
Family-Based Sleep Technologies: Opportunities and Challenges

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ABSTRACT

Sleep is a critical component of overall wellness, and pervasive and ubiquitous computing technologies have shown promise for allowing individuals to track and manage their sleep quality. However, sleep quality is also affected by interpersonal factors, especially for families with young children. In this study, we adopted a family informatics approach to understand opportunities and challenges for sleep technologies at the family level. We conducted home-based interviews with 10 families with young children, asking them about their current practices, values, and perceived role for technology. We describe challenges across three phases: bedtime, nighttime, and waking. We show that family-based sleep technologies may have the greatest impact by supporting family activities and rituals, encouraging children's independence, and providing comfort.

KEYWORDS

Family Informatics; Sleep; Children; Health Informatics; Qualitative

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Table 1: Participant demographics

#	Parents	Children	Home	Location
1	F-31/M-33	F-3	Apt	Urban
2	F-32/M-34	M-5/M-3/F-1	House	Rural
3	F-39/M-39	M-5	House	Urban
4	F-39	F-5	Townhouse	Rural
5	F-36/M-30s	M-4	House	Urban
6	F-30s/M-46	M-4/M-4	House	Urban
7	F-39/M-41	F-7/M-5/F-5	House	Urban
8	F-41/M-43	M-4/F-2	House	Urban
9	F-34/M-36	M-7/M-4/M-2	House	Urban
10	F-41/M-40	F-6/F-18mo	House	Urban

INTRODUCTION

Sleep is important for overall health and quality of life. Poor sleep can lead to a variety of serious health concerns [1], and 1 in 4 children experience sleep problems [7]. Furthermore, sleep researchers now recognize that family-level sleep concerns have a significant impact on the sleep quality of individual family members, and secondary effects on clinical, academic, and social factors in child development [4]. This is especially true in families with young children.

Over the last decade, HCI researchers have devoted significant attention to sleep tracking and management, and computing technologies have shown promise for allowing individuals to track and manage their sleep quality [10]. For example, the Lullaby system [5] incorporates temperature, light, and motion sensors, in addition to a commercial sleep sensor, to provide users with insights about the impact of environmental factors on their sleep quality. SleepTight [3] assists users with long-term sleep tracking through mobile phone-based widgets.

More recently, HCI researchers have begun to address the family itself as a health informatics context. In 2017, Piña et al. introduced the concept of *Family Informatics*, a family-level approach to health tracking technologies [9]. Piña and others have since refined this concept to align with Bronfenbrenner's Ecological Systems Theory [8], treating the family as a microsystem and acknowledging influence across layers from the sociocultural to the individual. HCI researchers have thus begun to address sleep technologies at the family level. For example, WAKEY is a smart toy that helps families with small children establish proper morning routines [2]. MOBERO is a smartphone-based bedtime routine system for families with young children with ADHD designed to be used by both children and parents [11]. However, to date there has been no holistic investigation of the potential roles and barriers for family-based sleep technologies.

In this paper, we report findings from a formative home-based interview study to explore the design space for family-based sleep technologies. We show that family-based sleep technologies may have the greatest impact by supporting parents and children alike in setting and maintaining healthy sleep habits. We describe challenges faced by families across three phases: bedtime, nighttime, and waking, and discuss ways technologies could support sleep practices through facilitating parent-child coordination and rewarding and enforcing rules and rituals.

METHODS

In late 2018 we conducted 10 home-based interviews with families in central Indiana with young children (age 3-7) for whom sleep was a concern but not a clinical issue. We selected the age range of 3-7 as it corresponds to a developmental stage where children are establishing and gaining greater control over their own sleep habits, but parental involvement in their sleep practices is still high[6]. We recruited families with flyers, on local parenting Facebook groups, and through snowball sampling.

Participants were predominantly middle class families living in standalone homes in the Indianapolis area. 8 families are Caucasian; 1 family has a Hispanic parent and 1 family has an African-American child. For more demographics, see Table 1. Each family filled out the Pittsburgh Sleep Quality Index (PSQI) for participants 12 and up, and the Children's Sleep Habits Questionnaire for children age 3-12. No family reported clinically-significant sleep issues affecting their children, although one parent did report concerns with sleep due to anxiety.

