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Design Implications for design of mind-body technology for adolescent sleep

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**Abstract**

Design Implications for design of mind-body technology for adolescent sleep

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Sleep problems are common in adolescents and impact many aspects of young people. Pervasive media use, particularly in the evening, is a major reason for sleep problems in adolescents. Current approaches to reducing media use in adolescents with sleep problems have been met with many challenges. A “harm reduction model” based intervention to reduce the adverse consequences of media use (i.e., arousal from media use) without trying to eliminate media use can be feasible and helpful. Yet, very few studies have used the harm reduction model to target media use in adolescents. Mind-body approaches that improve self-awareness and self-regulation offer an alternative harm reduction-based approach to reduce media-induced arousal that could be more acceptable to families but has not been explored for media use among adolescents.

Mind-body approaches have been shown to help adolescents in the treatment or self-management of various conditions including insomnia, and sleep disturbance. Existing mind-body approaches

for adolescents have been delivered in person or at schools but are not readily accessible due to high cost and high dropout rates. There have been increasing calls to deliver mind-body approaches digitally to adolescents making them more accessible and scalable. Even though there is an increasing focus on mind-body technology most of the existing literature has focused on the adult population. There is very little work involving adolescents in the design of mind-body technology. Because of the lack of work involving adolescents in the design of mind-body technology, this important primary user group is often left to use mind-body technology that is not designed considering their preferences and needs. Engaging adolescents in the development of technology for mind-body approaches can help inform design of tools that meet their needs.

In this dissertation, guided by Human-Centered Design (HCD) as a methodological framework that emphasizes the participation of technology users in the design process, I describe adolescent and parent perspectives on adolescent bedtime media use and parental mediation strategies of adolescent bedtime media use (Aim 1). I examine adolescents' and parents' interests in the use of mind-body approaches to mitigate the effects of media use on sleep (Aim 2). I then formulate design implications for digital mind-body technology through co-design workshops with adolescents (Aim 3). Results from these studies can inform the design of informatics solutions that have the potential to mitigate sleep problems in adolescents. Implications that future researchers, designers, and practitioners should consider when creating new mind-body technology for adolescents include providing a variety of content with the ability to customize and personalize, including functionalities that engage adolescents like games and rewards while avoiding distractions, allow for granular sharing controls, provide intelligent content while maintaining privacy and trust, offer multiple modalities for interaction with technology and consider the context

of adolescent and their families. Findings provide a foundation for designing digital mind-body tools for adolescent sleep.

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## Chapter 1 Introduction

Sleep problems are common among adolescents. Sleep disturbance impacts many aspects of young people including academic performance, social, and emotional life. Studies have shown the pervasive use of media like television, smartphones, video games, particularly in the evening is associated with sleep problems<sup>1-3</sup>. Media use can increase mental, emotional, and physiological arousal which in turn might lead to sleep disruptions<sup>2,4,5</sup>. With the growing prevalence of technology use among U.S adolescents<sup>6,7</sup>, media use and the associated sleep problems are likely to increase.

Current approaches to reduce media use in adolescents with sleep problems have been met with many challenges<sup>8-10</sup>. Interventions to reduce screen time have largely focused on restricting media usage<sup>11,12</sup> an option that most adolescents find unappealing<sup>13</sup>, and their families have challenges implementing/enforcing<sup>14</sup>. A harm reduction approach to reduce the adverse consequences of media use (i.e., arousal from media use) without trying to eliminate media use could be applied instead. Harm reduction<sup>15</sup> is an intervention approach that reduces the adverse consequences of health behavior in a non-judgmental manner without trying to eliminate the behavior itself<sup>15</sup>. Yet, very few studies have used the harm reduction model to target media use in adolescents<sup>16</sup>. Mind-body interventions improve self-awareness and self-regulation<sup>17</sup> and have the potential to serve as harm reduction-based interventions by mitigating the mechanisms of increased arousal due to media. Mind-body approaches have been shown to help adolescents in the treatment or self-management of various health conditions<sup>18-20</sup>. Yet there are many challenges with how existing mind-body approaches for adolescents are delivered including high cost, high dropout rates, and difficulty with implementation and training<sup>21,22</sup>. There have been increasing calls to deliver mind-body approaches digitally to adolescents making them accessible and scalable<sup>23</sup>. Despite the potential of technology to support mind-body approaches most of the work has focused on adult population<sup>21</sup> and there is very little work involving adolescents in the design of mind-body technologies<sup>21,24</sup>. Thus adolescents are often left to use digital mind-body tools that are not designed considering their needs and preferences. There is lack of work engaging adolescents in design of mind-body based digital tools.

