

More than Bedtime and the Bedroom: Sleep Management as a Collaborative Work for the Family

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ABSTRACT

Sleep is a vital health issue. Continued sleep deficiency can increase the chance of stroke, cardiovascular disease, obesity, and diabetes. Previous studies have investigated sleep as an individual activity performed within bedrooms at night. In this study with twenty parents of young children, we identify sleep as a complex experience entangled with social dynamics between family members. For example, children's sleep means not just time for children to rest, but time for self-care for parents. This paper's contributions are twofold. First, we show how the boundaries that define sleep in terms of time (at night), space (in bedrooms), and unit of analysis (individual-focused) limit designers' opportunities to tackle the deeper sleep issues of families. Second, we suggest "division of labor" as an important but rarely discussed design concept to enhance family sleep, and as a design theme for home technologies that address issues emerging from social dynamics between householders.

CCS CONCEPTS

• **Human-centered computing**; • **Collaborative and social computing**; • **Empirical studies in collaborative and social computing**;

KEYWORDS

Family, sleep, health, wellness, parent-child, division of labor, design, home, technology

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1 INTRODUCTION

Good sleep is a critical determinant of health and wellness. For adults to maintain a healthy life, the National Sleep Foundation recommends at least seven hours of sleep duration (the total daily

amount of sleep) and 85% sleep efficiency (the ratio of total sleep time to time in bed). However, one in three adults living in the United States does not meet the recommendation [45, 108]. It has become a critical public health issue that affects more than fifty million individuals in the United States [76, 77, 102].

When defining and assessing sleep quality, studies often consider several measures, including sleep duration and sleep efficiency [90]. Unhealthy sleep can be defined as insufficient sleep, irregular sleep patterns, or insomnia, but it also includes sleep disorders, such as sleep apnea. The negative effects of unhealthy sleep (e.g., low alertness, emotional regulation) can impinge on daytime functions, such as work or school [83, 106]. Furthermore, chronic sleep deficiency often negatively impacts an individual's health and causes diseases, including high blood pressure and type 2 diabetes [69, 70]. Studies showed that multiple factors can impact an individual's sleep quality, including but not limited to daytime activities, naps, diet, technology use, smoking, medication, home environment, cultural practices, mental health, and illness [22, 38, 51, 104]. To address those issues, the growing availability of smart devices has made several home-based sleep support technologies possible and created new opportunities for researchers to support individual's sleep quality at low cost [56, 103]. Studies have shown that technologies can accurately capture individuals' sleep traits and behaviors and provide guidance to improve [3, 30]. These studies commonly considered an individual as a unit of analysis.

In recent studies, the focus has moved from the individuals to the family and to the sleep environment - especially for families with young children [35, 76, 77]. For example, when children have abnormal sleep, it often impinges on the quality of the parents' sleep, causing increased stress and fatigue. Recent survey data indicated that more than 50% of American parents lose an average of thirty minutes of sleep each night because of their children's awakening during the night [76, 77]. The frequent crying of the children also has a significant impact on the quality of the parents' sleep and daytime functioning [75]. On the other hand, parents' beliefs about sleep, their habitual behaviors (e.g., listening to the music or watching TV at night), and increased stress levels from work can also have a negative impact on children's sleep patterns [35]. Because sleep problems can influence the physical, emotional, and behavioral health of the whole family, it is critical to address family sleep issues.

To support sleep in the home context, HCI studies have applied family system frameworks [20] to understand barriers that interfere with family sleep quality and provide design implications for future sleep support technologies. By focusing on how the family's interconnectedness influences its health management, the studies

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investigated the importance of supporting sleep for the family's sleep environment [28, 53], collective sleep information tracking [87], and collaborative bedtime or morning routine management [23, 25, 61, 106].

Compared to earlier medical literature that viewed sleep as an individual behavior, this body of literature focused more on the relational aspects of sleep behaviors in the actual home setting. However, despite efforts to see the family as a unit of analysis to support sleep behaviors, these studies still viewed sleep as a behavior that was tied to morning and nighttime, and that happened primarily in the bedroom setting. They did not capture the critical issues underlying family sleep that originated from family relationships or dynamics, as the studies were focused on specific times and spaces (e.g., bedtime, morning routine, and bedroom). Although some studies had perspectives on sleep that included participants' daytime activities as well as nighttime behaviors, these studies considered individuals as distinct from families. The specific needs of families, including interactions between family members, and issues arising from the transition to parenthood, were not addressed.

Building on the previous studies that emphasized the critical role of family environment to understand an individual's sleep behaviors, this study suggests expanding the view of sleep behaviors and looking beyond the family's sleep routine and bedroom settings. The study also provides the implications of the necessity to incorporate division of labor into sleep technology design. To do so, we present information obtained through forty semi-structured Zoom interviews with twenty parents of children between the ages of two and seven. Our contribution is twofold:

- This paper shows how expanding the view of family sleep can help researchers and designers understand the core issues of family sleep problems.
- This paper provides insights into how division of labor as a design concept helps designers to challenge existing social dynamics of families as a way to enhance the quality of family sleep.

2 RELATED WORK

Medical studies have investigated how individuals' sleep behaviors can accurately be captured and enhanced with technology-mediated solutions [2]. The early medical studies were performed in laboratory settings; however, recent studies have increased the attention paid to home settings. HCI studies have focused on everyday settings by examining the usability of personal smart technologies to enhance sleep and enable healthy sleep management [28]. In addition to these two types of sleep studies, we also present how previous home technology studies have investigated families' collaboration and division of labor, which we found to be an essential design factor for families' sleep technologies. As we review these three lines of investigation, we explain the need to reframe the definition of "family sleep" within the HCI context.

2.1 Medical studies understanding sleep via individuals' sleep monitoring

Medical literature has focused on two broad areas: 1) the accurate capture of sleep information in clinical lab settings; and 2) home-based therapeutic solutions via smart technologies.

Researchers in sleep medicine literature have considered sleep an unconscious activity that can only be assessed with sensing technologies in controlled environments, such as a laboratory. Such studies typically rely solely on the data captured by those technologies in clinical settings [54, 68]. In those studies, "sleep disorders" (or "sleep problems") are defined as changes in sleeping patterns that negatively influence an individual's health [74]. The most common sleep disorders are insomnia, night terrors, sleepwalking, and sleep apnea [5]. They are often diagnosed with polysomnographic (PSG) monitoring: tracking brain waves, heart rate and breathing, oxygen level, muscle tone, leg movements, and eye movements [44]. PSG-facilitated diagnoses can be quite accurate but require spending a night in a clinic while wearing sensors. Historically, however, PSG has been unable to measure the influence of an individual's environment, which typically includes other family members.

The growing availability of smart devices (including wearable PSG trackers and actigraphy) was a breakthrough that made the diagnosis of sleep problems in the home settings possible [2, 3, 27, 44]. This improved accessibilities of sleep-therapy to populations that previously lacked the resources to participate in clinical sleep studies. Recent studies have examined the accuracy of sleep information provided by technology-mediated devices and the benefits of the targeted treatments they enable [3, 31, 71]. They investigated the ability of various sensors, including accelerometers, gyroscopes, and microphones, to accurately track users' sleep information. In particular, researchers have developed mHealth apps [6, 15, 40, 57, 58, 79] and measured the effectiveness of the apps in improving an individual's sleep quality. For example, Fino et al. compared the ability of four smartphone-based apps to effectively detect sleep/wake states with movement and sound sensors [40]. Similarly, Bhat et al. examined the accuracy of an iPhone-based sleep app [15].

