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## EDUCATIONAL SERIES

### The Role of Sleep in Early Childhood Development

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The focus of this review is the science of sleep during early childhood. This review is intended as an educational resource for primary healthcare professionals involved in neonatal and infant care and development, including GPs, paediatric nurses and midwives, as well as pharmacists and pharmacy assistants.

#### Physiology and importance of sleep in early childhood

Surprisingly, we know very little about why humans need to sleep. Infants and young children spend a majority of their time asleep, suggesting that sleep is essential for the developing brain and body.<sup>1</sup> During the first years of life, the brain is most plastic, grows fastest and is most responsive to the outside world. Most of the brain's neural pathways supporting communication, understanding, social development and emotional well-being grow rapidly in the first three years.<sup>2</sup> We also know that lack of sleep can have serious consequences.

During Rapid Eye Movement (REM) sleep, (previously known in infants as "active" sleep), the brain is active and dreaming occurs. The body experiences low muscle tone (although twitching may occur in infants), breathing and heart rate are irregular, and blood pressure rises. The proportion of REM sleep is highest in infancy (55%) and declines to about 20% to 25% by age 5 years. During Non-REM sleep (previously known in infants as "quiet" sleep), blood supply to the muscles is increased, energy is restored, tissue growth and repair occur, and important hormones are released for growth and development.<sup>3</sup>

#### Sleep has important cognitive, social, behavioural and emotional benefits

Early childhood is a critical time for children to develop neurocognitive and intellectual abilities.<sup>4</sup> Sleep plays an important role in babies' brain maturation, learning and memory,<sup>5,6</sup> helping retain existing memories and create new ones,<sup>7-9</sup> and improving language learning.<sup>10</sup> Sleep also helps improve babies' social skills, including the ability to form relationships and relate to others,<sup>11</sup> and to be approachable and adaptable.<sup>12</sup> To maximize a child's potential, optimal sleep becomes a key component to the biological and environmental mix that shapes this development.<sup>4</sup> Potential consequences of sleep problems can therefore be significant.

#### How much sleep is normal?

During the first month of life, an infant's sleep is distributed almost equally across night and day.<sup>13</sup> Within the first six months, most infants develop the ability to sustain longer episodes of sleep and begin to consolidate sleep at night, gradually assuming a sleep pattern similar to that of adults.<sup>14</sup> By around 10-12 weeks of age, a circadian rhythm begins to emerge and the infant's sleep becomes increasingly nocturnal, with longer bouts of nighttime sleep complemented by three or four naps during the day. A major developmental milestone achieved by most infants by age 6-9 months is the ability to "sleep through the night" (i.e., to sleep for at least eight hours per night). This sleep period is typically accompanied by one morning nap and one afternoon nap.<sup>15</sup> Babies' sleep is highly variable – even two babies at the same age can have very different sleep patterns, from the time they fall asleep to the amount they sleep, to factors affecting their sleep.<sup>16</sup>

A meta-analysis of 34 studies described normal sleep patterns in infants and children (**Table 1**).<sup>15,17,18</sup> Most studies used subjective (questionnaire) data rather than objective data to describe sleep patterns. Because the main data analysis combined data from different countries and cultures, the reference values should be considered as global norms. Of note, the impact of too much sleep has not been well assessed, however clearly having the opportunity to interact with one's environment is important for development too.

