



## ORIGINAL ARTICLE

**Infant and toddler sleep in Australia and New Zealand**Arthur Teng,<sup>1,2</sup> Alex Bartle,<sup>3</sup> Avi Sadeh<sup>4</sup> and Jodi Mindell<sup>5</sup>

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**Aims:** To characterize sleep patterns and sleep problems in a large sample of young children (birth to 36 months) in Australia (AU) and New Zealand (NZ).

**Methods:** Parents and caregivers of 2154 infants and toddlers in AU and NZ completed an expanded version of the Brief Infant Sleep Questionnaire.

**Results:** Overall, young children in AU and NZ go to bed relatively early (19:35), awoken on average 1.08 times per night for an average of 23 min, have a low likelihood of bed-sharing with parents (7.2%) and obtain an average of 13.24 h total sleep. However, a significant percentage of parents perceive that their child has a sleep problem (30.69%). Sleep patterns in these children demonstrate clear developmental changes, including a decrease in daytime sleep and total sleep time, as well as consolidation of sleep during the night (decrease in night wakings and nocturnal wakefulness). Parents in AU and NZ are also highly likely to encourage independence and self-soothing, especially after the age of 3 months.

**Conclusions:** These findings provide parents and professionals reference data for assessing sleep in young children, as well as common parenting practices related to sleep behaviours.

**Key words:** Australia; infants; internet; New Zealand; parents; sleep; survey; toddlers.

**What is already known on this topic**

- 1 Sleep problems are common in infants and young children
- 2 There are rapid maturational changes in sleep patterns in the first years of life.
- 3 Online tools are increasingly used in research and telemedicine.

**What this study adds**

- 1 This is the largest Internet-based survey of the sleep patterns of young children in Australia and New Zealand.
- 2 Positive sleep practices with an emphasis on encouraging independence and self-soothing from the early age are reported by a large majority of the parents in Australia and New Zealand.
- 3 Despite this, sleep is perceived as a problem in a large proportion of parents.

In the first years of life, sleep problems are a source of major concern to parents and professionals.<sup>1-4</sup> It has been estimated that between 20% and 30% of children experience sleep problems during the first 3 years of life.<sup>1,4-9</sup> These problems appear to be persistent,<sup>9-11</sup> and are associated with daytime behaviour problems<sup>4,10-12</sup> and parental distress.<sup>4,9,11,12</sup>

Despite the growing awareness of the importance of sleep in child health and disease, there is a lack of normative sleep data within Australia (AU) and New Zealand (NZ). Because of the rapid maturational changes occurring in sleep-wake patterns during the first years of life,<sup>5,13,14</sup> a large sample is required to represent each age group. In recent years, the growing avail-

ability of the Internet has led to the development of telemedicine and to expanding Internet-based professional tools aimed at online assessment, data collection, and intervention programmes for various medical and behavioural problems.<sup>15-17</sup> This has allowed the collection of large bodies of data in a short period.

The aim of this study was to characterise sleep patterns and sleep problems in a large sample of children ages birth to 36 months in AU and NZ. An additional aim of this study was to assess the prevalence of parental interventions at bedtime and following night-time awakenings.

**Methods****Participants**

Parents and caregivers of 2154 infants and toddlers in AU and NZ participated in this study. Children's ages ranged from birth

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**Table 1** Demographic characteristics

	Percentage
Child's age (months)	
0–2	7.29
3–5	16.53
6–8	15.65
9–11	13.23
12–17	17.46
18–23	13.28
24–36	16.57
Child's sex	
Girl	48.79
Boy	51.21
Child's birth order	
Only child	46.29
Youngest child	31.43
Oldest child	19.03
Middle (multiple children)	3.25
Respondent	
Mother	96.89
Other	3.11
Respondent's education	
Post-graduate degree	13.69
College education or a college degree	34.39
High school degree	51.54
Less than high school degree	0.38
Respondent's employment	
Full time	13.00
Part-time	19.87
At-home parent, student status, unemployment, other	67.13
Respondent's age range (years)	
21–24	8.87
25–30	25.86
31–34	38.77
35–39	20.01
Age <21 or >39	6.50

to 36 months. Complete demographic data can be found in Table 1. There were equal boys and girls (girls = 48.79%), and the majority of the respondents were mothers (96.89%).