Other studies in home settings focused on behavioral sleep therapy through technologies, such as cognitive behavioral therapy for insomnia. Sleep Bunny is an app-based service that provides users with a brief, telephone-based, coaching manual for improved sleep quality [8]. Participants were satisfied with the app's usability and showed improvement in sleep. Horsch et al. tested a mobile health app that delivered sleep-aid services to participants who suffered from insomnia [48, 49].

As such, the growing availability of smart technologies was a big stepping stone, which moved the sleep assessment from the lab settings to the home environment. These studies provided a number of behavior guidelines through technologies, such as relaxation exercises in bed, maintaining a sleep diary, and education in sleep studies within a medical field.

2.2 HCI studies exploring sleep as individual issues that incorporate more collaborative factors

A large body of literature has examined how interactive technologies can improve sleep quality and thereby the general wellness of individuals [1, 9, 25, 28, 30, 80, 89]. Although medical literature has focused primarily on diagnosing sleep problems and providing therapeutic solutions, recent HCI studies have begun to consider how family members in the home setting affect an individual's sleep hygiene (i.e., recommendations that improve an individual's

sleep and behaviors that pertain to physical and mental relaxation) [28]. By suggesting action plans, studies explored ways to improve an individual's sleep. Studies can be categorized into two groups: 1) technologies that support transitional moments, such as morning and bedtime routines in the bedroom settings, and 2) technologies that help individuals' sleep management in relation to other social actors.

The most common sleep-aid technologies in HCI have been alarm clocks and routine reminder systems for transitional moments in bedroom settings [28, 55, 59, 84, 97]. By providing useful information, these technologies support users' bedtime or morning tasks. For example, a study developed a system that provides contextual information, including schedule, traffic, and weather, and thus enables users to adjust their wakeup times and other routines [59]. The Reverse Alarm Clock, developed by Ozenc et al. enabled children to know whether they should go back to sleep instead of getting up [84]. These studies suggested the use of tailored bedtime and morning routine support for users and improved practices regarding sleep.

The second group of studies investigated individuals' sleep management in relation to other social actors. They investigated the effects of sleep-related information sharing within the users' social networks [55, 97] and environmental factors that affect sleep [53]. For example, Schmidt et al. showed the usefulness of setting users' specific routines, such as wakeup and bedtime, based on the schedules of other family members (e.g., wakeup is when children get out of bed) and sharing information about users' sleep behaviors [97]. Aliakseyeu et al. captured information regarding family members' sleep or users' specific daily routines and suggested individualized wake-up times [4]. Studies have also highlighted design opportunities by examining the influence of environment and family settings on sleep [29, 53]. They developed technologies to capture environmental factors that affect sleep and suggested design implications [53].

As an extension of these relation-focused studies that examined the social aspects of sleep, more recent studies have investigated collaborative aspects of sleep among family members [86]. In these studies, sleep is considered as a set of interconnected behaviors among family members, particularly those with young children [23, 25, 26, 87]. Their results showed how interactive sleep data tracking among family members contributed to sustainable behavior changes and improved their health. For example, Pina et al. developed a family-centered, sleep-tracking tool, DreamCatcher, for parents and their school-aged children to track their sleep data with wrist-worn sleep sensors and report their mood [87]. Unlike previous research that primarily targeted adults, this study looked at children as users of sleep-tracking technology. Other studies focused on routine support in specific contexts, including the lives of dual-income families [23] and ADHD (Attention deficit hyperactivity disorder) support [106]. In their ethnographic study, Cherenshchykova and Miller also found that the maintenance of sleep routines provided significant design implications that support sleep for families of young children [25, 26].

In recent sleep studies, the definition of sleep has been reshaped by focusing on the collaborative aspects of sleep within family social dynamics. However, these studies still viewed sleep as a human behavior tied to morning and nighttime behaviors that happened

primarily in the bedroom [25, 26]. Although a few studies take a family collaborative practices approach to managing sleep [86, 87], they focused on tracking sleep data or associated mood, rather than on considering family relationships or dynamics as crucial design requirements. Similarly, although several studies discussed the impact of daytime activities outside the bedroom and the need for peripheral displays to improve behaviors for healthy sleep [9, 30], these studies focused on individuals outside the context of their families. In these studies, individuals were a unit of analysis or users, and the unique needs of families, including sleep-related matters that arose from relationships, dynamics, and interactions among householders, were not addressed. Because of these limitations, more profound issues of family sleep—in particular, those that stem from the transition to being parents of young children, and main issues underneath sleep management in family—are less studied.

2.3 Home technologies for family collaboration that affirm or challenge existing social dynamics

In previous home technology studies, families' collaboration has been continuously investigated as important design factors; however, there were two ways of dealing with family collaboration. One group of studies understand families' existing ways of collaboration and follow them as a way to enhance their existing strategies. The other group seeks how technologies can challenge existing social dynamics by looking at division of labor and gender roles.

First, studies have investigated the role of technologies in facilitating families' collaboration of domestic work. By promoting family members' awareness of each other's location [21], schedule [81], and current status, including health data (e.g., communicating blood glucose levels between children undergoing type 1 diabetes and their parents [46, 99]), studies showed how technologies helped the family coordinate their daily routines and achieve tasks (e.g., health goals) when they are together in the home, and apart. Examples include work coordination in specific home contexts (e.g., farm [66]), calendars that facilitate communication of schedule between family members [17, 81, 88], reminder systems [37], effective errand coordination [105], parents managing their children's routine [36, 85], facilitating the family relationships [101], and improving health management [43, 72]. For example, to alleviate difficulties in managing the family routine, Neustaedter et al. developed a family-centered calendar, LINC, which facilitated family's awareness of other members' activities and changes [81]. This increased awareness was identified as a facilitator which enabled an effective management of family routine in a more flexible manner.

While the first group of studies focused on more surface level of family collaboration by using their existing relationships or social dynamics, the other group of studies investigated how technologies challenge existing social, gender, and power dynamics among family members (e.g., division of labor, gender roles). They showed the relationships between social dynamics in the home environment, and the use of new and existing home technologies [10–13, 41, 42, 109, 110]. For example, Forlizzi's interview study showed how the attributes of robotic technology (e.g., autonomous, semi-intelligent) challenge the existing social dynamics among family members, particularly regarding families' division of labor and

gendered roles [41, 42]. Similarly, Rode investigated how families collaboratively work on digital housekeeping, particularly computer security and privacy matters [91]. The study results suggested that gender identity is the critical determining factor that shapes the role and responsibilities on domestic work within the family. By highlighting the importance of credibility for the appropriate use of Location-Based Service (LBS), Boesen et al. also showed how system design should consider the power relationships within the home [18]. These studies showed how sociotechnical systems can influence and reshape the existing social roles, responsibilities, and dynamics of the home environment.

