Sleep Difficulties in Infants at Risk for Developmental Delays: A Longitudinal Study

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Objectives We compared the sleep of infants at risk for neuromotor delays to that of infants without such risks, and examined the predictive validity of risk indicators to the development of sleep problems. Methods Conveniently recruited infants \((n = 142)\) were assessed for neuromotor achievements and sleep behaviors at 4–6 months and 10–12 months of age. Assessment tools were the Harris Infant Neuromotor Test and Morrell’s Infant Sleep Questionnaire. Based on a cumulative risk index, three groups were defined: higher risk \((n = 28)\), lower risk \((n = 42)\), and no risk \((n = 72)\). Results At both ages, the sleep scores were similar among the groups. In the no risk and lower risk group, sleep difficulties decreased with age, while for infants in the higher risk group, more difficulties were reported over time. Overall, the neuromotor attainments were not related to sleep fragmentation or settling difficulties. Conclusions In a diverse sample of infants, with and without risks for developmental delays, overall, sleep patterns were similar. It appears that the neuromotor achievements are not associated with sleep-wake regulation, as measured by caregivers’ report.

Key words at risk; developmental delays; infants; neuromotor attainments; sleep.

The quality of sleep in infancy and childhood has been linked to broader aspects of functioning, including neurobehavioral achievement (Kheirandish & Gozal, 2006; Sadeh, Gruber, & Raviv, 2002), emotional regulation (Dahl, 1996), and behavioral control (Bates, Viken, Alexander, Beyers, & Stockton, 2002). Infants’ sleep-wake regulation has long been an area of interest to researchers and clinicians (Sadeh & Anders, 1993), partly because of its assumed significance for development, and also because of the nighttime caregiving demands associated with the frequent transition between sleep and awake states in the early months (Burnham, Goodlin-Jones, Gaylor, & Anders, 2002; Ferber, 2006; Sears, 1999).

Models that examine the factors that contribute to the establishment of well regulated sleep development versus sleep problems (Goodlin-Jones, Burnham, Gaylor, & Anders 2001; Van Tassel, 1985) highlight child variables, parent variables, and contextual factors. Among the child variables that are considered correlates of sleep problems are developmental and health problems (Stores, 2001). While sleep problems are likely to exacerbate illness and adjustment problems in childhood (Mindell & Owens, 2003; Thunström, 2002), it is not clear if infants at risk for developmental delays are also at risk for sleep-related difficulties.

Studies in the neonatal and postnatal periods indicate a relationship between sleep-wake state organization and neurological integrity (Becker & Thoman, 1981; Beckwith & Parmelee, 1986). For example, Becker and Thoman (1981) found that intense REM during sleep in the first postnatal weeks was negatively correlated with mental development at 12 months. It has also been shown that the sleep-wake organization in the newborn stage predicts later developmental attainments (Whitney & Thoman, 1993; Borghese, Minard, & Thoman, 1995), and that in the second half of the first year, more motor activity in sleep and fragmented sleep were associated with lower psycho-motor achievements (Scher, 2005). Authors of these
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studies approached the question pertaining to the relationships between sleep and development with a focus on sleep-related processes and rhythms, relying on objective sleep measures like polysomnography and actigraphy. However, as sleep regulation involves the caregiving relationship (Anders, 1994), parents’ reports are an important source of data about infants’ sleep, in that they provide information on parents’ nighttime involvement and on the extent to which they view their infants’ sleep patterns as problematic or not. This is important given that sleep in infancy is one of the most common concerns raised by parents with childcare professionals (Ferber, 2006; Messer & Richards, 1993; Thunström, 1999). According to Coates and Thoresen’s (1981) survey, pediatricians indicated that >25% of respondent parents have sleep-related concerns and complaints. The most prevalent are bedtime difficulties and waking up in the middle of the night (Armstrong, Quinn, & Dadds, 1994).