## Procedure

All data were collected via BabyCenter.com, a popular parenting website, and all participants completed an expanded version of the Brief Infant Sleep Questionnaire (BISQ).<sup>8</sup> Participants were recruited via a pop-up screen that invited parents to complete a sleep survey for children ages 3 years old or younger. The BISQ includes specific questions about infant daytime and night-time sleep patterns, as well as sleep-related behaviours. The respondents were asked to describe their child's behaviour during the last 2 weeks. In addition to the BISQ, demographic information was collected, including parental age, education, race, employment status and child's birth order.

These data were collected as part of a larger cross-cultural study. A complete description of the methodology can be found

**Table 2** Night-time sleep variables

	M (SD)
Bedtime	19.58 (1.03)
Number of wakings	1.08 (1.16)
Duration of wakings	0.38 (.57)
Longest sleep	8.38 (2.99)
Rise time	6.63 (.87)
Night-time sleep	10.39 (1.42)
Number of naps	1.99 (1.10)
Daytime sleep	2.85 (1.66)
Total sleep time	13.24 (1.86)
Own room	72.47%
Parents' room	22.38%
Parents' bed	7.20%
Bedtime routine (>5 nights/week)	80.64%
Sleep latency (>30 min)	6.08%
Sleeps well	63.15%
Bedtime difficulty	11.15%
Sleep problem	30.69%

elsewhere.<sup>18</sup> Because of the large cohort size and the multiple analyses, findings were considered significant if  $P < 0.001$ .