Building upon these previous studies, our study seeks how technologies can challenge existing family dynamics rather than affirm families' current ways of managing their sleep issues. This study provides opportunities to consider family members' collaborative and balanced role in managing sleep in their day-to-day lives. From interviews with twenty participants, we discuss 1) how broadening the view of 'sleep behaviors' beyond bedtime and bedrooms can help researchers more deeply understand families' experiences of managing their lives for improved sleep and take a more critical view upon the issues, and 2) how designing the social roles of sleep-support technologies (e.g., division of labor) can provide insights for technologies designed for home settings.

3 METHODS

Data were collected in forty semi-structured interviews over Zoom video conferencing. In spring 2021, the lead author had two separate sessions with each participant. With participants' permission, all of the interviews were audio-recorded and transcribed verbatim. Each session lasted approximately forty-five minutes. To better understand participants' sleep environment and sleep management practices, it is important to observe participants' home environment and relevant artifacts that are mentioned during the semi-structured interview. Due to the reason, the team originally wanted to conduct in-home interviews that allow researchers to thoroughly understand participants' daily practices within a real environment [98]; however, the university's institutional review board did not permit in-person contact with the research participants, because of the COVID-19 pandemic. Therefore, whenever participants mentioned their sleep environments, or artifacts they used to help manage sleep, we asked them to photograph these environments and artifacts, and to share the photographs with us afterward. They include participants' home environment, sleep assistive devices (fans, white noise machines, etc.), and children's toys. The photographs and associated narratives functioned as supplemental materials that allowed the researchers to have a comprehensive understanding of participants' descriptions. The lead author also took field notes during each interview and referred to them during data analysis. Our university's Institutional Review Board provided ethical approval for this study.

3.1 Semi-structured interviews

Each participant participated in two separate interviews. The first interview focused on mapping activity, allowing participants to actively lead the conversation without pre-determined interview questions; the second interview focused on a set of questions about

the family's sleep. Because we wanted to learn about participants' experiences with their family's sleep without a pre-determined frame, we applied a map-making activity so that participants could freely share their experiences, perspectives, and feelings.

Inspired by Clarke's situational map [32], participants devised their own map about their sleep issues during map-making activities [62, 64, 65] (see figure 1). The collaborative map-making is a reflexive way to capture in-depth understanding of a situation from the perspectives of participants (e.g., older adult [62, 65], householders [64]). At the beginning of the first Zoom session, participants were given three keywords: 'sleep,' 'family,' and 'me.' Using sticky notes, whiteboards, or virtual drawing tools, participants generated twenty words that were related to the initial three keywords and explained how each of the twenty words was associated with their everyday life. Participants also chose the five most essential words to explain the three keywords that the interviewer had presented and explained how they related to each other. Throughout these processes, participants were permitted to conceptualize what "sleep behavior" is, based on their own experiences and views. Participants could freely construct the components and features of family sleep behaviors and identify what they considered relevant. Therefore, we did not restrict participants' discussions (e.g., by discussing only nighttime activities). If we had asked specific questions without first map-making, we would have framed participants within the researchers' definition of 'sleep behavior' rather than their own. The map-making allowed us to learn the genuine opinions of participants and their experiences related to their family's sleep, regardless of prevailing academic views of the topic. While they explained their maps, participants actively initiated and led discussions, and researchers probed if more explanations were needed. Participants' explanations about their map were audio-recorded for data analysis.

Within the two weeks following their first Zoom session, participants were invited for a second interview. Having two separate sessions allowed us to build rapport with participants and prepare interview questions to thoroughly capture their sleep-related experiences.

The design of the second interview was based on previous sleep studies that investigated how to improve individual and family sleep practices. We asked questions about the family's typical day; family bedtime routines and environment; family relationships; challenges and strategies to manage sleep; and technology used. We ended data collection after having interviewed twenty participants, because we assessed that their answers no longer provided new information. Audio recordings of both sessions were de-identified, transcribed verbatim, and entered into NVivo Pro 12 for analysis.

3.2 Participants

Participants were twenty parents of young children. We recruited participants from the university's group mailing for parents and by word of mouth. Potential participants were screened using a Qualtrics survey to determine their eligibility. They were required to be (1) experiencing low sleep quality; (2) parents of at least one child aged between two and seven years; (3) comfortable with reading and speaking English; (4) willing to participate in video conferencing interviews (i.e., able to access to internet and with a

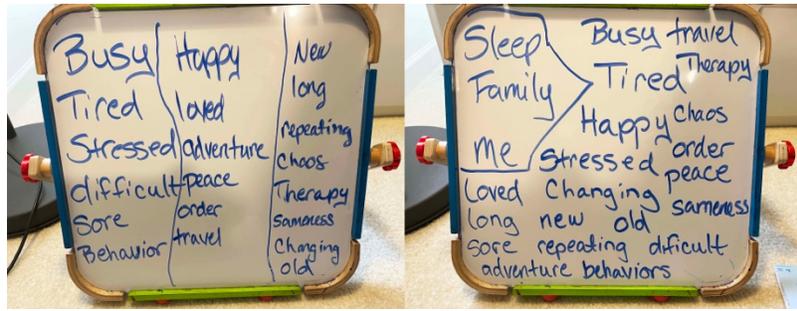


Figure 1: Examples of mapping activity outcomes during participants' first interview sessions.

camera-enabled device able to connect); (5) a resident in the United States of America; (6) willing to engage in a mapping activity; and (7) able to provide informed consent. We emailed participants who met our inclusion criteria and scheduled their first interview session after the participants signed informed consent. We note that children were not the participants of the current study, and we only include parents' views on their family's sleep management practices.

The participants included eighteen females and two males (eighteen mothers and two fathers). The mean age of the study participants was 38.3 years (ranging from 27-47 years). The majority were married or in a domestic partnership (18/20 [90%]), female (18/20 [90%]), employed full-time (14/20 [70%]). In addition, 11/20 [55%] of participants were White and 8/20 [40%] were Asian. Annual household incomes ranged from less than \$10,000 (1/20 [5%]), \$75,000-\$99,999 (3/20 [15%]), \$100,000-\$200,000 (9/20 [45%]) to more than \$20,000 (2/20 [10%]). See demographic information for Table 1

3.3 Data analysis

We applied a grounded theory approach for our study [24]. A constructivist approach enabled us to understand participants' experiences and opinions without a predetermined frame. During the data collection period, the research team regularly held group meetings to share emerging themes from the map-making activities and interviews. The lead author presented interesting findings and identified patterns to team members and discussed further interview directions. We used the interviewers' field notes and the photographs provided by the participants to help us become familiar with the interview themes and contexts. These regular discussions allowed us to iteratively modify the interview questions to better evoke participants' experiences and ideas related to their family's sleep behaviors and facilitate identification of data patterns for further investigation.