When asked about their infants’ sleep, about 20–50% parents of infants (depending on age, definition, and context) report sleep-related difficulties (Johnson, 1991; Paret, 1983; Scher & Asher, 2004). Most infants experience difficulties in regulating sleep cycles in the first months of life as part of normal maturation (Coons & Guilleminault, 1982); by the middle of the first year they have made important steps towards regulating sleep-wake cycles (Hoppenbrouwers, Hodgman, Arakawa, Geidel, & Sterman, 1988) and are better able to sustain longer sleep periods (Ficca, Fagioli, Giganti, & Salazarulo, 1999). Still, many infants continue to show fragmented sleep throughout the first year (Messer & Richards, 1993; Scher, 1991; Wolke, Meyer, Ohrt, & Riegel, 1995), and sleeping “through the night” is often an unmet parental goal (Daws, 1989). In Moore and Ucko’s (1957) study, nightwaking characterized >50% of the infants in the second half of the first year. Interestingly, only 10% of the infants had consistently interrupted nights, whereas for >40%, nightwaking reappeared after a period of uninterrupted nights.

Variability in sleep-wake regulation has been attributed not only to the child’s capacity for self-regulation (DeGangi, 2000), but also to mothers’ psychological well-being (Goodlin-Jones, Eiben, & Anders, 1997). Psychosocial adversity, such as parental unemployment and low education (Van Tassel, 1985), and maternal mental health (Warren et al., 2003) were also found to be associated with infants’ sleep problems. The question to be examined in this article is whether or not infants classified as at risk for developmental delays are also at risk for developing sleep problems in the course of the first year.

To address this question, we measured infants’ sleep patterns and habits, comparing infants with different risk indicators, at two periods: 4–6 months and 10–12 months. These ages mark significant changes in sleep regulation. By 4 months of age, the major maturational changes that underlie the establishment of circadian rhythms have occurred, allowing infants to elongate nocturnal sleep segments (Goodlin-Jones et al., 2001), and to sustain uninterrupted sleep for a period of 7 hours (Anders & Keener, 1985). Although longitudinal studies have shown that overall, sleep becomes less fragmented with age, around 9–12 months, increased nightwaking has been observed (Anders, 1979; Moore & Ucko, 1957; Scher, 1991). This trend has been linked to changes in the socio-emotional (Paret, 1983; Scher, 2001a), cognitive (Scher, 2005), and gross motor domains (Scher, 1996). By focusing on these periods, and examining the sleep patterns and difficulties in infants at risk for developmental delays, this study aimed to illuminate if and how infants’ risk-status relates to sleep regulation.

The objectives of this study were three: (a) to compare the sleep of infants who are at risk for neuromotor delays to that of infants without such risks; (b) to examine the predictive validity of child risk factors (e.g., pre maturity, low birth-weigh) and maternal variables (e.g., illness) to the development of fragmented and poorly regulated sleep; and (c) to address, longitudinally, stability, and change in the sleep patterns of at risk and a comparison group during the first year.

Methods

This article reports on one aspect of a larger longitudinal study of “Training and Outcomes for Early Identification of Infants with Neuromotor Delays,” which tests the validity of an early screening instrument and compares two methods of training professionals to administer the tool. In this report, we examine the sleep patterns of infants participating in the investigation. To compare the sleep behaviors between a group of infants at risk for neuromotor delays and a group with no such risk, we used a comparative descriptive design that consisted of neuromotor assessments at ages 4–6.5 months, 10–12.5 months, 24 months, and 36 months. This article reports the findings of the first two assessment periods: 4–6.5 (Time 1) and 10–12.5 months (Time 2). We used the Harris Infant Neuromotor Test (HINT) (Harris & Daniels, 2001, Harris, Megens, Daniels, & Hayes, 2003) to assess infants’ development, and Morrell’s (1999) Infant Sleep Questionnaire (ISQ) to assess sleep behaviors. The research protocol was approved by the ethics
Recruitment and Participants

Families with infants between 4 and 6.5 months of corrected age were invited to participate through pamphlets and posters distributed to Centres of Infant Development Program, health centers, participating universities’ websites, and word of mouth. It was required that parents could read and understand English. This convenience sample (recruited during 2004–2006) was comprised of 142 infants (71 girls and 71 boys) who are participating in the longitudinal study. Typical infants were defined as those who were born at term (38–42 weeks’ gestation), at a birth weight >2,500 g, with no postnatal infant health problems or congenital anomalies, and no major maternal health risk factors during pregnancy or delivery. The at-risk group was comprised of infants who did not meet these criteria, or were at risk by: advanced maternal age (≥35 years), maternal mental health concerns, prenatal substance exposure, multiple births, or use of reproductive technology such as in vitro fertilization. Eighty-seven of the infants were defined as at risk, whereas 55 “typical.”