In this dissertation, guided by Human-Centered Design (HCD) a methodological framework that emphasizes the participation of technology users in the design process<sup>25,26</sup>, I investigate user needs and formulate design implications for a digital mind-body based tool for mitigating effects of media use on sleep in adolescents. Findings from this research inform the design of informatics solutions that can mitigate sleep problems in adolescents.

## **1.1 Dissertation Aims**

Through this dissertation research, I address the following aims -

Aim 1: Explore adolescent bedtime technology use and parental mediation strategies of adolescent bedtime technology use. Specifically, I will:

- Describe adolescent bedtime technology use (1.1)
- Describe parental mediation strategies of adolescent bedtime technology use (1.2)
- Describe parental concerns about bedtime media use and challenges that parents face in implementing bedtime mediation strategies (1.3)

Aim 2: Describe parent and adolescent interest in the use of mind-body technology to mitigate the effects of media use on sleep. Specifically, I will

- Describe parents and adolescents' current exposure to mind-body approaches (2.1)
- Describe the challenges that adolescents face in learning and practicing mind-body approaches (2.2)
- Describe parents and adolescents' interest and preferences in using technology for learning and practicing mind-body approaches

Aim 3: Formulate design implications for the design of digital mind-body technology for adolescents through the use of co-design. Specifically, I will

- Engage with adolescents through co-design and
- Examine adolescent perceptions on mind-body technologies for sleep (3.1)

To achieve the three aims mentioned above, I conducted two studies – an interview study with adolescent-parent dyads (with two unique data analyses for Aims 1 and Aims 2 presented in

chapters 3 and 4) and co-design workshop study (for Aim 3 presented in chapter 5). It is important to note that both studies were conducted remotely during the COVID-19 pandemic.

### ***1.2.1 Focus on early adolescence.***

Throughout my dissertation, I focus on adolescents between the ages of 10-14. It is during this stage of adolescence that children are still dependent on their parents for many aspects of their life, yet are slowly learning and gaining independence over their bedtime media use and sleep routines. The skills, habits, and routines developed at this stage can be life skills that youth carry over throughout their life.

Adolescents are typically early adopters of technology<sup>27</sup>. It is also at this stage of life that parents are learning how to develop their child's independence and foster healthy relationships with their teens.

### ***1.2.2. Focusing on parent-adolescent dyads – a socio-ecological framework inspired research design***

According to Glanz et al., “*The core concept of an ecological model is that behavior has multiple levels of influences, often including intrapersonal (i.e., biological, psychological), interpersonal (i.e., social, cultural), organizational, community, physical environmental, and policy*”<sup>28</sup>(p.466). The four core principles of ecological perspective include 1) *Multiple levels of factors influence health behaviors* 2) *The influences interact across levels* 3) *multi-level interventions should be most effective in changing behavior; and 4) ecological model are more powerful when they are behavior-specific and tailored to specific behaviors*<sup>28</sup> (p.470).

Adolescents present a unique population to design interventions for as they are still dependent on their parents for many aspects of their life. Moreover, the support of family, peers, parents<sup>29</sup>, peers<sup>30,31</sup>, teachers<sup>32</sup> can positively impact media use behaviors of youth. Studies focusing on adolescent self-management for asthma<sup>33</sup>, pain<sup>34</sup> have incorporated the perspectives of adolescents, parents, and clinicians in their design process. Systematic reviews have recognized the need to incorporate “secondary users and supporting players” in the HCD process<sup>35</sup>. I utilized the socio-ecological model by McLeroy et al<sup>36,37</sup> as a guiding model for the research design of this dissertation. I specifically chose this model as it was created specifically for applications to health behaviors and health promotion<sup>28</sup>.

Figure 3 describes the impact of stakeholders on media use behaviors of adolescents across different levels of Mcleroy et al's ecological model for health promotion <sup>37</sup>. In my dissertation work, I involved key stakeholders across 2 levels (i.e., youth and family) to understand key perspectives on media use, sleep, and mind-body approaches (Aim 1 and Aim 2) and formulate design implications through co-design (Aim 3). In addition, I engaged with key stakeholders from the organizational and community level (highlighted in green in figure 3) as part of an advisory board which contributed by offering guidance and feedback on the study design, implementation, and results.

