Uninterrupted Sleep, Development, and Maternal Mood

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**Abbreviations:**
- SES: socioeconomic status
- CES-D: Center for Epidemiologic Studies Depression Scale
- MAVAN: Maternal Adversity, Vulnerability, and Neurodevelopment

**Table of Contents Summary:** A high percentage of infants do not sleep through the night, and this behavior is not associated with development or maternal mood in early infancy.

**What’s Known on This Subject:** Sleep plays a fundamental role in child development. Lack of sleep (total sleep duration) is associated with both physical and mental health problems in childhood. However, the specific association between consecutive sleep duration and development in early infancy remains unclear.

**What This Study Adds:** A high percentage of 6- and 12-month-old infants do not sleep through the night (uninterrupted sleep duration). When controlling for well-known confounding variables, no significant association was found between sleeping through the night, mental and psychomotor development, and maternal mood.
Contributors’ Statement Page
Dr Pennestri conceptualized the study, carried out the statistical analyses, interpreted the data, drafted the initial manuscript, reviewed and approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work.
Ms Laganière and Dr Bouvette-Turcot interpreted the data, critically reviewed the manuscript for important intellectual content, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.
Ms Pokhvisneva supervised the statistical analyses, participated in the data interpretation, critically reviewed the manuscript for important intellectual content, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work.
Dr Steiner participated in the study conceptualization and design, designed the data collection instruments, coordinated and supervised the data collection, interpreted the data, critically reviewed the manuscript for important intellectual content, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work.
Dr Meaney acted as the principal investigator of this study, participated in the study conceptualization and design, interpreted the data, critically reviewed the manuscript for important intellectual content, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work.
Dr Gaudreau coordinated and supervised the data collection, participated in the study conceptualization and design, participated in the data interpretation, critically reviewed the manuscript for important intellectual content, approved the final manuscript as submitted, and agrees to be accountable for all aspects of the work.
Abstract

Objectives: Contrary to the importance of total sleep duration, the specific association between sleeping through the night and development in early infancy remains unclear. The aims of this study were to investigate the proportion of infants who sleep through the night (6- or 8-hour sleep blocks) at age 6 and 12 months in a longitudinal cohort, and to explore associations between sleeping through the night, mental and psychomotor development, maternal mood, and breastfeeding.

Methods: At 6 and 12 months, maternal reports were used to assess the longest period of uninterrupted sleep and feeding method in a longitudinal cohort (n=388). Two different criteria were used to determine whether infants slept through the night: 6 and 8 hours of uninterrupted sleep. Mental and psychomotor developmental indices (Bayley Scales of Infant Development II) and maternal mood (Center for Epidemiologic Studies Depression) were measured at 6, 12, and 36 months.

Results: Using a definition of either 6 or 8 hours of uninterrupted sleep, from 27.9% to 57.0% of 6- and 12-month-old infants did not sleep through the night. Linear regressions revealed no significant associations between sleeping through the night and concurrent or later mental development, psychomotor development, or maternal mood (p>0.05). However, sleeping through the night was associated with a much lower rate of breastfeeding (p<0.0001).

Conclusions: Considering that high proportions of infants did not sleep through the night and that no associations were found between uninterrupted sleep, mental or psychomotor development and maternal mood, expectations for early sleep consolidation could be moderated.
Sleep plays a fundamental role in child development, and a growing body of evidence shows that lack of sleep in children is associated with both physical and mental health problems.1-5 Considering the high percentages of children with sleep problems (ranging from 20 to 35%),6-8 interest has grown in sleep disorder prevention, resulting in behavioral interventions at increasingly younger age.9, 10 Several recent studies have proposed such interventions in infants as young as 3 months old.11, 12

