Original Article

Caregiver-perceived sleep outcomes in toddlers sleeping in cribs versus beds

Ariel A. Williamson [a, *], Erin S. Leichman [b], Russel M. Walters [c], Jodi A. Mindell [a, b]

[a] Sleep Center, Children's Hospital of Philadelphia, Philadelphia, PA, USA
[b] Saint Joseph's University, Philadelphia, PA, USA
[c] Johnson & Johnson Consumer Inc., Skillman, NJ, USA

ABSTRACT

Objective: Little is known about whether sleep space impacts toddler sleep outcomes. We examined the prevalence of crib-sleeping and its association with caregiver-reported sleep patterns and problems in a large sample of toddlers from Western countries.
Methods: Participants were caregivers of 1983 toddlers ages 18.0–35.9 months (51.7% male; mean age 25.3 months) from Australia, Canada, New Zealand, the United Kingdom, and the United States sleeping in a crib or bed in a separate room from caregivers. Caregiver-reported sleep patterns and problems were collected via a free, publicly available child sleep smartphone application.
Results: Across countries/regions, rates of crib-sleeping decreased linearly with age, with 63.4% of toddlers ages 18.0–23.9 months, 34.3% of toddlers ages 24.0–29.9 months, and 12.6% of toddlers ages 30.0–35.9 months sleeping in a crib. Across age groups and countries, crib sleeping was significantly associated with an earlier bedtime, shorter sleep onset latency, fewer night awakenings, longer stretches of time asleep, increased nighttime sleep duration, and decreased bedtime resistance and sleep problems. The duration of night awakenings did not significantly differ by sleep space.
Conclusion: Sleeping in a crib instead of a bed is associated with enhanced caregiver-reported sleep quantity and quality for toddlers in Western countries. Consistent with practice recommendations, deferring the crib-to-bed transition until age 3 years may benefit toddlers' sleep in Western contexts. Additional research is needed to identify the impact of sleep space on child sleep in other countries/regions.

© 2018 Elsevier B.V. All rights reserved.

1. Introduction

A substantial proportion of young children in Western contexts have sleep problems, with 20–30% of caregivers in countries such as Australia, the United Kingdom, and the United States, reporting infant and toddler sleep problems [1–3]. Sleep problems, including difficulty falling and staying asleep, are especially common in toddlerhood due to a combination of environmental (eg, sleep location), developmental (eg, negotiating independence, nighttime fears), and caregiver (eg, presence at bedtime) factors specific to this period [4,5]. Aspects of the sleep environment are important determinants of child sleep patterns and problems. In a large sample of infants and toddlers ages birth to 36 months, having a regular bedtime routine, avoiding electronics at bedtime, and sleeping in a separate room were significant predictors of caregiver-reported nocturnal sleep duration, with sleeping in a separate room being the strongest predictor of caregiver-reported longer sleep duration [6]. Sleeping in a separate room was also associated with reduced night awakenings and longer stretches of continuous sleep. Other studies have also shown that in young children (under age 5) solitary sleepers are reported to have fewer caregiver-perceived sleep problems than children whose caregivers co-sleep (room- or bed-sharing) reactively in response to a child sleep problem, or intentionally [7]. Of note, however, these studies did not examine whether children sleeping in a separate room were sleeping in a crib or a bed.

Thus, although research has examined sleep location and other aspects of the sleep environment in relation to toddlers' sleep, few studies have examined the sleep space in early childhood. The sleep space is especially relevant, as most children typically transition to a bed from a crib during this developmental period. Whereas a crib offers a physically contained sleep space, a bed allows for toddlers to easily get out of bed independently, which may impact sleep onset latency and the duration of night awakenings, among other sleep parameters. For example, in a study of night awakening behaviors in 2- to 5-year-olds, children frequently got out of bed during awakenings to seek parental comfort and make other requests [8]. Remaining in bed at bedtime and overnight may be even more challenging for younger toddlers, who are still developing key self-regulation skills [9,10]. While sleep practitioners typically recommend that caregivers wait until closer to age 36 months to transition a toddler to a bed [11,12], little is known about whether sleeping in a crib versus a bed during toddlerhood is associated with variation in sleep patterns and problems.