Since the at-risk group was highly diverse, and given that for 33 of the infants the only risk indicator was mothers’ age >35 years, were grouped the participants into three categories: no risk, “lower risk,” and “higher risk” for developmental delays. For the purpose of the present analysis, we created a cumulative index that allows summing of the risk indices (Gorman & Pollitt, 1996), and we also used different weights for different indicators (Field et al., 1978). Each of the at-risk indicators (listed earlier) contributed a score of 1 to the index, except the following adaptations: maternal age, which was coded as a risk indicator only if a mother was <19 or >38 years; gestational age and birth weight were first graded on a scale of 0 to 3. An infant whose gestational age was <24 weeks received a score of 3 on this indicator, and one whose birth weight was <1,500 g received a score of 3 towards the risk index. Based on this cumulative index, infants were grouped into categories [a similar method was applied by Lefebvre, Grégoire, Dubois, & Glorieux (1998) who used a Neurobiologic Risk Score for defining three risk groups]. In the present sample, 72 infants obtained a risk index of 0 and were assigned to the no-risk (NR) group, 42 infants received a score ≥1 ≤3 (M = 1.60, SD = 0.77) and were assigned to the lower risk (LR) group (for 10 of the infants in this group the only risk indicator was maternal age ≥39 years), the 28 infants that obtained a score of ≥4 (M = 5.75, SD = 1.69) were assigned to the higher risk (HR) group. The mean cumulative risk index for the sample was 1.61, with a SD of 2.33 (range 0–9). Demographic data for the groups are presented in Table I.

Assessors

Data were collected by 21 volunteer assessors who were early childhood professionals, including physical and occupational therapists, nurses, and infant development consultants, based in both urban and rural areas of the province. Once they consented to participate, the assessors were trained to reliably administer the HINT. Inter-rater reliability was assessed using data obtained during the training workshops. There were good intrarater correlation coefficients (0.72–0.98) suggesting all the assessors can reliably administer the HINT.

Table I. The Demographic Characteristics, Neuromotor Achievements, and Sleep Scores of the Infants with Various Degrees of Risk for Developmental Delays

<table>
<thead>
<tr>
<th></th>
<th>No risk</th>
<th>Lower risk</th>
<th>Higher risk</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (T1) = 72</td>
<td>n (T2) = 63</td>
<td>n (T1) = 42</td>
<td>n (T2) = 40</td>
</tr>
<tr>
<td>Gender (% boys)</td>
<td>56</td>
<td>48</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Birth weight (grams)</td>
<td>3636 (453)²</td>
<td>3504 (551)²</td>
<td>2178 (834)²</td>
<td></td>
</tr>
<tr>
<td>Gestational age (weeks)</td>
<td>39.8 (1.02)²</td>
<td>38.9 (1.71)²</td>
<td>33.2 (4.64)²</td>
<td></td>
</tr>
<tr>
<td>Maternal age: (in years)</td>
<td>31.5 (3.59)²</td>
<td>35.02 (6.15)²</td>
<td>31.43 (6.67)²</td>
<td></td>
</tr>
<tr>
<td>HINT T1</td>
<td>23.77 (4.98)²</td>
<td>25.00 (4.93)²</td>
<td>27.78 (6.60)²</td>
<td></td>
</tr>
<tr>
<td>HINT T2</td>
<td>3.14 (2.71)²</td>
<td>4.76 (5.32)²</td>
<td>6.18 (6.01)²</td>
<td></td>
</tr>
<tr>
<td>Sleep-Q T1</td>
<td>10.63 (7.34)²</td>
<td>12.22 (3.68)²</td>
<td>8.35 (6.35)²</td>
<td></td>
</tr>
<tr>
<td>Sleep-Q T2</td>
<td>8.96 (6.97)²</td>
<td>8.86 (7.97)²</td>
<td>10.60 (9.00)²</td>
<td></td>
</tr>
<tr>
<td>Difficulty T1</td>
<td>28.2%</td>
<td>40.5%</td>
<td>7.1%</td>
<td></td>
</tr>
<tr>
<td>Difficulty T2</td>
<td>33.3%</td>
<td>17.5%</td>
<td>28%</td>
<td></td>
</tr>
</tbody>
</table>