For most parents, the time when infants should consolidate their sleep, a process often called “sleeping through the night,” is a major concern.13 Sleeping through the night is a different concept from “total nocturnal sleep duration,” which refers to the total sleep duration during the night, and from “total sleep duration,” which refers to the total sleep duration in a 24-hour period. Sleeping through the night is instead defined as the longest period of uninterrupted sleep without parental intervention (i.e., sleep blocks of a specific duration, typically 6 or 8 hours).14 This is widely considered a developmental milestone that should be achieved at about age 5 or 6 months.14, 15 However, several studies have reported that not all infants conform to this classic developmental timeline.14, 16, 17 Whereas studies show that increasing percentages of infants sleep through the night as they grow up, they also show major interindividual differences.14, 18

Sleeping through the night at age 6 to 12 months is generally considered the gold standard in Western industrialized nations, and behavioral sleep training (such as controlled crying) is very popular among parents and professionals.19, 20 However, the idea of night awakenings as being problematic in early development is not unanimous, leading to conflicting advice from professionals.10, 21, 22 To get infants to sleep through the night, interventions such as delayed
response and feeding during the night have been proposed.\textsuperscript{12,23} However, many parents report that these methods are incongruent with their personal beliefs and find sleep interventions too difficult, particularly attempts to ignore infant crying.\textsuperscript{24}

The beneficial effects of sufficient total sleep duration on emotional regulation, attention, memory, and executive functions, are well documented in the literature.\textsuperscript{2,25-31} Nevertheless, the specific contribution of sleeping through the night to infant development remains underinvestigated and unclear. Moreover, sleep interventions in early infancy are also meant to improve maternal well-being.\textsuperscript{32} Because poor maternal sleep quality is associated with increased maternal depressive symptoms,\textsuperscript{33,34} whether or not infants sleep through the night may influence maternal mood. Finally, breastfeeding and co-sleeping are frequently mentioned factors associated with sleep fragmentation in infants.\textsuperscript{35,36} Therefore, they are key factors to consider when investigating sleep–wake cycle consolidation.

Considering the importance of sleep in daily life and the conflicting messages parents receive about the importance of early sleep consolidation, it would be worthwhile to determine whether sleeping through the night in early infancy is associated with early child development and maternal mood. The aims of the present study were to 1) determine the percentage of infants who sleep through the night at age 6 and 12 months (using 6- or 8-hour sleep blocks as criteria) in a longitudinal cohort; 2) determine feeding method as a function of sleeping through the night or not; and 3) explore associations between sleeping through the night, mental development, psychomotor development, and maternal mood.
Methods

Participants

Participants were part of a longitudinal birth cohort study, Maternal Adversity, Vulnerability, and Neurodevelopment (MAVAN). Sleep measures were available for 388 mother–infant dyads at 6 months (182 girls, 206 boys; Table 1) and for 369 mother–infant dyads at 12 months (176 girls, 193 boys; 308 participants completed sleep measures at both time points). Pregnant mothers were recruited at from 13 to 20 weeks gestation from obstetric clinics in Montreal, Québec and Hamilton, Ontario (Canada). Inclusion criteria were age 18 years and older and fluency in English or French. Mothers who reported serious obstetric complications, chronic illness, congenital disease, or other serious medical condition were excluded. Babies with serious complications during delivery or serious medical condition or who were born at < 37 weeks gestation were also excluded. Mothers signed a consent form approved by the ethics committee of the Douglas Mental Health University Institute (Montreal) and St-Joseph’s Healthcare (McMaster University, Hamilton).

Table 1: Characteristics of the MAVAN cohort

<table>
<thead>
<tr>
<th>Socio-economic status (Low/High)</th>
<th>Total sample at 6 months (n=388)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (Female/Male)</td>
<td>21.8%/78.2%</td>
</tr>
<tr>
<td>Maternal age at birth (years)</td>
<td>46.9%/53.1%</td>
</tr>
<tr>
<td>Maternal mood at 6 months (CES-D)</td>
<td>30.53±4.94</td>
</tr>
<tr>
<td>Infant mental development at 6 months (Bayley)</td>
<td>11.36±9.90</td>
</tr>
<tr>
<td>Infant motor development at 6 months (Bayley)</td>
<td>97.32±8.33</td>
</tr>
</tbody>
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Measures and procedures
**Sleeping through the night**

