Norway, it has been shown that, although prevalence estimates of exposures and outcomes in the MoBa study may be biased owing to self-selection, estimates of exposure-outcome associations are not affected by self-selection and therefore do not constitute a validity problem in terms of reduced representativeness. Written informed consent was obtained from all MoBa participants upon recruitment. The study was approved by the Regional Committee for Medical Research Ethics in South-Eastern Norway. Participants did not receive financial compensation.

The present study is based on version 8 of the quality-assured data files released for research in February 2014. The data were collected from MoBa Questionnaire 1 (gestational week 17), MoBa Questionnaire 5 (18 months after birth), and MoBa Questionnaire 7 (5 years after birth) in addition to information from the Norwegian Medical Birth Registry. As of February 14, 2014, the study comprises a longitudinal sample with valid data on the dependent variables (Child Behavior Checklist [CBCL] subscales), including a total of 32,662 of the initial 91,489 pregnancies. The reason for the large difference in numbers between included and invited participants is that most of the children had not yet reached age 5 years and thus were not enrolled in the study.
Measures

Clinical and Demographic Variables
Information on maternal age, birth weight, sex, gestation, and parity was collected from the Norwegian Medical Birth Registry. Educational level was assessed by self-report from MoBa Questionnaire 1. These measures were included as potential confounders.

Emotional and Behavioral Problems
The CBCL\textsuperscript{13} version for preschool children (CBCL/1.5-5) is constructed to cover a range of emotional, social, and behavioral problems. The CBCL/1.5-5 consists of 99 items describing a behavior exhibited by the child during the preceding 2 months, and the respondent, in the current study the mother, rates each item on a scale from 0 (not true), 1 (somewhat or sometimes true), or 2 (very true or often true). The CBCL/1.5-5 has several subscales (Emotionally Reactive, Active/Depressed, Somatic Complaints, Attention Problems, and Aggressive Behavior). These 5 subscales are also combined into 2 aggregated scales measuring internalizing (the first 3 subscales) and externalizing behavior problems (the last 2 subscales). The CBCL version for older children has been validated in a Norwegian study,\textsuperscript{14} whereas the CBCL/1.5-5 has been validated in Dutch and Danish samples.\textsuperscript{15,16} These studies show that the psychometric properties are comparable to those obtained for American samples, with adequate internal consistency, test-retest reliability, and interparent agreement as well as discriminatory power and high stability with problem ratings 2 years later. The Cronbach $\alpha$ values based on polychoric correlations\textsuperscript{27} for the aggregated internalizing and externalizing subscales in the present study were 0.65 and 0.72 at 18 months and 0.86 and 0.89 at 5 years, respectively.

The MoBa study was designed to cover a range of areas relevant to child health and development, and the full CBCL/1.5-5 was not included owing to space restrictions in the questionnaires. The questionnaires for ages 18 months and 5 years in MoBa contain CBCL/1.5-5 items that were intended to represent all CBCL subscales with 2 or 3 items and to be clinically and theoretically relevant indications of behavior problems. Thirteen of the CBCL items included in the questionnaires for both ages 18 months and 5 years were used in the present study as indices of behavior problems (no sleep items). A recent publication\textsuperscript{18} from the MoBa study showed that the items assessing externalizing problems in the abbreviated version of the CBCL were representative of the full externalizing scale of the CBCL, with a correlation of 0.92. The original CBCL scoring manual\textsuperscript{19} defines scale scores above the 93rd percentile as clinically significant (corresponding to a T score >65). The same procedure was used on the corresponding subscales of the abbreviated scales in the present study. Because these subscales included fewer items, percentile scores are less accurate. Hence, the cutoffs were based on the nearest valid value to the 93rd percentile for each subscale.

Sleep Variables
Sleep duration at 18 months was assessed by the question, “How many hours in total does your child sleep in 24 hours?” Response categories were 10 hours or less, 11 to 12 hours, 13 to 14 hours, and 15 hours or more. The 2 latter categories were combined to form the reference category based on the most frequent sleep durations in this age group.

Nocturnal awakenings were assessed with a single question, “How often does your child usually wake during the night?” Response categories were 3 or more times every night, once or twice every night, a few times a week, and seldom or never. The two latter categories were combined to form the reference category.

Statistical Analysis
Negative binomial regression analyses were used to examine associations between sleep variables at 18 months and emotional and behavioral problems at 18 months and 5 years. Effect sizes are presented as relative risks (RRs) with 95% CIs using robust standard errors. Both crude/unadjusted and adjusted analyses were conducted. Adjustment variables included maternal age, educational level, duration of pregnancy, parity, birth weight, and sex. For the longitudinal analyses, we additionally adjusted for the corresponding CBCL subscale/aggregated scale at 18 months. Missing data were handled using listwise deletion.

