

Long-term Efficacy of an Internet-based Intervention for Infant and Toddler Sleep Disturbances: One Year Follow-Up

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SCIENTIFIC INVESTIGATIONS

Objective: To examine at one-year follow-up the efficacy of an internet-based intervention for infant and toddler sleep disturbances, as well as to assess any indirect benefits to maternal sleep and confidence.

Methods: Participants included 171 (64.8%) of 264 mothers of an infant or toddler (ages 18-48 months) who had previously participated in a 3-week study. Families had been randomly assigned to one of 2 intervention groups (algorithmic internet-based intervention alone or in combination with a prescribed bedtime routine) or a control group. After a one-week baseline, the intervention groups followed personalized sleep recommendations. The initial internet-intervention was found to be efficacious at 2 weeks post-intervention. The current study investigates a one-year follow-up, with mothers completing a short survey that included 8 questions from the Brief Infant Sleep Questionnaire and 1 question from the Pittsburgh Sleep Quality Index.

Results: Improvements in difficulty falling asleep, number/

duration of night wakings, and longest continuous sleep period were maintained at one year follow-up in the 2 intervention groups compared to baseline and end of the initial study, $p < 0.001$. Children in the control group, in which limited changes were seen in the initial study, showed improvements in the duration of night wakings and longest continuous sleep period compared to the end of the initial study. Mothers in all groups were less likely to describe their child's sleep as a problem.

Conclusions: These results suggest that a brief internet-intervention for early childhood sleep problems is effective in improving child and maternal sleep, with improvements maintained one year later.

Keywords: Sleep, infant, toddler, sleep problems, bedtime disturbances, night wakings, behavioral intervention

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Sleep problems are highly prevalent in young children, occurring in approximately 20 to 30% of infants and toddlers.^{1,2} They are one of the most common behavioral issues brought to the attention of primary care providers.^{3,4} Fortunately, these behaviorally based sleep disturbances are highly amenable to treatment, with the American Academy of Sleep Medicine having released a Standards of Practice documenting the high efficacy of behavioral interventions for bedtime problems and night wakings in young children.^{1,5} Concomitant improvements in parental well-being and sleep are also often found following behavioral treatment of children's sleep.^{1,6,7}

These types of behavioral interventions have traditionally been conducted in face-to-face sessions, with limited availability, or through written educational materials, which lack individual tailoring. With the advent of telemedicine, there have been a few studies conducted supporting the efficacy of internet interventions for sleep issues, primarily for insomnia in adults. For example, one study found an internet intervention to be effective in reducing symptoms of insomnia, and these improvements were maintained at 6-month follow-up.⁸ Other studies have also found that behavioral interventions delivered via the internet to be effective for insomnia and improving sleep quality. In addition, we recently found that an internet-based

BRIEF SUMMARY

Current Knowledge/Study Rationale: Behavioral interventions are known to be efficacious in the treatment of infant and toddler sleep disturbances. However, there has been a lack of empirically based evidence of long-term improvements in sleep in young children following behavioral intervention, especially pertaining to an internet-based program that had previously been shown to be efficacious in the short term.

Study Impact: This study supports the efficacy of a brief internet-based intervention for early childhood sleep problems, including improvements in child and maternal sleep, with improvements maintained one year later.

intervention was effective in improving multiple aspects of infant and toddler sleep, including bedtime difficulties and sleep consolidation.⁹ This previous study involved 264 families of young children (ages 6 to 36 months) with mild to moderate sleep problems. Significant improvements were found 2 weeks following behavioral intervention. However, as noted in a review paper of empirically supported behavioral interventions for bedtime problems and night wakings, there is little assessment of longer-term outcomes beyond the initial treatment phase.¹ Those studies that have included long-term follow-up have generally assessed outcomes at 6 months or less.