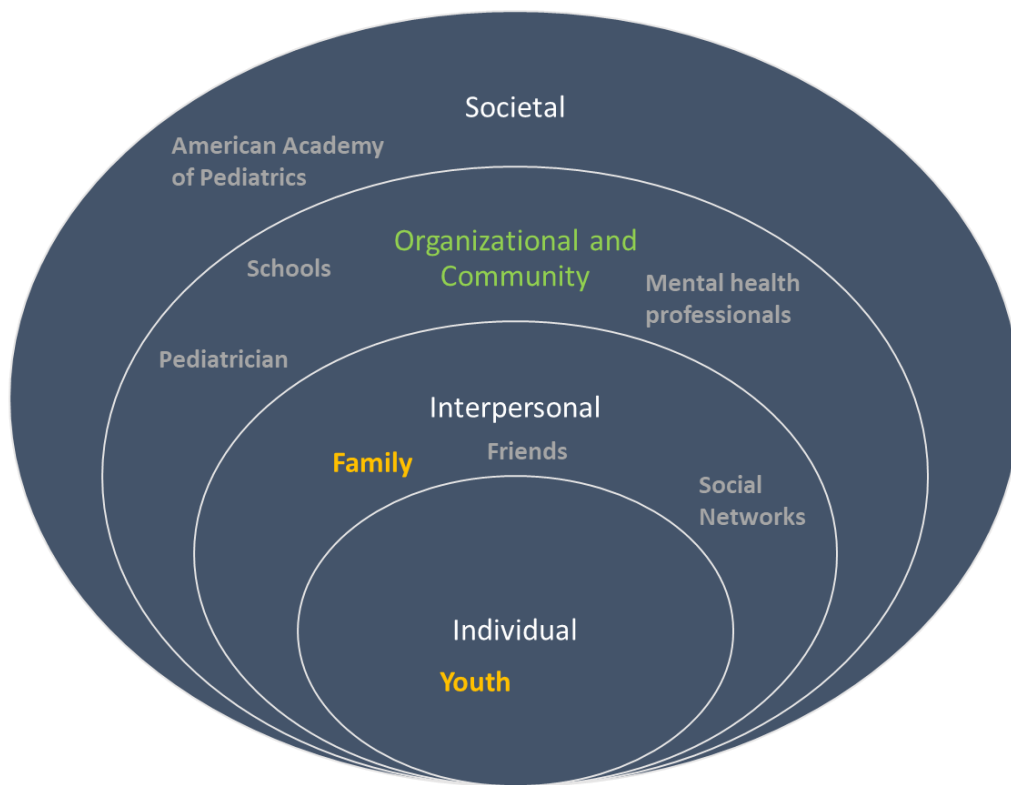


Figure 1.1 Socio-ecological framework illustrating stakeholders that can positively impact media use behaviors of adolescents. Highlighted in yellow are key stakeholders I will include in Aim 1 and Aim 2 and green includes stakeholders from the advisory group. Adapted from Mcleroy et al's ecological model for health promotion<sup>37</sup>

### 1.2.2. Scope of mind-body approaches

Given that there are many types of mind-body approaches I first focused on scoping the available literature of mind-body approaches for this dissertation. I created a list of the mind-body approaches based on literature <sup>38-40</sup> (see Appendix A: Table of Mind-Body approaches.) I identified

14 approaches. I then utilized Liverpool et al.'s framework<sup>41</sup> of factors influencing engagement in children and young people's mental health digital intervention to define inclusion criteria to narrow the mind-body approach list so that it's pertinent to adolescents and consumer health informatics domain. Liverpool et al propose that there are three intervention-specific influencing factors for engaging adolescents in digital interventions namely i) suitability (i.e., the degree to which the digital intervention is in line with daily activities and is accessible and convenient) ii) usability (i.e., the degree to which the digital intervention is able to be used like easy to use, not too difficult, self-paced) and iii) acceptability (willingness to use like features of the digital interventions e.g. Interfaces)<sup>41</sup>. I particularly focus on suitability in this dissertation to narrow the list of mind-body approaches as usability and acceptability are factors related to features of the technology. Utilizing this framework, I defined 3 criteria for ensuring the mind-body approach was suitable (i.e., accessible and convenient) 1) adolescents should be able to practice the approach on their own at home, 2) the approach should not require any kind of specialized equipment, 3) the approach should not involve any special setting/postures. Using these three criteria I narrowed the list from 14 possible approaches to 5 approaches (see bolded rows in Appendix A) that I focus on for my dissertation: meditation, relaxation, yoga, art therapy, and music therapy.