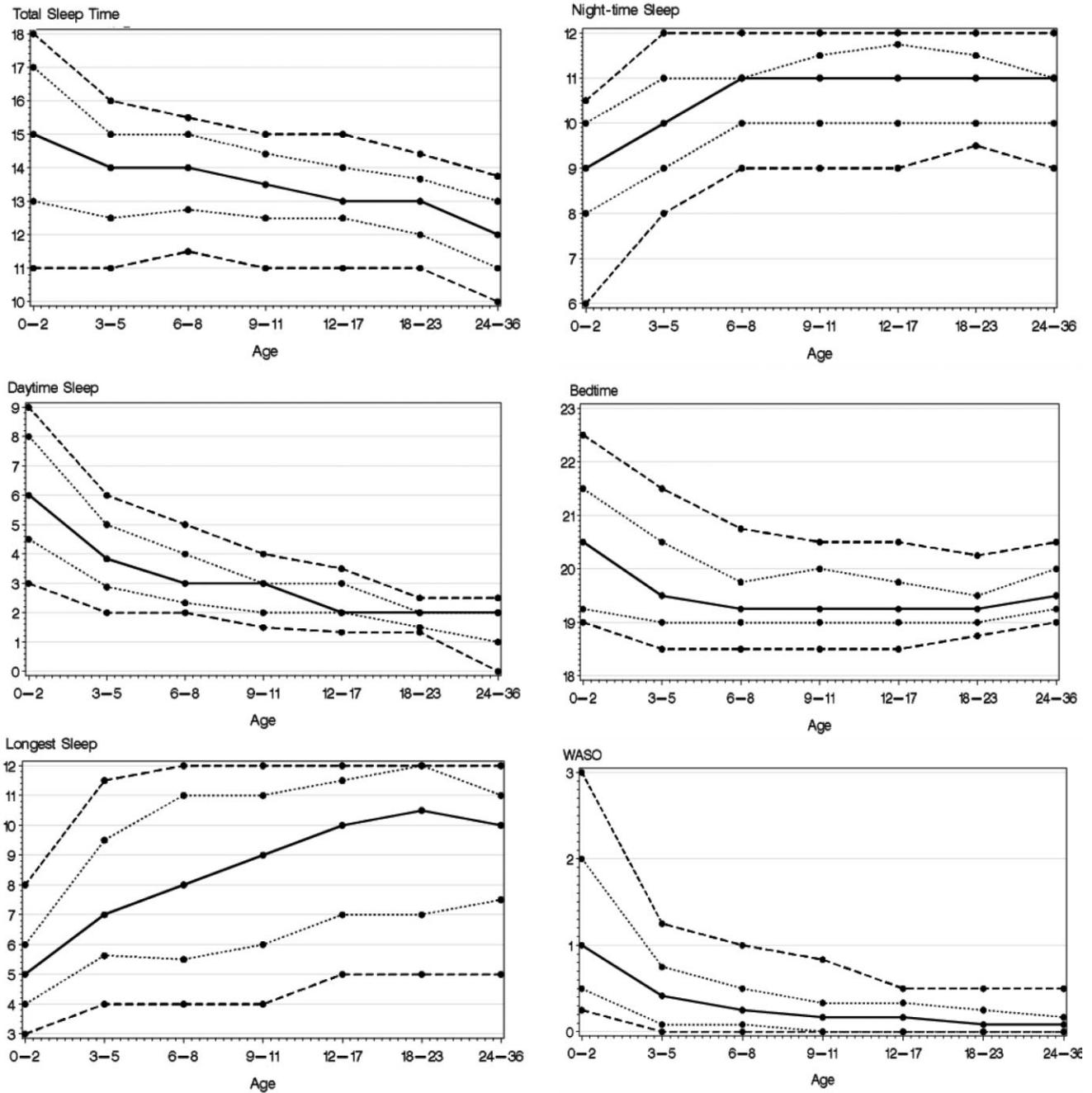
## Results

### Descriptive data and developmental changes

Data analysis was based on ANOVA, with age group as the independent variable. Duncan's *post hoc* analyses were used to test for specific age group differences. The analyses were performed on the following sleep measures: (i) total sleep time (hours); (ii) daytime sleep (between 08:00 and 19:00, in hours); (iii) night-time sleep (between 19:00 and 08:00, in hours) (iv); night-day sleep ratio (the percentage of night-time sleep from total sleep time); (v) average number of night wakings; (vi) longest period of consolidated sleep; and (vii) duration of nocturnal wakefulness.

Data on these measures are presented in Tables 1 and 2, as well as Figure 1. Total sleep time decreased significantly across development ( $F = 65.48$ ,  $P < 0.0001$ ). Duncan's *post hoc* analysis revealed that only the age groups between 3 and 8 months are not significantly different from each other. All the other (younger and older) age groups are significantly different from each other and from the groups in the age range between 3 and 8 months. The main decrease in sleep time occurs in daytime sleep ( $F = 335.89$ ,  $P < 0.0001$ ), with all age groups significantly different from each other, with a commensurate decrease in the number of naps ( $F = 633.97$ ,  $P < 0.0001$ ) as well. Significant increases also occurred in night-time sleep ( $F = 51.59$ ,  $P < 0.0001$ ).

The assessment of sleep consolidation is based on three measures: the average number of nocturnal night wakings, the average duration of nocturnal wakefulness, and the average duration of the longest continuous sleep episode at night. In addition, we analyzed the number of daytime naps. The results are summarized in Table 3.



**Fig. 1** Sleep according to age groups: full circles represent group means, blank circles represent 25th and 75th percentiles, and triangles represent 5th and 95th percentiles.

Significant age differences were found on all four measures. The average number of night wakings, the duration of nocturnal wakefulness, and the number of daytime naps decrease with age and, concurrently, the longest sleep episode extends.

**Sleep ecology: setting and parental behaviours**

We analysed a broad spectrum of common parental sleep-related behaviours. The age-dependent frequencies of parental

sleep-related behaviours are presented in Table 4. Significant age-related changes occur in the sleep setting as far as parental interventions are involved, both in the sleep initiation process and in response to nocturnal awakenings. The percentage of parents reporting bottle feeding, nursing, rocking and holding the infant during sleep initiation sharply decrease with age, whereas the percentage of infants falling asleep in their crib alone increases. Falling asleep independently is the number one strategy at bedtime across all age groups, ranging from 49.0% at