Thus, the purpose of this study was to examine whether sleeping in a crib or a bed (in a separate room) was associated with variation in caregiver-perceived sleep outcomes in a large sample of toddlers ages 18–36 months from Western countries. We hypothesized that sleeping in a crib would be associated with the following caregiver-perceived toddler sleep outcomes: an earlier bedtime, a shorter sleep onset latency, fewer and shorter night awakenings, more consolidated sleep, a longer nighttime sleep duration, decreased bedtime resistance, and fewer sleep problems.

2. Methods

2.1. Participants

Caregivers of 1983 toddlers ages 18.0–35.9 months from Australia, Canada, New Zealand, the United Kingdom, and the United States participated in this study. Additional demographic information about study participants appears in section 3.1, below.

2.2. Procedure

Data were collected using the Johnson's® Bedtime® baby sleep application (app), a free, publicly available smartphone app for sleep education and management in young children. The Brief Infant Sleep Questionnaire (BISQ) [6,13] and the Customized Sleep Profile (CSP) [14,15], which is a tailored behavioral sleep intervention, are provided in the app. Based on caregiver report of child sleep problems, the CSP provides customized and empirically supported behavioral sleep strategies. Details about the CSP and its efficacy for improving child sleep are described elsewhere [14,15].

Participants were recruited for the present study via a prompt in the Bedtime® app that asked caregivers' permission for the use of their app data for research purposes. Caregivers provided informed consent to participate in the study, which was approved by the Institutional Review Board at Saint Joseph's University. Caregivers were free to decline study participation and to continue to use the Bedtime® app. Data were collected from the baby sleep app between August 2013 and September 2016 (37 months). For inclusion in the present study, caregivers had to have a child between the ages of 18.0 and 35.9 months who was sleeping in a separate room from the caregivers, in either a crib or a bed. We chose to exclude toddlers who shared a room with a caregiver, as room-sharing has been associated with significant variation in child sleep patterns and problems.

2.3. Measures

For the present study, only caregivers' responses from the first BISQ entry were used in analyses, thus prior to the provision of any behavioral recommendations. Caregivers completed demographic questions (caregiver and toddler age; caregiver role; country) and an expanded version of the BISQ within the app [6,13]. The BISQ is a well-established measure of caregiver-perceived infant and toddler sleep patterns and problems that has been validated against actigraphy [13]. The expanded BISQ [6], which includes additional items related to bedtime practices and caregiver behaviors, is sensitive to developmental and environmental effects on child sleep patterns, and has been used in previous research [14,15]. Caregivers responded to BISQ questions related to daytime and nighttime sleep patterns, toddler and caregiver behaviors at bedtime and during night awakenings, and aspects of the sleep environment (eg, sleep location and space). On the BISQ, caregivers also rated the extent of toddler resistance at bedtime (bedtime difficulty, rated from very easy to very difficult) and toddler sleep problems (rated from no problem to severe problem). These items were dichotomized, as in previous research [2,14,16], so that bedtime resistance reflected a somewhat to very difficult bedtime and sleep problems reflected a small to severe sleep problem.

2.4. Statistical analyses

We preliminarily examined means and standard deviations for continuous data and proportions for categorical data. Chi-square tests were used to examine the prevalence of crib versus bed-sleeping by toddler age and by country. For all analyses, three age groups were considered: ages 18.0–23.9 months, 24.0–29.9 months, and 30.0–35.9 months. Analyses of covariance (ANCOVA) were used to test study hypotheses for continuous data and logistic regression was used to test the hypotheses for the categorical bedtime resistance and sleep problems outcomes. We examined main effects for sleep space (crib versus bed) and child age, and interaction effects for sleep space by child age. In all analyses, we covaried for dichotomous child sex and country, as well as whether children fell asleep independently (ie, with or without a caregiver present at bedtime), as this can impact caregiver-perceived child sleep patterns and problems [5,17]. For the country covariate, participants from the United States and Canada were combined due to small numbers of toddlers from Canada, and in line with other studies indicating comparable findings in toddler sleep in North America [6]. Toddlers from Australia and New Zealand were also combined into one region due to small numbers of toddlers from New Zealand. Similarly, previous research has indicated minimal differences in sleep between these two countries [3]. Given the large sample size and the number of analyses, $p < 0.01$ was used to indicate significance.