Statistically significant differences between participants with complete data at both time points and those who withdrew after the 18-month assessment were found for some variables. Those not dropping out by 5 years were characterized by mothers who had a greater educational level and were slightly older and by children who had somewhat higher levels of internalizing and externalizing problems. However, all significant effect sizes (Cohen $d$) were very small ($d = 0.03$-$0.07$). No differential attrition between 18 months and 5 years was observed for any of the other variables. All analyses were performed using SPSS, version 22 (SPSS Inc).

Results

Demographic and Clinical Characteristics
The longitudinal sample in the present study comprised 32 662 children. The mean (SD) age was 30.6 (4.4) years. A total of 67.2% of the mothers reported an educational level beyond high school. Of the children, 48.9% were girls (Table 1 reports the data according to sleep duration). At 18 months, most (58.9%) of the sample slept 13 to 14 hours per day, whereas 36.2% and 1.9% slept 11 to 12 hours and 10 or fewer hours, respectively. There were no significant sex differences in terms of sleep duration. Nightly awakenings were reported in 26.9% of the children at 18 months, and these were more common among boys than girls (28.8% vs 25.6%; $P < .001$).

Cross-Sectional Associations
Sleep duration of less than 13 hours was significantly associated with an increased risk of concurrent emotional and behavioral problems at 18 months. This pattern was evident across all CBCL subscales. The aggregated scale of internalizing problems showed the strongest association with sleeping 10 hours or less vs 13 or more hours (RR, 3.46; 95% CI, 3.07-3.89), whereas the corresponding risk for externalizing
problems was lower (RR, 2.09; 95% CI, 1.80-2.41). As
detailed in Table 2, the associations were substantially
lower, but remained significant, between sleep duration of
11 to 12 vs 13 or more hours and the CBCL aggregated scales
(RRs, 1.22-1.39).
Adjustments for potential confounding factors (maternal
age and educational level, duration of pregnancy, parity, birth
weight, and sex) did not reduce or only slightly reduced the
RRs. All associations remained significant in the fully ad-
justed analyses.

As reported in Table 3, a total of 3 or more nocturnal
awakenings per night was significantly associated
with all CBCL subscales in the crude analyses (RRs, 1.50-
4.04). As with sleep duration, the strongest associations
were with internalizing problems. In addition, 1 or 2 awak-
enings per night were significantly associated with all CBCL
subscales, although the RRs were substantially smaller.
Adjusting for confounders had little effect on the associa-
tions, and all RRs remained significant in the fully adjusted
model.

Table 1. Demographic and Clinical Variables Stratified by Sleep Duration at 18 Months

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Sleep Duration, Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤10 h</td>
</tr>
<tr>
<td>Demographics</td>
<td></td>
</tr>
<tr>
<td>Parity, first born, No. (%)</td>
<td>634 (44.6)</td>
</tr>
<tr>
<td>Maternal educational level (a degree beyond high school), No. (%)</td>
<td>679 (52.1)</td>
</tr>
<tr>
<td>Girls, No. (%)</td>
<td>673 (47.3)</td>
</tr>
<tr>
<td>Birth weight, g</td>
<td>3546 (597)</td>
</tr>
<tr>
<td>Gestation, wk</td>
<td>39.4 (1.9)</td>
</tr>
<tr>
<td>Maternal age, y</td>
<td>30.6 (5.0)</td>
</tr>
<tr>
<td>CBCL subscales at 18 moa*</td>
<td></td>
</tr>
<tr>
<td>Emotionally Reactive</td>
<td>1.9 (4.2)</td>
</tr>
<tr>
<td>Anxious/Depressed</td>
<td>3.2 (2.9)</td>
</tr>
<tr>
<td>Somatic Complaints</td>
<td>5.6 (7.3)</td>
</tr>
<tr>
<td>Attention Problems</td>
<td>3.2 (2.2)</td>
</tr>
<tr>
<td>Aggressive Behavior</td>
<td>9.0 (6.0)</td>
</tr>
<tr>
<td>Combined subscale</td>
<td></td>
</tr>
<tr>
<td>Internalizing</td>
<td>14.2 (13.7)</td>
</tr>
<tr>
<td>Externalizing</td>
<td>12.2 (6.8)</td>
</tr>
<tr>
<td>CBCL subscales at 5 y*</td>
<td></td>
</tr>
<tr>
<td>Emotionally Reactive</td>
<td>2.0 (4.4)</td>
</tr>
<tr>
<td>Anxious/Depressed</td>
<td>1.3 (2.2)</td>
</tr>
<tr>
<td>Somatic Complaints</td>
<td>2.2 (3.1)</td>
</tr>
<tr>
<td>Attention Problems</td>
<td>1.7 (1.9)</td>
</tr>
<tr>
<td>Aggressive Behavior</td>
<td>8.3 (7.2)</td>
</tr>
<tr>
<td>Combined subscale</td>
<td></td>
</tr>
<tr>
<td>Internalizing</td>
<td>7.2 (9.8)</td>
</tr>
<tr>
<td>Externalizing</td>
<td>10.0 (8.5)</td>
</tr>
</tbody>
</table>