² Groups sharing symbols are not significantly different from each other.
**Instruments**

The HINT is a screening tool designed to detect atypical neuromotor development, as well as cognitive and behavioral concerns, in 2.5–12.5-month-old infants. This test is intended for use by a range of early childhood professionals, including community health nurses, physical therapists, occupational therapists, physicians, and early childhood special educators (Harris & Daniels, 2001). In about 30 minutes, the assessor gathers background information, the perception and concerns of the caregiver about the infant’s development, and the infant’s neuromotor development. The assessment is based on 21 items objectively assessing the infant’s motor skills in five positions (supine, prone, supine-to-prone transition, sitting, and standing), muscle tone, movement against gravity, cooperation, any stereotypical behaviors (e.g., persistent head banging), and head circumference (Harris, Megens, Backman, & Hayes, 2003). Lower HINT total scores indicate more mature or more optimal infant development. The HINT has been normed and has been shown to be both reliable and valid in a number of previously published studies (Harris & Daniels, 1996, 2001; Harris et al., 2003; Megens, Harris, Backman, & Hayes, 2007).

The ISQ (Morrell, 1999), a reliable paper-and-pencil tool (e.g., test–retest .92) was slightly modified and used to obtain data on the child’s sleep. The ISQ consists of items that assess the severity of bedtime difficulties (e.g., “How long does it take to settle your child to sleep on average?”) and nightwaking (e.g., “On average, how many times does your baby wake up each night and need re-settling?”). In addition, parents are asked to respond to: “Do you think that your baby has sleep difficulties?” We introduced two modifications: one item that we thought was culturally biased as worded was modified to: “How often do you take your baby/child into your bed because he/she is upset and won’t sleep?” and an item pertaining to co-sleeping was added: “How often does your baby sleep throughout the night in parents’/primary caregiver’s bed?” in order to clearly establish whether or not the child co-sleeps with the parents. The overall scoring of this version (called the Sleep-Q to distinguish it from the ISQ) is scored the same as the ISQ, namely a total score ranging from 0 to 38, where higher values denote more sleep difficulties (Morrell, 1999).

Data collection occurred at either the participants’ homes or child development centers. During the first assessment session, after written consent was obtained, demographic data and medical history of the infant and parents were collected. In addition to the HINT and the Sleep-Q, infants were assessed using the Alberta Infant Motor Scale (AIMS) (Piper & Darrah, 1994), and parents completed the Ages & Stages Questionnaire (ASQ) (Squires, Potter, & Bricker, 1999). Findings from the AIMS and ASQ are reported elsewhere. The same assessment tools were administrated at Time 2.

**Results**

Based on parents’ responses to the Sleep-Q, sleep onset occurred within 10 min for 44% (Time 1) and 42% (Time 2) of the infants. Sleeping “through the night,” defined as caregivers’ indication that the baby did not wake up at night, was reported for 67% of the infants at Time 1 and for 73% at Time 2. Taking the baby to the parents’ bed as a regular soothing technique was reported by 21% at Time 1 and 25% at Time 2. Routine co-sleeping was reported by 15%, at both ages; co-sleeping was stable across ages: 10% of the infants always co-slept whereas 52% never slept in parents’ bed ($\chi^2 = 63.44$, $p < .001$). There was no association between routine co-sleeping and maternal perception of the infant’s sleep difficulty ($\chi^2 = 2.10$, n.s. and $\chi^2 = 4.34$, n.s., respectively at 4–6 and 10–12 months). Co-sleeping was associated with the child’s risk status at Time 1 ($\chi^2 = 9.66$, $p < .05$), but not at Time 2 ($\chi^2 = 2.52$, n.s.). At 4–6 months, >20% of the at-risk infants routinely slept in parents’ bed (21% in the LR and 25% in the HR group) as opposed to 7% of the no-risk group.

More nightwaking was reported for boys as compared with girls, but only at the 4–6 months measurement ($t(1,139) = 2.24$, $p < .05$). Mothers of first-born infants, as compared with later-borns, showed a tendency to perceive their child’s sleep as more problematic (e.g., at 10–12 months, $\chi^2 = 3.46$, $p = .06$). No association was found between maternal age and education level, and infants’ sleep difficulty scores. Among the babies’ postnatal variables, birth weight showed a positive, albeit marginal, link with sleep difficulties ($r = .17$, $p < .05$). To further examine this trend, we compared the Sleep-Q scores of infants with the highest 20% and lowest 20% of birth weight, and found no difference in the sleep of the two groups. In this subsample, however, maternal perception of sleep difficulty was linked to higher birth weight (31% vs. 7%, $\chi^2 = 5.50$, $p < .05$).