### ***1.2.3 Engaging an advisory board of domain experts.***

I engaged an advisory board made up of domain experts in mind-body approaches, adolescent health care providers, mental health professionals during all phases of the project (See Appendix B for advisory board members). The advisory board provided input and feedback during various stages of the dissertation including

- 1) Scoping the mind-body approaches - The advisory board provided insights on the framework chosen to narrow the list of mind-body approaches.
- 2) Recruitment Materials – The advisory board provided input on study recruitment materials (i.e., surveys, interview protocol and design session protocol)
- 3) Recruitment – The advisory board helped brainstorm potential recruitment methods for reaching adolescent participants. For example, an advisory board member provided information regarding a university parenting listserv that I utilized for recruitment for Aim 3.

- 4) Design Session Planning – The advisory board also help with identifying technologies that are available commercially that I utilized in the design session (described in section 5.2)
- 5) Results – The advisory board also served as a sounding board for the results from the project

## **1.2 Dissertation Overview**

I begin this dissertation in *Chapter 2* by summarizing the related work in medicine, consumer health informatics, and human-computer interaction fields. Based on this review of the literature, I identify three key areas to explore in this dissertation including 1) the need to understand bedtime technology use of adolescents and parental mediation practices for bedtime media use, 2) the needs, interests and preferences for digital mind-body tools for adolescents and 3) involving adolescents and formulating design implications in the design of mind-body technology. To explore these areas, I utilize a Human-Centered Design as a guiding framework.

### **Overview guided by Human Centered Design**

My overall dissertation is guided by the framework of Human-Centered Design process<sup>25</sup>. I employed the ISO standard for Human-Centered Design (HCD) (figure 4), a methodological framework that emphasizes the participation of technology users in the design process<sup>25</sup>, to guide the aims of this project. The approach involves a multi-stage problem-solving process in which the needs, desires, and limitations of users are inquired and analyzed. HCD involves an iterative process comprised of 4 phases (as shown in figure 2) to 1) Understand user needs and specify context of use, 2) Specify user requirements, 3) Produce design solutions, and 4) Evaluate designs against requirements<sup>25</sup>. In this dissertation, through Aims 1, 2 and 3, I focus on phase 1 and phase 2 of this process (indicated in red in Figure 1.1).