3. Results

3.1. Demographic characteristics

As noted above, the full sample consisted of 1983 toddlers ages 18.0–35.9 months (51.7% male; mean age 25.3 months, SD = 4.98 months). The breakdown of toddlers by age categories was 45.3% ages 18.0–23.9 months, 32.8% ages 24.0–29.9 months, and 21.9% ages 30.0–35.0 months. Caregiver reporters were predominantly mothers (85.0%), followed by other caregivers (9.5%), fathers (3.0%), grandparents (1.4%), and guardians, babysitters, or nannies (1.1%). The majority of participants were from the United States ($n = 1131$), followed by 742 participants from the United Kingdom, 76 from Australia, 29 from Canada, and five from New Zealand.

3.2. Sleep location

Across age groups, a total of 42.7% of toddlers slept in a crib and 57.3% of toddlers slept in a bed. When examined by the three toddler age groups, older toddlers were less likely to sleep in a crib than in a bed, with 63.4% of toddlers ages 18.0—23.9 months, 34.3% of toddlers ages 24.0—29.9 months, and 12.6% of toddlers ages 30.0—35.9 months sleeping in a crib, $\chi^2(2, N = 1983) = 336.00$, $p < 0.001$. The overall prevalence of crib-versus bed-sleepers across did not significantly differ when examined across countries/regions, with 44.8% of toddlers in the United States and Canada, 40.4% in the United Kingdom, and 33.3% of toddlers in Australia and New Zealand sleeping in a crib, $\chi^2(1, N = 1983) = 6.61$, $p = 0.037$.

3.3. Sleep patterns and problems

Table 1 shows means and frequencies for sleep patterns and problems, as well as the results of ANCOVA and logistic regression models. Across models, toddler age by sleep space interaction terms were not statistically significant, indicating that the association between sleep space between sleep outcomes did not vary by age.

Toddlers sleeping in a crib as opposed to a bed were significantly more likely to have earlier bedtimes, by about 12 min overall (Table 1, $p < 0.001$). Within each age group, crib-sleeping toddlers had an earlier bedtime by about 16 min for those ages 18.0—23.9 months, 11 min for those 24.0—29.9 months, and 13 min for those ages 30.0—35.9 months (Fig. 1a). Toddlers sleeping in a crib were also more likely to have a shorter sleep onset latency compared to those sleeping in a bed across age groups, by about 9 min overall (Table 1, $p < 0.001$). Within each age group, the difference in sleep onset latency for crib- versus bed-sleeping toddlers was about 10 min for those ages 18.0—23.9 months, 8 min for those 24.0—29.9 months, and 7 min for those ages 30.0—35.9 months (Fig. 1b).

Across age groups, toddlers sleeping in a crib had significantly fewer night awakenings compared to those sleeping in a bed (Table 1, $p = 0.002$; Fig. 1c), although the duration of night awakenings did not differ by sleep space (Table 1, $p = 0.164$; Fig. 1d). Crib-sleeping toddlers had longer stretches of time asleep overnight by about 43 min overall (Table 1, $p < 0.001$). Within each age group, crib-sleeping toddlers had longer stretches of time asleep by about 58 min for those ages 18.0—23.9 months, 38 min for those 24.0—29.9 months, and 55 min for those ages 30.0—35.9 months (Fig. 1e), compared to bed-sleeping toddlers. In addition, toddlers sleeping in a crib had a longer nighttime sleep duration overall, by about 29 min (Table 1, $p < 0.001$). By age, nighttime sleep duration was longer for crib-sleeping toddlers by about 37 min for those ages 18.0—23.9 months, 25 min for those 24.0—29.9 months, and 32 min for those ages 30.0—35.9 months (Fig. 1f). There were no differences

in parental presence at bedtime across sleep space (29.0% crib sleepers; 28.1% bed sleepers), $p = 0.638$, although parental presence was associated as expected with sleep outcomes, $p < 0.001$.