The neuromotor achievements were negatively correlated with the risk index ($r = -.28$, $p < .01$, and $r = -.27$, $p < .01$, respectively at Time 1 and 2). In order to identify the specific contributors to this association, we separated the infants’ and the maternal risk criteria. It was shown that, at both ages, the infants’ indicators, but not the...
mothers’, were significantly related to the HINT scores [for example, at age 4–6 months, the correlation of the HINT with the child’s risk score was \( r = .23 \) (\( p < .01 \)), and with the mother’s \( r = .03 \), n.s.].

The association between the HINT and the Sleep-Q scores was insignificant at both Time 1 (\( r[141] = -.13 \), n.s.) and Time 2 (\( r[127] = .03 \), n.s.). A logistic regression aiming to predict developmental delays at Time 2 (11% of the sample, cut-off HINT score >8) based on the Sleep-Q at 4–6 and 10–12 months did not yield a significant prediction. In order to examine if parents’ subjective perceptions of their infants’ sleep difficulties were related to their infants’ developmental progress, we divided the infants into four groups according to their neuromotor achievements. At Time 1, the prevalence of infants who were considered to have a sleeping difficulty was not associated with their mean HINT score (\( \chi^2 = 3.75 \), n.s.); however, when the infants were 10–12 months, the perception of difficulty was significantly associated with the child’s neuromotor progress (\( \chi^2 = 10.16 \), \( p < .01 \)). That is, among the infants with the highest neuromotor achievements (\( n = 36 \)), 42% were described as having sleeping difficulty, whereas in the delayed group (\( n = 13 \)), only 31% were considered as having sleep difficulties.

The comparison between the HINT scores of the three risk groups is presented in Table I. A one-way analysis of variance indicates significant differences between the groups (\( F[2/139] = 5.17 \), \( p < .01 \), and \( F[2/125] = 4.66 \), \( p < .05 \), respectively at Time 1 and Time 2); a post hoc Scheffé procedure revealed that only the scores of the HR and the NR groups differed significantly from each other. As shown in Table I, at 4–6 months, the sleep of the LR infants show a tendency to be more disrupted, as indicated by their higher Sleep-Q mean score, compared with the two other groups (\( F = 2.91 \), \( p = .06 \)); at 10–12 months, the sleep of the three groups was comparable.

A further comparison of the prevalence of sleeping difficulty as subjectively perceived by the caregivers, showed that at 4–6 months, significantly more mothers in the LR group perceived their child to have a sleep problem (\( \chi^2 = 9.34 \), \( p < .01 \)). At 10–12 months, the groups were not different from one another (\( \chi^2 = 3.09 \), n.s.). Interestingly, while the prevalence of sleeping problem decreased in the LR group, it increased from 7% at 4–6 months to 28% at 10–12 months in the HR group.

In order to examine change and continuity in the infants’ sleep across time, we correlated the Sleep-Q scores at Time 1 and 2, and found a moderate association (\( r = .38 \), \( p < .001 \)). Pearson correlation coefficients were \( r = .41 \) (\( p < .01 \)) in the NR group, \( r = .34 \) (\( p < .05 \)) in the LR group, and \( r = .38 \) (\( p < .06 \)) in the HR group. When comparing the Sleep-Q score across ages, repeated measures ANOVA showed that the severity of sleep difficulties significantly decreased with age (\( \bar{F}[1,126] = 6.00 \), \( p < .05 \)), although the effect was small (estimated effect: \( \eta^2 = .05 \)). Paired t-tests for each of the groups independently showed that the age-related decrease in Sleep-Q was significant in the no-risk group (\( t[62] = 1.98 \), \( p = .05 \)) and in the LR group (\( t[39] = 2.73 \), \( p < .01 \)), but not in the HR group (\( t[24] = -.95 \), n.s.).