Using NVivo Pro 12, we performed open coding for forty transcripts with these primary focuses. Because we focused primarily on the family's social dynamics and the unique underlying situations that affected their sleep, open coding resulted in codes that represented the family dynamics, associated challenges, and relationships with sleep. This allowed us to have upper-level themes that encompass the subthemes. Initial open coding of the transcripts yielded 1161 discrete codes regarding families' daily routines and sleep-related issues. We iteratively aggregated codes based on their

commonalities until they were mutually exclusive; this resulted in 86 representative codes. These 86 codes were used to perform affinity diagramming. Each of 86 codes was written on a separate sticky note, and clustered by their relationships, including similarity, differences as well as hierarchy. The affinity diagramming resulted in three levels of themes, and allowed us to identify upper-level themes that encompass the subthemes. For example, high-level themes include 'opportunity for parents' alone-time after children's sleep,' 'time management and sleep,' and 'appropriate division of labor.' Mid-level themes include 'parents' small activities for self-care,' 'parents' strategies to keep stable routine,' and 'motivations of having stable routine.' Low level themes include 'influences of naptime,' 'delay in children's routine and parents' sleep,' 'reminder system,' and 'transition object for bed.' Captured images during the mapping activities and detailed analysis of each word will be presented in our follow-up study. In this paper, we analyzed only the conversations during the first and second sessions with each participant.

4 RESULTS

In our study, parents shared their opinions about the importance of a healthy sleep routine and described various factors that disrupted their family's healthy sleep. Those disruptive factors included children coming into their parent's room at night, night terrors, frequent bathroom use, movement of family members in bed, balancing naps and nighttime sleep, discrepant schedules among family members, and disciplinary issues with children who disregard routine. Families also shared their efforts to find or create physical sleep environments that suited them. These findings echoed previous studies of family sleep [25, 26, 29].

Our results indicate that the most critical factors that affected the family's sleep involved more than the nocturnal bedtime routine. The deeper issues of sleep stem from the transition to being parents. Our participants noted that, after they had children, their criteria to determine whether they had "good sleep quality" shifted from an individual experiencing sound sleep at night to more complex issues involving family dynamics.

For example, good sleep can be achieved only if the children have an early bedtime and sleep through the night. If a child's sleep routine was not settled, this drastically affected the sleep of parents and siblings. This new perspective on good sleep shows that collaboration among family members is essential.

Table 1: Demographic information of twenty participants

Participant	Age	Gender	Occupation	Race	Child(ren)'s Age	Other Household Member(s)	Household Income (\$)
P1	27	F	Unemployed	Asian	2(F)	Husband	Less than 10,000
P2	33	M	Student	Asian	2(F), 5 (F)	Wife	25,000 -34,999
P3	41	F	Full time	Asian	6(F)	Parents (Mother and Father)	75,000 - 99,999
P4	46	M	Student	White	6(F), 11(M), 16(M)	Wife	75,000 - 99,999
P5	32	F	Full time	Asian	2(F)	Husband	More than 200,000
P6	33	F	Full time	Asian	5(M), 6(M), 10(M)	Husband	75,000 - 99,999
P7	37	F	Full time	White	3(M), 6(M)	Husband	100,000 -200,000
P8	40	F	Full time	Asian	6(M)	Husband	100,000 -200,000
P9	33	F	Student	Asian	3(F), 5(M), 6(M)	Husband	10,000 - 14,999
P10	47	F	Full-time	White	4(M)	Husband	100,000 -200,000
P11	32	F	Full-time	White	1(F), 3(F)	Husband	100,000 -200,000
P12	41	F	Unemployed	White	8 ^a (M), 9(M), 11(M)	Husband	100,000 -200,000
P13	43	F	Full-time	White	3(M), 4(M)	Single Parent	50,000 - 74,999
P14	41	F	Full-time	White	6(M), 13(F)	Husband	100,000 -200,000
P15	39	F	Full-time	Asian	6(F)	Husband	25,000 - \$34,999
P16	43	F	Full-time	White	6(M), 8(M)	Husband	100,000 -200,000
P17	38	F	Full-time	White	3(F), 7(M)	Husband	More than 200,000
P18	45	F	Full-time	White	6(F), 8(M)	Husband	100,000 -200,000
P19	37	F	Self- employed (part-time)	White/ American Indian	1(F), 3(F), 5(F)	Husband	100,000 -200,000
P20	38	F	Full-time	White	5(F), 7(F)	Husband	Prefer not to answer

^a P12's youngest child was seven when the participant was recruited, and turned eight shortly before the interview took place. (M=Male, F=Female)

In this section, we report major themes in our participants' experiences with family sleep, which are associated with family dynamics and individual situations. They include: 1) children's sleep means an opportunity for parents' alone-time and self-care; 2) managing both daytime and evening routine is essential for on-time, quality sleep; 3) appropriate 'division of labor' and mutual care in the home to achieve a family sleep routine; and 4) challenges emerge when family dynamics are altered.

4.1 Children's sleep means an opportunity for parents' alone-time and self-care

When participants described their daily, sleep-associated routine, they frequently discussed how their lives had changed drastically after they became parents. For our participants, alone-time and opportunities for self-care were possible only during children's sleep. Attending to a child's basic needs took much time and labor from parents and made it hard to focus on self-care during the daytime.

Thirteen participants (13/20) described this time as "my time," "me-time," and "time for me-things" and said that they used this time to improve their self-care and unwind from the pressure of the day's obligations, including work, study, and childcare. Because of their busy routines, they found relaxation time - both physical and mental - to be more precious.

For example, participant 17 mentioned that although she enjoyed and valued the time with her children most, having multiple roles throughout the day made her desire a chance to relax in the evening.

I think it's the time that you can be selfish. I don't think it's the most valuable time, I like being with them. But I think it's necessary. It's the only time that you can get to breathe. And honestly, by that time, by 8:15 at night, when we've been up since 7:00, and we've been with kids the whole time, and working full-time jobs and cooking dinners, making lunches... there's nothing left of me by that point. So I'm just going to lie on the couch. So I don't think it's my most valuable time of the day, but I think it is my most relaxing time. It's really normal time I feel relaxed in the day. (P17)

As the quote shows, her alone-time provided her with comfort, relaxing moments, and opportunities to focus on her own needs instead of her family's schedule and routines. Other participants shared how they secured more extended self-care time by giving their children a fixed bedtime. For participant 7, securing free time for parents was as important as implementing healthy everyday habits for children. For this reason, she gives her sons a countdown before bedtime.

We have a relatively strict routine. For a few reasons. I just want to instill healthy sleeping habits for my kids, but also we want our kids to go to bed so that we can have a few hours to ourselves. Yeah. So at, or maybe 10 minutes before bedtime ... We'll give them a countdown. We'll say, "It's 10 minutes before bedtime, five until bedtime, one minute." (P7)

In a similar way, participant 5 mentioned that she would do anything for her daughter's regular, early bedtime at 7 pm because it provides her with more free time; this is her only opportunity to focus on herself.

To me, I would sacrifice anything just to put her to sleep early. . . . So keeping her doing this routine is stressful, but personally, as long as she cooperates, this is not stressful for me at all. In fact, actually I love this. The reason why I say that is, because once we put her down to sleep, we have all the time to ourselves, and it's pretty much the only time I have to myself. (P5)

Therefore, she trained her daughter to follow a strict bedtime by the time she was five months old, which provided participant 5 with great satisfaction. She mentioned that if she ever has a second child, she will follow the same sleep education and patterns for that child as well.