Overall, 32.0% of caregivers reported toddler bedtime resistance and 34.9% reported that they considered their toddler's sleep to be problematic. Logistic regression showed that across age groups, caregivers of toddlers sleeping in a crib were significantly less likely to report bedtime resistance (OR = 0.42, 95% CI [0.31, 0.56], $p < 0.001$) and sleep problems (OR = 0.65, 95% CI [0.49, 0.87], $p = 0.004$). Proportions for bedtime resistance and sleep problems by toddler age group are shown in Fig. 2a, b, respectively.

4. Discussion

This study identified the prevalence of crib- versus bed-sleeping toddlers in a large, Western sample, and provided information about the extent to which sleep space is associated with variation in caregiver-perceived sleep patterns and problems. The prevalence of crib-sleeping was highest for those ages 18—24 months (63%), with a linear decrease by age group with only 13% of 30 to 36-month-olds sleeping in a crib. Toddlers sleeping in a crib had better caregiver-perceived sleep outcomes, including an earlier bedtime, shorter sleep onset latency, fewer night awakenings, longer stretches of time asleep, and increased nighttime sleep duration across all toddler ages and countries/regions. In addition, those sleeping in a crib showed less caregiver-perceived bedtime resistance and fewer sleep problems.

These differences in sleep outcomes may be due to the newfound freedom of sleeping in a bed. As noted previously, there are only imaginary boundaries when sleeping in a bed and behavioral control is needed to stay within those boundaries. Increased bedtime resistance in bed-sleeping toddlers in particular may reflect this freedom, as these toddlers may be more likely to show difficulties getting into bed at bedtime and remaining in bed after lights out as compared to toddlers who are placed in a crib to sleep. Indeed, in one study of night waking behaviors in young children, getting out of bed at bedtime was associated with getting out of bed during night awakenings [8]. It also could be that crib-sleeping toddlers are waking just as often as those sleeping in a bed, but because crib-sleeping toddlers are unable to physically leave the sleep space to elicit caregiver attention during night awakenings, caregivers of crib-sleeping toddlers perceive fewer night awakenings and better sleep overall. It should be noted, however, that although the toddlers sleeping in a crib had a fewer number of night awakenings, there were no differences in night waking duration. This similarity is consistent with other studies that have found no differences in night awakening duration based on sleep location (eg, own or parental room) in younger children

Table 1
Caregiver-perceived sleep patterns by sleep location.

	Total		Crib-sleepers		Bed-sleepers		F	η^2
	M	SD	M	SD	M	SD		
Bedtime (time)	20:08	1.00	20:02	0.94	20:14	1.04	16.13***	0.009
Sleep onset latency (mins)	34.83	29.26	29.91	27.25	38.55	30.16	18.21***	0.009
Number of night awakenings	1.31	1.21	1.23	1.20	1.38	1.21	9.26**	0.005
Duration of night awakenings (min)	25.90	38.32	25.23	36.75	26.39	39.47	1.94	0.001
Longest stretch asleep (hours)	8.39	3.06	8.81	2.96	8.09	3.10	20.54***	0.011
Nighttime sleep duration (hours)	10.08	1.59	10.36	1.49	9.88	1.63	30.22***	0.016

|	Total		Crib-sleepers		Bed-sleepers		OR (95% CI)	
	%	n	%	n	%	n		
Perception of child bedtime resistance	32.0	634	29.1	191	63.9	443	0.40*** (0.31, 0.56)	
Perception of child sleep problem	34.9	693	43.6	257	62.3	436	0.65** (0.49, 0.87)	