#### Sleep problems in early childhood

Sleep problems are one of the most common behavioural concerns brought to the attention of paediatricians.<sup>19,20</sup> Defining when certain sleep behaviour becomes a problem will vary and depends on family expectations and cultural norms. Furthermore, there are no widely accepted criteria for diagnosing sleep problems in infants and young children. Difficulty falling asleep and night wakings are the most common sleep problems during infancy and early childhood.<sup>21</sup> The International Classification of Sleep Disorders classifies difficulty falling asleep and night wakings as Behavioural Insomnia of Childhood, which is further classified as limit-setting type or sleep-onset association type.<sup>22</sup> Limit-setting type behavioural insomnia, primarily seen in children 2 years of age and older, is typically described as stalling, verbal protests, crying, clinging, refusing to go to bed, getting out of bed, attention-seeking behaviours, and multiple requests for food, drinks and stories. Parents demonstrate difficulties in adequately enforcing bedtime limits (e.g. inconsistent or inappropriate bedtime for the child's age, conceding to multiple requests for attention after bedtime). Sleep-onset association type behavioural insomnia describes infants and young children who are reliant on sleep onset associations (e.g. rocking, feeding, parental presence) to fall asleep at bedtime. During the course of normal nighttime waking, these children are then unable to recreate this sleep association, requiring parental assistance to return to sleep.

Australian and New Zealand epidemiological studies suggest that problematic sleep behaviours are common in young children, with approximately 30% of parents reporting that their infant or toddler had a sleep problem.<sup>23,24</sup> This estimate appears consistent with North American research suggesting that 20-30% of infants and toddlers experience problems sleeping.<sup>25,26</sup>

#### Consequences of sleep problems

Not only do sleep problems tend to persist,<sup>27</sup> but there is increasing evidence that inadequate sleep quality and quantity in infants and young children can have negative impacts on daytime functioning in relation to behaviour and cognitive development,<sup>28</sup> including academic performance,<sup>11</sup> as well as psychiatric and health outcomes, such as obesity and metabolic consequences,<sup>29</sup> and accidental injury.<sup>30</sup> Furthermore, sleep problems early in life have been linked to later behavioural and emotional problems<sup>31</sup> and some aspects of poor neuropsychological functioning in adolescence.<sup>32,33</sup>

Sleep problems in infants and young children lead to a secondary negative impact on maternal well-being and family functioning.<sup>4</sup> Maternal depression<sup>34,35</sup> and marital discord<sup>36</sup> are common and child abuse has been described.<sup>37</sup> In Australia, the average cost associated with seeking professional healthcare to manage infant sleep problems in the second 6 months of life is

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estimated at \$A380 per family.<sup>38</sup> Australian population data indicate that sleep problems in children aged 0-7 years are associated with a \$A27.5 million cost to the government every year.<sup>39</sup> An awareness and understanding of the potential consequences cited above, brings into perspective the importance of managing sleep problems.

**Table 1.** Total sleep duration, number of night wakings, daytime nap frequency and daytime sleep duration during early childhood<sup>15,17,18</sup>

Age	Mean	Recommended sleep duration by the US National Sleep Foundation <sup>18</sup>
<b>Total sleep duration (hours)</b>		
0-2 months	14.6	14-17
3 months	13.6	14-17
6 months	12.9	12-15
9 months	12.6	12-15
12 months	12.9	11-14
1-2 years	12.6	11-14
2-3 years	12.0	10-14
4-5 years	11.5	10-13
<b>Number of night wakings</b>		
0-2 months	1.7	
3-6 months	0.8	
7-11 months	1.1	
1-2 years	0.7	
<b>Daytime nap frequency</b>		
0-5 months	3.1	
6-11 months	2.2	
1-2 years	1.7	
<b>Daytime sleep duration (hours)</b>		
6 months	3.4	
9 months	2.8	
12 months	2.4	
18 months	2.0	
2 years	1.8	
3 years	1.7	
4 years	1.5	

## Sleep behaviour management

Sleep behaviour management primarily begins with parental education about good sleep hygiene.<sup>40</sup> The term 'sleep hygiene' includes having an appropriate sleep environment, as well as the child and their parents engaging in routines and practices that encourage sleep of good quality and sufficient duration. To ensure good sleep hygiene infants and young children should have soothing activities preceding bedtime, a consistent bedtime and wake-up time for both nocturnal and daytime sleep, an appropriate quiet place to initiate sleep, and avoidance of environmental and behavioural associations with sleep onset (e.g. being rocked to sleep, parents laying on the child's bed, nursing to sleep). Children who need behavioural associations to fall asleep initially will need these resources again to fall asleep again upon waking during the night.