For parents of children who disregarded routines, limited opportunities for self-care had a significant impact on their own sleep time. Our participants mentioned that although both mother and father are engaged in bedtime routine, children often make requests to their mothers at bedtime (including for their mother to stay with them, or bring them water, or give them another hug). When children sleep less soundly, this often leads to revenge sleep procrastination, particularly for mothers: staying up late to have time for themselves, despite being aware of the probable negative consequences the next day.

For example, participants 19 and 20 described how their children's unhealthy sleep routines reduced their self-focused time, which made their sleep drastically later. Because participant 20's daughter would fall asleep only at 11 pm after making multiple excuses not to sleep (e.g., more water, another hug), participant 20 often stayed up until 2 am to have some time for herself. One of participant 19's three daughters repeatedly - and loudly - disobeyed the bedtime routine. Participant 19 and her husband were concerned that this would disturb the other children's sleep. Calming the child at the end of the day took a significant amount of time and energy, and Participant 19 said that she wanted to have more time for herself afterward - which led to bedtime revenge procrastination.

But since having kids, I oftentimes will... After that then they go to bed is that I feel is my time. And so I want to extend that my time

as long as I can. So I go to bed at 11:30 sometimes almost midnight if it's the coming towards the weekend. Like, last night I didn't go to bed until midnight because I just wanted that time. . . . And so that helps me just kind of... Even though I know I'm going to be tired in the morning and I know I shouldn't... I really should just go to bed for my mental health, maybe not my physical health, but for my mental health I stay up later just doing me things. (P19)

During our interviews, nine parents also shared how they used their free time after children's bedtime to ease the tension built up from their daily routines. After their children fell asleep, parents indulged in activities that they could not do during the day, including hobbies (e.g., sewing and knitting) and self-improvement (e.g., reading books). As a single mother, participant 13 had difficulties when her two sons spent the whole day with her because of illness (and, later, because of the pandemic). On such days, after her sons went to bed, she would knit. Her yarn collection helped her stay centered (see figure 2).

Yeah. So yeah, knitting and yarn are definitely things that make me feel centered, and help me breathe again. I think part of that is the rhythm of working through a row of knitting. It really helps me to breathe and center myself, so that's good. (P13)

The most frequently mentioned self-care activity that helped parents wind down at night was reading a book. Participant 5 said:

I also read before I go to bed. I don't do that every night, but I would say 80% of the times, I would read and that helps me sleep for sure. . . . When I think about the non-fiction I read last year, they were mostly self-improvement books, or self-help books. (P5)

Other participants mentioned that they preferred to rest their minds with "mindless" activities - television or social media. These examples show that children's sleep provided parents with the time to engage in self-care activities.

In summary, our results show that the criteria for "good sleep" drastically change when people become parents. The most important sleep agenda for our participants was their children's sleep, because it provides self-care time for the parents. This self-focused time is guaranteed only with the children's fixed bedtime routine and sound sleep.

4.2 Managing both daytime and evening routine is essential for on-time, quality sleep

To meet their primary goal of having children sleep, our participants reported that time management was crucial throughout the entire day. However, for families with young children, time is always a limited, valuable, and collective resource. How the family managed their time throughout the day affected the structured and on-time bedtime routine that led to a good sleep for both children and parents. During the interview, they shared how they planned their family's routines around their children's needs, such as naptimes and school schedules. According to our participants, mothers are usually in charge of planning and coordinating families' schedule. The participants said they always had "a list of things to do" in their head to maintain structured schedules. They emphasized



Figure 2: Participant 13's yarn collection, which makes her feel relaxed and centered.

the importance of maintaining a stable daytime routine to have a relaxed evening, and the combination of the two could result in a satisfactory day.

For example, eight participants (8/20) mentioned that with young children, planning their daytime activities to include regular nap times was a critical factor for a successful evening routine and stable sleep. Participant 2's children often stayed up past 11pm if their daytime nap had lasted too long, and this made it difficult for him to plan daytime schedules. To avoid having irregular activities (e.g., shopping, dinner out) affect the sleep routine, many families planned such activities for after the children's naptime. Participant 11 reported how her family tried to avoid scheduling anything around her daughter's naptime. Also, she shared how she planned everyday physical activities during the day and maintained better sleep quality for her child.

I'm trying this thing this year to do a thousand hours of play outside. So we've, even yesterday, we were outside two and a half hours. So I'm really trying that. And I've realized that the days that we're outside longer, we're more tired, so she's sleeping better. So that's helpful to me too. (P11)

The daytime schedules and also the evening bedtime schedules and routines had an impact on the stable sleep of a family. Six participants (6/20) shared that they had a relatively early dinner, so that they could go to bed to prepare for their next day - especially if it was a regular school day. Participant 12's children were attending online school due to the pandemic, but the family has maintained an early sleep time so that they will be able to resume in-person school without complications.

Whereas now we're a bit more relaxed, because you can't win because they're not that tired. But I think we'll be more strict because they are

going to go back to school part-time here in the next few weeks. So you have to get up, catch the bus and all that stuff. (P12)

Although parents planned daytime schedules carefully, they did not always succeed. If children's bedtime routine were delayed or interrupted and they did not fall asleep on time, the parents' evening routine and bedtime were also affected, and eventually parents felt more fatigue. P15's daughter falls asleep quite late, and this affects her own sleep time. Because she can only sleep when she has finished her housework and can begin preparing for the next day only after her daughter has fallen asleep, she needed to stay up until midnight.

After she goes to bed, I need to do some housework and I also need to prepare for my job. Some work for my job too. I teach and I need to prepare the teaching materials... It's because during the day I have to be with her and only after she went to bed or fall asleep, I can work. I can do whatever I need to do. . . I always tell myself that good for our health and you should go to bed early. Go to bed early, go to bed early, but every day I end up with bed... Yesterday, I went to bed at 2:00am. (P15)

This quote shows that children's irregular sleep patterns and late sleep directly influenced their parents' evening routines.

To manage the family's time and secure a certain amount of sleep at night, parents used various strategies to maintain their children's bedtime routine. These included rewards, reminders, comfort objects (e.g., emotionally significant stuffed animals) and communication strategies. Participant 17 created a reward basket to motivate her children to maintain a healthy routine (see figure 3). If children followed their responsibilities (e.g., using the bathroom appropriately at bedtime), they had a chance to choose a small toy from the basket. Participant 20's family created a token system using yarn-wrapped balloons. Children receive three of them each night, and may 'spend' them on getting out of bed for any reason they want (e.g., a drink of water, or another hug) at a cost of one token each time. Participant 12 needed to verbally remind her sons to follow the routine every night.

And then about 9:30, used to be 9:00 but lately they ask for an extension of their bedtime. 9:00, 9:30 we get upstairs. And honestly the kids, they're being loud, they're jumping around, they're goofing around. Guys, it's time to get to bed, you're going to be tired tomorrow. We're tired, we want to sleep, get to bed. (P12)

Participant 5's daughter was pre-verbal, and thus used a more visually-oriented reminder system: a chart with pictures of morning, naptime, and bedtime responsibilities (see figure 4). The chart helped the child maintain the routine, regardless of which adult was in charge - mother, father, or even a babysitter. Participant 5 mentioned that she particularly desired for a more structured routine for her daughter to alleviate her postpartum anxiety and having the chart was definitely helpful for securing more sleep and rest for herself.