** $p < 0.01$, *** $p < 0.001$.
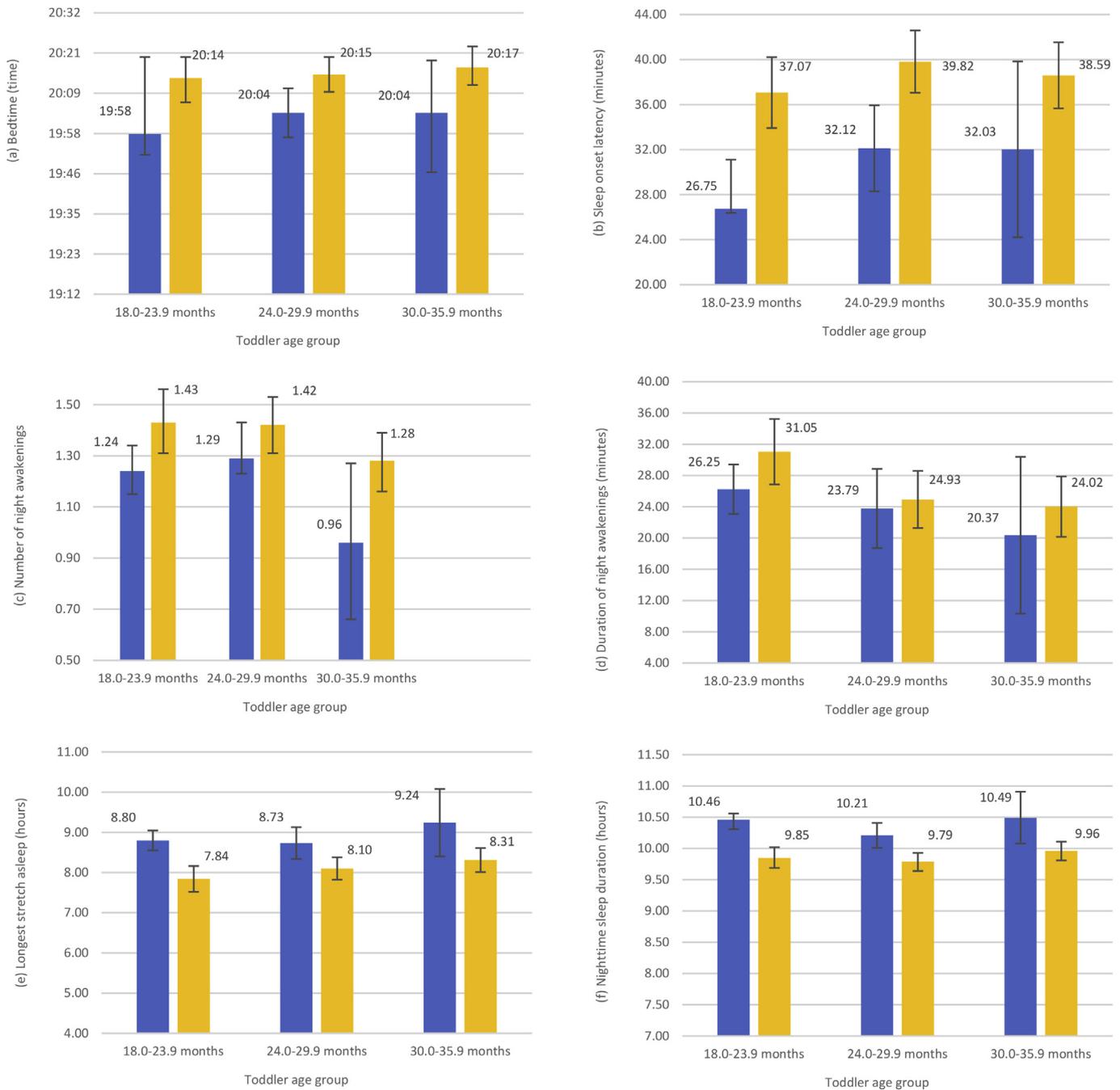
Fig. 1. Sleep patterns by sleep space across age groups. Note: Crib-sleepers in blue, bed-sleepers in yellow. (a) Adjusted means for bedtime for crib- and bed-sleeping toddlers by age group; (b) adjusted means for sleep onset latency for crib- and bed-sleeping toddlers by age group; (c) adjusted means for number of night awakenings for crib- and bed-sleeping toddlers by age group; (d) Adjusted means for duration of night awakenings for crib- and bed-sleeping toddlers by age group; (e) Adjusted means for longest stretch asleep for crib- and bed-sleeping toddlers by age; (f) Adjusted means for nighttime sleep duration for crib- and bed-sleeping toddlers by age.