**Table 3** Sleep measures across age groups (Mean ± SD)

	Age group (months)							F
	0–2 n = 157	3–5 n = 356	6–8 n = 337	9–11 n = 285	12–17 n = 376	18–23 n = 286	24–36 n = 357	
Total sleep time (h)	14.9 ± 2.76 <sup>a</sup>	13.8 ± 1.95 <sup>b</sup>	13.7 ± 1.72 <sup>b</sup>	13.3 ± 1.61 <sup>c</sup>	13.1 ± 1.45 <sup>c</sup>	12.8 ± 1.32 <sup>d</sup>	12.0 ± 1.45 <sup>e</sup>	65.48*
Night-time sleep (h)	8.87 ± 1.71 <sup>a</sup>	9.96 ± 1.48 <sup>b</sup>	10.51 ± 1.23 <sup>c</sup>	10.56 ± 1.44 <sup>c</sup>	10.75 ± 1.22 <sup>cd</sup>	10.81 ± 1.15 <sup>d</sup>	10.55 ± 1.23 <sup>c</sup>	51.59*
Daytime sleep (h)	6.03 ± 2.18 <sup>a</sup>	3.79 ± 1.61 <sup>b</sup>	3.14 ± 1.14 <sup>c</sup>	2.75 ± 0.97 <sup>d</sup>	2.37 ± 0.86 <sup>e</sup>	1.98 ± 0.64 <sup>f</sup>	1.50 ± 0.94 <sup>g</sup>	335.89*
Night wakings (n)	1.83 ± 0.99 <sup>a</sup>	1.30 ± 1.11 <sup>b</sup>	1.28 ± 1.31 <sup>b</sup>	1.19 ± 1.38 <sup>b</sup>	.96 ± 1.10 <sup>c</sup>	.70 ± 0.94 <sup>d</sup>	.70 ± 0.88 <sup>d</sup>	29.36*
Longest sleep episode (h)	5.17 ± 1.88 <sup>a</sup>	7.55 ± 2.71 <sup>b</sup>	8.09 ± 3.07 <sup>c</sup>	8.43 ± 3.09 <sup>c</sup>	9.04 ± 2.83 <sup>d</sup>	9.42 ± 2.72 <sup>d</sup>	9.30 ± 2.63 <sup>d</sup>	57.71*
Nocturnal wakefulness (h)	1.22 ± 0.94 <sup>a</sup>	.55 ± 0.59 <sup>b</sup>	.39 ± 0.49 <sup>d</sup>	.30 ± 0.39 <sup>d</sup>	.24 ± 0.35 <sup>de</sup>	.20 ± 0.34 <sup>e</sup>	.20 ± 0.48 <sup>e</sup>	99.40*
Naps (n)	3.50 ± 1.03 <sup>a</sup>	3.09 ± 0.88 <sup>b</sup>	2.55 ± 0.65 <sup>c</sup>	2.04 ± 0.49 <sup>d</sup>	1.55 ± 0.60 <sup>e</sup>	1.13 ± 0.50 <sup>f</sup>	.84 ± .46 <sup>g</sup>	633.97*

\*P < 0.0001. Column means with the same letters are not significantly different (Duncan's *post hoc* test).