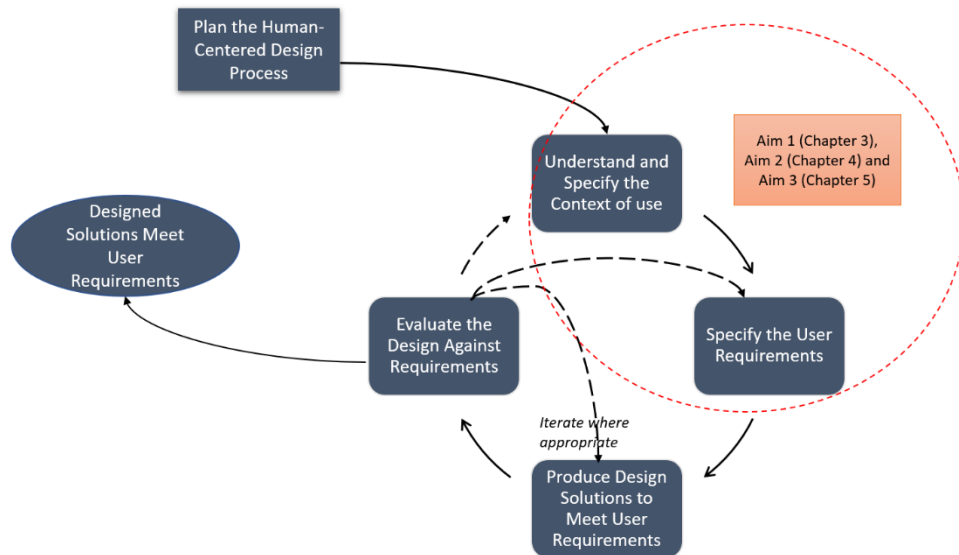


Figure 1.2 Human-Centered Design Framework adopted from<sup>25</sup>

In *Chapter 3*, I report on Aim 1. I detail the methods and findings of interviews and surveys with parent-adolescent dyads (n=11). I describe adolescent bedtime media use, the parental mediation strategies of adolescent bedtime media use, and describe challenges that parents face in implementing bedtime mediation strategies. I highlight the need for digital interventions for adolescent bedtime media use take into account the technology adolescents use at bedtime, mediation strategies of families and challenges parents face in implementing mediation strategies.

In *Chapter 4*, I report on Aim 2. I reiterate the methods and detail findings of interviews with parent-adolescent dyads (n=11) to describe exposure to, interest in, and preferences for digital mind-body technology for sleep. I show that parents and adolescents not only demonstrate a willingness to learn mind-body approaches via technology they also have several challenges in learning mind-body approaches and some preferences for mind-body technology.

In *Chapter 5*, I report on Aim 3. I detail the methods and findings of co-design sessions where I engaged adolescents (n=16) in design of mind-body technology and examine adolescent perceptions on mind-body technologies for sleep. Based on these findings, I formulate design implications for mind-body technologies for sleep.

Finally, *Chapter 6* contains a summary of my key findings and contributions as well as how they fulfill the aims of this dissertation. In this chapter, I point to areas for future research and provide a concluding statement about the contributions of my dissertation work.

## Chapter 2 Related Work

I draw upon several knowledge domains to inform and guide my work, particularly from the fields of medicine, consumer health informatics and human-computer interaction. In this chapter, I describe the primary motivation of this dissertation. I summarize the problem of sleep in adolescents due to bedtime media use, and the limitations of existing approaches to reducing bedtime media use. I outline the potential for mind-body approaches to help reduce impact of media use on sleep and the need for technology-based mind-body approaches for adolescents.

### **2.1 Sleep problems in adolescents due to pervasive media use is an important public health problem**

Sleep problems are increasing in adolescents. The American Academy of Pediatrics recommends that children (6-12 years) should sleep 9-12 hours per 24 hours and teenagers (13-18 years) should sleep 8-10 hours per 24 hours<sup>42</sup>. A study by Wheaton et al based on the Youth Risk Behavior Survey showed that the prevalence of short sleep duration ranged from 31.2% in adolescents ages 13-17 years with only 23.8% among adolescents reporting a regular bedtime<sup>43</sup>. Similarly, a study by Tsao using the National Survey of Children's Health showed that shorter sleep duration was found in 36.4% of 6- to 12-year-olds and in 31.9% of 13- to 17-year-olds<sup>44</sup>. Further studies have also shown that COVID-19 pandemic significantly altered normal sleep patterns for children and teenagers<sup>45</sup>. Lack of sleep affects psychosocial health (e.g., depression, mood disturbances), school performance and risk-taking behaviors (e.g., use of nicotine and marijuana) of adolescents<sup>46</sup>. Sleep disturbance in childhood can also lead to long-term health consequences like obesity, depression, substance abuse<sup>47,48</sup>.

The pervasive use of media (e.g., television, smartphones, computer, video games), particularly in the evening, has been linked to sleep problems<sup>1-3</sup>. The American Academy of Pediatrics recommends that *parents of children (5-18 years) place consistent limits on use of **any** media including entertainment media as well as educational media*<sup>49</sup>. They further recommend keeping media outside of kid's bedroom<sup>49</sup>. However, a study by Common Sense Media in 2019 using a nationally representative sample of 1660 U.S. adolescents has shown that on average children (8-12 years) use 5 hours of media and teens (12-18 years) use seven hours of media per day<sup>6</sup>. This includes only media use for entertainment and did not include time spent using screens for school

or homework. Similarly, a study in 2019 with 1000 U.S. adolescents showed that 68% of youth kept their mobile device either in bed or within reach at night<sup>7</sup>. The study further reported that 70% of youth used their devices within 30 minutes of falling asleep at night.