Table 1—Demographic variables

| Variable | Initial sample (n = 264) | Follow-up sample (n = 171) |
|------------------------|-----------------------------|-------------------------------|
| | Percent (n)/ Mean (SD) | Percent (n)/ Mean (SD) |
| Child's Gender | | |
| Boy | 49.6 (131) | 45.6 (78) |
| Girl | 50.4 (133) | 54.4 (93) |
| Child's age (months) | 19.35 (8.88) | 30.95 (9.07) |
| Age of Mother | | |
| 18-29 | 32.6 (86) | 28.7 (49) |
| 30-39 | 59.1 (156) | 60.8 (104) |
| 40-49 | 8.3 (22) | 10.5 (18) |
| Married | 89.0 (235) | 91.2 (156) |
| School | | |
| Graduated high school | 6.8 (18) | 6.4 (11) |
| Some college | 28.8 (76) | 24.6 (42) |
| College degree or more | 64.4 (170) | 69.0 (118) |
| Employed | | |
| Full-Time | 26.5 (70) | 27.5 (47) |
| Part-Time | 23.5 (62) | 22.2 (38) |
| Not Employed | 50.0 (132) | 50.3 (86) |
| Income | | |
| < \$30,000 | 4.2 (11) | 2.9 (5) |
| \$30,000 - \$39,999 | 15.5 (41) | 13.5 (23) |
| \$40,000 - \$49,999 | 10.2 (27) | 11.1 (19) |
| \$50,000 - \$74,999 | 34.1 (90) | 33.9 (58) |
| \$75,000 - 99,000 | 21.2 (56) | 25.1 (43) |
| \$100,000 or more | 14.4 (38) | 12.9 (22) |

Given the lack of empirically based evidence of long-term improvements in sleep in young children following behavioral intervention, especially pertaining to an internet-based program, we now report on these families one year later. Thus, the objective of the current study was to examine the efficacy one year later of an internet-based intervention for infant and toddler sleep disturbances.

METHODS

Initial Study Procedure

In the initial study, 264 mothers and their young child (6-36 months; 49.6% boys) participated. Families were randomly assigned to one of 3 groups, and the entire study (baseline and intervention weeks) was conducted during the same 3-week period for all participants. During baseline, all mothers followed their child's usual bedtime practices. Ninety-six (36%) families were randomly assigned to an internet-based intervention group (internet). Following the baseline period, the mothers were instructed to complete the internet-based intervention from their home computer (see description below), and mothers were instructed to follow the individualized recommendations that were provided. Eighty-four (32%) families were randomly assigned to the internet-based intervention plus routine group (internet+routine). In addition to completion of the internet-based intervention, these mothers were instructed to institute a nightly 3-step bedtime routine that included a bath (using a pro-

vided wash product), a lotion/massage (using a provided moisturizing product), and quiet activities (e.g., cuddling, singing lullaby) with lights out within 30 minutes of the end of the bath. Eighty-four (32%) families participated as controls and were randomly assigned to this group. These mothers were instructed to follow their child's usual bedtime practices throughout the entire 3-week period.

Customized Sleep Profile (CSP)

The CSP is an algorithm-based internet intervention developed by two of the authors (Mindell and Sadeh). The CSP collects caregivers' responses on an expanded version of the BISQ and provides parents with individualized information across 3 general domains: (1) a normative comparison of their child's sleep to other children of the same age (based on a normative database of > 5000 children ages 0-3)²; (2) a rating of whether their child is an "excellent, good, or disrupted sleeper" (based on an age-based algorithm that takes into account total sleep time, sleep onset latency, and number/duration of night wakings); (3) customized advice on how caregivers can help their child sleep better at night. All advice is based on empirically supported recommendations.^{1,5} Complete information regarding the internet intervention and the methodology can be found in the description of the initial study.⁹

Participants

At one-year follow-up, 171 (64.8%) of families participated. See **Table 1** for demographic information for all families with complete data at follow-up.

Inclusion criteria for the initial study indicated that all children must have a parent-identified sleep problem, with all mothers endorsing that their child had a sleep problem, as well as experienced bedtime difficulties.

Methods

This follow-up study was approved by an institutional review board. All families were contacted one year to date from the initial study. An automated phone call was first made to all previous participants informing them of the purpose of the study, with a follow-up email sent that included information about the follow-up study and a link to a secure website. Completion of the online survey indicated consent to participate. All participants were paid \$5 for completion of the follow-up portion of this study.