There are a number of studies on the efficacy of behavioural interventions for sleep problems in infants and young children. Among a review of 52 studies, 94% reported that behavioural interventions were efficacious and 80% of children treated demonstrated clinically significant improvements in bedtime problems and night wakings.<sup>25</sup> Noteworthy was that the majority of the intervention studies reviewed included a bedtime routine as part of a multi-component treatment programme. The most studied methods are discussed below.

## Extinction

The extinction or 'cry it out' method involves putting the child to bed at a designated time and ignoring the child until a certain time the following morning (although monitoring for illness or injury).<sup>25,40</sup> This method is based on eliminating the acts that reinforce behaviours such as crying, calling out, and tantrums, aiming at their extinction over time. The greatest difficulty implementing this strategy is parental inconsistency and parental anxiety.

## Gradual extinction

Gradual extinction or 'sleep training' consists of parents ignoring the demands of the child for specified periods.<sup>25,40</sup> The duration between check-ins with the child is often tailored to the child's age and temperament, as well as the parents' judgment of how long they can tolerate the child's crying. Parents may employ a fixed schedule (e.g. every 5 minutes) or they can wait progressively longer intervals (e.g. 5 minutes, 10 minutes, then 15 minutes) before checking on their child. The technique aims to promote the child's ability to self-soothe and return to sleep without undesirable associations or parental interference.

## Scheduled awakenings

Scheduled awakenings involve parents awakening and consoling their child approximately 15 to 30 minutes before a typical spontaneous awakening.<sup>25,40</sup> This strategy begins with establishing a baseline of the number and time of spontaneous nighttime awakenings. Scheduled awakenings then commence, with parents responding as they would to spontaneous awakenings (e.g. rocking or nursing their child to sleep). Over time, this method tends to extinguish spontaneous awakenings and the process of reducing scheduled awakenings begins, resulting in increased sleep consolidation.

## Positive bedtime routines

There is considerable evidence from North America that behavioural interventions for the treatment of sleep problems in infants and young children are efficacious, including a bedtime routine as a part of a multi-component treatment programme.<sup>25,41,42</sup> Recommended routines include a warm bath, a soothing massage, and a calming time such as a lullaby, or reading a book.<sup>4,42</sup> Such a routine provides multisensory stimulation through direct skin-to-skin contact,<sup>43</sup> direct eye contact,<sup>44</sup> hearing the sound of their parent's voice,<sup>45</sup> and recognizing familiar scents such as that of the parent<sup>46</sup> and/or the bath products used.<sup>43</sup>

Routines help babies learn, by providing two key ingredients for learning: relationships and repetition. When a baby experiences the same things over and over, the pathways of connections in the brain become stronger and more complex.<sup>47</sup> Daily routines in general lead to predictable and less stressful environments for young children and are related to improved daytime behaviours and greater parental sense of competence.<sup>48</sup> Parental care in the context of a routine caregiving task is associated with lower stress reactivity and with earlier circadian patterning in very young infants.<sup>49</sup>

## Experts recommend a consistent before bed routine

The sleep-wake cycle is regulated by light and dark and these rhythms take time to develop, resulting in the irregular sleep schedules of newborns. The rhythms begin to develop at about six weeks, and by three to six months most infants have a regular sleep-wake cycle.<sup>3</sup> Before bed routines help make sleep times and wake times different and distinguishable, supporting the child's ability to self-regulate their sleep states.<sup>50</sup> However, helping infants establish a sleep pattern can be challenging for parents. Paediatric sleep experts and paediatricians agree that having a consistent, regular before bed routine is an important element for ensuring sleep success,<sup>4,25,41</sup> with over 90% of paediatricians recommending establishment of a consistent bedtime routine to improve sleep quality in children.<sup>19</sup>