Media use has been associated with shorter sleep duration, difficulties falling sleep, later bedtimes, awakening at night<sup>2</sup>. Media use affects sleep through several mechanisms, including displacement of time, psychological stimulation and arousal from content, and circadian effects of light<sup>50</sup> Media use can increase mental, emotional, and physiological arousal<sup>2,4,5</sup> which in turn can lead to sleep disruptions. Figure 2.1 illustrates the relationship between media use, and sleep and the mechanisms of how media use affects sleep<sup>5</sup>. With the growing prevalence of technology usage among U.S. adolescents<sup>6</sup>, media use is likely to increase. Hence, there is a need for interventions that target bedtime media use and sleep in adolescents.

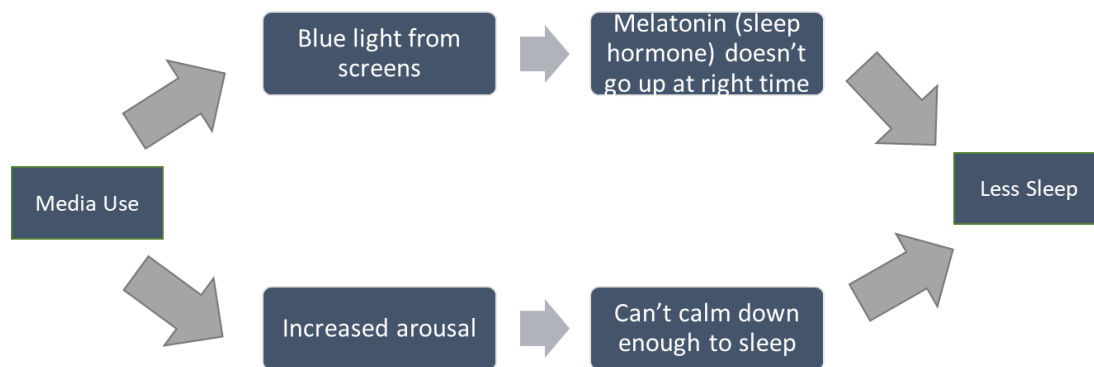


Figure 2.1 Figure illustrating the relationship between media use, and sleep. Adapted from<sup>5</sup>

## 2.2 Current approaches to reduce bedtime media use have been met with challenges.

Current approaches to reducing bedtime media use among adolescents as recommended by the American Academy of Pediatrics include placing consistent limits on use of media, turning off screens and removing them from bedroom 30-60 minutes before bedtime, parents developing media use plan with kids<sup>11</sup>. Current approaches to decreasing media use have been met with challenges when enforcing and implementing by both adolescents and parents<sup>8-10</sup>. A systematic review of interventions altering children's screen use and its effect on sleep highlighted the challenges with sustainability, long-term compliance and maintenance of strategies to maintain

reduced screen time<sup>12</sup>. Interventions to reduce screen time have largely focused on restricting media usage, an option that youth have found unappealing<sup>13</sup>. Additionally, most of the approaches to reduce bedtime media use for adolescents rely on parental mediation behavior and need the help of parents and caregivers to implement, support, and sustain.

### **2.2.1 Role of parental mediation on adolescent media use**

Parental mediation has been defined as strategies that parents use to control, supervise or interpret content to mitigate the negative effects on children's physical, psychological, and emotional health<sup>51</sup>. Various factors influence parental mediation, including parent-related factors (e.g., parent age, gender, parent's belief, parent's digital skills, family dynamics) and child-related factors (e.g., age, gender, child technology use patterns, child's self-regulation, and digital skills)<sup>29,52</sup>. Parental mediation practices of media use have been primarily rooted in television studies<sup>51</sup>. Six types of parental mediation have been distinguished in the literature: no mediation, active mediation, co-use, restrictive mediation, investigative mediation and diversionary mediation<sup>51,53</sup>:

Jiow and colleagues assert that some parents use multiple mediation strategies concurrently and toggle between different mediation strategies<sup>53</sup>. As families use different types of media beyond television there is need for more research on how parental mediation fits within digitally saturated home environments<sup>54,55</sup>. In 2013 American Academy of Pediatrics reported that two-thirds of parents lacked rules about time spent with electronic media<sup>55</sup>. Parents have reported various barriers to implementing mediation strategies including their busy lifestyles, lack of skills, lack of parental control, difficulty keeping up with expert recommendations<sup>14</sup>. Systematic reviews have shown that most of parental mediation literature is quantitative and primarily focuses on use of the internet<sup>56</sup>. Modecki et al further state that "*Current approaches to understanding how parents monitor and support adolescent development in the digital age are arguably antiquated, fragmented, and riddled with ad hoc measurement. Yet the way researchers conceptualize, study, and understand the interface of parenting and technology is becoming ever more critical*" (p1677)<sup>56</sup>. To effectively design interventions to reduce bedtime media use among adolescents it is important to consider the newer digital technology that adolescents use, the parental mediation strategies, the role of parenting, family dynamics and context.