When infants were 6 and 12 months old, mothers responded to a questionnaire about their infant’s sleeping habits during the last two weeks (adapted from the Self-Administered Questionnaire for the Mother (SAQM)). To determine whether infants slept through the night, mothers answered the question: “During the night, how many consecutive hours does your child sleep without waking up?” In their review, Henderson and colleagues (2011) identified 6 or 8 hours of consecutive sleep as the two most often used criteria in the literature to define sleeping through the night. Accordingly, we used both criteria (6 or 8 hours of uninterrupted sleep) as a definition of sleeping through the night or not.

**Child development**

Mental and psychomotor developmental indices were measured at home at age 6, 12, and 36 months (Bayley Scales of Infant Development II) by trained research assistants. This instrument includes both mental (cognitive and language) and motor (gross and fine motor skills) development scales, and is used to assess development in early childhood.

**Maternal mood**

Maternal mood was assessed during pregnancy (third trimester) and at 6, 12, and 36 months postnatally with the Center for Epidemiologic Studies Depression Scale (CES-D). Items reflect symptom frequency during the previous week. This instrument has been validated in postpartum samples.

**Feeding method**
Feeding method was assessed at 6 and 12 months with the retrospective breastfeeding questionnaire. At each time point, infants were classified as breastfed or not.

Covariates
The SAQM also contains questions on co-sleeping status and total sleep duration in a 24-hour period. Given the well-known associations between education, income, sleep, and child development, socioeconomic status (SES) was assessed (reported by the mother during pregnancy). Statistics Canada’s low-income cutoff (before tax) was used to assess income level (high vs. low). Maternal education was dichotomized between low and high education (high education: at least some college education). SES was broken down into two categories: high SES (high income and high mother education) and middle-to-low SES (low on at least one category).

Statistical analyses
The percentage of infants who slept through the night or not in our cohort was calculated at age 6 months and 12 months using a 6-hour criterion and an 8-hour criterion. Chi-square tests were used to assess the relationships between sleeping through the night and gender, SES, and breastfeeding. Significance level for the descriptive statistics was set at \( p < 0.05 \). Linear regressions were used to assess the associations between sleeping through the night or not and mental development, psychomotor development, and maternal depression (concurrently and for the next available time point). For all regressions, gender, SES, breastfeeding status, co-sleeping status, and total sleep duration in a 24-hour period were used as covariates. In addition, prenatal maternal mood was used as a covariate in regressions predicting maternal mood to control for
initial level before birth. Statistical analyses were conducted using IBM SPSS Statistics24. The Holm–Bonferroni method was used to adjust for multiple comparisons (regressions).

**Results**

*Sleeping through the night or not at 6 months using the 6-hour criterion*

Figure 1a shows the percentage of infants who slept through the night or not at 6 months using the 6-hour criterion, as reported by mothers. Whereas 62.4% of mothers reported that their infant got at least 6 hours of consecutive sleep (6-hour sleep blocks), 37.6% reported less than 6 hours. A higher percentage of girls than boys slept through the night (69.8% vs 55.8%, $\chi^2=8.02$, p=0.005). SES was similar between infants who slept through the night or not ($\chi^2=0.33$, p=0.57). In the group that slept through the night, 55.0% were breastfed at age 6 months, whereas this proportion was much higher in the group that did not sleep through the night (80.8%; $\chi^2=26.67$, p<0.0001; Figure 2a).
**Figure 1: Proportions of Infants Sleeping or Not Through the Night**

**a)** 6 months, 6 hours of uninterrupted sleep
- 70% sleeping through the night
- 30% not sleeping through the night

**b)** 6 months, 8 hours of uninterrupted sleep
- 70% sleeping through the night
- 30% not sleeping through the night

Figure caption: At 6 months, 52.4% of infants were sleeping through the night, using the 6-hour criterion; while 37.6% of infants were not.

