ORIGINAL ARTICLE

Mother–infant sleep patterns and parental functioning of room-sharing and solitary-sleeping families: a longitudinal study from 3 to 18 months

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Abstract

Study Objectives: To examine longitudinally differences in (1) objective and subjective sleep patterns and (2) parenting functioning (i.e. maternal emotional distress, maternal separation anxiety, and parental involvement in infant care) between room-sharing and solitary-sleeping mother–infant dyads.

Methods: Maternal and infant sleep, sleeping arrangements, and parental functioning were assessed at 3 (N = 146), 6 (N = 141), 12 (N = 135), and 18 (N = 130) months postpartum. Maternal and infant sleep were assessed with actigraphy and sleep diaries for five nights. Questionnaires were used to assess sleeping arrangements, nighttime breastfeeding, and parental functioning.

Results: Persistent room-sharing mothers (i.e. sharing a room with the infant on at least three assessment points) had significantly lower actigraphy-based sleep percent, lower longest sleep periods, and more night-wakings than persistent solitary-sleeping mothers. For infants, differences in actigraphic sleep were found only in longest sleep period, although mothers of persistent room-sharing infants reported more infant night-wakings than mothers of persistent solitary-sleeping infants. The trajectories of maternal and infant sleep in both room-sharing and solitary-sleeping groups demonstrated that sleep became more consolidated with time. Group differences indicated higher maternal separation anxiety and lower paternal overall and nighttime involvement in infant caregiving in room-sharing families compared with solitary-sleeping families.

Conclusions: The findings are discussed in light of the latest American Academy of Pediatrics recommendation to share a room until 12 months postpartum. Although no causal effects can be inferred from this study, maternal sleep quality and certain parenting characteristics seem to be important factors to consider when parents consult about sleeping arrangements.

Statement of Significance

Infant sleep problems have been associated with bed-sharing. However, little is known about the characteristics of infant and maternal sleep in room-sharing arrangements. The present longitudinal study provides data on objective and subjective sleep of room-sharing mother–infant dyads from 3 to 18 months and demonstrates that in comparison to solitary sleep, room-sharing is associated with more objective sleep disturbances in mothers but hardly any in infants. Findings also highlight the importance of considering sleeping arrangements in the family context because factors such as paternal involvement and maternal separation anxiety differ between room-sharing and solitary-sleeping families. Future studies should explore whether sleeping arrangements directly influence maternal sleep, or whether early maternal sleep disturbances and parenting factors shape parental-sleeping arrangement choices.

Introduction

Infant sleeping problems, manifested mainly in frequent night-wakings and in the inability to resume sleep without parental help, characterize 20%–30% of all infants and toddlers and are among the most frequent complaints parents present to child care professionals [1, 2]. The development of infants' sleep patterns and sleep problems is influenced by complex interactions among physiological, environmental, and psychosocial factors [3, 4]. Among those factors, infant-sleeping arrangements (where and with whom infants sleep) have attracted scientific, clinical, and public attention because of the ongoing controversy about the potential benefits versus risks of infant cosleeping (and especially bed-sharing) on infants' sleep quality, safety (e.g. Sudden Infant Death Syndrome—SIDS), and psychological development (e.g. emotional needs, attachment security, and autonomy development) [4–7]. The relevance of this debate is highlighted by the increase in the percentage of parents in western societies that choose to share a room or a bed with their infants [8, 9], and by the recent updated policy statement of the American Academy of Pediatrics (AAP) task force on SIDS which recommends that "infants sleep in the parents' room, close to the parents' bed, but on a separate surface designed for infants, ideally for the first year of life, but at least for the first 6 months" [10]. The recommendation to avoid bed-sharing but to endorse room-sharing is expected, according to the AAP, to decrease the risks of SIDS and unintentional suffocation in comparison to bed-sharing and solitary arrangements [10]. However, empirical evidence showing that the rates of SIDS in room-sharing infants are lower than in independent sleeping arrangements after the age of 6 months is lacking [11]. Besides the SIDS controversy, another source of disagreement in the literature on sleeping arrangements relates to the impact of cosleeping on infant sleep quality. Most studies, relying mainly on subjective measures of sleep, report more sleeping problems in bed-sharing infants than in solitary-sleeping infants [12–15]. However, the implications of room-sharing (without bed-sharing) on infants' and parents' sleep have almost not been studied, especially not during the second half of the infant's first year. This is an important question to study in light of the AAP latest recommendations to keep the infant in the parents' room beyond the age of 6 months. The few studies, which have examined the sleep patterns of room-sharing infants, found room-sharing to be associated with more disturbed infant sleep and shorter infant sleep duration as reported by the parents [11, 16, 17]. However, no significant differences in infant sleep quality were found when objective measures (i.e. actigraphy) were used to assess sleep [16, 17].

Although, as suggested by the AAP policy statement, room-sharing may facilitate nighttime caregiving (e.g. feeding, monitoring, and soothing), it is unclear whether the presence of the infant in the parent's room may affect parental sleep quality. This question, which has received only scarce attention, is of importance because maternal sleep disturbances in the postpartum have been associated with maternal mood problems [18–21] and with more impaired mother–infant bonding [22, 23]. Two recent studies which have examined maternal sleep quality in cosleeping (mostly room-sharing) and solitary-sleeping mothers found that cosleeping mothers had significantly more disturbed sleep assessed both objectively and subjectively [16, 17].

Additional findings suggest that there are also differences in maternal distress as a function of sleeping arrangements.

Higher levels of maternal depressive and stress symptoms and lower marital adjustment have been reported in bed-sharing mothers compared with solitary-sleeping mothers [24–26], even though these links might be partially moderated by ethnicity [5, 14, 27]. To the best of our knowledge, only one study has examined parental correlates of room-sharing versus solitary-sleeping arrangements. This study demonstrated that mothers in persistent room-sharing arrangements reported higher levels of marital and co-parenting distress compared with mothers who stopped cosleeping by 6 months and mothers who never coslept [16].

The role fathers have in relation to sleeping arrangements is another topic that has received only minimal scientific attention [5]. Higher levels of paternal involvement in early childhood caregiving have been associated with more consolidated sleep in children and mothers [28–30], but it is unknown whether paternal involvement differs as a function of sleeping arrangement.

Overall, previous studies provide initial evidence for the existence of complex links among mother–infant sleep, parental functioning, and sleeping arrangements, but clearly more research is needed to understand the characteristics of these links. Accordingly, the main objectives of the current study were (1) to examine longitudinally sleep patterns of both infants and mothers in room-sharing and solitary-sleeping arrangements with objective and subjective means in the context of a longitudinal design ending at 18 months postpartum. We hypothesized that room-sharing mothers would (a) demonstrate more disturbed objective and subjective sleep than solitary-sleeping mothers and (b) report more infant night-wakings than solitary-sleeping mothers. However, in line with previous findings [16, 17], we did not expect to find differences in objective infant sleep quality. (2) Our second primary aim was to examine whether parental factors that have previously been linked to the development of infant sleep consolidation [4, 18, 29, 31] would differ as a function of sleeping arrangements. Specifically we focused on general maternal emotional distress (depressive and anxiety symptoms), infant-related maternal emotional distress (maternal separation anxiety), and paternal involvement in infant caregiving. We expected to find higher levels of maternal emotional distress and lower levels of fathers' caregiving involvement in room-sharing families compared with solitary-sleeping families.

We explored differences in mother–infant sleep patterns and parenting factors as a function of sleeping arrangements cross-sectionally at each age point (3, 6, 12, and 18 months). In addition, taking advantage of our longitudinal design, we looked at the trajectories of mother-infant sleep and of parental factors from 3 to 18 months and examined whether they differed between persistent room-sharing families and persistent solitary-sleeping families. Because breastfeeding has strongly been associated with both cosleeping [5, 14] and infant sleep problems [32, 33], we assessed nighttime breastfeeding (NBF) in relation to sleeping arrangements and sleep quality and included it as a covariate.

Methods

Participants

One hundred eighty-eight married Israeli couples expecting their first child were recruited during pregnancy through

prenatal courses and announcements on internet forums for expectant parents. Only two-parent families with a singleton full-term pregnancy and a healthy infant (by self-report) participated in the study. Of the 188 families recruited, 14 dropped out from the study at the 3 months assessment point, 12 withdrew from the study at 6 months, 16 discontinued their participation at 12 months, and 8 families dropped out at 18 months. The main reasons for discontinuation were lack of willingness to participate, overload, moving abroad, and medical problems. The families who withdrew from the study were compared with the participating families on sociodemographic variables (e.g. age and education of both parents). No differences were found on any of these variables.

Demographic characteristics were collected during the third trimester of pregnancy. Mothers were between 21 and 47 years old ($M = 28.98$, $SD = 3.23$) and fathers were between 22 and 64 years old ($M = 31.94$, $SD = 7.23$; four percent of the fathers [$N = 7$] were above the age of 50). Average maternal education was 15.80 years ($SD = 1.95$) and average paternal education was 15.19 years ($SD = 2.19$). The ethnic background of the participants was quite homogenous: all participants were Jewish, and the majority were secular (except for a few modern religious families). Eighty percent of the mothers and 78% of the fathers were born in Israel, and 12% of the mothers and 10% of the fathers were born in the former Soviet Union. The rest of the participants were born in various countries. The average number of rooms in the parents' home (a proxy of socioeconomic status) was 3.32 ($SD = 0.92$).

Procedures

The study was approved by a hospital's Helsinki committee. All parents signed informed consent before the first study assessment. The results presented in this study are based on four assessment points (3, 6, 12, and 18 months postpartum). At each assessment, a research assistant visited the participants at their home and instructed them about the study procedures (e.g. actigraphy use, questionnaires, and diaries completion). The Hebrew language was used for all questionnaires. Maternal and infant sleep were assessed for five nights (excluding weekends) using actigraphy and sleep diaries. Sleep was assessed only on days when a regular routine was maintained (e.g. infant and mother fell asleep at home). After completing the assessments, participants received a small gift (value of about 20$) and a graphic report of the infant's and the mother's actigraphic sleep.