**Table 4** Percentages of children in each age group using specific method

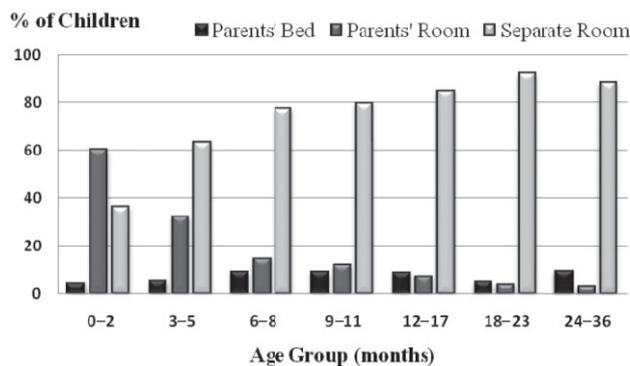
	Age group (months)							χ <sup>2</sup>
	0–2	3–5	6–8	9–11	12–17	18–23	24–36	
Sleep initiation method								
Bottle feeding	15.3 <sup>a</sup>	12.1 <sup>a</sup>	8.6 <sup>a</sup>	13.0 <sup>a</sup>	10.4 <sup>a</sup>	7.0 <sup>a</sup>	6.2 <sup>a</sup>	19.00*
Nursing	43.3 <sup>a</sup>	27.8 <sup>b</sup>	24.0 <sup>b</sup>	19.0 <sup>b</sup>	7.7 <sup>c</sup>	3.2 <sup>c</sup>	1.1 <sup>c</sup>	255.67**
Rocking	35.0 <sup>a</sup>	25.0 <sup>b</sup>	16.3 <sup>b</sup>	9.1 <sup>c</sup>	5.9 <sup>c</sup>	2.8 <sup>c</sup>	2.5 <sup>c</sup>	206.87**
Holding	47.1 <sup>a</sup>	27.3	16.0 <sup>c</sup>	11.6 <sup>c</sup>	12.5 <sup>c</sup>	5.6 <sup>d</sup>	4.5 <sup>d</sup>	216.29**
Watching TV	1.3 <sup>a</sup>	3.9 <sup>b</sup>	0.3 <sup>c</sup>	1.8 <sup>a</sup>	1.9 <sup>a</sup>	2.1 <sup>a</sup>	9.5 <sup>b</sup>	62.93**
In crib alone in the room	49.0 <sup>a</sup>	68.5 <sup>b</sup>	72.1 <sup>b</sup>	70.9 <sup>b</sup>	76.3 <sup>b</sup>	83.6 <sup>b</sup>	71.7 <sup>b</sup>	65.61**
In parents' bed alone	1.3 <sup>a</sup>	2.5 <sup>a</sup>	1.2 <sup>a</sup>	2.5 <sup>a</sup>	1.6 <sup>a</sup>	0.7 <sup>a</sup>	3.1 <sup>b</sup>	7.53
In crib with parental presence	19.8 <sup>a</sup>	10.4 <sup>b</sup>	8.3 <sup>b</sup>	5.6 <sup>b</sup>	7.5 <sup>b</sup>	5.9 <sup>b</sup>	14.0 <sup>c</sup>	39.10**
In parents' bed with parent	5.7 <sup>a</sup>	3.7 <sup>a</sup>	5.9 <sup>a</sup>	6.0 <sup>a</sup>	5.6 <sup>a</sup>	4.9 <sup>a</sup>	7.6 <sup>a</sup>	5.56
Resuming sleep								
Holding or rocking to sleep	16.7 <sup>a</sup>	14.6 <sup>a</sup>	14.2 <sup>a</sup>	20.4 <sup>a</sup>	16.0 <sup>a</sup>	8.7 <sup>b</sup>	5.9 <sup>b</sup>	38.56**
Picking up – returning awake	9.6 <sup>a</sup>	11.5 <sup>a</sup>	20.5 <sup>b</sup>	24.9 <sup>b</sup>	29.0 <sup>b</sup>	31.5 <sup>b</sup>	29.4 <sup>b</sup>	71.30**
Rub or pat in crib	15.9 <sup>a</sup>	19.1 <sup>a</sup>	22.0 <sup>a</sup>	26.0 <sup>b</sup>	33.5 <sup>b</sup>	31.1 <sup>b</sup>	35.6 <sup>b</sup>	49.33**
Giving a bottle	14.2 <sup>a</sup>	13.3 <sup>a</sup>	11.6 <sup>a</sup>	20.7 <sup>b</sup>	20.5 <sup>b</sup>	10.9 <sup>c</sup>	8.1 <sup>c</sup>	48.14**
Nurse back to sleep	65.6 <sup>a</sup>	50.0 <sup>a</sup>	40.1 <sup>b</sup>	24.2 <sup>c</sup>	12.8 <sup>d</sup>	3.5 <sup>e</sup>	0.8 <sup>c</sup>	504.47**
Give child pacifier	28.7 <sup>a</sup>	36.8 <sup>a</sup>	32.9 <sup>a</sup>	24.9 <sup>a</sup>	28.2 <sup>a</sup>	23.1 <sup>a</sup>	11.8 <sup>b</sup>	69.27**
Verbal comfort in crib	5.1 <sup>a</sup>	10.1 <sup>a</sup>	12.5 <sup>a</sup>	13.7 <sup>a</sup>	16.5 <sup>b</sup>	20.6 <sup>b</sup>	26.1 <sup>b</sup>	59.49**
Bring child to parents' bed	8.3 <sup>a</sup>	12.1 <sup>b</sup>	13.7 <sup>b</sup>	16.8 <sup>b</sup>	20.0 <sup>b</sup>	21.0 <sup>b</sup>	24.1 <sup>b</sup>	34.76**
Let cry to fall asleep	7.0 <sup>a</sup>	8.7 <sup>a</sup>	18.4 <sup>b</sup>	22.1 <sup>b</sup>	23.1 <sup>b</sup>	25.9 <sup>b</sup>	16.8 <sup>b</sup>	56.02**
Wait a few minutes	36.3 <sup>a</sup>	32.3 <sup>a</sup>	48.1 <sup>b</sup>	46.3 <sup>b</sup>	52.9 <sup>b</sup>	48.6 <sup>b</sup>	43.1 <sup>b</sup>	40.86**
Play until ready for sleep	1.3 <sup>a</sup>	0.8 <sup>a</sup>	0.9 <sup>a</sup>	0.0 <sup>a</sup>	0.8 <sup>a</sup>	0.0 <sup>a</sup>	0.6 <sup>a</sup>	5.69
Watch TV or video	1.3 <sup>a</sup>	0.3 <sup>a</sup>	0.6 <sup>a</sup>	1.1 <sup>a</sup>	0.8 <sup>a</sup>	0.7 <sup>a</sup>	1.1 <sup>a</sup>	2.59
Sing to child	3.8 <sup>a</sup>	3.4 <sup>a</sup>	7.4 <sup>a</sup>	6.7 <sup>a</sup>	6.9 <sup>a</sup>	3.2 <sup>a</sup>	5.3 <sup>a</sup>	11.78