## Bedtime routine: positive impact on sleep in infants/toddlers and maternal mood

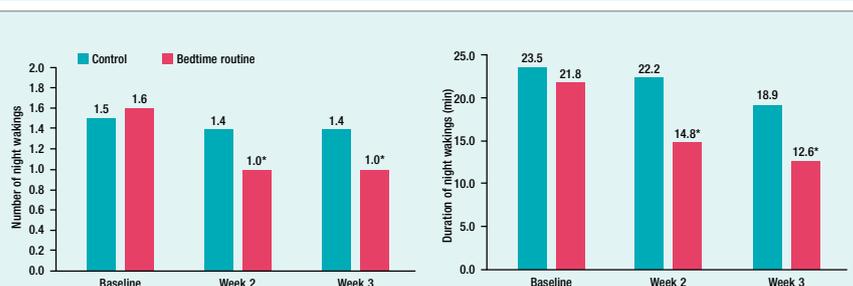
The efficacy of a bedtime routine (as an independent intervention) on infant and toddler sleep, and on maternal mood, was assessed in a three-week randomised study performed in the US.<sup>42</sup> Using a two-age group design, 405 mothers and their infant (ages 7-18 months) or toddler (ages 18-36 months) were randomly assigned to follow their usual bedtime routine (control group) or to follow a consistent specific bedtime routine for a period of two weeks after a 1-week baseline period. The specific bedtime routine involved three sequential steps:

1. Bath using a provided wash product.
2. Massage using a provided massage product.
3. Quiet activities such as cuddling, singing, lullaby.

In the infant cohort, the specific bedtime routine resulted in significant ( $p < 0.001$ ) reductions in the number and duration of night wakings (**Figure 1**) and in time to sleep onset compared with baseline. Sleep continuity also increased and there was a significant reduction in the number of mothers who rated their child's sleep as problematic. Similar improvements in sleep quality and quantity were observed in the toddler group following the specific bedtime routine. Maternal mood was also significantly improved in the infant cohort. In contrast, sleep patterns and maternal mood in the control group did not significantly change versus baseline over the study period. Importantly, these improvements were maintained at 1 year in a follow-up study.<sup>51</sup>

## KEY POINT

**A consistent nightly bedtime routine, including a warm bath, massage, and quiet activities (such as lullabies and cuddling), was beneficial in improving multiple aspects of sleep in infants and toddlers, especially wakefulness after sleep onset and sleep continuity.**



**Figure 1.** Number and duration of night wakings in infants (n=206) following a consistent specific bedtime routine.<sup>42</sup> \* $p < 0.001$  versus baseline

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### Bedtime routine: positive impact on sleep at 3 years+

The role of a regular bedtime routine on the development of sleep regulation and consolidation was examined in US study of 87 young children aged 30, 36 and 42 months.<sup>50</sup>

Any activity that was part of a bedtime routine was considered 'regular' when the mother stated the activity was part of the routine prior to the study or when the activity occurred on all seven nights. The four most common steps in the bedtime routine, each of which was regular for about half to three-quarters of the families, were reading a story, taking a bath/shower, putting on pajamas, and brushing teeth.

Adherence to a bedtime routine was concurrently associated with a greater amount of nightly sleep at 36 and 42 months. In addition, adherence to a bedtime routine predicted an increase in nightly sleep minutes over a 6-month period. Finally, this study demonstrated that adherence to a bedtime routine was particularly supportive of developmental gains for children of mothers who used consistent parenting practices during the day.

#### KEY POINT

A consistent nightly bedtime routine was beneficial in improving nighttime sleep quantity in children aged 36 and 42 months.