A multiple regression analysis aimed to predict sleep difficulties at Time 2, based on the cumulative risk score and sleep at Time 1, entered simultaneously, showed a statistically significant effect (\( F[2/125] = 9.99 \), \( p < .001 \)), with 14% of the Sleep-Q variance accounted for by the infant’s sleep characteristics at Time 1 (\( \beta = .37 \)) and by the risk index (\( \beta = .10 \)).

To further examine how the risk status impacted the changes in the child’s sleep across time, a MANOVA revealed a significant interaction of group by time (\( F[2/125] = 3.17 \), \( p < .05 \), \( \eta^2 = .05 \)). Figure 1 depicts the changes in the Sleep-Q from 4–6 months to 10–12 months. In the no risk and LR groups, sleep difficulties decreased with time. In contrast, the results for the HR group showed a trend toward increased sleep difficulties, but statistically, this trend was not significant. In order to further examine the change over time, a difference score was calculated (Sleep-Q Time 1–Sleep-Q Time 2). Analysis of variance indicated a significant difference between the groups (\( F = 3.18 \), \( p < .05 \); post hoc tests identified that the LR and HR differed significantly. In the LR group sleep difficulties decreased with age, whereas in the HR group sleep disruption increased over time.

**Discussion**

In this study, we examined the association between neuromotor attainments and sleep–wake regulation in a heterogeneous sample and found that (a) overall the sleep difficulties were not related to the child’s neuromotor achievements, and (b) the degree of risk, as defined by a cumulative risk index that represented pre- and post-natal indicators, was only mildly associated with the infants’ sleep patterns. Upon examining the predictive validity of the risk indicators to sleep problems, we found that that the index explained a very small, albeit statistically significant, portion of the sleep variance.

A number of explanations are possible. The first is that since sleep–wake regulation in the first year is a robust process which is governed primarily by biological rhythms
(Salzarulo & Fagioli, 1999), variations in child variables (such as birth weight or gestational age) and maternal factors (such as health or age) have only small impacts on infants’ sleep (Van Tassel, 1985). It is also possible that the sleep of infants assigned to the three groups differed in ways that our methodology failed to tap. A future study that applies objective sleep recordings could address the sleep–wake rhythms and structure of infants at risk for neuromotor delays with comparative samples.

One of the main findings of the present investigation was that at 4–6 months, caregivers of infants classified into the HR group reported less sleep-related difficulties compared with the no-risk group. It could be that parents of infants with health and/or developmental concerns may not expect their baby to be “sleeping through the night” at a young age, and, therefore, do not identify the regulation difficulties as a problem. Stores (2001) maintain that sleep problems in infants with medical and developmental disorders, are often overlooked because other aspects of their condition occupy the caregiver’s attention.

A second issue that we examined was continuity and change is sleep over time. The present data set revealed that across the risk groups, sleep difficulties showed a moderate stability over time, irrespective of the risk category; stability was more pronounced among the nonrisk infants. Moderate stability in sleep fragmentation during infancy and beyond has been documented by Scher et al. (2004) in a longitudinal study applying actigraphy. Along with the stability overtime, the present results revealed age-related changes in sleep fragmentation and in settling difficulties. Together, this pattern of results suggests that the individual’s susceptibility to sleep disruption is relatively stable during infancy, but that the degree of settling difficulty and/or sleep interruption changes across time. Stability, which marks relative ranking, and continuity which refers to group levels, are independent of one another (Bornstein, Tamis-LeMonda, & Haynes, 1999).

Changes in sleep overtime were dependant on the risk status of the child. It was found that in the no risk and LR groups, sleep became less fragmented and better regulated across the period from 4–6 months to 10–12 months. This trend is in line with the age-related increase in sleep regulation (Goodlin-Jones et al., 2001). In contrast, in the HR group, an increase in sleep difficulties from Time 1 to 2 was indicated. While at 4–6 months, mothers in the HR group reported less sleep-related difficulties, by 10–12 months, the groups did not differ significantly. The interaction between the risk status and pattern of change over time, as presented in Fig. 1, may be explained in a number of ways. First, it is possible that the influence of some risk conditions is cumulative over time (Gorman & Pollitt, 1996). Accordingly, it is not until later in infancy that sleep is impacted by the earlier adverse conditions. Future data from our cohort will allow testing to see if indeed sleep problems in high risk groups become more pronounced as the child gets older. Stores (2001) states that while some parents neglect or endure infants’ sleeping problems in the early months, with time the disruption creates more distress and concern for both the child and the parent. The present findings raise the possibility of the diminishing impact of early mild risk status as time passes and possibly points to the involvement of protective factors and positive experiences (Rutter, 1987). While our findings are in accord with such prediction, the magnitude of the documented increase in sleep disruption is too small to warrant clinical conclusions. Future longitudinal studies on the predictive validity of early risk status to subsequent sleep difficulties should also include measures that shed light on the protective factors and mechanism that ameliorate risk.