**c)** 12 months, 6 hours of uninterrupted sleep
- 70% sleeping through the night
- 30% not sleeping through the night

**d)** 12 months, 8 hours of uninterrupted sleep
- 70% sleeping through the night
- 30% not sleeping through the night

Figure caption: At 12 months, 72.1% of infants were sleeping through the night, using the 6-hour criterion; while 27.9% of infants were not.

Figure caption: At 6 months, 43.0% of infants were sleeping through the night, using the 8-hour criterion; while 57% of infants were not.

Figure caption: At 12 months, 56.6% of infants were sleeping through the night, using the 8-hour criterion; while 43.4% of infants were not.
Figure 2: Proportions of Breastfed Infants as a Function of Sleeping or Not Through the Night

a) 6 months, 6 hours of uninterrupted sleep

Figure caption: In the sleeping through the night group (6-hour criterion), 55.0% of infants were breastfed at the age of 6 months, as opposed to 80.8% in the non-sleeping through the night group ($\chi^2=26.67; p<0.0001$).

b) 6 months, 8 hours of uninterrupted sleep

Figure caption: In the sleeping through the night group (8-hour criterion), 49.1% of infants were breastfed at the age of 6 months, as opposed to 76.5% in the non-sleeping through the night group ($\chi^2=31.19; p<0.0001$).

c) 12 months, 6 hours of uninterrupted sleep

Figure caption: In the sleeping through the night group (6-hour criterion), 23.8% of infants were breastfed at the age of 12 months, as opposed to 56.4% in the non-sleeping through the night group ($\chi^2=34.96; p<0.0001$).

d) 12 months, 8 hours of uninterrupted sleep

Figure caption: In the sleeping through the night group (8-hour criterion), 22.1% of infants were breastfed at the age of 12 months, as opposed to 47.1% in the non-sleeping through the night group ($\chi^2=25.24; p<0.0001$).
Sleeping through the night or not at 6 months was not associated with concurrent mental development ($\beta=-1.78$, $p=0.10$), psychomotor development ($\beta=-1.33$, $p=0.39$), or maternal mood ($\beta=-0.96$, $p=0.34$). Similar results were observed for the same outcomes at 12 months (mental development: $\beta=-1.89$, $p=0.17$; psychomotor development: $\beta=-0.75$, $p=0.67$; maternal mood $\beta=1.17$, $p=0.27$).

*Sleeping through the night or not at 6 months using the 8-hour criterion*

Using the 8-hour criterion, 43.0% of mothers reported that their infant got at least 8 hours of consecutive sleep, whereas more than half (57.0%) reported less than 8 hours (Figure 1b). A slightly higher percentage of girls than boys slept through the night (47.8% vs 38.8%; $\chi^2=3.17$; $p=0.08$), but this difference was not statistically significant. SES was similar for the two groups ($\chi^2=0.10$, $p=0.76$). Again, the group that did not sleep through the night contained a higher percentage of breastfed infants (76.5% vs 49.1%; $\chi^2=31.19$, $p<0.0001$; Figure 2b).

Using the 8-hour criterion, sleeping through the night or not at 6 months was not associated with concurrent mental development ($\beta=-1.53$, $p=0.15$), psychomotor development ($\beta=-2.14$, $p=0.15$), or maternal mood ($\beta=0.12$, $p=0.90$). Comparable results were observed for all variables at 12 months (mental development: $\beta=-1.78$, $p=0.19$; psychomotor development: $\beta=-0.77$, $p=0.66$; maternal mood: $\beta=1.51$, $p=0.14$).

*Sleeping through the night or not at 12 months using the 6-hour criterion*

At 12 months, a higher percentage of mothers reported that their infant slept at least 6 consecutive hours (72.1%), but 27.9% still reported less than 6 hours (Figure 1c). Again, the
percentage of girls compared to boys who slept through the night was slightly higher, but not statistically significant (76.7% vs 67.9%; $\chi^2$=3.57, $p=0.059$), and no association with SES was observed ($\chi^2$=1.01, $p=0.32$). Nonetheless, breastfeeding status and consecutive sleep duration remained strongly associated. In the group that slept through the night, only 23.8% were breastfed, whereas in the group that did not sleep through the night, half were still breastfed (56.4%; $\chi^2$=34.96; $p<0.0001$; Figure 2c).