### Bedtime routine: dose-dependent association with sleep outcomes

The findings of the above are supported by those of a large multinational study (10,085 mothers from 14 countries), which included 830 mothers from Australia and New Zealand.<sup>52</sup> It demonstrated that a regular nightly bedtime routine (defined as  $\geq 3$  times per week) was associated with improved sleep in young children (aged 0-5 years), including earlier bedtimes, shorter sleep onset latency, reduced night wakings and increased sleep duration (Figure 2). Decreased parent-perceived sleep problems and daytime behaviour problems were also related to institution of a regular before bed routine. The frequency of having a bedtime routine was also important and demonstrated a dose-dependent relationship, with better sleep outcomes associated with the more nights a week that a routine was implemented. Furthermore, instituting a bedtime routine during infancy also demonstrated a dose-dependent relationship in sleep outcomes at a later age, with those having a bedtime routine as an infant and later in childhood demonstrating the best sleep and behavioural outcomes. The authors suggest that recommendation of a before bed routine is a simple message that parents can easily implement and one that requires minimal practitioner time.

#### KEY POINTS

A consistent before bed routine was associated with better sleep outcomes in infants, toddlers, and preschool-aged children, including earlier bedtimes, shorter sleep onset latency, reduced night wakings and increased sleep duration.

The more often a bedtime routine occurred the better the outcomes, and instituting it early on during infancy resulted in better outcomes at an older age.

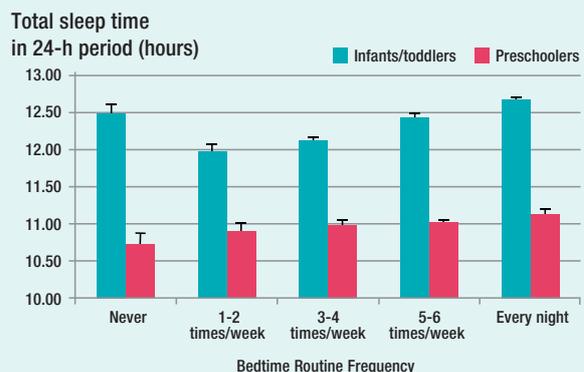
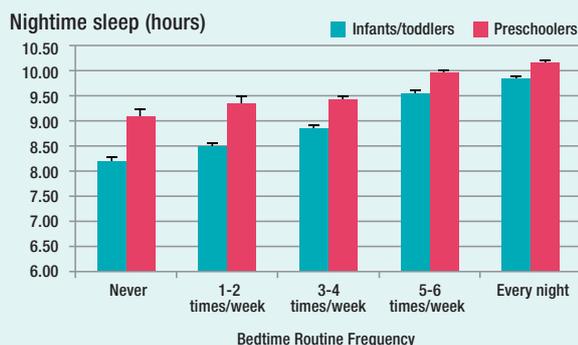
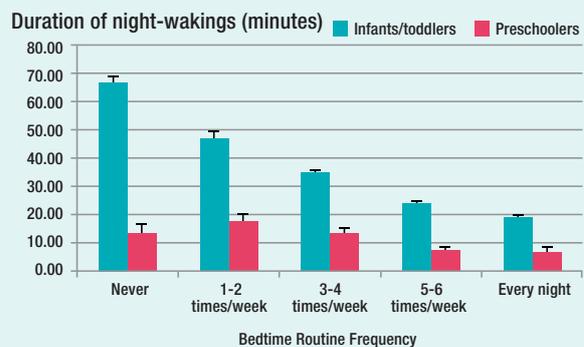
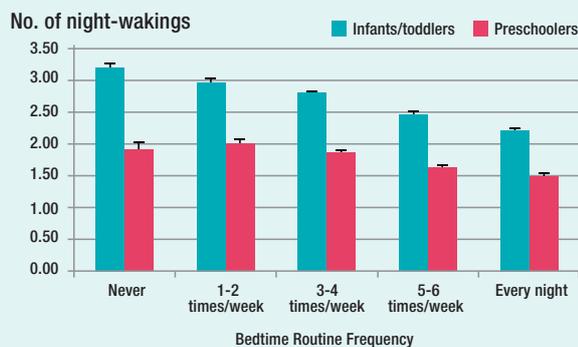
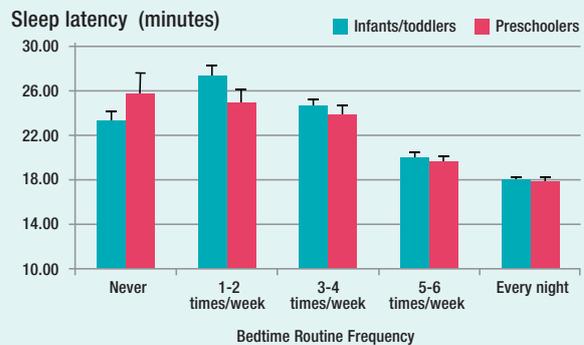
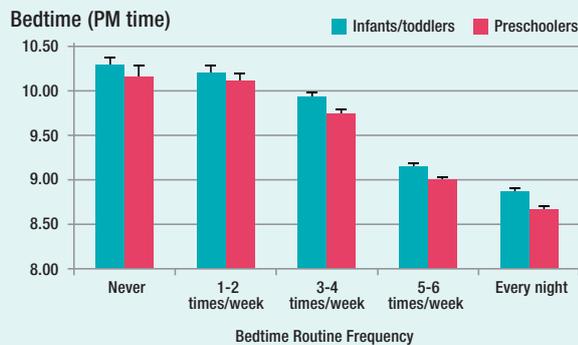