We conducted 90-minute semi-structured home-based interviews. We asked families about their day-to-day schedules, sleep challenges (drawn from the sleep questionnaires and any problems reported in-person), and sleep distractors. We also asked about existing technologies or tools for sleep, and their perceptions of the potential for technological solutions. Parents and children were all present throughout. Families then gave us a tour of their home. We audio-recorded the interviews, took notes, and took photos. Throughout the data collection period we met to discuss emerging themes and adjust areas of focus for the interviews. We then met to thematically analyze the interview data and identified major opportunities and barriers. The study was approved by the Indiana University IRB.

FINDINGS

In this section, we describe families' sleep-related challenges, their current solutions to these challenges, and their perspectives on technological solutions to family-level sleep concerns. Families reported children's sleep as the main challenge to family sleep quality, so for the purposes of this paper, we focus on challenges and opportunities related to children's sleep.

Challenge: Bedtime

All families worked to establish regular bedtime routines, such as bath time and reading books together, calm games or a little TV, a final snack before bedtime, potty time, singing, and evening prayer. Families emphasized that they cherish this "magic time" as a key bonding activity, and no family reported using cancellation of these rituals as a punishment. However, bedtime was also a source of sleep challenges. Many parents reported that children wanted bedtime rituals to last as long as possible, raising a fuss when parents tried to leave their room since, in the words of one parent, they wanted "the party to continue" –F2. This transition, from 'party' to slumber, was the primary barrier to sleep quality for all families we spoke to. Children described feeling afraid to fall asleep alone ("[Mom, Dad] I am scared and I need you [to fall asleep]" –F6). Others begin to cry shortly after their parents leave, which in some cases lasted for hours (F6,8).

Families tried to mitigate this challenge by allowing children to sleep with the rest of the family: "I believe that it is not fair not to be welcome to our room when all the rest family [both parents] and even a dog are there" –F10. However co-sleeping can also disrupt the sleep of parents. The mother from F4, the only single parent in our participant pool, valued this time so much, she was willing



Figure 1: A home-based trampoline used for "jump minutes" in case a child is too excited and cannot calm down.



Figure 2: A child's bedside, including a noise machine and a clock which switches from moon to sun during the night, showing the child when it's appropriate to visit their parents' room.



Figure 3: A child-friendly clock which glows green when the child is allowed to come to their parents' room, and red when it's too early.

to reduce her own sleep quality in exchange for quality time with her child. “We usually fall asleep together with my daughter in my bed...[but] you know children in her age move a lot at night, so sometimes I don't have enough space and even can move to another bed. She falls asleep better with me and sleep is time when we can be actually together after my work day, so that's why I don't want to change it”. –F4. Families with multiple children tended to be more strict. As one parent said: “if you say yes to one, you will need to say yes to all three children, and bedtime will continue forever” –F9.

Half of the families also employed *transitional objects*, artifacts which provide psychological comfort security to those children attached to them [12]. These took various forms, such as security blankets, stuffed animals, even pillowcases, and children have in their bed and sometimes like to do even daily activity with them. Families reported that while these objects were no substitute for parents, they did help children feel comfortable while falling asleep alone. Parents also employed tactics to tire their children out during the day. For example, families added walk time to their child's daily schedule, or encouraged other outdoor activities. One family (9) installed an indoor trampoline, encouraging their child to rack up “jump minutes” (see Figure 1). However, not all parents were in favor of late physical activity, so they sought to eliminate any exciting activity close to bedtime.

Challenges: Night Waking and Early Waking

While bedtime caused the most frequent sleep challenges for families, two other challenges—night waking and early waking—also presented obstacles to quality family sleep. Night waking occurred either because of nightmares or bed-wetting, or child illness. Bed-wetting was occasionally extremely disruptive. As one mother told us: “Once, [5-year old] woke up from a wet bed which he shares with his sister and [a dog]...so all of them—2 children and 1 dog joined me, my husband, and our older dog in 1 bed’ –F7”. Nightmares were also a fairly common form of night waking, which some parents connect to difficulty falling asleep. As the mother from F10 told us: “My daughter [often] wakes up in the middle of the night, goes to my husband and wakes him up.” While less common than bedtime challenges, when it occurred, night waking was extremely disruptive to family sleep.