Measures

Infant sleeping arrangement

One item from the Brief Infant Sleep Questionnaire (BISQ) [34] was used at each assessment point to obtain information from parents about infants' sleeping arrangements. On each postpartum assessment point, mothers were asked to indicate where the infant slept during the night: (1) infant crib in a separate room; (2) infant crib in the parent's room; and (3) parents' bed. Only a small number of infants ($N = 9$ at 3 months, $N = 11$ at 6 months, $N = 15$ at 12 months, and $N = 13$ at 18 months) were sharing the same bed with their parents. As there were no significant differences for the sleep measures (except for infant

longest sleep period and maternal night-wakings at 3 months) between bed-sharing and room-sharing (without bed-sharing) families, we combined these two groups into one group referred to as "room-sharing" families without further distinction in the analyses. Sleeping arrangement distribution across phases is presented in Figure 1.

Complete sleeping arrangement data were available for 136 families. To examine the longitudinal patterns of sleep as a function of sleeping arrangements, we classified these families into two sleeping arrangement categories: persistent solitary sleeping (infant slept in a separate room on at least three out of four assessment points, $n = 66$) and persistent room-sharing (infants sharing their parents' room on at least three assessment points, $n = 42$). Five families were persistent bed-sharers. These families were included in the persistent room-sharing group (we repeated all our analyses without these five families to examine whether the room-sharing participants influence the results, but the findings were similar when these families were excluded). We examined whether any of the sociodemographic variables (i.e. maternal and paternal age and education, country of birth, and number of rooms at home) differed between these groups. No significant differences were found. There were additional 28 families who could not be classified into one of the two persistent groups because they showed varied sleeping arrangement patterns (e.g. families showing an inconsistent pattern moving back and forth between the sleeping arrangements). None of the sociodemographic variables accounted for membership in this group. Because we were mainly interested in comparing the groups that demonstrated distinct persistent sleeping arrangement patterns, and because the 28 families who were not included in these two groups showed varied patterns that created multiple small subsamples, we conducted our trajectories analyses only on the two main persistent (solitary and room-sharing) groups.

Infant and maternal sleep

Actigraphy

Actigraphy is a reliable and valid method for the assessment of sleep–wake patterns in infants, children, and adults [35–37]. The actigraph is a watch-like device, which continuously registers body motility data that are translated to sleep–wake measures based on a computerized scoring algorithm. The main advantage of actigraphy is that it provides an objective assessment of
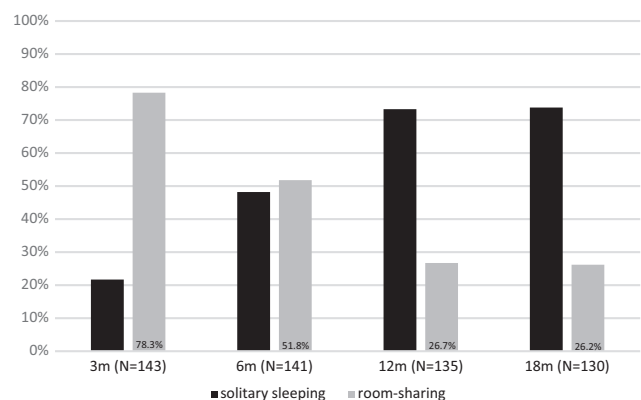

Figure 1. Distribution of sleeping arrangement across assessments.

sleep–wake patterns for prolonged periods in the participants' natural sleep environment. In the present study, we used the micromotion logger sleep watch (Ambulatory Monitoring, Inc., Ardsley, NY) with a 1 min epoch interval according to the standard working mode for sleep–wake scoring. The Actigraphic Sleep Analysis (ASA) program was used to score the data based on Sadeh's validated scoring algorithm for infants [38] and adults [37]. Mothers were asked to wear the actigraph on their wrist and to attach it to their infants' ankle 15 min before they went to sleep and to remove it 15 min after they woke up. The measures included in the present study were as follows: (1) Night-Wakings—number of night-wakings lasting at least 5 min; (2) Sleep Percent—percentage of true sleep time (excluding night-time wakefulness) from total sleep period (from sleep onset to morning wake-up time); (3) Longest Sleep Period—longest sleep period without fragmentation (of more than 5 min) during the night; and (4) Sleep Minutes—true sleep time. Actigraphy data were obtained for 136 infants and 140 mothers at 3 months; 135 infants and 138 mothers at 6 months; 120 infants and 130 mothers at 12 months; and 111 infants and 119 mothers at 18 months. The main reasons for actigraphic missing data were technical problems or mothers' refusal to attach the actigraph.

Sleep diaries

Mothers were asked to complete a sleep diary of their own [39] and their infant's [40] sleep schedules and night-wakings. These diaries were completed in the morning following each assessment night and were used mainly to detect possible actigraphy artifacts and errors. In addition, we included the number of maternal and infant night-wakings (Diary Night-Wakings) in the analyses of the present study as a measure of reported sleep fragmentation.

Parental functioning

Maternal emotional distress

The Edinburgh Postnatal Depression Scale (EPDS) [41, 42] and the Beck Anxiety Inventory (BAI) [43] were used to assess general maternal emotional distress. The EPDS is a widely used screening tool for postpartum depression. It consists of 10 short statements addressing maternal depressive symptoms during the past week. Higher scores indicate higher maternal depressive symptoms. In the present sample, Cronbach's α ranged from 0.77 to 0.80 for the four assessment points. The BAI was used to assess maternal anxiety symptoms. This well-validated questionnaire consists of 21 questions asking about physiological and cognitive aspects of anxiety with regards to the last week. In our study, Cronbach's α ranged from 0.74 to 0.84 for the four assessment points. Maternal EPDS and BAI scores were highly correlated in our sample (3 months $r = .63$; 6 months $r = .64$; 12 months $r = .67$; 18 months $r = .62$) Hence, for the purpose of the present study, we averaged the standard scores of EPDS and BAI, thus creating a general Maternal Emotional Distress score. This score was used in all relevant analyses.

Maternal separation anxiety

The Maternal Separation Anxiety Questionnaire (MSAQ) [44] was used to examine maternal anxiety that is specifically related to parenting. The MSAQ includes 35 items designed to measure (1) maternal separation anxiety, which reflects the mother's distress when separated from her child, (2) maternal perceptions regarding her infant's reaction to separation, and (3) employment-related separation concerns. In the present study, we used the total average score of the 35 items. Higher scores represent higher maternal separation anxiety. The Cronbach's α of the total score ranged from 0.83 to 0.91 for the four assessment points.

Parental involvement in infant caregiving

The Parental Involvement Questionnaire (PIQ) [28] was used to assess the relative degree of maternal and paternal involvement in infant caregiving. Both mothers and fathers completed the PIQ, which includes 10 different infant-care tasks (e.g. feeding, bathing, playing, putting to sleep, and nighttime caregiving). Each parent is asked to rate his or her degree of involvement relative to his or her partner in each task, on a 7-point Likert-type scale (e.g. "Who usually feeds the infant?" From 1 = only the mother to 7 = only the father). This questionnaire was validated before and good internal reliability, based on Cronbach's α of 0.80, was found for both parents' scales [28]. Two involvement scores were calculated for each parent for the purpose of the present study: (1) Overall Parental Involvement score, based on nine items (excluding the nighttime caregiving item); (2) Nighttime Parental Involvement score, based on the nighttime caregiving item ("who usually approaches the infant during the night when he or she wakes up or cries"). Higher scores represent a relatively higher involvement of fathers. In the present study, the scores of fathers and mothers were highly correlated at all assessment points ($.70 < r < .85$), and therefore, we calculated averaged scores for each pair of parents, at every assessment point.

Background questionnaires

Parents completed background questionnaires to collect sociodemographic and developmental data such as parental age, education, employment (completed during pregnancy), infant gender, child care arrangements (home, babysitter, and daycare), and medical problems. NBF was assessed with one question asking the mother to indicate how often she uses breastfeeding to sooth the infant during the night on a 5-point scale ranging from 1 (never) to 5 (frequently).

Statistical Analyses

To examine the cross-sectional differences in maternal and infant sleep between room-sharing and solitary-sleeping families, we conducted Multivariate Analysis of Covariance (MANCOVA), with group (sharing vs. solitary) as the independent variable, sleep measures as the dependent variables, and NBF report as the covariate. To test whether the two persistent sleep arrangement groups (solitary and room-sharing) showed different trajectories of maternal and infant sleep development from 3 to 18 months, we ran a series of 3-level growth multilevel models (MLMs) [45] in which days were nested within phases which themselves were nested within participants. This approach allowed us to take into account the nested structure of the data as well as to adjust for missing data (thus to include all available assessments). In the MLMs, we used daily data measures, and for cross-sectional analyses, each measure was averaged across the monitoring phase.

To examine whether there are significant cross-sectional differences in Maternal Emotional Distress, Maternal Separation Anxiety, and Paternal Overall and Nighttime Involvement in infant care between room-sharing and solitary-sleeping families, we conducted one-way MANCOVAs while controlling for NBF. To test whether parental functioning (Emotional Distress, Maternal Separation Anxiety, and Paternal Overall Involvement and Nighttime Involvement) in persistent room-sharing families showed different trajectories in comparison to persistent solitary-sleeping families from 3 to 18 months, we ran a series of 2-level growth MLMs in which phases were nested within families.

Study analyses were conducted on data of families for which we had at least three assessment points ($N = 146$ at 3 months postpartum, $N = 141$ at 6 months, $N = 135$ at 12 months, and $N = 130$ at 18 months).