[18]. It may be that once a young child is awake and a caregiver responds, sleep space does not affect the duration of the awakening.

An alternative explanation for these findings is that caregivers respond to sleep issues by moving their child from a crib to a bed, either due to safety concerns because their child is climbing out of the crib already or based on the perception that a change in sleep space will resolve problems. Given that these findings are correlational in nature, it is difficult to know the direction of effects. However, while the present study did not examine the timing of this transition and additional research is needed, it is plausible that

this change in sleep space may contribute to the onset or exacerbation of sleep problems in some toddlers. Another possibility is that there are differences in caregiver presence at bedtime that mediate the relationship between sleep space and sleep outcomes. However, this is not the case. Notably, caregivers report that they are equally likely to stay with their child at bedtime until sleep onset whether their child is in a crib or a bed, with approximately 28% caregivers of staying regardless of sleep space.

Furthermore, it is noteworthy that the associations between sleep space and sleep outcomes were stable across the three toddler age groups, over and above other factors that can significantly
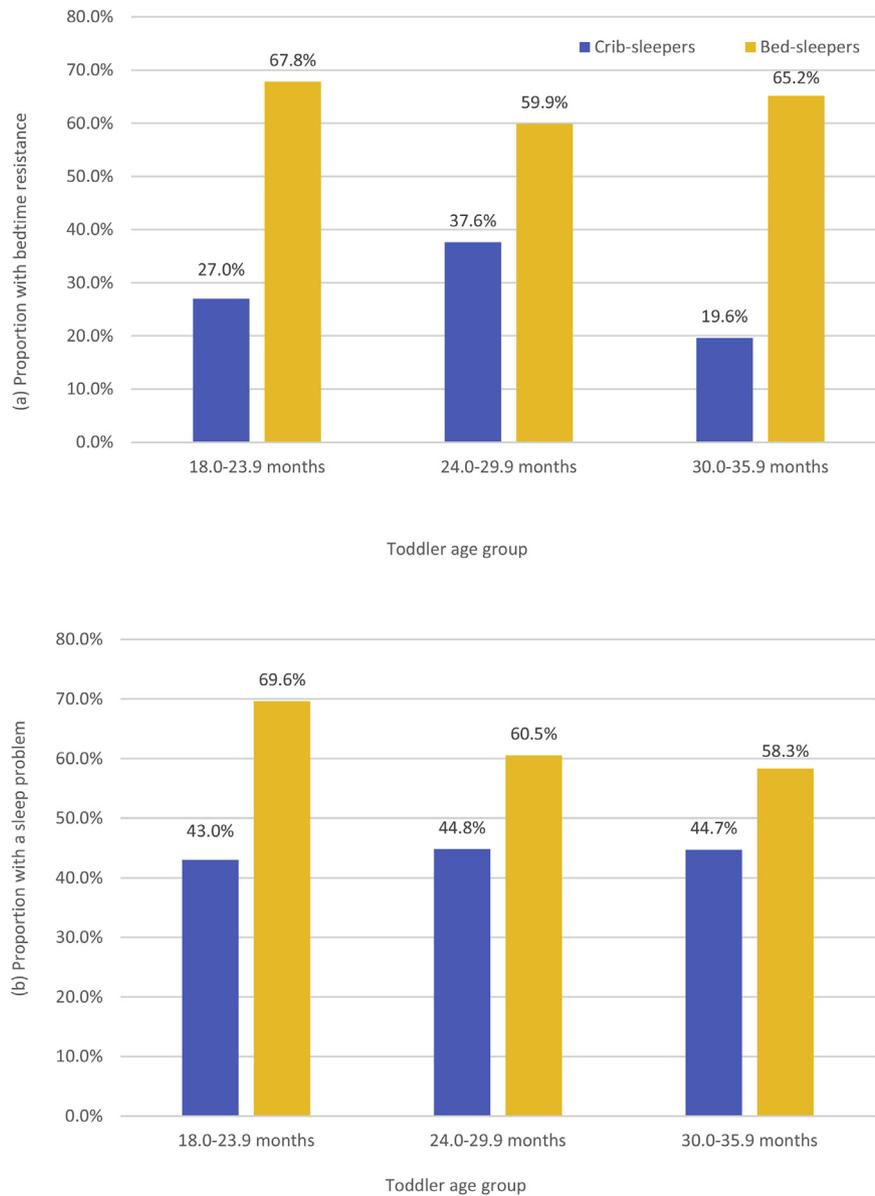
Fig. 2. Prevalence of caregiver reported bedtime resistance and sleep problems across age groups. Note: Crib-sleepers in blue, bed-sleepers in yellow. (a) Proportion of toddlers with bedtime resistance by sleep space and toddler age; (b) Proportion of toddlers with bedtime resistance by sleep space and toddler age.