### **2.3 A harm reduction model-based approach to reduce adverse effects of media use on sleep can help**

Commonly used in the field of addiction and substance use, harm reduction is “*an evidence-based, person-centered approach that seeks to reduce the health and social harms associated with a particular behavior, without necessarily requiring people from abstaining or stopping the behavior (pg. 335)*”<sup>57</sup> Harm reduction models offer a practical and compassionate alternative to other disease models of public health<sup>58</sup>. Harm reductions acknowledges abstinence as an ultimate goal but at the same time stives to reduce the harmful behavior and associated causes<sup>58</sup>. Research on harm reduction interventions for alcohol, substance use has shown efficacy in reducing its adverse consequences for adult behavior<sup>59,60</sup>. There have been calls to utilize harm reduction strategies for media use. Heller has recommended use of harm reduction approaches for infant media use iterating that such an approach may be more feasible than eliminating media use<sup>61</sup>. Further Leigh et al recommend that “*embracing tenets from the harm reduction literature may prove useful in limiting the negative impact of screen time in which we know children, and their parents, will continue to participate*” (pg.336)<sup>57</sup>. Thus a “harm reduction model” based intervention to reduce the adverse consequences of media use (i.e., arousal from media use) without trying to eliminate media use can be feasible, useful and helpful. Despite this promise, few studies using harm reduction models target media use and sleep in youth<sup>16</sup>.

### **2.4 Mind Body approaches have the potential to serve as a harm reduction-based interventions to mitigate media-induced arousal, but have limited accessibility and scalability.**

Mind-body approaches that improve self-awareness and self-regulation offer an alternative to reduce media-induced arousal that could be more acceptable to families but has not been explored for media use among adolescents. Mind-body approaches include a large and diverse group of procedures and techniques e.g., yoga, acupuncture, tai chi, breathing exercises, meditation, biofeedback. Mind-body approaches have been shown to help in treatment or self-management of various conditions like chronic pain, headache, anxiety, eating disorders, insomnia, stress, sleep disturbances in children and adolescents<sup>18-20,62-65</sup>. A systematic review of mind-body interventions for sleep in adolescents demonstrated that mind-body approaches can help improve sleep

efficiency and outcomes<sup>21</sup>. Mind-body approaches involve three core processes to increase mind-body awareness: 1) experiential awareness 2) attention control and 3) acceptance<sup>66</sup>. Mind-body approaches can increase self-regulation, body awareness, attention regulation<sup>17</sup>. Fig 2.2 illustrates the potential harm reduction-based approach through which mind-body approaches can help reduce the impact of media use on sleep.

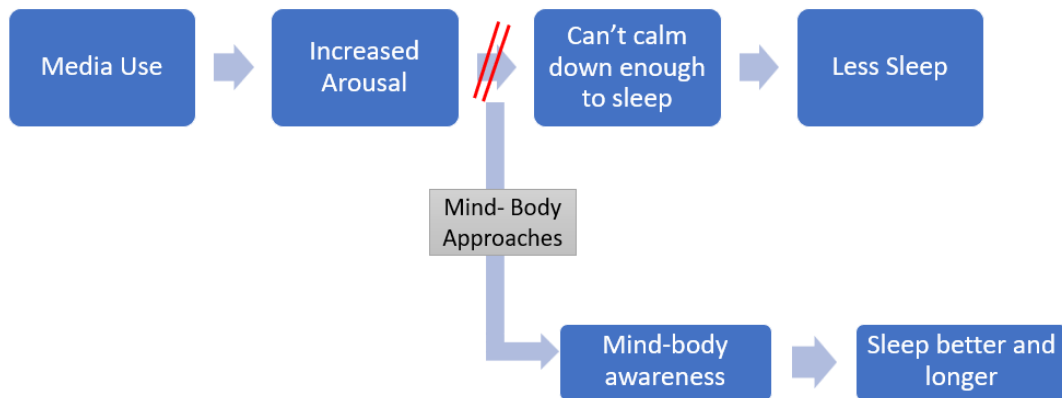


Figure 2.2 Use of mind-body approaches to reduce the impact of media use on sleep. Adapted from<sup>5</sup>