Results

Preliminary analyses

Correlations between background variables and main study variables

Nighttime breastfeeding (NBF). Independent sample t tests were conducted to examine whether there are differences in the use of NBF between solitary-sleeping and room-sharing families. Significantly higher level of NBF in room-sharing families compared with solitary-sleeping families was found at 6 [$t(130) = 2.97$, $p = .003$], 12 [$t(119) = 15.78$, $p = .002$], and 18 months [$t(120) = 4.73$, $p = .030$]. Pearson correlations were calculated to examine whether NBF was associated with any of the sleep measures. Higher levels of NBF were consistently associated with more disturbed maternal and infant sleep at 6, 12, and 18 months. For instance, at 12 months, NBF was significantly correlated with more maternal Actigraphic Night-Wakings ($r = .386$, $p < .001$), lower maternal Sleep Percent ($r = -.266$, $p = .004$), higher maternal Diary Night-Wakings ($r = .316$, $p < .001$), lower infant's Longest Sleep Period ($r = -.211$, $p = .029$), higher infant's Actigraphic Night-Wakings ($r = .202$, $p = .036$), and Diary Night-Wakings, ($r = .384$, $p < .001$). Pearson correlations were also calculated to examine whether NBF was associated with the parenting measures. Higher levels of NBF were associated with higher Maternal Separation Anxiety at 3 months ($r = .246$, $p = .004$) and at 12 months ($r = .280$, $p = .002$), with lower Paternal Overall Involvement at 6 months ($r = -.193$, $p = .031$) and at 12 months ($r = -.307$, $p = .001$), and with lower Nighttime Paternal Involvement at 3 months ($r = -.215$, $p = .012$), 6 months ($r = -.415$, $p < .001$), 12 months ($r = -.325$, $p < .001$), and 18 months ($r = -.266$, $p = .003$). Because NBF was consistently associated with sleeping arrangements, with maternal and infant sleep measures, and with some of the parenting factors, we controlled for NBF in all further analyses. All analyses were repeated without controlling for NBF. Since all findings remained similar, we report only the finding controlling for NBF.

Pearson correlations were also calculated to examine whether any of the background variables (e.g. maternal and paternal age and education) were associated with the sleep measures or with the parental functioning measures. There were no significant consistent correlations (i.e. only few sporadic correlations) between these variables and the main study variables. Thus, NBF was the only variable controlled for in subsequent analyses.

Maternal and infant sleep in room-sharing and solitary-sleeping families

Cross-sectional comparison

One way MANCOVAs, controlling for NBF, were conducted to examine differences in maternal and infant sleep measures (Actigraphic Night-Wakings, Sleep Percent, Longest Sleep Period, Sleep Minutes, and Diary Night-Wakings) between room-sharing and solitary-sleeping mother–infant dyads at each assessment point (Tables 1 and 2).

Maternal sleep. At 3 months, the MANCOVA (including the five sleep measures) was significant [$F(5, 124) = 2.40$, $p = .040$]. Follow-up ANCOVAs revealed that room-sharing mothers had significantly lower Sleep Percent than solitary-sleeping mothers. No significant difference was found between the groups for the other sleep measures. At 6 and 12 months, the MANCOVA was significant [$F(5, 117) = 5.24$, $p < .001$; $F(5, 108) = 3.07$, $p = .012$, respectively] with follow-up ANCOVAs revealing that there were significant differences in maternal Actigraphic Night-Wakings, Sleep Percent, Longest Sleep Period, and Diary Night-Wakings between room-sharing mothers and solitary-sleeping mothers. These differences demonstrated poorer sleep in room-sharing mothers. At 18 months, the MANCOVA was not significant [$F(5, 103) = 1.15$, $p = .357$; see Table 1 for a detailed description].

Infant sleep. At 3 months, the MANCOVA was not significant [$F(5, 120) = 0.89$, $p = .490$]. At 6 months, the MANCOVA was significant [$F(5, 114) = 4.03$, $p = .002$]. Follow-up ANCOVAs revealed more Actigraphic Night-Wakings and Diary Night-Wakings in room-sharing infants compared with solitary-sleeping infants. At 12 months, the MANCOVA was significant [$F(5, 99) = 3.65$, $p = .005$] and follow-up ANCOVAs revealed shorter Longest Sleep Period and more Diary Night-Wakings in room-sharing infants. At 18 months, the MANCOVA was not significant [$F(5, 95) = 1.95$, $p = .093$; see Table 2 for a detailed description].

Longitudinal comparison: sleep development trajectories in persistent solitary-sleeping and persistent room-sharing families

To test whether the two sleeping arrangement groups showed different trajectories of maternal and infant sleep development from 3 to 18 months, we ran a series of 3-level growth MLMs. The generic model's equations were as follows:

$$\text{Level 1:} \quad \text{Sleep}_{ijk} = \pi_{0jk} + e_{ijk}$$

$$\text{Level 2:} \quad \pi_{0jk} = \beta_{00k} + \beta_{01k} * \text{Time}_{jk} + \beta_{02k} * \text{Time}^2_{jk} + r_{0jk}$$

$$\text{Level 3:} \quad \beta_{00k} = \gamma_{000} + \gamma_{001} * \text{Group}_k + u_{00k};$$

$$\beta_{01k} = \gamma_{010} + \gamma_{011} * \text{Group}_k + u_{01k};$$

$$\beta_{02k} = \gamma_{020} + \gamma_{021} * \text{Group}_k + u_{02k};$$

where the sleep measure for day i from phase j for subject k was modeled at level 1 as a function of the subject's sleep mean at this

Table 1. ANCOVA tests (controlling for NBF) comparing **maternal** sleep measures between room-sharing and solitary-sleeping families at 3, 6, 12, and 18 months

	Maternal sleep							
	Total		Solitary-sleeping		Room-sharing			
	Mean (SD)	$N^{\dagger}$	Mean (SD)	N	Mean (SD)	N	F (df)	Partial η^2
Three months								
Night-Wakings	3.07 (1.29)	131	2.56 (1.56)	28	3.20 (1.19)	103	3.00 (1,128)	.045
Sleep Percent	86.04 (5.64)	131	88.92 (4.82)	28	85.25 (5.6)	103	4.98 (1,128)*	.072
Longest Sleep Period	147.92 (46.25)	131	161.79 (57.88)	28	144.08 (42.16)	103	2.04 (1,128)	.031
Sleep Minutes	390.56 (57.80)	131	386.59 (58.62)	28	391.92 (57.77)	103	.14 (1,128)	.002
Night-Wakings (Diary)	2.88 (1.33)	131	2.49 (1.49)	28	2.98 (1.27)	103	1.87 (1, 128)	.028
Six months								
Night-Wakings	2.78 (1.39)	124	2.12 (1.22)	60	3.41 (1.25)	64	22.76 (1, 121)***	.273
Sleep Percent	89.16 (5.03)	124	91.31 (4.90)	60	87.15 (4.22)	64	18.57 (1, 121)***	.235
Longest Sleep Period	153.76 (49.13)	124	171.83 (53.64)	60	136.83 (37.59)	64	10.26 (1, 121)***	.145
Sleep Minutes	381.90 (48.10)	124	383.45 (47.79)	60	380.45 (48.73)	64	.179 (1, 121)	.003
Night-Wakings (Diary)	2.84 (1.49)	124	2.28 (1.53)	60	3.37 (1.25)	64	12.67 (1, 121)***	.173
Twelve months								
Night-Wakings	2.08 (1.18)	115	1.80 (1.00)	84	2.84 (1.34)	31	15.77 (1, 112)***	.220
Sleep Percent	90.91 (4.97)	115	91.91 (4.67)	84	88.07 (4.93)	31	9.01 (1, 112) ***	.139
Longest Sleep Period	170.61 (65.01)	115	183.50 (68.15)	84	135.71 (36.69)	31	7.02 (1, 112)**	.111
Sleep Minutes	388.63 (43.96)	115	392.80 (45.89)	84	377.34 (38.82)	31	1.45 (1, 112)	.025
Night-Wakings (Diary)	2.25 (1.63)	115	1.96 (1.30)	84	3.04 (2.13)	31	8.89 (1, 112)***	.137
Eighteen months								
Night-Wakings	1.99 (1.35)	110	1.80 (1.20)	82	2.54 (1.50)	28	8.52 (1, 107) ***	.137
Sleep Percent	91.94 (5.35)	110	92.55 (5.11)	82	90.15 (5.66)	28	7.84 (1, 107)**	.128
Longest Sleep Period	175.87 (69.43)	110	182.01 (73.18)	82	154.76 (52.52)	28	3.34 (1, 107)*	.059
Sleep Minutes	384.61 (45.22)	110	385.76 (43.88)	82	381.26 (49.61)	28	1.35 (1, 107)	.025
Night-Wakings (Diary)	1.89 (1.09)	110	1.78 (0.99)	82	2.21 (1.31)	28	2.85 (1, 107)	.051

Night-Wakings = number of actigraphic night-wakings lasting at least 5 min; Sleep Percent = percentage of true sleep time (excluding nighttime wakefulness) from total sleep period; Longest Sleep Period = longest sleep episode without fragmentation during the night; Sleep Minutes = true sleep time; Night-Wakings (Diary) = number of diary night-wakings.
*$p < .05$, **$p < .005$; ***$p < .001$.
†The N's on which these analyses are based represent the number of mothers for which we had sleep and NBF data. The N is somewhat lower than the N described in Measures (Actigraphy) because of missing NBF data.

phase (π_{0jk}) plus a residual term quantifying the specific-day deviation from this mean (e_{ijk}). At level 2, the time effects were introduced. Specifically, the time variable was rescaled into 3-month units which were then centered (3 months = −2.5, 6 months = −1.5, 12 months = 1.5, 18 months = 2.5), and then its linear and quadratic forms were included as level-2 predictors; thus, at level 2, the subject's sleep mean at this phase was modeled as a function of the linear (β_{01k}) and quadratic (β_{02k}) effects of Time, plus a level-2 residual term quantifying the specific phase-deviation for this subject (r_{0jk}). At level 3, the Group effect as well as the Group × Time and Group × Time^2 interaction effects were introduced; thus, at level 3, the sleep of subject k was modeled as a function of the sample's intercept (γ_{000}), and Time effects (γ_{010}, γ_{020}), plus the deviation of this subject's Group from the sample's intercept (γ_{001}), and Time effects (γ_{011}, γ_{021}), plus residual terms quantifying the deviation of this subject from his or her Group's intercept (u_{00k}), and Time effects (u_{01k}, u_{02k}). The Group variable was effect coded (−0.5 = solitary sleep, 0.5 = room-sharing).