To reduce the occurrence of night waking, families sought to make the child's bedroom as calm and consistent an environment as possible. Almost every family employed a noise machine to provide comfort and reduce the chance of waking due to household noises such as parents' TV watching. Some families also employed humidifiers and heaters to provide the most comfortable environment for their child, although this was less common. One family also used a ‘moon clock’ to help their child know when not to disrupt their parents (see Figure 2). Families also made modifications to their bedtime rituals to reduce night waking, such as adjusting their child's late-night liquid intake and potty time, and being quiet after the children are asleep (see Figure 5).

Many families experienced challenges when children woke up earlier than parents would have liked, especially on the weekend. For example, one family (F3) experienced this on a regular basis,

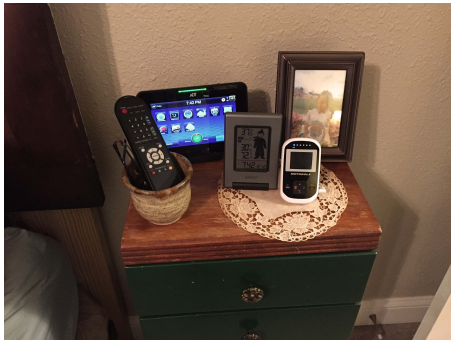


Figure 4: Bedside table in parents' room. From left to right: TV remote, touchscreen alarm/video monitor, climate monitor, radio, family photo.



Figure 5: Sign on a child's door warning: "You wake him, you take him."

with a child who consistently woke up at 5:45am no matter how they adjusted his bedtime or other factors. This case was more extreme than most, but early waking was a common challenge that all families had encountered. Parents tried to address early waking through routines and rules, adjusting bedtime to encourage waking at an acceptable time, and setting rules for how early their children could wake them up. Several families used bedside clocks to emphasize these rules. (see Figure 3).

Technology Acceptance

Overall, the families in our study reported themselves as technology followers rather than early adopters, and expressed worries about too much 'screen time' for their children, particularly with respect to sleeping. Families were also concerned about the cost of technologies, seeking to avoid needless expense on devices with limited perceived utility. Families were also wary of hacking and of perceived health dangers of wifi and bluetooth. For example families 1, 9 and 10 turned their phones to airplane mode at night since they slept with their phones on bedside tables. Yet families also expressed optimism about the potential for technologies to help them with family-level sleep concerns, as long as those technologies could facilitate calmness, fit into their busy lives, and were secure.

DESIGN OPPORTUNITIES

For families with young children, effective sleep technologies may look quite different from individual-level sleep tracking and management tools. Instead, our finding suggest a sociotechnical approach—in which technologies support family activities and rituals, encourage children's independence, and provide comfort—is likely to be more successful.

Supporting family activities and rituals. Parents struggled to manage the tension between family bonding time and the transition to solitary sleep, and technologies that support and reinforce healthy habits without disrupting family togetherness may help with family-level sleep concerns. Such tools could help families track and manage bedtime rituals as well as activities throughout the day, such as exercise, time spent outdoors, napping, or mealtimes.

Encouraging children's independence. One common challenge at bedtime was children's transition from family to solitary time. To address this, half of the families we interviewed provided transitional objects, such as teddy bears or blankets, and these families generally reported fewer issues at bedtime. Sleep technologies that take the form of transitional objects are likely to be adopted and fit into existing patterns of use, while encouraging independence. Two families provided clocks for their children, embedding expectations and rules about waking. Computing technologies could reinforce rules, support children in managing their sleep independently, and reward their progress.

Providing comfort. Most children in our study had bedside devices to regulate their room's climate, provide low light and soothing sounds, and manage hydration. Technologies which—in addition to

tracking these environmental factors—can more actively support night-time comfort and a sense of safety for children may improve overall family sleep quality.

Limitations. Our participants have limited diversity in family arrangement, socioeconomic status, and geography, and the formative nature of the study limits our ability to make specific recommendations.

CONCLUSION

In this paper, we have described sleep-related challenges faced by families with young children, and outlined opportunities for computing technologies to help families improve overall sleep quality.

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