This subsection shows that a family's bedtime at night is affected by time management throughout the day and a stable evening routine; these also provide improved sleep for both children and parents. The connection between the routine and their quality of



Figure 3: Participant 17’s reward basket to motivate her children to maintain a healthy routine.



Figure 4: Participant 5 created a chart with pictures of bedtime and morning responsibilities. She also had one for her daughter’s naptime.

nighttime sleep led parents to develop different strategies for their children to maintain bedtime stability.

4.3 Appropriate ‘division of labor’ and mutual care in the home to achieve a family sleep routine

Our results indicated that the implementation of appropriate household management strategies was critical for a successful sleep routine for the participants. To successfully collaborate to manage their routine, parents divided their tasks depending on their daily schedule, and taught children small household responsibilities to manage the family life effectively. Many participants mentioned that having other relatives nearby (e.g., the children’s grandparents, aunts, and uncles) was helpful in terms of coordinating their lives.

Furthermore, participants noted that they provided more sleep for their other family members by adjusting their responsibilities to accommodate each other’s needs. Although these practices happened throughout the day and were not restricted to bedtime or nighttime sleep, participants noted that coordination of efforts and division of labor affected the family’s routine and eventually their sleep.

Twelve participants (12/20) mentioned that their families divided their housework based on who was available at a given time. This was the most frequently mentioned type of coordination of labor and was particularly helpful for securing sufficient amounts of sleep for parents. For instance, if one of the parents were in charge of the family’s morning routine, the other parent contributed more to the family later in the day. Participant 20 and her husband took turns putting their children to bed, depending on which parent had work the next day: that parent could go to bed early without having to manage the children’s bedtime routine.

So for us, even actually when it comes to putting the kids to sleep and stuff, it all depends on who’s working the next day because I work during the week and he works the weekends. . . . When I’m at work all day, he’ll cook dinner. When he’s at work, I’ll cook. (P20)

The participant mentioned that she and her husband try to handle their responsibilities as a “team.” For her and her husband to get enough sleep, it is necessary to help each other. Similarly, Participant 5’s husband was a morning person, whereas participant 5 herself was not; therefore, he was in charge of their daughter’s morning routine, and participant 5 could get more sleep even after their daughter woke up. In the case of six out of twenty households where mothers are stay-at-home parents or part-time employees, mothers in the family had dominant childcare responsibility as their spouses had more intensive work schedules. In these cases, participants emphasized the importance of role-sharing with their husbands to have necessary things done during the day (e.g., going to a clinic appointment or bank) or time to breathe. Participant 1 shared that they switched their weekday roles on the weekend (e.g., a father spends more time with the child), which helps her to understand her husband and vice versa.

Seven parents (7/20) emphasized the importance of teaching children small household responsibilities, so that they would know what was expected of them in the family and be able to contribute to the household as they grew. This role-sharing enabled parents to have more help in accomplishing the routine, and children could better understand their household structures and rules. In participant 4’s family, as the oldest child became able to take care of his siblings, the parents could leave them by themselves for limited amounts of time. When one parent had to leave home before the other could return, the children could stay by themselves if the school had closed due to inclement weather. In that case, they divided the responsibilities among the children and efficiently reduced tension about who would do what.

In other words, the older brother wasn’t watching him [the second child], he was watching himself, but the older brother was responsible for the youngest, for the sister. So that was our approach to it. So that we think help reduce the tension between the boys who are responsible for their sister. (P4)

Because of participant 4's busy routine of doctoral studies, structure was particularly important for his sleep schedule. If part of his routine were obstructed, he needed to stay late on campus and finish his work. Teaching his children household responsibilities eased the demands on him and his wife, and helped them maintain their schedule and be on time for tasks throughout the rest of the day.

For some participants, having relatives nearby was quite helpful. For instance, participant 3 lived with her parents; as a result, she was able to briefly catch up on lost sleep while her parents helped take care of her daughter.

And if [my parents] feel I don't have enough sleep, they will watch my daughter for maybe one hour, two hours in the afternoon, so I can take a longer nap, sometimes. (P3)

To provide more rest for other family members, participants flexibly adjusted their responsibilities to accommodate each other's needs. Although it can involve greater sacrifice for one party, the other party has more time for rest and is able to maintain wellness. On weekends, participant 17 and her husband take turns sleeping with their youngest daughter, who frequently comes to their bedroom at night. If one of them sleeps with the child, it is convenient to put her back to sleep when she wakes up.

My husband and I actually on the weekends we split [the task], so one of us will sleep on Friday night and sleep in [her daughter's] bed while the other parent sleeps with [her daughter]. And on Saturday night, we switch so that you can sleep all the way through. (P17)

As the quote shows, in this way, the other parent can sleep through the night, and the other party can have a more extended amount of sleep until morning.

This subsection showed how the effective division of labor can help a family achieve a successful sleep routine. Participants' experiences showed that sharing roles, responsibilities, and providing care are necessary to manage their everyday lives and improve their families' sleep. In particular, our results indicated that the division of labor, which was critical to managing sleep, involved not just spouses, but also older siblings and extended family members.

4.4 Challenges emerged when family dynamics are altered

Although families tried to establish and maintain a desirable bedtime routine and healthy sleep, they were not able to do so, when life situations changed. Our results showed that many factors dynamically influenced family routines and sleep patterns, including the developmental stage of the children and changing life circumstances (e.g., travel, visitors, and the COVID-19 pandemic). All of our participants (20/20) devised various coping strategies to handle these changes. The effectiveness of these strategies is critical for maintaining sleep.

First, children's needs change as they enter new developmental stages, and thus parents are asked to meet new requirements. One participant described her parenting and disciplining efforts as "just trying to figure it out as it goes." For our participants, parenthood and family life are learning processes that involve new requirements, mistakes, and reflection. They shared how their ongoing



Figure 5: One participant's children recently started to sleep together as they entered a new developmental stage.

and continuous efforts improved their sleep training and helped them establish a stable life as a family. For example, in participant 4's family, children's screen time at night was an ongoing discussion topic as children became older. Because children's screen time had a significant impact on their sleep and associated parental stress, parents frequently discussed how much screen time was allowed for each child, and when they could use the devices. As the children grew, the family's rules on bedtime screen use changed based on their schedules and needs. Participant 13 also shared her perceived need for continuous learning when training her children with a stable sleep routine. She mentioned that although she found effective strategies that initially seemed to work for her children's sound sleep, they often did not work when children met new developmental stages.

I feel like every time we start to get to a stage where I feel like we kind of understand how this is going, they're always growing and changing. . . And I feel like we're still a work in progress, right? We're still tweaking things as they go. But we've figured out some good stuff that is working. And once I figure out something that's working, I'm sticking with it. (P13)

For her, there was no 'one size fits all' bedtime strategy applicable to different periods of her children's developmental stages. She learned to be flexible and established good strategies. In participant 18's family, her children, aged six and eight, recently developed a fear of the dark. To comfort them, she and her husband spent extra time with them, and moved the two children's beds into the same room. This was a significant success, because it both assuaged the children's fear and facilitated the family's evening routine.