Maternal sleep. The fixed effects from the growth MLMs for mothers are presented in Table 3. As the table shows, for the Actigraphic Night-Wakings variable, we found a significant

Group effect, indicating lower number of Actigraphic Night-Wakings for persistent solitary-sleeping mothers across all phases. We also found a significant Time effect, indicating a linear decrease in Actigraphic Night-Wakings over Time (Figure 2A). No significant interactions between group and the time effects were found. For the Sleep Percent variable, we found significant Time and Time^2 effects, as well as a significant Time^2 × Group interaction. Simple slope analysis revealed that whereas for the solitary-sleeping group the Time^2 effect was negative and significant ($b = −0.40$, SE = 0.11, $p < .001$), for the room-sharing group no significant effect was found ($b = −0.03$, SE = 0.13, $p = .636$). Indeed, as Figure 2B shows, in the solitary-sleeping group, Sleep Percent was higher at all assessment points, and solitary-sleeping mothers reached their optimal Sleep Percent levels at 12 months. In contrasts, in the room-sharing group, Sleep Percent increased linearly during the first 18 months postpartum. For the Longest Sleep Period variable, we found significant Time and Group effects, as well as a significant Time^2 × Group interaction. Simple slope analysis revealed that whereas for the solitary sleeping group the Time^2 effect was negative and significant ($b = −1.96$, SE = 0.98, $p = .049$), for the room-sharing group no significant

Table 2. ANCOVA tests (controlling for NBF) comparing **infant** sleep measures between room-sharing and solitary-sleeping families at 3, 6, 12, and 18 months

	Infant sleep							
	Total		Solitary-sleeping		Room-sharing			
	Mean (SD)	N[†]	Mean (SD)	N	Mean (SD)	N	F(df)	Partial η²
Three months								
Night-Wakings	2.82 (1.20)	127	2.67 (1.29)	27	2.85 (1.18)	100	.251 (1, 124)	.004
Sleep Percent	91.81 (4.00)	127	92.44 (3.27)	27	91.64 (4.18)	100	.483 (1, 124)	.008
Longest Sleep Period	253.01 (83.78)	127	263.74 (89.75)	27	250.11 (82.45)	100	.429 (1, 124)	.007
Sleep Minutes	557.43 (83.89)	127	536.52 (95.08)	27	563.07 (81.40)	100	1.226 (1, 124)	.019
Night-Wakings (Diary)	2.24 (1.17)	127	1.99 (1.23)	27	2.31 (1.14)	100	.993 (1, 124)	.016
Six months								
Night-Wakings	2.25 (1.30)	121	2.01 (1.24)	59	2.47 (1.34)	62	3.35 (1, 118)*	.054
Sleep Percent	93.58 (3.32)	121	94.11 (3.35)	59	93.07 (3.30)	62	1.95 (1, 118)	.032
Longest Sleep Period	234.40 (81.32)	121	249.45 (79.12)	59	220.09 (83.98)	62	2.01 (1, 118)	.033
Sleep Minutes	579.86 (75.83)	121	593.04 (70.78)	59	567.35 (78.90)	62	1.877 (1, 118)	.032
Night-Wakings (Diary)	2.67 (1.50)	121	2.03 (1.44)	59	3.28 (1.31)	62	14.42 (1, 118)***	.196
Twelve months								
Night-Wakings	1.65 (1.14)	106	1.55 (1.08)	80	1.92 (1.28)	26	2.97 (1, 103)	.055
Sleep Percent	95.41 (3.16)	106	95.71 (2.83)	80	94.47 (3.92)	26	2.06 (1, 103)	.038
Longest Sleep Period	271.57 (90.73)	106	286.17 (85.44)	80	226.63 (93.44)	26	5.35 (1, 103)*	.094
Sleep Minutes	594.17 (57.30)	106	596.67 (47.08)	80	586.47 (46.34)	26	1.19 (1, 103)	.023
Night-Wakings (Diary)	2.05 (1.26)	106	1.75 (1.12)	80	2.98 (1.26)	26	14.16 (1, 103)***	.216
Eighteen months								
Night-Wakings	1.11 (0.91)	102	1.16 (0.97)	79	.94 (0.65)	23	.585 (1, 99)	.012
Sleep Percent	97.05 (2.40)	102	96.95 (2.25)	79	97.42 (1.81)	23	.779 (1, 99)	.016
Longest Sleep Period	316.94 (97.15)	102	318.54 (97.10)	79	311.44 (99.33)	23	.058 (1, 99)	.001
Sleep Minutes	580.47 (80.67)	102	577.15 (81.98)	79	591.88 (76.65)	23	.494 (1, 99)	.010
Night-Wakings (Diary)	1.40 (0.99)	102	1.27 (0.89)	79	1.86 (1.17)	23	3.35 (1, 99)*	.063

Night-Wakings = number of actigraphic night-wakings lasting at least five minutes; Sleep Percent = percentage of true sleep time (excluding nighttime wakeful-ness) from total sleep period; Longest Sleep Period = longest sleep episode without fragmentation during the night; Sleep Minutes = true sleep time; Night-Wakings (Diary) = number of diary night-wakings.

*$p < .05$; **$p < .005$; ***$p < .001$.

[†]The N's on which these analyses are based represent the number of infants for which we had sleep and NBF data. The N is somewhat lower than the N described in Measures (Actigraphy) because of missing NBF data.

effect was found ($b = 1.51$, $SE = 1.20$, $p = .212$). Indeed, as Figure 2C shows, in the solitary-sleeping group, mothers' Longest Sleep Period was longer across all phases and it reached its optimal levels by 12 months postpartum. In contrast, in the room-sharing group, the levels of Longest Sleep Period continued to increase until 18 months postpartum. For the Sleep Minutes variable (Figure 2D), there were no significant effects. For the Diary Night-Wakings variable, we found significant Time and Time² effects, as well as a significant Group effect. As Figure 2E shows, in both groups the number of Diary Night-Wakings decreased over time. However, in the room-sharing group, the levels of Diary Night-Wakings were higher across all phases.

Infant sleep. The fixed effects from the growth MLMs for infants are presented in Table 4. As the table shows, for the Actigraphic Night-Wakings and Sleep Percent variables, we found only a significant Time effect indicating overall improvement (decrease in Night-Wakings and increase in Sleep Percent) for infants' sleep over time (Figure 3A and B) without group differences. For the Longest Sleep Period variable, we found significant Time, Time², and Group effects indicating on average higher Longest Sleep Period for solitary-sleeping infants. Both groups showed a quadratic sleep consolidation pattern, which reached its highest level at 18 months (Figure 3C). For the Sleep Minutes variable, we found significant Time and

Time² effects indicating overall increase in infant's sleep min-utes over time without group differences as demonstrated in Figure 3D. For the Diary Night-Wakings variable, we found sig-nificant Time, Time², and a significant Time² × Group effects. Simple slope analysis revealed that whereas for the solitary-sleeping group the Time² effect was not significant ($b = -0.04$, $SE = 0.03$, $p = .121$), for the room-sharing group it was nega-tive and significant ($b = -0.13$, $SE = 0.03$, $p = .001$). Indeed, as Figure 3E shows, in the solitary-sleeping group, Diary Night-Wakings were lower across all assessment points compared with the room-sharing group. The Diary Night-Wakings vari-able was stable from 3 to 6 months and then decreased from 6 months to 18 months. However, in the room-sharing group, a quadratic pattern of change emerged: specifically, the Diary Night-Wakings variable increased from 3 to 6 months, it was then stable from 6 to 12 months, and finally, decreased from 12 to 18 months.