Figure 2. Dose-dependency of sleep outcomes by frequency of current bedtime routine<sup>52</sup>

## EXPERTS' COMMENTS

### Jacob Twiss

Sleep duration and quality have important bidirectional interactions with health, development and daytime behaviour. Nevertheless the 'normal' range is wide, especially in the very young, and cultural practice varies so care must be taken not to impose 'problems' that aren't there. Difficulties initiating and maintaining sleep are common and, as described, usually respond well to strategies aimed at the development of self-settling skills. Parasomnias, especially sleep terrors, are much more common in pre-schoolers than previously appreciated and need to be differentiated from 'behavioural' or 'medical' concerns. Smartphones, the bane of good sleep in older age groups, can assist diagnosis through parental video recordings but history is usually sufficient and formal polysomnography rarely required. As parental sleep is often also impacted, helping parents through careful assessment and practical evidence-based advice can be highly rewarding for all concerned. Medication is rarely a helpful long-term strategy and may be counter-productive.

### John Widger

This article summarises the importance of sleep in infancy and early childhood as well as discussing sleep problems and sleep behaviour management. Sleeping difficulties are common at this age and often pose a considerable challenge to busy parents. The point at which parents will seek help with sleep behaviour will depend on family expectations and cultural norms. When taking a sleep history it is vital to tease out parental concerns and expectations. Parental motivation is essential to the success of any behavioural intervention. Exclusion of medical causes of sleep problems such as obstructive sleep apnoea, restless legs and nocturnal seizures will also be necessary. This can be done on history taking in the majority of cases although further investigations such as a formal sleep study may occasionally be necessary. The most common problems reported in infant sleep are difficulties falling asleep and maintaining sleep. It is important to recognise that waking overnight is normal but the failure to get back to sleep easily arises from an inability to self-settle. Sleep behaviour strategy usually revolves around reducing the infant's dependence on parental presence to fall asleep. There is no 'one size fits all' approach and sleep behaviour management should be tailored according to each family's circumstance. Medications to aid sleep are rarely helpful, should only be used under medical supervision and as part of a sleep behaviour strategy.

## Take home messages

- Sleep is linked to multiple key domains in child development including brain maturation, learning and memory and social skills
- Between 20% and 30% of children experience sleep problems during the first three years of life
- Sleep problems are a source of major concern to parents and professionals and are associated with daytime behaviour problems and parental distress
- Establishment of a consistent nightly bedtime routine can result in:
  - improved night time sleep and fewer sleep problems in infants
  - improved maternal mood
  - improved sleep and behavioural outcomes at an older age
- The recommendation of a consistent before bed routine can be easily adopted by primary healthcare professionals involved in neonatal and infant care

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