\*P < 0.001; \*\*P < 0.0001. Column means with the same letters are not significantly different from each other in Chi Square *post hoc* analysis.

0–2 months to a high of 83.6% at 18–23 months. Rarely does falling asleep in the parents' bed alone occur or even in the parents' bed with parents present.

When resuming sleep following night waking is addressed, significant age-related changes are also evident. Interventions such as holding, rocking, giving a bottle and nursing show a sharp decrease with age. Nursing is the predominant strategy in the newborn months (65.5%) but rarely occurs in the oldest age

group (0.8%). Waiting a few minutes to see if their child returns to sleep on their own is commonly used, even in the first few months (36.3%). In addition, interventions like letting the baby cry to fall asleep and verbal comfort in crib increase with age; whereas other interventions (e.g. bring child to parents' bed, watch television) do not show any age-related tendency. Furthermore, parents rarely respond to a child's night wakings by playing with them or watching television during the night.



**Fig. 2** Sleep setting by age group – sleeping in parents’ bed, sleeping in parents’ room but not in parents’ bed and sleeping in separate room.

Similarly, television viewing rarely occurs at bedtime, although there is a significant increase to almost 10% of children in the oldest age group.

**Room-sharing and bed-sharing**

Overall, 72.47% of AU and NZ children slept in their own room and only 7.2% slept in their parents’ bed. As can be seen in Figure 2, across age, significant increases in sleeping in a separate room occur between 0–2 months and 3–5 months, as well as between these ages and 6–36 months. After 6 months, sleep setting remains stable across the ages.

**Parentally defined sleep problems**

Few parents (11.15%) reported bedtime to be difficult. In contrast, however, approximately one-third (30.69%) of parents in AU and NZ were likely to view their child as having a sleep problem. Across age groups, sleep problems were reported by 31.21% of parents of 0–2-month-olds, 28.37% of 3–5-month-olds, 33.85% of 6–8-month-olds, 38.94% of 9–11-month-olds, 33.25% of 12–17-month-olds, 25.88% of 18–23-month-olds and 24.37% of 24–36-month-olds ( $\chi^2 = 42.22, P < 0.0001$ ).

**Discussion**

To our knowledge, this is the largest Internet-based survey of the sleep patterns of young children in AU and NZ. It is likely that this will be an important reference data set for future Web-based research.