Measures

A short 11-question (control group), 13-question (intervention group), or 14-question (intervention plus routine group) follow-up survey was developed for this study. Ten of the questions were identical to questions asked at the time of the initial study. The follow-up survey included 8 questions from the expanded Brief Infant Sleep Questionnaire,² asking specifically about sleep onset latency, perception of bedtime difficulty, number and duration of night wakings, longest stretch of sleep, total sleep during the day and night, and perception of sleep problems. One question asked about maternal sleep quality ("During the past week, how would you rate your sleep quality overall?") from the Pittsburgh Sleep Quality Index,¹⁰ and another question regarded maternal confidence in managing their child's sleep ("During the past week, how confident have you felt in managing your

child's sleep?"). The new additional questions included maternal perception of the internet-intervention ("How helpful were the recommendations that were provided to you last year?") and whether participants continued to utilize the recommendations ("How often are you following the recommendations that were provided to you last year?" and "How often are you using the 3-step bedtime routine (e.g., bath, massage/lotion, quiet activities) that was recommended to you last year?").

Families accessed the survey from their home computer via a free-standing secure study website and mothers were provided with individual usernames and passwords to access the site.

Data Analyses

Descriptive analyses (means, frequencies) were used to describe demographic and sleep variables. Given that differences were found for sleep patterns at baseline, although randomly assigned to group, individual repeated measures one-way ANOVAs were conducted separately for each variable within the control group and the intervention groups. All significant findings were followed by Tukey HSD post hoc testing. Because of the multiple analyses conducted, findings were considered significant if $p < 0.001$.

RESULTS

Response Rate

No differences in response rate were found across the 3 groups (64%, 65%, and 66%), $\chi^2 = 0.03$, $p = 0.99$. Furthermore, there were no differences in responders compared to non-responders in terms of demographics (e.g., age, gender) or sleep (e.g., perception of sleep problems) at baseline and at week 3, utilizing ANOVAs for continuous variables and χ^2 tests for categorical variables, $p > 0.05$.

Child Sleep

As indicated in **Table 2**, results of repeated measure ANOVAs ($p < 0.001$) demonstrated maintenance of improvements in sleep latency, difficulty falling asleep, number/duration of night wakings, longest continuous sleep period, and maternal confidence in managing their child's sleep in the 2 intervention groups (effect sizes = 0.34 to 0.53). In addition, children in the CSP + prescribed routine group had significantly more total sleep time at night compared to baseline. No significant differences were found at the end of intervention between the 2 intervention groups for any sleep outcome, $p > 0.05$.

Children in the control group, in which very limited changes were seen in the initial study, showed improvements in the number/duration of night wakings and longest continuous sleep period (ES = 0.25 to 0.46). Mothers in all groups were less likely to describe their child's sleep as a problem and reported improved sleep compared to baseline.

Maternal Sleep

Maternal sleep quality significantly improved ($p < 0.001$) during the initial study between baseline and week three. Sleep quality at 1-year follow up, however, fell between that reported at baseline and week 3 and was not significantly different from either time point ($p \geq 0.001$); thus improvement

was seen compared to baseline but was not as high as at the end of the initial study.

Sleep Recommendations

Overall, parents continue to be positive about the internet-based intervention (see **Table 3**). On a 5-point Likert scale, 67.5% of the mothers in both intervention groups reported that they found the individualized recommendations "helpful" (16.2% "very helpful"). At the time of the initial study, 93.3% said that they were likely (74.4% "very likely") to continue using the recommendations after the study, with 94% of the mothers in the internet+routine group stating they were likely to continue using the prescribed routine and products (75% very likely). At one-year follow-up, 57.2% of parents in both intervention groups said that they continued to follow the individualized recommendations provided during the initial study at least half of the time (12.8% "always") following the recommendations.