Differences between room-sharing and solitary-sleeping families in parenting functioning

Cross-sectional differences

One-way MANCOVA, examining differences in parental meas-ures as a function of sleeping arrangements was significant at 3 months [$F(2,125) = 2.89$, $p = .025$]. Follow-up ANCOVAs,

Table 3. Fixed effects estimates (SE) from the growth MLM for mothers

	Night-Wakings	Sleep Percent	Longest Sleep Period	Sleep Minutes	Night-Wakings (Diary)
Intercept	2.47 (0.11)***	90.15 (0.44)***	158.22 (5.26)***	389.21 (4.35)***	2.62 (0.13)***
Group	1.28 (0.23) ***	−4.86 (0.89)***	−47.57 (10.52)***	−2.79 (8.71)	.98 (0.26)***
Time	−0.20 (0.04)***	1.00 (0.14)***	3.98 (1.23)**	−0.58 (1.12)	−.25 (0.03)***
Time × Group	0.00 (0.07)	−0.11 (0.28)	−4.51 (2.47)	−2.74 (2.24)	−.01 (0.06)
Time^2	0.03 (0.02)	−0.21 (0.09)*	−0.22 (0.78)	−0.21 (0.69)	−.07 (0.02)***
Time^2 × Group	−0.09 (0.05)	0.37 (0.17)*	3.46 (1.55)*	1.07 (1.37)	−.05 (0.04)

Night-Wakings = number of actigraphic night-wakings lasting at least 5 min; Sleep Percent = percentage of true sleep time (excluding nighttime wakefulness) from total sleep period; Longest Sleep Period = longest sleep episode without fragmentation during the night; Sleep Minutes = true sleep time; Night-Wakings (Diary) = number of night-wakings according to diary report.
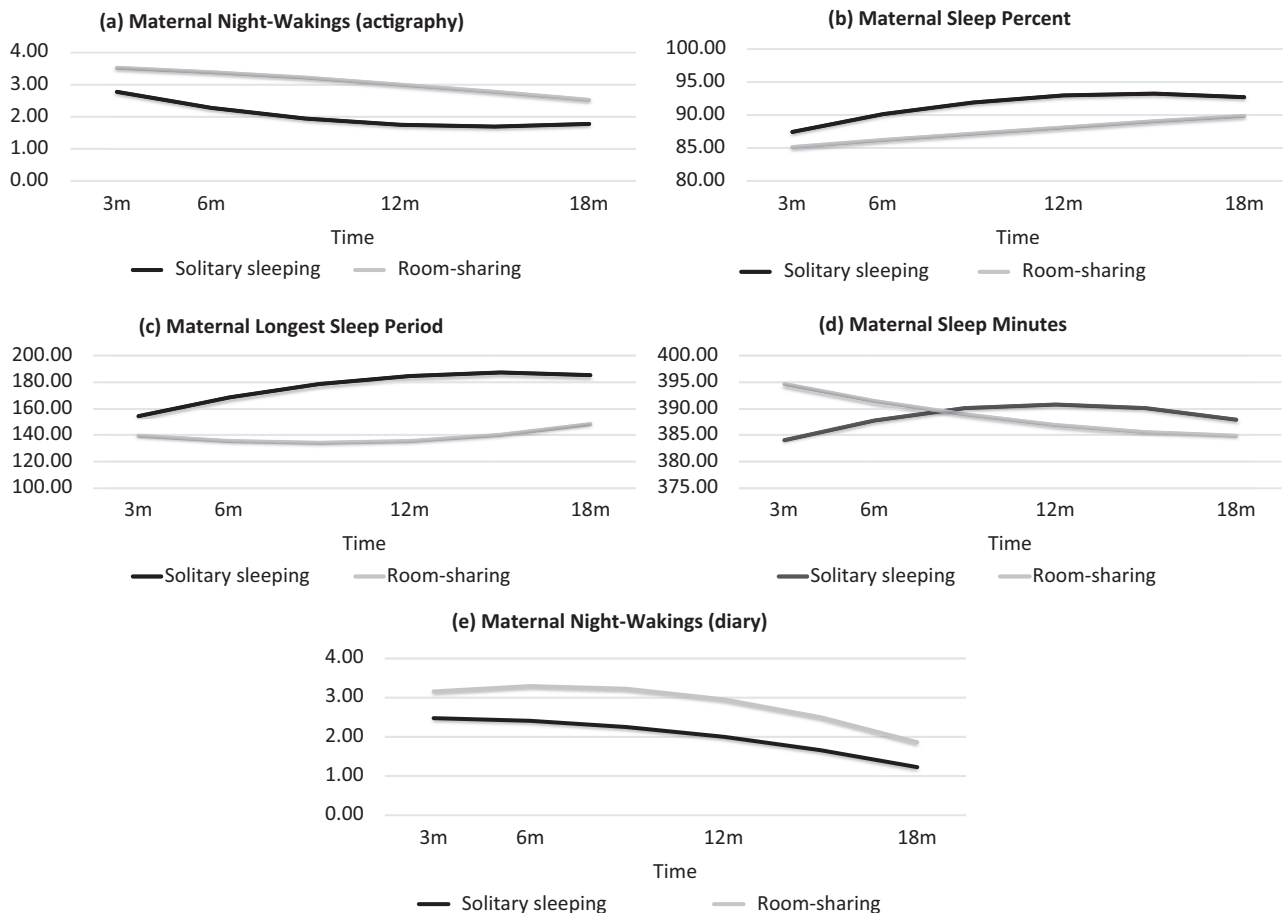*$p < .05$; **$p < .005$; ***$p < .001$.

Figure 2. Maternal sleep trajectories by Group: solitary-sleeping (*N* = 66) and room-sharing (*N* = 42).

controlling for NBF, revealed lower Maternal Emotional Distress, lower Maternal Separation Anxiety, and higher Paternal Nighttime Involvement for solitary-sleeping families compared with room-sharing families at 3 months. At 6 months, the MANCOVA was not significant [*F*(4, 120) = 2.03, *p* = .09]. At 12 months, the MANCOVA was significant [*F*(4, 101) =2.47, *p* = .049]. Follow-up ANCOVAs indicated lower Maternal Separation Anxiety levels and higer Paternal Overall and Nighttime Involvement in solitary-sleeping families. At 18 months, the overall MANCOVA was again significant [*F*(4, 101) = 2.76, *p* = .031]. Follow-up ANCOVAs revealed higher Paternal Nighttime Involvement for solitary-sleeping families compared with room-sharing families (Table 5).

Trajectories of parental functioning for persistent solitary-sleeping and persistent room-sharing families

To test whether the two sleeping arrangement groups showed different trajectories of parenting measures from 3 to 18 months postpartum, we ran a series of 2-level growth MLMs in which phases were nested within subjects.

The generic model's equations were as follows:

$$\text{Level 1: } \text{Outcome}_{ij} = \beta_{0j} + \beta_{1j} * \text{Time}_{ij} + \beta_{2j} * \text{Time}^2_{ij} + e_{ij}$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + \gamma_{01} * \text{Group}_j + u_{0j};$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11} * \text{Group}_j + u_{1j};$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}^* \text{Group}_j + u_{2j};$$

where the outcome measure for phase i for subject j was modeled at level 1 as a function of the subject's intercept, linear effect of time, and the quadratic effect of time, and a level-1 residual quantifying the specific-phase deviation from these effects. At level 2, the Group effect as well as the Group × Time and Group × Time^2 interaction effects were introduced; thus, at level 2, the outcome of subject j was modeled as a function of the sample's intercept (γ_{00}), and Time effects (γ_{10}, γ_{20}), plus the deviation of this subject's Group from the sample's intercept (γ_{01}), and Time effects (γ_{11}, γ_{21}), plus residual terms quantifying the deviation of this subject from their Group's intercept (u_{0j}), and time effects (u_{1j}, u_{2j}).

The fixed effects from the growth MLMs for parental measures are presented in Table 6. For Maternal Emotional Distress, we found only a quadratic time effect indicating a decrease in Maternal Emotional Distress levels from 3 to 12 months, and an increase in Maternal Emotional Distress levels from 12 to 18 months for both Groups (Figure 4A). For Maternal Separation Anxiety, we found a significant Group effect, indicating lower levels of Maternal Separation Anxiety for solitary-sleeping mothers across all phases. We also found a significant Time effect as well as a significant Time × Group interaction. Simple slope analysis revealed that the linear effect was negative and significant for both the room-sharing group ($b = -0.09$, SE = 0.01, $p < .001$) and the solitary-sleeping group ($b = -0.06$, SE = 0.01, $p < .001$). However, as Figure 4B shows, mothers in the room-sharing group showed greater decline over time in Separation Anxiety. For Paternal Overall Involvement, we found significant Time and Group effects. As Figure 4C shows, Paternal Overall Involvement levels were significantly higher on average for solitary-sleeping families. In both groups, Paternal Overall Involvement levels consistently increased over time. For Paternal Nighttime Involvement, we found a significant Group effect, indicating higher levels of paternal Nighttime Involvement for solitary-sleeping families across all phases. We also found a significant Time effect, a significant Time × Group interaction and a significant Time^2 effect. Simple slope analysis revealed that the linear effect was positive and significant for both the room-sharing group ($b = 0.13$, SE = 0.04, $p = .001$) and the solitary-sleeping group ($b = 0.25$, SE = 0.04, $p < .001$). However, as Figure 4D shows, fathers in the solitary-sleeping group showed greater increase over time in their levels of nighttime involvement.

Discussion

The findings of this longitudinal study demonstrate that although mothers in room-sharing arrangements had lower objective and subjective sleep quality, almost no differences in objective infant sleep quality were found between the groups. However, room-sharing mothers reported more night-wakings in their infants than mothers did in solitary arrangements. In addition, higher levels of maternal separation anxiety were found in room-sharing mothers compared with mothers in solitary-sleeping arrangements, and paternal overall and night-time involvement in infant caregiving was higher in solitary arrangements.

Maternal and infant sleep in room-sharing and solitary-sleeping arrangements

Taking into account the cross-sectional and longitudinal analyses, our findings demonstrated that although both room-sharing mothers and solitary-sleeping mothers demonstrated an improvement over time in their sleep quality, room-sharing mothers had significantly lower sleep percent, lower longest sleep periods, and more night wakings than solitary-sleeping mothers from 3 to 18 months postpartum. These findings extend previous results [17] by demonstrating that poorer maternal sleep quality in room-sharing mother persists also beyond the infant's age of 6 months and are consistent with Teti et al. [16] who found that mothers in persistent cosleeping arrangements across the first year had more disrupted actigraphy-based sleep compared with mothers in other sleeping arrangements.