Abbreviation: CBCL, Child Behavior Checklist.
*a Values represent the mean sum scores on each subscale and combined subscale.

Table 2. T Score at 18 Months for Cross-Sectional Associations Between Short Sleep Duration and Concurrent Emotional and Behavioral Problems*

<table>
<thead>
<tr>
<th>CBCL Subscale</th>
<th>Sleep Duration Model, RR (95% CI)b</th>
<th>Adjustedc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤10 h</td>
<td>11-12 h</td>
</tr>
<tr>
<td>Emotionally Reactive</td>
<td>3.92 (2.75-5.58)</td>
<td>1.23 (1.02-1.48)</td>
</tr>
<tr>
<td>Anxious/Depressed</td>
<td>2.90 (2.56-3.29)</td>
<td>1.29 (1.21-1.37)</td>
</tr>
<tr>
<td>Somatic Complaints</td>
<td>3.00 (2.52-3.57)</td>
<td>1.29 (1.19-1.40)</td>
</tr>
<tr>
<td>Attention Problems</td>
<td>2.27 (1.89-2.74)</td>
<td>1.13 (1.04-1.23)</td>
</tr>
<tr>
<td>Aggressive Behavior</td>
<td>1.64 (1.43-1.89)</td>
<td>1.17 (1.11-1.23)</td>
</tr>
<tr>
<td>Combined subcales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internalizing</td>
<td>3.46 (3.07-3.89)</td>
<td>1.39 (1.31-1.48)</td>
</tr>
<tr>
<td>Externalizing</td>
<td>2.09 (1.80-2.41)</td>
<td>1.22 (1.15-1.30)</td>
</tr>
</tbody>
</table>

Abbreviations: CBCL, Child Behavior Checklist; RR, relative risk.
*b T score greater than 65.
*c Reference: sleep duration of 13 hours or more.
*d Adjusted for maternal age and educational level, duration of pregnancy, parity, birth weight, and sex.
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Abbreviations: CBCL, Child Behavior Checklist; RR, relative risk.

All CBCL subscale scores. There were no significant differences between the aggregated scales regarding internalizing problems (RR, 2.12; 95% CI, 1.66-2.69) and externalizing problems (RR, 2.15; 95% CI, 1.69-2.71). Adjusting for confounders reduced the RRs to some extent, but even in the fully adjusted model with additional adjustment for the corresponding CBCL subscales at 18 months, sleeping 10 hours or less per night as well as between 11 and 12 hours per night remained significant risk factors for development of later emotional and behavioral problems.

As detailed in Table 5, nocturnal awakenings at 18 months significantly predicted later emotional and behavioral problems in a dose-response manner. This pattern was evident across all CBCL subscales except for Attention Problems. Adjusting for confounders did not or only slightly reduce the RRs, and even additional adjustment for the corresponding CBCL subscale or aggregated scale had little or no effect on the magnitude of the risk (fully adjusted RRs for ≥3 awakenings per night, 1.23-1.85). However, 1 or 2 awakenings per night at age 18 months were not significantly associated with externalizing problems at 5 years in the fully adjusted analyses.

Discussion

This large population-based study provides evidence that both short sleep duration and frequent nocturnal awakenings at age 18 months significantly predict concurrent and later incidence of emotional and behavioral problems at age 5 years. The risk was somewhat larger for internalizing than for externalizing problems. All effects remained significant in the fully adjusted analyses except for the association between 1 or 2 awakenings per night and externalizing problems.