Notably, 87.3% of the mothers who were recommended the prescribed routine and products continued to use them "at least half of the time" one year later (50.9% using them "most of the time" and 20.0% using them "always"). Results from one-way between-groups analyses of variance showed no significant differences between the 2 intervention groups in how helpful they found the recommendations or how often they were following them at follow-up ($F_{1,115} = 1.56$, $p = 0.210$; $F_{1,115} = 0.412$, $p = 0.514$).

DISCUSSION

The results of this study indicate that an internet-based intervention that included empirically supported behaviorally based recommendations was not only beneficial in improving multiple aspects of infant and toddler sleep immediately following intervention, but continued to be efficacious one year later. That is, all improvements were maintained or further improved one year later. Improved parental perception of sleep was also maintained, including perception of their child having a sleep problem and bedtime ease, as well as mothers' confidence in managing their child's sleep. In addition, concurrent positive changes in maternal sleep quality were maintained following intervention.

We also found improvements in the control group, compared to baseline for several, but not all, of the sleep indices. Specifically, sleep continuity and parental perception of a sleep problem improved, though not as much as the improvements from baseline seen in the intervention group. Note that there were very limited improvements in the control group at the end of the initial 3-week study. These positive changes one year later were likely indicative of normal developmental changes. Development across time has been shown to result in sleep consolidation and decreased sleep difficulties in young children. For example, a recent longitudinal study of 75 infants found the greatest maturational changes in the first 4 months, with additional maturation up to 12 months.¹¹ However, Touchette and colleagues found that one-third of infants with nighttime awakenings at 5 months or 17 months of age continued to have sleep difficulties at 29 months of age,¹² indicating that not all sleep problems spontaneously resolve. Note that these maturational changes would have affected not only the control group, but also the intervention groups. Thus, it appears that the intervention advanced improvement as seen in the early results of