What is not clear is why at the earlier part of infancy, the sleep of the infants in the HR group tended to be less fragmented and with less settling difficulties compared with infants who were not at risk (LR). Moreover, only 7% of the HR infants were perceived as having sleep difficulties as compared with 40% in the LR group. This discrepancy, which is the opposite to intuitive expectation, is both surprising and supportive of the distinction between the two risk groups. It is worth noting that the mothers in the LR group were significantly older than the mothers in the other two groups. It is conceivable that with age, mothers react less favorably to sleep difficulties.
interruption, although the findings on the associations between maternal age and infants' sleep are inconsistent (Goodlin-Jones, Burnham, & Anders, 2000). Had we employed objective sleep measures it would have been possible to examine if the difference between the groups lies in sleep quality or in the way it is perceived by the caregiver. It is interesting that while in the HR group caregivers expressed less concern about sleep difficulties, the prevalence of co-sleeping was significantly higher than in the NR group. It may also be that parental concerns about infants' sleep in the LR group are moderated by co-sleeping, which has been linked to improved regulatory control (McKenna, Mosko, Dungy, & McAninch, 1990). Parents could have been perceiving fewer difficulties, because close sleeping proximity lessens anxiety in parents, infants, or both (Fukumizu, Kaga, Kohyama, & Hayes, 2005). It is worth examining if sleeping in close proximity to the infant, in cultural contexts that do not normally endorse this practice, marks adverse or favorable child and/or maternal conditions. Finally, methodological caveats should be also pointed out. Given the limited and uneven number of participants in the groups, the restricted power and the possibility of making type 1 and 2 errors should be acknowledged. Thus, statistically failing to detect early sleep problems in the HR group is also a possibility that should be raised.

From a different angle, another age-related finding that is worth noting is the association between developmental achievements and sleep–wake regulation. The prevalence of sleep difficulties was positively linked to neurodevelopmental achievements, so that among the infants who were most advanced (e.g., independently walking by the 10–12 month assessment), more sleeping difficulties were reported. This finding is consistent with the contention that at the end of the first year, sleep-related difficulties are common in infants with advanced gross motor achievements (Scher, 1996), and positive communicative skills (Scher, 2001b).

The present study provides a community-based sleep study of infants in Western Canada where none had previously existed. It was found that the majority of infants were reported by their parents to sleep “through the night” by the time they were 6 months (67%); still, at the latter part of the first year, one out of four infants experiences nightwaking regularly. This corresponds to reports obtained in numerous studies across cultural contexts (Anders, Halpern, & Hua, 1992; Morrell, 1999; Sadeh, Acebo, Seifer, Aytur, & Carskadon, 1995; Scher, 1991). Our data show that taking the baby to parents’ bed as a soothing technique was reported by 24% of the participants, and that routine co-sleeping was practiced with 15% of the infants. This is a relatively high percentage of infants who are sleeping in their parents’ bed, either for the entire night or part of it, especially given the current campaign to refrain from co-sleeping with infants (American Academy of Pediatrics, 2005; Raydo & Reu-Donlon, 2005). Clinicians should note that the prevalence of co-sleeping was particularly high with the young infants in the at-risk group, a finding that calls for further clinical and research attention.

In summary, the contribution of this report is threefold. First, it provides findings related to the sleep patterns of a diverse sample of Canadian infants. Second, it indicates that the sleep of infants defined with low level of risk for neuromotor delays and disabilities did not differ from the sleep of a comparison nonrisk group. In contrast, the sleep of infants with a higher degree of risk for developmental delays differed from the sleep of infants with LR. In the HR group, sleep difficulties appeared to increase with age. Finally, as our longitudinal study includes assessments of infants at 24 and 36 months, we will have data to enable us to examine the impact of early risk indicators and sleep patterns during infancy to later developmental outcomes.

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Conflicts of interest: None declared.

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