Using the 6-hour criterion, sleeping or not through the night at 12 months was not associated with concurrent mental development ($\beta=-1.19$, $p=0.45$), psychomotor development ($\beta=1.43$, $p=0.49$), or maternal mood ($\beta=-1.52$, $p=0.19$). Similar results were observed when assessing the same outcomes at 36 months (mental development: $\beta=-1.51$ $p=0.41$; psychomotor development: $\beta=-1.59$, $p=0.48$), and maternal mood ($\beta=-0.08$, $p=0.96$).

Sleeping through the night or not at 12 months using the 8-hour criterion

Figure 1d shows the percentage of infants who slept through the night at 12 months using the 8-hour criterion: 56.6% of mothers reported that their infant slept at least 8 consecutive hours, whereas 43.4% of mothers reported less than 8 hours. No significant associations were found between sleeping through the night and gender ($\chi^2=2.38$, $p=0.12$) or SES ($\chi^2=1.83$, $p=0.18$). However, breastfeeding status and sleeping through the night remained strongly associated: 22.1% of infants who slept through the night were breastfed at 12 months as opposed to 47.1% in the group that did not sleep through the night ($\chi^2=25.24$; $p<0.0001$; Figure 2d).
Using the 8-hour criterion, sleeping through the night or not at 12 months was not associated with concurrent mental development ($\beta = -0.92$, p=0.50), psychomotor development ($\beta = -0.29$, p=0.87), or maternal mood ($\beta = 0.10$, p=0.92), nor at 36 months: mental development ($\beta = -2.90$, p=0.06), psychomotor development: ($\beta = -1.85$, p=0.33), and maternal mood ($\beta = 1.53$, p=0.22).

**Discussion**

The results of this study indicate that, using a commonly accepted definition (6 hours of consecutive sleep), a high percentage of infants in our cohort did not sleep through the night, at either age 6 months (37.6%) or 12 months (27.9%). Using an 8-hour criterion for consecutive sleep, over half the 6-month-old infants did not sleep through the night (57.0%), with 43.4% at 12 months. These results fall within the range reported in a recent review. Moreover, a higher percentage of girls than boys slept through the night at some time points. This gender difference is consistent with another recent large longitudinal study that found more awakenings in boys compared to girls in infancy.

In the present sample of typically developing infants, we were unable to find any associations between sleeping through the night or not at 6 and 12 months and variations in mental or psychomotor development. Whereas the beneficial effects of sufficient total sleep duration in childhood and adolescence are well-known, the associations between sleep–wake cycle patterns and development are much less straightforward during the first year of life. Although a few studies found associations between certain polysomnographic sleep measures and development in early infancy, most of these studies did not specifically measure consecutive sleep
duration. To our knowledge, only one study performed in 1985 demonstrated an association between the longest consecutive sleep duration and higher mental development scores at 24 months.\textsuperscript{48} However, this study was performed in a small sample of preterm infants. Considering that individual differences may also be linked to brain maturation, other authors have questioned the existence of a straightforward relationship between sleep and early development.\textsuperscript{45, 49}

Moreover, we found no associations between sleeping through the night or not and postnatal maternal mood. This is noteworthy, because maternal sleep deprivation is often invoked to support the introduction of early behavioral interventions.\textsuperscript{33, 34} Perhaps maternal total sleep duration (during the night and/or daytime naps) or fatigue could be better predictors of maternal well-being. Future studies could document mother’s sleep quality and duration in association with their infant’s sleep patterns, considering not only total sleep duration but also sleeping through the night. Earlier timepoints should also be assessed to clarify if associations are present before 6 months.