Table 2—Outcome data

| Variable | Baseline | Week 3 | 1 yr f/u | ANOVA | | | |
|--|---------------|---------------|---------------|-------|-----------|---------|-------|
| | M (SD) | M (SD) | M (SD) | WL | F | p | ES |
| Sleep latency (min) [‡] | | | | | | | |
| Control | 22.18 (16.71) | 21.39 (15.29) | 20.79 (13.84) | 0.993 | 0.176 | 0.839 | 0.007 |
| Internet ^a | 25.12 (16.00) | 15.81 (13.42) | 15.69 (11.97) | 0.659 | 15.53*** | < 0.001 | 0.341 |
| Internet & Routine ^d | 24.14 (15.92) | 13.64 (13.26) | 16.68 (12.25) | 0.612 | 16.82*** | < 0.001 | 0.388 |
| Number of night wakings [‡] | | | | | | | |
| Control ^b | 1.70 (1.10) | 1.50 (1.13) | 0.94 (1.04) | 0.745 | 8.88*** | < 0.001 | 0.255 |
| Internet ^a | 1.76 (1.13) | 1.13 (0.86) | 0.77 (0.86) | 0.571 | 22.59*** | < 0.001 | 0.429 |
| Internet & Routine ^a | 1.73 (0.89) | 0.96 (0.82) | 0.76 (0.82) | 0.474 | 29.43*** | < 0.001 | 0.526 |
| Total time awake at night (hours) [‡] | | | | | | | |
| Control ^{b,c} | 0.69 (0.68) | 0.64 (0.70) | 0.23 (0.49) | 0.540 | 22.12*** | < 0.001 | 0.460 |
| Internet ^a | 0.83 (0.80) | 0.41 (0.51) | 0.26 (0.57) | 0.676 | 14.37*** | < 0.001 | 0.324 |
| Internet & Routine ^a | 0.66 (0.51) | 0.30 (0.36) | 0.17 (0.30) | 0.561 | 20.71*** | < 0.001 | 0.439 |
| Longest continuous sleep period (hours) [‡] | | | | | | | |
| Control ^{b,c} | 6.24 (2.54) | 6.92 (2.64) | 8.50 (2.68) | 0.646 | 13.44*** | < 0.001 | 0.354 |
| Internet ^a | 5.90 (2.49) | 7.55 (2.50) | 8.65 (2.40) | 0.513 | 27.48*** | < 0.001 | 0.487 |
| Internet & Routine ^a | 5.97 (2.52) | 7.99 (2.52) | 8.44 (2.33) | 0.477 | 27.99*** | < 0.001 | 0.523 |
| Total nighttime sleep (h) | | | | | | | |
| Control | 9.66 (1.31) | 9.81 (1.61) | 9.87 (1.33) | 0.966 | 0.924 | 0.403 | 0.034 |
| Internet | 9.48 (1.50) | 9.90 (1.21) | 10.13 (1.22) | 0.824 | 6.40 | 0.003 | 0.176 |
| Internet & Routine ^d | 9.50 (1.39) | 10.22 (1.12) | 9.90 (1.13) | 0.711 | 10.59*** | < 0.001 | 0.289 |
| Total naps (hours) | | | | | | | |
| Control | 2.11 (0.84) | 1.99 (0.93) | 1.76 (0.96) | 0.910 | 2.57 | 0.086 | 0.090 |
| Internet ^b | 2.39 (1.16) | 2.12 (0.81) | 1.73 (0.89) | 0.748 | 10.10*** | < 0.001 | 0.252 |
| Internet & Routine | 2.43 (1.33) | 2.28 (0.88) | 1.80 (0.92) | 0.848 | 4.75 | 0.013 | 0.152 |
| Consider sleep a problem ^{†‡} | | | | | | | |
| Control ^a | 2.96 (1.01) | 2.46 (1.19) | 1.94 (1.07) | 0.574 | 19.31*** | < 0.001 | 0.426 |
| Internet ^a | 2.89 (0.93) | 2.06 (0.99) | 1.95 (1.17) | 0.543 | 25.24*** | < 0.001 | 0.457 |
| Internet & Routine ^a | 3.18 (0.98) | 2.00 (1.07) | 2.05 (1.25) | 0.388 | 41.76*** | < 0.001 | 0.612 |
| How difficult was falling asleep? ^a | | | | | | | |
| Control | 4.33 (1.10) | 4.15 (1.54) | 3.78 (1.37) | 0.869 | 3.93 | 0.026 | 0.131 |
| Internet ^a | 4.24 (1.52) | 3.55 (1.42) | 3.03 (1.19) | 0.611 | 19.14*** | < 0.001 | 0.389 |
| Internet & Routine ^a | 4.31 (1.35) | 3.36 (1.43) | 3.25 (1.31) | 0.637 | 15.12*** | < 0.001 | 0.363 |
| Maternal confidence [‡] | | | | | | | |
| Control | 2.70 (1.16) | 2.31 (1.24) | 1.93 (1.20) | 0.755 | 8.434 | 0.001 | 0.245 |
| Internet ^a | 3.06 (1.10) | 1.82 (.92) | 1.81 (0.92) | 0.346 | 56.82*** | < 0.001 | 0.654 |
| Internet & Routine ^d | 2.65 (1.09) | 1.78 (1.07) | 2.00 (1.29) | 0.593 | 18.21*** | < 0.001 | 0.407 |
| Maternal sleep quality | | | | | | | |
| Control | 1.50 (0.69) | 1.24 (0.67) | 1.19 (0.59) | 0.842 | 4.882 | 0.011 | 0.158 |
| Internet ^d | 1.53 (0.72) | 0.90 (0.62) | 1.15 (0.60) | 0.601 | 19.158*** | < 0.001 | 0.390 |
| Internet & Routine ^d | 1.42 (0.63) | 0.84 (0.71) | 1.35 (0.75) | 0.622 | 16.129*** | < 0.001 | 0.378 |

A one-way repeated-measures ANOVA was utilized to analyze group differences over time. ^aSignificant difference between baseline/week 3 and baseline/1 year. ^bSignificant difference between baseline and 1 year. ^cSignificant difference between week 3 and 1 year. ^dSignificant difference between baseline and week 3. [†]Lower scores are better. [‡]Significant interaction. WL, Wilk's Lambda; ES, Effect size as partial Eta² where 0.10 = small effect, 0.25 = moderate effect, and 0.40 = large. ***p < 0.001.

the study, thus saving unknown time of more disrupted sleep, as well as providing additional benefits. These results suggest that a brief internet-intervention for early childhood sleep problems is effective in improving child and maternal sleep with improvements maintained one year later.