These results extend the outcomes to a younger age group and are consistent with findings from a review by Gregory and Sadeh, who concluded that sleep problems in older children and young adolescents significantly predicted the later development of emotional and behavioral difficulties. Our findings indicate that this conclusion is also true for toddlers. Specifically, a strong link between short sleep duration and nightly awakenings at age 18 months was strongly associated with emotional and behavioral problems 3 to 4 years later. To the best of our knowledge, ours is
the first population-based longitudinal study to explore this connection before the age of 4 years. Nocturnal awakenings were most strongly associated with internalizing problems, while there were little differences between internalizing and externalizing problems for short sleep duration.

There are several potential mechanisms that may explain the link between sleep problems and emotional and behavioral problems, including common genetic and environmental risk factors. One study found that parent reports of sleep disturbances in children aged 3 years appeared to be genetically unrelated to emotional and behavioral problems, whereas environmental factors were consistently related to both sleep and emotional and behavioral problems. Negative life experiences, such as marital instability, have been shown to be related to both sleep and emotional and behavioral problems, and the quality of child-parent interactions has been linked to the development of later sleep problems and mental health problems. The finding that coexistence of sleep problems and internalizing problems in the present study may be a result of family factors is further supported by a study in which the co-occurrence of anxiety and sleep problems in 3- to 4-year-old children was partly accounted for by family disorganization and maternal depression. Other possible parental behaviors that may affect both sleep and emotional and behavioral problems include daily routines and the presence of parents at nighttime, which are linked to anxiety and sleep problems among infants, as well as limit-setting behavior; these possible mechanisms need further investigation. Taken together, although both genetic and environmental factors may play a role in sleep problems, the precise nature of the interacting contributions remains unresolved, and additional studies using different samples (eg, children with twin or other sibling control) or other methods to study causality are needed to generate empirical evidence.

Short sleep duration and sleep problems may also directly impede emotional regulation and increase irritability and negative affect, which are key characteristics of emotional and behavioral problems. Sleep is independently related to emotional and behavioral problems and is not accounted for by shared risk factors among preschool children. This association is further supported in school-aged children when extending sleep duration was associated with improved emotional regulation. Sleep interventions in children with sleep problems have also shown positive effects on daytime functioning.

The results from the present study must be interpreted in light of several methodologic limitations. First, the assessment of sleep was crude and did not include validated or objective measures of relevant methodologic issues (eg, rater bias). However, because previous research has reported similar findings when assessed by different raters (eg, parental-reported sleep and child self-reported emotional problems), it seems unlikely that all associations can be explained by methodologic concerns.

Second, mother-reported child sleep duration was assessed in predefined categories (ie, not in exact hours and minutes), and this measure included both nocturnal sleep as well as potential daytime naps. Although no objective measure of the children’s sleep was available in the present study, previous research has shown a very high correlation (r = 0.90) between parent-reported sleep duration and actigraphy-recorded sleep duration in young healthy children, with parents tending to slightly overestimate the sleeping hours of their children.

Third, sleep was not assessed when the children were aged 5 years; therefore, we were unable to examine and control for concurrent sleep problems at that age. As such, the present study cannot conclude whether interventions aimed at early sleep problems may have a positive effect on later emotional and behavioral problems or whether sleep in early life is merely a risk factor for later sleep problems and that concurrent sleep may be the biologically relevant exposure window affecting behavioral problems.

Fourth, the MoBa study did not include the full CBCL 1.5/5 instrument. Although the items indicating internalizing and externalizing problems at 18 months have been used in a previous publication from the MoBa database, the use of these abbreviated and unvalidated versions of the original scales may limit the generalizability of the results.

### Table 5. T Score at 5 Years for Longitudinal Associations Between Awakenings at 18 Months and Subsequent Emotional and Behavioral Problems