Interestingly, the cross-sectional examination revealed almost no significant differences in objective infant sleep between the groups. However, mothers in room-sharing arrangements reported more infant night-wakings than mothers in the solitary-sleeping group at 6, 12, and 18 months. The longitudinal comparison of infant sleep patterns in the persistent room-sharing and persistent solitary-sleeping groups revealed a significant time effect for both groups on all actigraphic measures, reflecting the expected consolidation of infant sleep over time [15, 46]. In line with the findings of Teti et al. [16], infants in both groups had similar actigraphic sleep patterns. The only difference we found was in the longest sleep period for which infants in persistent solitary-sleeping arrangements had a longer stretch of uninterrupted sleep in comparison to persistent room-sharing infants. Moreover, and consistent with recent findings [11, 16], our results also indicate that mothers in

Table 4. Fixed effects estimates (SE) from the growth MLM for infants

	Night-Wakings	Sleep Percent	Longest Sleep Period	Sleep Minutes	Night-Wakings (Diary)
Intercept	1.82 (0.12)***	94.85 (0.31)***	240.84 (7.61)***	593.16 (4.59)***	2.44 (0.19)***
Group	0.28 (0.24)	−0.59 (0.63)	−54.12 (15.22)**	−5.32 (9.18)	1.14 (0.24)***
Time	−0.34 (0.03)***	1.04 (0.10)***	12.79 (2.37)***	7.74 (1.38)***	−0.16 (0.03)***
Time × Group	−0.08 (0.07)	0.13 (0.19)	4.52 (4.73)	4.85 (2.77)	0.03 (0.06)
Time^2	0.02 (0.02)	−0.06 (0.06)	5.59 (1.54)***	−2.00 (0.96)*	−0.08 (0.02)***
Time^2 × Group	−0.04 (0.04)	0.01 (0.13)	5.86 (3.08)	−0.34 (1.92)	−0.09 (0.04)*

Night-Wakings = number of actigraphic night-wakings lasting at least 5 min; Sleep Percent = percentage of true sleep time (excluding nighttime wakefulness) from total sleep period; Longest Sleep Period = longest sleep episode without fragmentation during the night; Sleep Minutes = true sleep time; Night-Wakings (Diary) = number of night-wakings according to diary report.
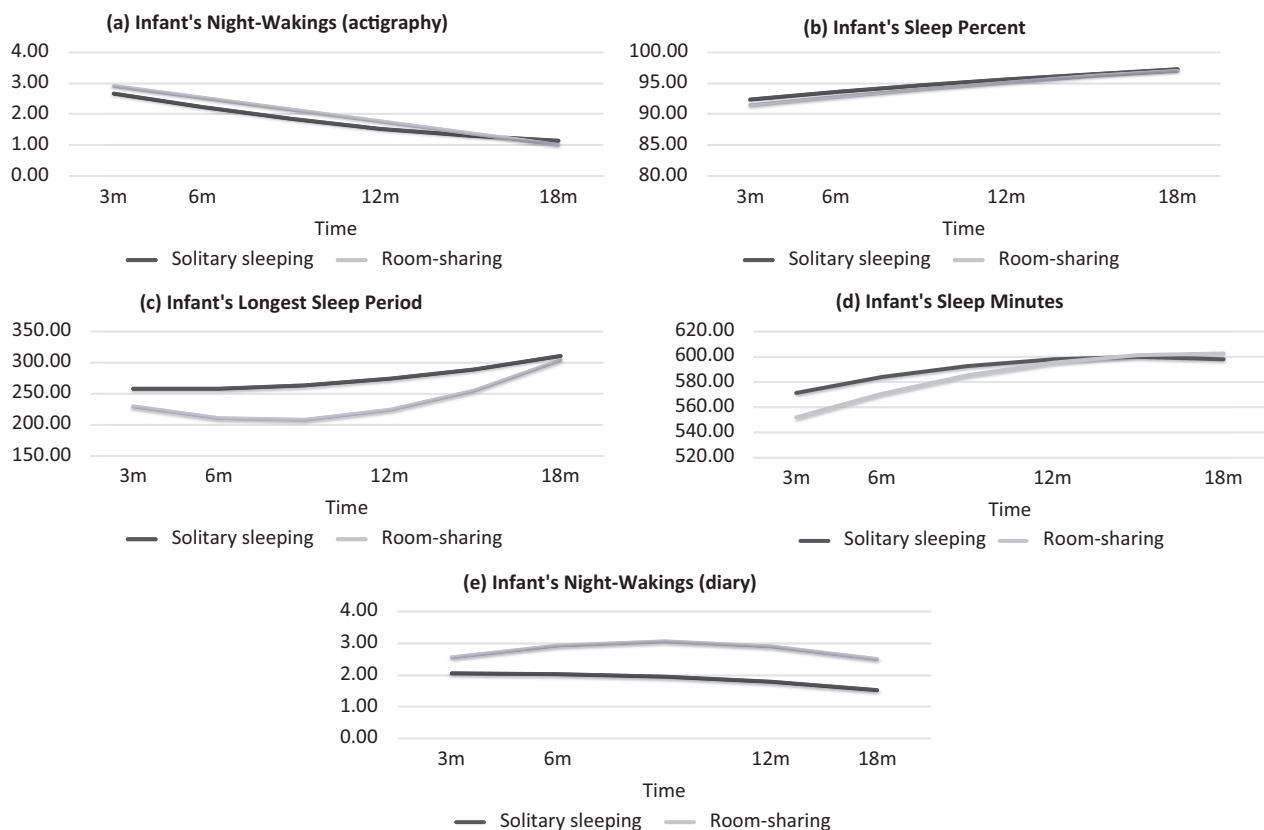*$p < .05$; **$p < .005$; ***$p < .001$.

Figure 3. Infant sleep trajectories by Group: solitary-sleeping (N= 66) and room-sharing (N = 42).

persistent room-sharing arrangements report that their infants wake up more frequently during the night than do mothers in persistent solitary-sleeping arrangements.

Why is it that mothers in persistent room-sharing arrangements have poorer objective and subjective sleep than mothers in persistent solitary arrangements, whereas for their infants, differences are reflected mainly in maternal reports of night-wakings but not in objective sleep? The correlational design of the present study precludes inferring about causality. We do not know whether sleeping arrangements per se are the cause for the differences in maternal sleep quality, or whether another factor explains them. For example, it could be that persistent room-sharing mothers had pre-existing sleep disturbances that influenced their choice to room-share in the first place [17], or that certain psychological characteristics, such as heightened postpartum distress, were responsible for both their choice to share a room and their higher levels of sleep disturbances. However, although not definitive, the possibility that the conditions created by the sleeping arrangements explain the differences in maternal sleep quality, should be taken into consideration. For instance, it could be that because of their proximity to the infant during the night, room-sharing mothers were more likely to be awakened by their infant's awakenings or by the infant's movements and vocalizations during sleep. Thus, their sleep might be more easily interrupted by the natural sounds of the infants during sleep, or by short arousals that may go unnoticed when the infant sleeps in a different room. This may also explain why room-sharing mothers report more infant night-wakings, as they may detect more night-wakings, or may be more likely to interpret activity

during sleep (change in position, vocalizations) as awakenings. Teti et al. [16] suggested that the differences in the number of reported infant awakenings could be related to heightened levels of distress in cosleeping mothers. Accordingly, the higher levels of maternal separation anxiety characterizing our sample of room-sharing mothers might have contributed to hypersensitivity to infant night-wakings, leading to higher reports of these awakenings. Another possible explanation for the differences in reported infant night-wakings, but not in objective infant night-wakings, is that persistent solitary-sleeping infants may have had more opportunities to develop self-soothing capacities that enable them to resume sleep after naturally awakening during the night [4], whereas room-sharing infants might signal more upon awakening and might require more parental help to resume sleep. If this is true, then room-sharing mothers will naturally be more aware of the infant awakenings. It might also be the case that the capacity to self-sooth has a positive impact on the infant's ability to stretch sleep for longer periods of time; as interestingly, the only actigraphic sleep parameter that differed between the two groups of infants was the longest uninterrupted sleep period. All these hypothetical explanations should be further explored in future studies. Nevertheless, the possibility that room-sharing may contribute to consistent poorer maternal sleep quality during the first 18 months, whereas solitary-sleeping arrangements may encourage infants to develop nighttime self-soothing, should be thoughtfully examined and considered, especially in light of the recent recommendation of the AAP that parents share a room with their infants until the infant's age of 12 months [10].

Table 5. ANCOVA tests (controlling for NBF) comparing parental functioning between room-sharing and solitary-sleeping families at 3, 6, 12, and 18 months

	Total		Solitary-sleeping		Room-sharing			
	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	F (df)	Partial η²
Three months								
# Maternal Emotional Distress	.096 (.95)	131	−.00 (.78)	29	.44 (1.33)	102	4.06 (1, 128)*	.060
Maternal Separation Anxiety	2.95 (.41)	131	2.94 (.37)	29	2.95 (.43)	102	4.06 (1, 128)*	.060
Paternal Overall Involvement	2.88 (.59)	131	3.08 (.49)	29	2.82 (.60)	102	2.54 (1, 128)	.038
Paternal Night Involvement	1.85 (.92)	131	2.15 (1.11)	29	1.77 (.85)	102	4.83 (1, 128)*	.070
Six months								
# Maternal Emotional Distress	−.02 (.84)	126	.07 (.93)	59	−.11 (.80)	67	1.08 (1, 123)	.017
Maternal Separation Anxiety	2.84 (.43)	126	2.75 (.36)	59	2.92 (.48)	67	3.03 (1, 123)	.047
Paternal Overall Involvement	3.06 (.60)	126	3.19 (.59)	59	2.94 (60)	67	3.95 (1, 123)	.06
Paternal Night Involvement	2.37 (1.12)	126	2.64 (1.14)	59	2.14 (1.06)	67	14.53 (1, 123)***	.19
Twelve months								
# Maternal Emotional Distress	.10 (.99)	108	.10 (1.01)	79	.10 (.94)	29	.00 (1, 105)	.000
Maternal Separation Anxiety	2.67 (.38)	108	2.60 (.32)	79	2.86 (.48)	29	6.31 (1, 105) **	.108
Paternal Overall Involvement	3.10 (.64)	108	3.32 (.62)	79	2.89 (.58)	29	8.03 (1, 105)***	.142
Paternal Night Involvement	3.03 (1.48)	108	3.24 (1.44)	79	2.46 (1.45)	29	7.30 (1, 105)***	.123
Eighteen months								
# Maternal Emotional Distress	−.04 (.83)	107	.02 (.89)	80	−.23 (.58)	27	.90 (1, 104)	.017
Maternal Separation Anxiety	2.58 (.37)	107	2.54 (.36)	80	2.69 (.38)	27	2.08 (1, 104)	.039
Paternal Overall Involvement	3.33 (.63)	107	3.38 (.62)	80	3.19 (.65)	27	1.90 (1, 104)	.035
Paternal Night Involvement	3.25 (1.54)	107	3.51 (1.42)	80	2.50 (1.66)	27	9.07 (1, 104)***	.148

Maternal Emotional Distress = averaged standard scores of EPDS (depressive symptoms) and BAI (anxiety) measures.
*$p < .05$; **$p < .005$; ***$p < .001$.