And so we put the beds in the same room, and now they feel like they're not alone because they are a little bit afraid of the dark, and those things, so. It's around 9:30, or maybe a little bit later by the time all of that is done. They usually fall asleep within 10 minutes, I'd say. . . Getting them, I think that was actually a really big key to moving forward. (P18)

As the quote shows, they developed the new strategy based on their children's recent behavior patterns associated with sleep, and the newly implemented bedtime environment was successful

for the family. For our participants, training children to accept a bedtime routine involves many tests and a learning process. They emphasized the importance of acknowledging that parents also can learn from uncertainty and new experiences, and use them as an opportunity to improve the family's lives.

Visits were another frequently mentioned alteration to family routine: either by the family to another region or by a guest to the family's home. Such visits involved sleep environment changes and breaks in routine (e.g., shifted bedtime) and often had a residual negative impact on the family's sleep after the regular routine had resumed. To alleviate the impact on their routine, five families (5/20) shared that they developed strategies for sound sleep, such as keeping the same bedtime as on normal days or traveling with children's attachment toys or white noise generators. Participant 17 mentioned that whenever they were on a trip, they still had "quiet time" and kept the children on the same bedtime. Because she has two children under seven, keeping a structured routine even during a trip is important for their physical and emotional condition.

We try as much as possible to keep our daily routine. So if we take a vacation, we still try to have quiet time and bedtime might be a little bit later, but we still follow everything. (P17)

During the interview, three participants (3/20) mentioned that the degree of adherence to bedtime routines depended on with whom they traveled and their travel destination. If they were visiting people with whom they did not have as strong a bond, it was more difficult to insist on adhering to their own family practices.

It depends a little bit on who we're with. So we'll often stay with [my wife's] brother's family. They're probably a bit stricter than we are about routineing in TV and stuff. But like one of the things that's challenged there is their kids go to bed really early, and they wake up really early. And me as a cardinal sin above all is waking up early because that's the time that I want to get up and read, I don't like that. So when my kids, when they get up at 6:00 AM at their cousin's house, I'm not a big fan of that because then they're worn out and they're tired, or we'll sometimes stay with [my wife's] cousin. They don't have any rules. They have no rules about when kids go to bed, about video games and it drives me crazy. ...Like we stay with my mom and dad, or often I'll just tell them, get off... I'll tell my kids, get off the TV, go do something. When we're there, then we'll insert ourselves in the situation. But when we're with cousins, then it's maybe less so, I guess. (P4)

Unexpected circumstances and issues, such as the COVID-19 pandemic, were significant contributors to less sound sleep and increased anxiety and fatigue. During the interviews, mothers, particularly those who worked full-time (14/20), related their difficulties in maintaining schedules because the pandemic had caused imbalances between work and family lives. Uncertainty led participants to worry about changes to their life circumstances (e.g., work and school now being done from home). Many had not slept well, and some had insomnia. For example, participant 13, who was a single mother for two sons, had established stable sleep patterns for her children before the pandemic. But, once the pandemic began, one of the children awakened screaming every twenty minutes. To comfort him, she stayed with him until he slept again, but this was time-

and energy-consuming and negatively impacted her own sleep and daytime functions. To alleviate the difficulties associated with unexpected circumstances, other participants engaged in simple therapy (e.g., online counseling, parenting groups) or meditation, and tried to have open communication with their families. Participant 7 often had the opportunity to explain her feelings and situation to her children. Explaining difficulties openly provided comfort to the family. Because of her husband's obligation for work, she was the one who spent most of the time with her children and worked from home at the same time.

I don't know if this is necessarily the best plan or not, but particularly during this pandemic, sometimes I'm just not having a good day. There's just a lot happening for me. And I'll tell them, "Honey, it's a hard day for mommy today, and I'm just kind of feeling a little stressed out, a little frustrated," whatever the case may be. And it doesn't necessarily make my day easier, but I think it's made my kids very understanding of when I am just sort of on my last nerve with them. (P7)

She mentioned that after explaining the situation to her children and giving them some space from each other, they recognized her difficulties and talked about their feelings more openly. She tried to have daily, open conversations, which helped her family to become relaxed at the end of the day.

This subsection shows the necessity to understand family sleep from a transactional perspective. Established bedtime routines and strategies often were not sustained when internal or external factors changed life situations. Through trial and error, participants had to continuously find the best approaches that worked for their families.

5 DISCUSSION

5.1 Sleep as a complex and collaborative experience for the family

To our participants, family sleep issues denote complex and collaborative experiences that are not limited by the three boundaries that have been frequently used within the existing discourse about sleep: 1) time, 2) space, and 3) unit of analysis.

In previous studies, sleep was considered solely as an activity that occurred at nighttime. Thus, with a few exceptions [9, 25, 26, 30], researchers have focused on how nighttime routines are managed and how sleep is sustained until morning. Nighttime routines were important in our study; however, all-day routines were important as well. For example, for our participants, the coordination of their daily schedule to consider appropriate naptimes and children's school schedules was critical for a stable sleep. They also shared how having guests in the home influences the sleep environment and routine (e.g., delays to dinner and bedtime). To establish an effective routine that sustained the family, they implemented various strategies (e.g., routine checklists for the nap and bedtime routine), rules (e.g., token system), and motivation for children (e.g., reward). These examples showed the necessity of considering the family's daytime activities and evening routines to understand family sleep properly.

To understand complex issues related to family sleep, designers need to consider spaces beyond the bedroom. In previous studies,

researchers investigated how technologies can create an improved sleep environment by providing better lighting, sounds, air quality, and humidity, and by detecting other family members' motions [29, 53]. When we permitted participants in our study to freely explain their sleep issues without providing our conceptual boundary of what defines sleep, they explained issues both inside and outside the bedroom, including the playground, where children can tire themselves out. For example, one of the most important sleep issues for our participants emerged when families are traveling. To alleviate the effect of sleep environment changes, families needed to have strategies. As these examples showed, the issues originate from the changed environment, which is not necessarily bounded to the bedroom or even to the house.

Lastly, the unit of analysis for our participants was not the individual but rather families as a whole. When medical studies investigated sleep, they focused on an individual's sleep quality. These subjects were examined in the lab, and their sleep behaviors were quantified (e.g., how many times they awakened at night, how long they slept). Because of the unit of analysis was the individual sleeper, apps created as a result of medical studies suggested individual-focused solutions to improve sleep quality. In HCI, the unit of analysis has become the family [26, 86, 87]. Because both family-centered and system perspectives have been critical lenses for understanding family health management in different contexts, including everyday wellness management [67, 72, 94–96] and chronic illness contexts [100], studies have emphasized that collaborative effort in daily life can facilitate successful family sleep [87].

However, the importance of the family as a unit of analysis works only when the social dynamics among the family members are considered. For example, participants often explained that their children's frequent waking up was an important sleep issue. This is problematic because children could not have quality sleep as individuals, which caused tantrums and other behavior issues during the day. In many cases, this frequent waking up caused not only children's behavior issues but also affected parents' mental and physical wellness. For our participants, this frequent waking up impinged on their own valuable self-care time. This was especially true for the mothers in our study. After spending a busy schedule supporting and managing families, the mothers wanted to focus on themselves. However, their children's unstable sleep was a major interruption for their self-care time. In addition, this issue reminded them to question why the frequent waking up should always be handled by the mothers rather than their partners. As the example shows, the sleep issue is not only an individual issue (child's sleep). The real issue emerged from the family's unbalanced role distributions or gendered roles. Although there are many sleep-information tracking and routine reminder apps that are commercially available through smartphones and wrist-worn devices, those solutions focus on tracking information among family members by motivating each other to participate. They do not take into account the complex social dynamics among family members. Even after HCI researchers applied family-system perspectives, they focused on the benefits for families to collaboratively track and share health information, or parents to support their children's tracking. However, as the example above explains, the actual issues need stronger social intervention rather than merely sharing sleep-quality, tracking data among family members. Our results showed that technologies that

lack family dynamic aspects would not be effective for families, particularly those with young children.