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Unadjusted (RR (95% CI))</th>
<th>Adjusted (RR (95% CI))</th>
<th>Fully Adjusted (RR (95% CI))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥3 1-2</td>
<td>≥3 1-2</td>
<td>≥3 1-2</td>
</tr>
<tr>
<td>CBCL subscale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotionally Reactive</td>
<td>2.13 (1.48-3.07)</td>
<td>1.38 (1.13-1.68)</td>
<td>1.91 (1.28-2.84)</td>
</tr>
<tr>
<td></td>
<td>1.40 (1.13-1.72)</td>
<td>1.85 (1.24-2.77)</td>
<td>1.40 (1.13-1.72)</td>
</tr>
<tr>
<td>Anxious/Depressed</td>
<td>1.76 (1.47-2.12)</td>
<td>1.27 (1.15-1.40)</td>
<td>1.71 (1.41-2.09)</td>
</tr>
<tr>
<td></td>
<td>1.29 (1.17-1.43)</td>
<td>1.53 (1.25-1.86)</td>
<td>1.22 (1.10-1.35)</td>
</tr>
<tr>
<td>Somatic Complaints</td>
<td>1.54 (1.32-1.80)</td>
<td>1.17 (1.08-1.27)</td>
<td>1.53 (1.29-1.81)</td>
</tr>
<tr>
<td></td>
<td>1.18 (1.09-1.29)</td>
<td>1.42 (1.20-1.68)</td>
<td>1.16 (1.06-1.26)</td>
</tr>
<tr>
<td>Attention Problems</td>
<td>1.41 (1.11-1.78)</td>
<td>1.04 (0.93-1.17)</td>
<td>1.33 (1.04-1.71)</td>
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<tr>
<td></td>
<td>1.05 (0.93-1.19)</td>
<td>1.29 (1.01-1.66)</td>
<td>1.01 (0.89-1.15)</td>
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<tr>
<td>Aggressive Behavior</td>
<td>1.44 (1.17-1.77)</td>
<td>1.13 (1.02-1.25)</td>
<td>1.30 (1.03-1.63)</td>
</tr>
<tr>
<td>Combined subscales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internalizing</td>
<td>1.82 (1.50-2.21)</td>
<td>1.33 (1.20-1.47)</td>
<td>1.77 (1.44-2.17)</td>
</tr>
<tr>
<td></td>
<td>1.35 (1.21-1.50)</td>
<td>1.57 (1.28-1.93)</td>
<td>1.29 (1.16-1.44)</td>
</tr>
<tr>
<td>Externalizing</td>
<td>1.49 (1.21-1.84)</td>
<td>1.14 (1.03-1.27)</td>
<td>1.34 (1.07-1.68)</td>
</tr>
<tr>
<td></td>
<td>1.14 (1.02-1.27)</td>
<td>1.25 (1.00-1.58)</td>
<td>1.11 (0.99-1.24)</td>
</tr>
</tbody>
</table>

Abbreviations: CBCL, Child Behavior Checklist; RR, relative risk.

* T score greater than 65.

* Reference. a few times a week or seldom or never.

* Adjusted for maternal age and educational level, duration of pregnancy, parity, birth weight, and sex.

* Additional adjustment for the corresponding CBCL subscale at 18 months.
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ORIGINAL INVESTIGATION Research

Despite the associations between predictor variables and outcomes, such as higher maternal age, fewer health-related risks, factors, a lower rate on some predictor variables was detected, such as higher maternal age, fewer health-related risks, and children who had received better neonatal healthcare relative to children of mothers not participating in MoBa. However, the associations between predictor variables and outcomes were not biased. The same pattern holds true for the variables in the present study, the prevalence of sleep problems may even be underestimated.

Finally, the epidemiologic design used here cannot determine causality, and emotional and behavioral problems may precede sleep problems. Methods designed to investigate unmeasured confounders, such as common genetic or environmental factors (eg, sibling comparison), or intervention studies are needed to ascertain whether altering predictors, such as improved sleep duration, may affect subsequent development of emotional and behavioral difficulties.

The strengths of the present study include that it is, to the best of our knowledge, the largest investigation on the prospective associations between sleep and later emotional and behavioral problems in this age group, allowing us to assess less prevalent sleep factors. The strongest associations were reported between emotional problems and nocturnal awakenings of 3 or more times per night and sleep duration of 10 hours or less. These groups constitute only 3.2% (n = 1033) and 1.7% (n = 556) of our sample, respectively, and would have been difficult to analyze in smaller samples. The longitudinal design allowed us to control for previous emotional and behavioral problems when assessing outcomes at age 5 years.

Conclusions

Sleep problems preceded and occurred concomitantly with emotional and behavioral problems in toddlers in the present study. Targeting sleep patterns during early life could thus constitute a pathway to reduce or prevent current and later mental health problems. Preventive educational programs as well as behavioral interventions have shown efficacy in children, and interventions also show promising effects on daytime functioning.

ARTICLE INFORMATION

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Author Contributions: Dr Sivertsen had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Sivertsen, Harvey, Reichborn-Kjennerud, Hysing.
Acquisition, analysis, or interpretation of data: Sivertsen, Reichborn-Kjennerud, Torgersen, Ystrom, Hysing.
Drafting of the manuscript: Sivertsen, Harvey, Hysing.
Critical revision of the manuscript for important intellectual content: All authors.
Statistical analysis: Sivertsen, Hysing.
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