One striking finding of the results presented was the continued large effect sizes for the primary outcome variables. There were major improvements in infant and toddler sleep, with decreases in number and duration of night wakings of 50% or more and increases in sleep continuity of over two

hours. Similar, although less dramatic, changes were noted in maternal sleep.

Another promising finding was the continued positive evaluation by the mothers regarding the recommendations that were made one year earlier. Over two-thirds of the mothers reported that the recommendations were helpful. Furthermore, while only 68% of mothers indicated they were still using the individualized recommendations at least half of the time, it is important to note that the recommendations provided were age-specific, and many were likely no longer relevant one year later (such as those related

Table 3—Participant perceptions

INTERVENTION GROUPS

How helpful were the recommendations that were provided to you last year?

| | Internet % (n) | Internet + routine % (n) |
|-------------------------------|----------------|--------------------------|
| Very unhelpful | 8.1 (5) | 5.5 (3) |
| Unhelpful | 16.1 (10) | 9.1 (5) |
| Neither helpful nor unhelpful | 16.1 (10) | 9.1 (5) |
| Helpful | 41.9 (26) | 61.8 (34) |
| Very helpful | 17.7 (11) | 14.5 (5) |

How often are you following the recommendations that were provided to you last year?

| | Internet N (%) | Internet + routine N (%) |
|---------------------|----------------|--------------------------|
| Never | 1.6 (1) | 0.0 |
| Almost never | 14.5 (9) | 5.5 (3) |
| About half the time | 30.6 (19) | 32.7 (18) |
| Most of the time | 35.5 (22) | 54.5 (30) |
| Always | 17.7 (11) | 7.3 (4) |

INTERNET+ROUTINE ONLY

How often are you using the 3-step bedtime routine (e.g., bath, massage/lotion, quiet activities) that was recommended to you last year?

| | |
|---------------------|-------|
| Never | 1.8% |
| Almost never | 10.9% |
| About half the time | 36.4% |
| Most of the time | 30.9% |
| Always | 20.0% |

to nursing and sleep). Furthermore, it may be that families no longer needed to utilize the recommendation if their child's sleep problem was resolved. Of those who received the recommendation to institute a prescribed bedtime routine, which included a bath, massage/application of lotion, and quiet activities, 87% of the mothers continued to use this bedtime routine at least half of the time, and over 50% most of the time. Clearly, the perception was that the bedtime routine was efficacious, as well as a positive aspect of the recommendations that was maintained one year later.

There are a number of continued limitations to this study. First, this study did not include an objective measure of child or parental sleep, such as actigraphy, and thus is based on parental subjective report. Second, not all participants were included at follow-up, although we found no differences in responders and non-responders at baseline or at the end of the initial study. Furthermore, there was equal participation across all three groups. Third, we did not ask families about whether they sought guidance for their child's sleep issues over the one-year follow-up period. Thus, all families may have received treatment, resulting in improvement in sleep over the one-year period, beyond the online intervention that was provided to the families in the intervention groups.

Overall, this study found that a brief internet-based intervention incorporating individualized empirically based recommendations (with and without a prescribed bedtime routine)

improves sleep in infants and toddlers in the short term, and continues to be efficacious one year later. Not only does this intervention improve sleep in young children, but it also has the indirect benefit of improving maternal well-being, specifically maternal sleep. We continue to believe that there is a definite place for internet-based interventions, which are widely accessible, in the treatment of sleep disturbances in young children, and can easily be recommended by practicing pediatricians and other pediatric providers. Our findings, in conjunction with previous studies, demonstrate the applicability of telemedicine expanding the reach and availability of clinical interventions for common sleep problems, although there are clearly limitations, including lack of universal access and limited ability to tailor to every unforeseen variation in sleep issues.

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