When social problems are examined, evaluated, and addressed within a set of boundaries, there is always the possibility that the solution lies outside those boundaries. Thus, technologies that were designed within the constraints of these boundaries (time, space, and unit of analysis) were not able to properly assist our participants with their complex sleep issues that stemmed from family dynamics. The limits imposed by boundaries to understand complex social issues have been criticized in both HCI and STS [33, 50, 52, 60, 64]. For example, Cowan described how the boundary between workplace and home excludes home as part of a socioeconomic system, and how that exclusion devalued the labor at home [33]. Latour explained how sociology did not see the complex issues of society, because researchers tend to focus on predefined boundaries, such as geographically-bounded social actors [60]. Jenkins discussed difficulties in representing families' unique needs and cultures when designers focused on general, idealized home environments that were predicated on traditional boundaries [52]. Reconstructing the elements of family sleep will enable researchers to understand sleep issues of families with young children, which were previously invisible due to widely accepted perspectives on sleep [77]. Although sensing technologies for sleep improved an understanding of individuals' sleep during the nighttime, they could focus on less visible factors (e.g., children's frequent requests after bedtime routine) that actually cause deeper issues regarding families' well-being (e.g., parents having less self-time, more daytime fatigue, and eventually worsened sleep quality). By visualizing the interconnectedness, family-based technology can allow families to consider neglected but critical issues, thereby improving their routine wellness behaviors.

5.2 Towards sleep technologies that challenge an unbalanced division of labor

One of the most salient themes discussed in our interviews was how participants, especially mothers, want to share their heavy responsibility: they wanted to redistribute labor among family members. In our study, the parents of young children, particularly mothers, expressed burdens related to managing family life regardless of their occupations. For example, stay-at-home mothers said it is their responsibility to manage children's time for school, academics, and extracurricular activities while their husbands are at work, and working mothers also mentioned that children tend to ask for mothers' attention, especially around their bedtime. Among the twenty parents who participated in our interviews, only two were male (fathers). We acknowledge that we did not have enough male participants to discuss their view of family sleep. Although intended to have a balanced gender ratio of participants to understand both sides of the view on family sleep, only two male participants expressed their interest during the recruitment phases, and this indicated that household tasks related to children's sleep can mainly be considered a mother's duty. In fact, mothers in our study believed that it was primarily their responsibility to create the necessary conditions for a family's sleep, particularly for family schedule management and coordination of work. They expressed that redistribution of their household responsibilities among other

family members was essential not only for improving their sleep, but also for having appropriate self-care and well-being. For our participants, children's sleep meant not just time for children to rest, but securing self-care time and engaging in different activities (e.g., reading a book, hobbies) to unwind from the day's obligations. Unlike previous sleep studies focusing on efficient collaboration among family members [37, 72, 78, 81, 82, 88, 96], including health and wellness management [16, 39, 47, 72, 86, 87, 96], we address the importance of challenging and intervening on the existing division of labor in home settings by reallocating labor [91] as a way to support quality sleep for the whole family.

In HCI, the division of labor has been a vital concept for investigating unbalanced labor distribution among family members [12, 19, 63, 92]. For example, Lee and Šabanović [63] pointed out gendered roles as an essential but less highlighted concept of technology design in home settings. The study found that domestic technologies are used, adopted, and envisioned in the context of gendered social dynamics. A STS scholar, Cowan, showed how the unbalanced division of labor in home settings was reinforced by domestic technologies [33]. She explained how labor distribution is socially, politically, and economically constructed inside the home as part of a larger socioeconomic system and how domestic technologies reflect that division of labor. The early smart home studies were criticized due to its lack of understanding of gender dynamics and division of labor [14, 93], and studies addressing gender dynamics opened a new direction of home technology studies [13, 91]. As gender dynamics gain more attention in HCI, researchers have adopted more feminist approaches in home technology design [7]. Lukoff et al. used a feminist HCI lens to understand how design of technology can encourage fathers' involvement in childcare, and engagement with their identities as fathers [73]. D'Ignazio showed how breast pump design, an important technology for motherhood was overlooked, and discussed emotional burdens and changes of the postpartum period for mothers [34]. In line with this series of studies, our study explores how technology design could intervene in division of labor, and how previously invisible gender roles come into play in sleep management in home settings.

The integration of division of labor into the design of sleep-support technology can change the social dynamics among family members so that parents - particularly mothers - can no longer be considered to have sole responsibility for managing the family's sleep and instead can strive to secure their own time and sleep. Such a platform could enable family time and labor to be common resources by, for instance, visually showing how time-saving practices in one part of family life (e.g., children doing their chores) can benefit other parts of their life (e.g., saving parents' time) and eventually contributing to improved sleep for them. By revealing the involvement of each family member in what would otherwise be invisible work [107], we can emphasize the interconnectedness that motivates family members. This critical view could help HCI researchers to enhance families' collaborative work regarding sleep issues by challenging their existing gender dynamics rather than affirming them.

6 LIMITATIONS

As the majority of participants were upper middle class from the midwestern United States and mothers, our study populations were relatively homogeneous. We also included only two single-parent families; the rest of our participants were heterosexual parent households with child(ren). Given that today's families are becoming more diverse, expanding study populations (e.g., single parent, same-sex parents, extended families) could help us be reflexive regarding the conventional definition of families. It would also be useful to compare groups of participants with specific characteristics, such as by age or number of children in a household. Also, our study only included parents' voices, not children's. For future phases, it will be necessary to understand how children perceive their family's sleep management practices, and identify implications for the technology design. Similarly, future studies should address details of each family members' sleep-related behaviors and different motivations that affect the actual quality of their sleep. Addressing such factors will contribute to knowledge on how family-centered sleep technologies can improve individual family members' sleep by considering specific factors of family sleep.

7 CONCLUSION

In this study, we interviewed twenty parents of young children and showed that sleep is a complex experience entangled with social dynamics between family members. Previous sleep studies have focused on family sleep through the lens of a specific time, space, and unit of analysis, thus limiting the opportunities to tackle the deeper issues. Through interviews with our participants, we found that although the bedtime routine and bedroom environment are critical to maintaining good sleep, they are only one aspect of understanding family sleep. We suggest reconstructing the elements of family sleep to look beyond the bedroom, beyond bedtime, and beyond the individual sleeper. This will enable researchers to consider the integration of the division of labor into sleep-support technology design and change the social dynamics among family members so that mothers no longer feel sole responsibility for coordinating their family's sleep routine. This study will give designers a broader perspective - one that considers the role of householders - on family sleep and the use of home technologies.

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