impact early childhood sleep, such as caregiver presence at bedtime [4,5]. Although these findings are correlational in nature, it could be that delaying the crib-to-bed transition for as long as is safe during toddlerhood (eg, toddlers are not climbing out of their crib) benefits toddler sleep. Delaying this transition could also augment caregiver practices that promote independent sleep onset at bedtime, at least in Western contexts. For example, caregivers who choose to implement behavioral strategies to encourage independent sleep onset and reduce sleep problems may find that toddler limit-testing behaviors are easier to manage and ignore when the child cannot repeatedly get out of bed at bedtime. Future research is needed to identify whether the effects of behavioral sleep treatments for toddler sleep problems differ according to sleep space and the timing of the bed-to-crib transition. In addition, the findings of this study are limited to toddlers living in the Western, democratic, and industrialized countries/regions included in this study.

There are a number of other limitations with this study. Similar to other internet and app-based studies, there is the possibility that caregivers are more likely to access these resources if sleep is a

concern. However, the results reported here are similar to previous studies conducted for such outcomes as caregiver-perceived sleep problems and sleep patterns [2,6]. Furthermore, there is the likelihood that the sample in this study represents higher educated, higher socio-economic families, as in previous Internet-based research [6,19]. Future research should examine variation in sleep patterns and problems across different socio-cultural groups within each country/region. As noted above, additional, non-Western countries/regions (eg, Asia, Middle East, Africa) need to be considered in order to clearly understand whether differences in sleep location can be applied to other populations of toddlers. Additionally, as indicated above, the data in this study are cross-sectional in nature. Longitudinal data would help elucidate whether the shift to a bed results in increased sleep issues or whether the development of sleep issues precipitates the decision to shift to a bed from a crib. To fully understand whether sleeping in a bed potentially causes sleep issues in toddlers, experimental studies should be conducted with random assignment. Finally, future research should include actigraph-derived estimates of toddler sleep.

5. Conclusions

As expected, there is a transition from sleeping in a crib at age 18 months (63.4%) to 36 months, with few older toddlers sleeping in a crib (12.6%). Sleeping in a crib (in a separate room) is associated with better caregiver-perceived sleep outcomes in toddlers than those who sleep in a bed. Caregivers report an earlier bedtime, shorter sleep onset latency, fewer night awakenings, longer stretches of time asleep, increased nighttime sleep duration, and fewer toddler bedtime resistance and sleep problems. Although these results are correlational in nature, it may still be prudent to encourage families to delay the transition to a bed until closer to 36 months, particularly given that sleep problems and insufficient sleep in early childhood have been associated with a number of adverse developmental outcomes [20–25]. However, differences in other aspects of parenting and limit setting should be explored to understand differences in toddler sleep outcomes and problematic sleep behaviors.

Conflict of interest

The authors have no conflicts of interest relevant to this article.
The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2018.10.012.

References

[1] Hiscock H, Canterford L, Ukoumunne OC, et al. Adverse associations of sleep problems in Australian preschoolers: national population study. Pediatrics 2007;119(1):86–93.

[2] Sadeh A, Mindell J, Rivera L. "My child has a sleep problem": a cross-cultural comparison of parental definitions. Sleep Med 2011;12(5):478–82.