Importantly, our results show a strong relationship between breastfeeding and not sleeping through the night. This association was present at 6 and 12 months, using both the 6- and 8-hour criteria. Studies have documented the many benefits of breastfeeding for both children and mothers, including lower risk of respiratory infections, gastroenteritis, and asthma.\textsuperscript{50} Breastfeeding also has a positive impact on cognitive functions.\textsuperscript{51} The World Health Organization recommends exclusive breastfeeding for the first 6 months and partial breastfeeding for up to 2 two years, or for as long as mother and child wish.\textsuperscript{52} However, over the same developmental period, parents are encouraged to teach their infant to sleep through the night, and among the factors associated with sleep
fragmentation, breastfeeding is often invoked.\textsuperscript{35} This conflicting advice may undoubtedly confuse parents and contradictory information was specifically identified as a risk factor for maladaptation in new parents.\textsuperscript{53} Yet, the present study does not allow drawing any causality between not sleeping through the night and breastfeeding, this should be evaluated in future studies.

Some authors have questioned the use of sleep behavioral techniques in young infants, since sleep consolidation is a developmental process that is influenced by interindividual variations.\textsuperscript{22} Moreover, some mothers have reported feeling tense and depressed when they tried to get their infant to “sleep through the night,” explaining that for them, rapid sleep consolidation was not a priority.\textsuperscript{54} Furthermore, authors have proposed that because parents are routinely asked about sleep consolidation at medical follow-up meetings, this may implicitly suggest that infants “should” sleep through the night.\textsuperscript{55, 56} In a recent review, authors concluded that behavioral interventions at younger than 6 months neither reduced crying nor prevented sleep problems, and noted side effects such as anxiety and premature cessation of breastfeeding.\textsuperscript{21} However, the conclusions of this review have been questioned by others,\textsuperscript{10} again reflecting the controversy over the desirability of early sleep consolidation.

In the absence of a consensus on the importance of early onset of sleeping through the night, breastfeeding, and sleep-related parental practices, it was shown that experts often refer to their own values or experience when advising parents.\textsuperscript{57} However, these values are not necessarily congruent with every parent’s needs. It is important to teach behavioral sleep interventions when there is a need and upon parental request. However, parental expectations and sleep arrangements vary considerably according to culture and values.\textsuperscript{58} Therefore, health
professionals should also take into consideration alternative parental values, especially in non-clinical samples.

Limitations
The findings of this exploratory study should be replicated in larger normative cohorts. It is possible that a larger sample would show associations between sleeping through the night, mental development, psychomotor development, and maternal mood. Nevertheless, this study included 388 participants, and although several time points, criteria, and outcome measures were tested, no significant associations were found. In addition, the strength of our results is supported by the fact that no previous study to our knowledge has demonstrated a clear association between these measures and consecutive sleep duration.

It is possible that some awakenings were not signaled to the mothers by infants, or that mothers did not hear their infant. Whereas it would be informative to replicate these results using an objective measure of sleep (actigraphy or videosomnography), the present results reflect the general parental perception: wondering when their infant will (or should) sleep through the night. Variables such as frequency of nocturnal breastfeeding, use of behavioral sleep interventions, introduction of solid food and parental sleep-exhaustion were not available in our study and should be measured in future studies.

Conclusion
New mothers appear to be greatly surprised about the degree of sleep disturbance and exhaustion that they experience. As a potential protective strategy, mothers could be more informed about
the normal development of the sleep–wake cycle instead of only focusing on methods and interventions. Transition to parenthood is a vulnerable period of life and it could be reassuring for parents to learn that, in a typically developing cohort, up to 37.6% of infants do not sleep 6 consecutive hours at age 6 months, and up to 27.9% at 12 months. While there is a clear need to replicate these findings, we found no associations between infants sleeping through the night at 6 or 12 months and variations in their mental or motor development and maternal well-being. However, a significantly higher rate of breastfeeding was found in infants who did not sleep through the night. Keeping in mind the wide variability in the age when an infant starts to sleep through the night, expectations for early sleep consolidation could be moderated.

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References