Parental functioning in room-sharing and solitary-sleeping arrangements

Various personal, familial, and cultural factors have been described in the literature as affecting parental choices regarding sleeping arrangements. Among those reasons, convenience and facilitation of nighttime caregiving and breastfeeding are frequently cited [5, 8, 10]. Our findings support these assumptions by demonstrating higher rates of breastfeeding in room-sharing mother–infant dyads. However, our findings shed light on several other parental psychological factors that are associated with room-sharing and that have received only limited scientific attention in the past. Specifically, we found

Table 6. Fixed effects estimates (SE) from the growth MLMs for parental variables

	Maternal emotional distress	Maternal separation anxiety	Paternal Overall Involvement	Paternal Nighttime Involvement
Intercept	−0.28 (0.08)***	2.76 (0.04)***	3.12 (0.06)***	2.68 (0.13)***
Group	−0.11 (0.15)	0.25 (0.08)***	−0.44 (0.12)***	−1.00 (0.26)***
Time	−0.02 (0.01)	−0.07 (0.01)**	0.073 (0.01)***	0.19 (0.03)***
Time × Group	−0.03 (0.03)	−0.04 (0.02)*	−0.04 (0.02)	−0.12 (0.05)*
Time²	0.03 (0.01)**	0.01 (0.00)	−0.00 (0.00)	−0.04 (0.02)**
Time² × Group	0.00 (0.02)	−0.01 (0.01)	0.01 (0.01)	0.04 (0.03)

Maternal emotional distress = averaged standard scores of EPDS (depressive symptoms) and BAI (anxiety) measures.
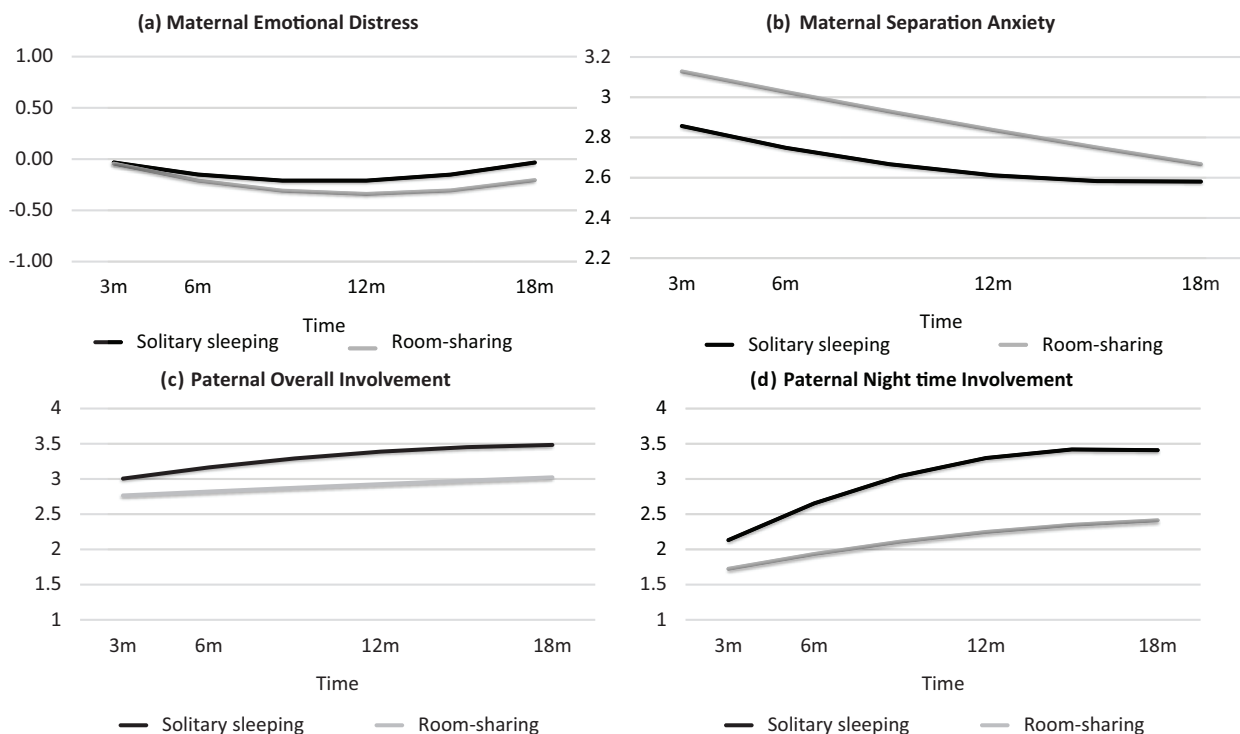*$p < .05$; **$p < .005$; ***$p < .001$.

Figure 4. Trajectories of parental factors by Group: solitary-sleeping (*N* = 66) and room-sharing (*N* = 42).

that mothers in room-sharing arrangements had higher levels of separation anxiety from their infants than mothers in solitary arrangements at 3 and 12 months postpartum, and fathers in room-sharing families were relatively less involved in nighttime infant caregiving at 3, 12, and 18 months postpartum. Differences in general emotional distress were found only at 3 months postpartum with mothers in solitary-sleeping arrangements reporting higher levels of distress, but this trend was not consistent and disappeared at the following assessments. The examination of the trajectories for the two persistent groups revealed a similar pattern. Persistent room-sharing families were characterized by a higher level of maternal separation anxiety and by lower levels of paternal overall involvement and paternal nighttime caregiving. Maternal separation anxiety (feelings of concern, longing, and loneliness when separating from the infant) is a relevant construct with regard to sleeping arrangement decision because putting the infant to sleep in a different room involves separating from him or her physically every night [31, 47]. A mother with initial higher separation anxiety might worry that she would not be able to protect or help her infant if he or she would sleep in a different room and her need for proximity is likely to influence her decision to sleep close to the infant. Sleeping close to the infant, and being aware to the infant's night-wakings, may reinforce or maintain the mother's separation anxiety in turn. Our findings are in line with those of Scher [31] who found that higher maternal separation anxiety was associated with more maternal involvement in settling the infant to sleep. These findings, together with the fact that maternal depressive or anxiety symptoms were not associated with persistent sleeping arrangement patterns, suggest that maternal emotional distress, which is specifically infant-related, might be more relevant to the understanding of maternal decisions

regarding infant sleep location than maternal general emotional distress.

Our findings regarding lower paternal involvement in overall caregiving and in nighttime caregiving in persistent room-sharing families resemble the results of Teti et al. [16] who found persistent cosleeping to be associated with maternal reports of coparenting distress and suggested that cosleeping may help the mother compensate for feelings of lack of support in her marriage [16]. The present findings indicate that when early in the infant's life parents share caregiving responsibilities during the day and night, it is more likely that they would endorse solitary-sleeping arrangement. Highly involved fathers might be more dominant in decision-making regarding infant sleep location, and they may prefer solitary sleep for their infants and for themselves. In families where mothers are the main caregiver, mothers may be more likely to choose room-sharing, because closeness to the infant might facilitate nighttime caregiving especially when the mother is solely responsible for addressing the infant awakenings.

This study has several limitations. Our sample was comprised mainly of families from the middle socioeconomic class in Israel who, in general, seems to endorse western norms regarding infant sleep and sleeping arrangement [48]. Although large individual differences in terms of sleeping arrangement choices and the timing of implementing these changes exist in western societies, including Israel, solitary-sleeping arrangement as a desirable goal is the common standard. Therefore, the characteristics of our sample limit the generalizability of our findings to others cultures in which cosleeping (bed-sharing or room-sharing) is the norm [5, 49]. Second, although the longitudinal nature of the study is a clear advantage that allowed examining the trajectories of infant and maternal sleep as a function of sleeping arrangements,

the design is still correlational. Third, because of our relatively small sample size, we were limited in the number of subgroups that we could analyze. Consequently, we looked only on the broad distinction between persistent room-sharing and solitary-sleeping families and could not make a finer differentiation between additional subtypes of sleeping arrangements such as families who share a room part of the night or families who switch between the different arrangements from one point in time to the other. Also, we did not ask parents about their motivations or intentions; thus, we do not know whether room-sharing was proactive (planned) or reactive and whether this has influenced infant sleep quality as has been suggested previously [50].