[3] Teng A, Bartle A, Sadeh A, et al. Infant and toddler sleep in Australia and New Zealand. J Paediatr Child Health 2012;48(3):268–73.

[4] Honaker SM, Meltzer LJ. Bedtime problems and night wakings in young children: an update of the evidence. Paediatr Respir Rev 2014;15(4):333–9.

[5] Mindell JA, Kuhn B, Lewin DS, et al. Behavioral treatment of bedtime problems and night wakings in infants and young children. Sleep 2006;29(10):1263–76.

[6] Sadeh A, Mindell JA, Luedtke K, et al. Sleep and sleep ecology in the first 3 years: a web-based study. J Sleep Res 2009;18:60–73.

[7] Ramos KD, Youngclarke D, Anderson JE. Parental perceptions of sleep problems among co-sleeping and solitary sleeping children. Infant Child Dev 2007;16(4):417–31.

[8] Coulombe JA, Reid GJ. What do preschool-aged children do when they wake at night: toward an understanding of night-waking behaviors among community children. Behav Sleep Med 2014;12(2):89–105.

[9] Best J, Miller P. A developmental perspective on executive function. Child Dev 2010;81(6):1641–60.

[10] Guerra G, Williamson A, Lucas-Molina B, et al. Normal development: infancy, childhood and adolescence. IACAPAP textbook of child and adolescent mental health, Chapter A 2012;2:1–39.

[11] Meltzer LJ, McLaughlin Crabtree V. Pediatric sleep problems: a clinician's guide to behavioral interventions. American Psychological Association; 2015.

[12] Mindell JA, Owens JA. A clinical guide to pediatric sleep: diagnosis and management of sleep problems. Lippincott Williams & Wilkins; 2015.

[13] Sadeh A. A brief screening questionnaire for infant sleep problems: validation and findings for an Internet sample. Pediatrics 2004;113(6):e570–7.

[14] Mindell JA, Du Mond CE, Sadeh A, et al. Efficacy of an internet-based intervention for infant and toddler sleep disturbances. Sleep 2011;34(4):451–8.

[15] Mindell JA, Du Mond CE, Sadeh A, et al. Long-term efficacy of an internet-based intervention for infant and toddler sleep disturbances: one year follow-up. J Clin Sleep Med 2011;7(5):507–11.

[16] Mindell JA, Sadeh A, Kwon R, et al. Cross-cultural differences in the sleep of preschool children. Sleep Med 2013;14(12):1283–9.

[17] Allen SL, Howlett MD, Coulombe JA, et al. ABCs of SLEEPING: a review of the evidence behind pediatric sleep practice recommendations. Sleep Med Rev 2016;29:1–14.

[18] Mindell J, Leichman ES, Walters RM. Sleep location and parent-perceived outcomes in older infants. Sleep Med 2017;39:1–7.

[19] Mindell JA, Sadeh A, Wiegand B, et al. Cross-cultural differences in infant and toddler sleep. Sleep Med 2010;11(3):274–80.

[20] Baird J, Hill CM, Harvey NC, et al. Duration of sleep at 3 years of age is associated with fat and fat-free mass at 4 years of age: the Southampton Women's Survey. J Sleep Res 2016;25(4):412–8.

[21] Kocevska D, Muetzel RL, Luik AI, et al. The developmental course of sleep disturbances across childhood relates to brain morphology at age 7: the Generation R Study. Sleep 2017;40(1).

[22] Mindell JA, Leichman ES, DuMond C, et al. Sleep and social-emotional development in infants and toddlers. J Clin Child Adolesc Psychol 2017;46(2):236–46.

[23] Sivertsen B, Harvey AG, Reichborn-Kjennerud T, et al. Later emotional and behavioral problems associated with sleep problems in toddlers: a longitudinal study. JAMA Pediatr 2015;169(6):575–82.

[24] Touchette É, Petit D, Séguin JR, et al. Associations between sleep duration patterns and behavioral/cognitive functioning at school entry. Sleep 2007;30(9):1213–9.

[25] Touchette É, Petit D, Tremblay RE, et al. Associations between sleep duration patterns and overweight/obesity at age 6. Sleep 2008;31(11):1507–14.