As would be expected from an Internet survey, the cohort is likely skewed towards those with higher education and in the higher socioeconomic strata. Furthermore, data were collected online through a parenting website, which may have influenced the representative nature of this cohort. However, a recent study revealed that data on sleep of young children obtained over the Internet are very similar in nature to data obtained by more traditional forms of research.<sup>8</sup>

Our present Internet-based findings are very similar to those based on traditional (non-computerised) surveys. For example, Hiscock and Wake<sup>19</sup> reported that 73% of infants slept in their

own room and only 7% slept in their parents’ bed. We reported 72.47% and 7.20% respectively. Furthermore, they reported that 36% of parents thought that sleep was a problem, and we reported 30.69%. Their cohort consisted of mothers attending a hearing screen in a free maternal and child health centre with infants of a median age of 8.7 months, whereas ours was a community sample, ranging from newborn to 36 months.

Another Australian study based on a well-baby clinic sample of 692 mothers of infants with a mean age of 4.6 months adds external validity to our study.<sup>20</sup> They showed that a similar percentage (34%) felt that their infant had a sleep problem. This was a socioeconomically diverse sample. Armstrong’s often-quoted paper on the sleep patterns of Australian infants aged between newborn and 38 months also showed a strikingly similar percentage of reported sleep problems at 28.6%.<sup>5</sup> Theirs was a cross-sectional questionnaire study across diverse populations in the state of Queensland, with 3383 questionnaires given out and 3269 returned, an impressive 96.5% response rate. They also showed that 68% of the children slept in their own room.

Several of the findings in this study should be highlighted. First are the age-related changes that occur in sleep patterns, with significant increases in night-time sleep, decreases in daytime sleep and increases in sleep consolidation that occur across the age span of birth to 36 months. Another striking finding of this study is the sleep practices that are reported by a large majority of the parents in AU and NZ, with an emphasis on encouraging independence and self-soothing from as early as 3 months. For example, the majority of young children in this study are reported to fall asleep independently in their crib. Furthermore, few parents report poor sleep practices such as television viewing occurring at bedtime or during the night. However, approximately one-third of parents at every age report that their child has a sleep problem. This belief should be further explored within the context of these positive sleep practices and positive sleep outcomes, especially as it relates to parental expectations.

Previously, we reported on cross-cultural sleep patterns and sleep problems in young children, comparing a large sample of predominantly Caucasian and predominantly Asian children,<sup>18</sup> as well as across countries/regions. There were marked differences in the sleep of AU and NZ children reported in this study compared to children from predominantly Asian countries/regions (China, Hong Kong, India, Indonesia, Japan, South Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand and Vietnam). AU and NZ children have significantly more total sleep (13.24h vs. 12.31 h), earlier bedtimes (19.58 h vs. 21.44 h), fewer awakenings (1.08 vs. 1.69 times), less likely to bed-share with parents (7.2% vs. 64.65%) and take less time to fall asleep (6.08% took longer than 30 min vs. 19.29%). Parent perception of sleep problems is also less common in AU and NZ (30.69% vs. 51.90%). Similar results can be found between children in AU and NZ, as well as children in predominantly Caucasian countries (Canada, United States and United Kingdom). Again, AU and NZ children have significantly more total sleep (13.24 h vs. 12.94 h), earlier bedtimes (19.58 h vs. 20.73 h), less likely to bed-share with parents (7.2% vs. 13.5%) and take less time to fall asleep (6.08% took longer than 30 min vs. 10.87%). Parent perception of sleep problems, however,

is more common in AU and NZ (30.69% vs. 24.66%). These marked differences in sleep, especially in comparison to predominantly Asian countries/regions, may be due to a number of factors, including higher density of housing in various Asian countries, work and transport arrangements, climate and care of children by extended family members. In addition, although Australia and New Zealand are part of the Asia-Pacific region, sleep patterns and perception of sleep problems are more similar to those seen in predominantly Caucasian populations in North America and Europe, in this case specifically Canada, United States and United Kingdom.

The increased sleep and fewer sleep disturbances seen in AU and NZ merits further study, including investigation of underlying beliefs and practices about sleep that may result in better sleep for young children.<sup>21</sup> One explanation for these positive sleep outcomes may be the positive parenting sleep practices that are reported by the majority of parents in AU and NZ. A recent NZ study confirmed the rapid maturational changes in the first 12 months of life and showed that by 5 months of age, most infants were sleeping through the night, at the same times that their parents were.<sup>22</sup> Considering the fact that young children in AU and NZ sleep more than most of their peers in other countries, it raises the possibility that they are better protected from the adverse consequences of insufficient sleep. Further research should address this issue as well.

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