Conclusions

This longitudinal study demonstrated that in comparison to persistent solitary-sleeping families, persistent room-sharing families were characterized by higher levels of maternal sleep disturbances, higher maternal separation anxiety, and lower paternal daytime and nighttime involvement. These differences existed from the infant's age of 3 months and remained consistent until the age of 18 months. Because the differences between the groups were evident as early as at 3 months postpartum, it could be possible that these parental factors shaped the parents' choice about their preferred sleeping arrangement [16]. However, in a broader context, when applying the transactional model of infant sleep development to our findings [3, 4], it is plausible that the different factors examined in this study mutually and continuously interact and influence each other over time. For example, we suggest that the following chain of transactions may occur among sleep, parent functioning, and sleeping arrangements: mothers with higher levels of early separation anxiety and disturbed sleep are more likely to choose room-sharing arrangements especially when their partner is not involved in caregiving; these mothers are more likely to be vigilant to the infant's awakenings and are more likely to be awakened by the infants' sounds during the night; being awake during the night increases the likelihood of maternal active involvement in soothing the infant back to sleep when the infant wakes up; active nighttime soothing may reinforce the infants signaling behavior, which in turn may affect the mother's sleep and separation anxiety, the levels of paternal involvement, and the decision to maintain room-sharing arrangements, and so on. Of course this is a hypothetical suggestion for a possible chain of relationships between the different factors examined in this study, which should be examined further in future studies.

To conclude, the findings of the current study do not imply that one sleeping arrangement is better than the other, and naturally there are many factors that influence parental sleeping arrangements decisions. However, we do believe that our findings showing more disturbed sleep in persistent room-sharing mother should be taken into account among the various considerations leading parents to choose their preferred sleeping arrangements. The present study also suggests that sleeping in the parents' room does not seem to make a big difference for the infants in terms of their objective sleep quality. An important question for future studies will be whether the higher frequency of reported infant night-wakings in room-sharing infants is a result of differences in the development of infant self-soothing behaviors.

Notes

Conflict of interest statement. None declared.

References

1. Mindell JA, *et al*.; American Academy of Sleep Medicine. Behavioral treatment of bedtime problems and night wakings in infants and young children. *Sleep* 2006;**29**(10):1263–1276.
2. El-Sheikh M, *et al*. I. Sleep and development: introduction to the monograph. *Monogr Soc Res Child Dev* 2015;**80**(1):1–14.
3. Sadeh A, *et al*. Infant sleep problems: origins, assessment, interventions. *Infant Ment Health J* 1993;**14**(1):17–34.
4. Sadeh A, *et al*. Parenting and infant sleep. *Sleep Med Rev* 2010;**14**(2):89–96.
5. Mileva-Seitz VR, *et al*. Parent-child bed-sharing: the good, the bad, and the burden of evidence. *Sleep Med Rev* 2017;**32**:4–27.
6. Thoman EB. Co-sleeping, an ancient practice: issues of the past and present, and possibilities for the future. *Sleep Med Rev* 2006;**10**(6):407–417.
7. Ball HL. Reasons to bed-share: why parents sleep with their infants. *J Reprod Infant Psyc* 2002;**20**(4):207–221.
8. Mileva-Seitz VR, *et al*. Association between infant night-time-sleep location and attachment security: no easy verdict. *Infant Ment Health J* 2016;**37**(1):5–16.
9. Baddock SA, *et al*. Differences in infant and parent behaviors during routine bed sharing compared with cot sleeping in the home setting. *Pediatrics* 2006;**117**(5):1599–1607.
10. AAP Task Force on Sudden Infant Death Syndrome. SIDS and other sleep-related infant deaths: Updated 2016 Recommendations for a safe infant sleeping environment. *Pediatrics* 2016;**138**(5):e20162938.
11. Paul IM, *et al*. Mother-infant room-sharing and sleep outcomes in the INSIGHT study. *Pediatircs* 2017;**140**(1):e20170122.
12. Madansky D, *et al*. Cosleeping in a community sample of 2- and 3-year-old children. *Pediatrics* 1990;**86**(2):197–203.
13. Bruni O, *et al*. Longitudinal study of sleep behavior in normal infants during the first year of life. *J Clin Sleep Med* 2014;**10**(10):1119–1127.
14. Luijk MP, *et al*. Ethnic differences in prevalence and determinants of mother-child bed-sharing in early childhood. *Sleep Med* 2013;**14**(11):1092–1099.
15. Hysing M, *et al*. Trajectories and predictors of nocturnal awakenings and sleep duration in infants. *J Dev Behav Pediatr* 2014;**35**(5):309–316.
16. Teti DM, *et al*. Sleep arrangements, parent-infant sleep during the first year, and family functioning. *Dev Psychol* 2016;**52**(8):1169–1181.

17. Volkovich E, *et al*. Sleep patterns of co-sleeping and solitary sleeping infants and mothers: a longitudinal study. *Sleep Med* 2015;**16**(11):1305–1312.

18. Bayer JK, *et al*. Sleep problems in young infants and maternal mental and physical health. *J Paediatr Child Health* 2007;**43**(1-2):66–73.

19. Park EM, *et al*. Poor sleep maintenance and subjective sleep quality are associated with postpartum maternal depression symptom severity. *Arch Womens Ment Health* 2013;**16**(6):539–547.

20. Dørheim SK, *et al*. Sleep and depression in postpartum women: a population-based study. *Sleep* 2009;**32**(7):847–855.

21. Coo S, *et al*. Mood and objective and subjective measures of sleep during late pregnancy and the postpartum period. *Behav Sleep Med* 2014;**12**(4):317–330.

22. Tikotzky L, *et al*. Postpartum maternal sleep and mothers' perceptions of their attachment relationship with the infant among women with a history of depression during pregnancy. *Int J Behav Dev* 2012;**36**(6):440–448.

23. Tikotzky L. Postpartum maternal sleep, maternal depressive symptoms and self-perceived mother-infant emotional relationship. *Behav Sleep Med* 2016;**14**(1):5–22.

24. Countermine MS, *et al*. Sleep arrangements and maternal adaptation in infancy. *Infant Ment Health J* 2010;**31**(6):647–663.

25. Teti DM, *et al*. Marital and emotional adjustment in mothers and infant sleep arrangements during the first six months. *Monogr Soc Res Child Dev* 2015;**80**(1):160–176.

26. Hiscock H, *et al*. Infant sleep problems and postnatal depression: a community-based study. *Pediatrics* 2001;**107**(6):1317–1322.

27. Broussard DL, *et al*. The Black and White of infant back sleeping and infant bed sharing in Florida, 2004-2005. *Matern Child Health J* 2012;**16**(3):713–724.

28. Tikotzky L, *et al*. Infant sleep and paternal involvement in infant caregiving during the first 6 months of life. *J Pediatr Psychol* 2011;**36**(1):36–46.

29. Tikotzky L, *et al*. Infant sleep development from 3 to 6 months postpartum: links with maternal sleep and paternal involvement. *Monogr Soc Res Child Dev* 2015;**80**(1):107–124.

30. Bernier A, *et al*. Paternal involvement and child sleep: A look beyond infancy. *Int J Behav Dev* 2016; **41**(6):1–9.

31. Scher A. Maternal separation anxiety as a regulator of infants' sleep. *J Child Psychol Psychiatry* 2008;**49**(6):618–625.

32. Huang XN, *et al*. Feeding methods, sleep arrangement, and infant sleep patterns: a Chinese population-based study. *World J Pediatr* 2016;**12**(1):66–75.

33. Galbally M, *et al*. Breastfeeding and infant sleep patterns: an Australian population study. *J Paediatr Child Health* 2013;**49**(2):E147–E152.

34. Sadeh A. A brief screening questionnaire for infant sleep problems: validation and findings for an Internet sample. *Pediatrics* 2004;**113**(6):e570–e577.

35. Ancoli-Israel S, *et al*. The role of actigraphy in the study of sleep and circadian rhythms. *Sleep* 2003;**26**(3):342–392.

36. Sadeh A, *et al*. Actigraphic home-monitoring sleep-disturbed and control infants and young children: a new method for pediatric assessment of sleep-wake patterns. *Pediatrics* 1991;**87**(4):494–499.

37. Sadeh A, *et al*. Activity-based sleep-wake identification: an empirical test of methodological issues. *Sleep* 1994;**17**(3):201–207.

38. Sadeh A, *et al*. Activity-based assessment of sleep-wake patterns during the 1st year of life. *Infant Behav Dev* 1995;**18**(3):329–337.

39. Monk TH, *et al*. The Pittsburgh Sleep Diary. *J Sleep Res* 1994;**3**(2):111–120.

40. Sadeh A. Evaluating night wakings in sleep-disturbed infants: a methodological study of parental reports and actigraphy. *Sleep* 1996;**19**(10):757–762.

41. Cox JL, *et al*. Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *Br J Psychiatry* 1987;**150**:782–786.

42. Gibson J, *et al*. A systematic review of studies validating the Edinburgh Postnatal Depression Scale in antepartum and postpartum women. *Acta Psychiatr Scand* 2009;**119**(5):350–364.

43. Beck AT, *et al*. An inventory for measuring clinical anxiety: psychometric properties. *J Consult Clin Psychol* 1988;**56**(6):893–897.

44. Hock E, *et al*. Maternal separation anxiety: Mother– infant separation from the maternal perspective. *Child Dev* 1989;**60**:793–802.

45. Raudenbush SW, *et al*. *Hierarchical Linear Models: Applications and Data Analysis Methods,* 2nd ed. Newbury Park, CA: Sage; 2002.

46. Henderson JM, *et al*. Sleeping through the night: the consolidation of self-regulated sleep across the first year of life. *Pediatrics* 2010;**126**(5):e1081–e1087.

47. Anders TF. Infant sleep, nighttime relationships, and attachment. *Psychiatry* 1994;**57**(1):11–21.

48. Scher A, *et al*. Sleep patterns of infants and young children in Israel. *Int J Behav Dev* 1995;**18**(4):701–711.

49. Mindell JA, *et al*. Cross-cultural differences in infant and toddler sleep. *Sleep Med* 2010;**11**(3):274–280.

50. Ramos KD, *et al*. Parental perceptions of sleep problems among co-sleeping and solitary sleeping children. *Infant Child Dev* 2007;**16**(4):417–431.