The use of mind-body approaches among adolescents is increasing. For example, Wang et al utilized a nationally representative sample to show that 10 million parents of children (4-17) with mental health issues reported the use of alternative therapies including herbal remedies, mind-body therapies and chiropractic care<sup>67</sup>. The study further showed that the prevalence of mind-body approach among children with mental health condition significantly increased when children had sleep problems<sup>67</sup>. Yet many existing mind-body approaches for youth have been delivered in person either in schools<sup>68,69</sup> or in group settings<sup>21</sup>. Unfortunately, not all adolescents can access these options. In-person sessions are not accessible for many adolescents due to high cost and high dropout rates<sup>21</sup>. Additionally, delivery of mind-body approaches in school has been met with many challenges including implementation and training<sup>22</sup>. There have been increasing calls to deliver mind-body approaches digitally to adolescents making them accessible and scalable<sup>23</sup>.

## **2.5 Digital technology can make mind-body approaches more accessible and scalable.**

Digital technology provides the opportunity to deliver mind-body approaches to adolescents via an easy-to-access, low cost and scalable modality. Experts on adolescent sleep research have highlighted the need for leveraging innovative technology for adolescent sleep interventions and also utilizing mindfulness-based interventions as a first line-treatment for adolescent sleep problems<sup>70</sup>.

Emerging evidence suggests that mind-body interventions delivered online can lead to improved mental health outcomes in adolescents<sup>71-73</sup>. Despite the potential of technology to support mind-body approaches, there is very little work in technology-based mind-body interventions for adolescents in general<sup>74,75</sup> and even less focused on adolescent sleep<sup>21,24</sup>. A scoping review of mind-body approaches for adolescent sleep by Garbers et al found that only one of twelve studies utilized technology to deliver the mind-body approach to adolescents<sup>21</sup>. In the review, the authors identified that the internet-based mind-body intervention was able to reach a large population and had the biggest sample size. Digital technology can help overcome barriers associated with in-person approaches (e.g., high cost, high dropout rates, lack of availability). Adolescents these days have daily contact with a wide range of digital technologies and nearly 95% of teens ages (13-17) have access to smartphones<sup>27</sup>. Thus, digital technology can make mind-body approaches more accessible to adolescents at scale.

## **2.6 Adolescents need to be involved in the design of mind-body technology**

Over the last decade, there has been increased focus on research on digitally mediated mind-body practices to support mental health outcomes in adults. For example, there has been a focus on supporting mind-body approaches through apps<sup>76-79</sup>, interactive technologies like virtual reality<sup>80-82</sup>, and intelligent chatbots<sup>83</sup>. Each of these technologies presents a unique potential for a digital mind-body approach. But most of this work has focused on adults. The commercial mobile app space also has been flooded with mindfulness apps for adults. Systematic review of mindfulness-based apps for adolescents showed that a majority of apps are non-evidence based and even when scientific evidence supporting their effectiveness exists it is only for adult populations<sup>77</sup>. Thus, even though there is an increasing focus on mind-body technology most of the existing literature

has focused on the adult population. There is very little work involving adolescents in the design of mind-body technologies<sup>21,84</sup>.

Designing digital technologies for mindfulness has been identified as a “grand challenge” for HCI researchers<sup>85</sup>. Research indicates that digital tools work best when they are user-centered (i.e. take the needs, barriers, and design preferences of target users into account) and can be tailored to different types of users and across different contexts<sup>35,86</sup>.

Because of lack of work involving adolescents in the design of mind-body technology, this important primary user group is often left to use mind-body technology that is not designed considering their preferences and needs. In a survey of parent “Calm” app (<https://www.calm.com/>) users (n=2944) 52% reported that their children used Calm among which 76% of children used it for sleep<sup>84</sup>. Calm is an app that is designed for adults and not adolescents<sup>84</sup>. Nunes et al conducted a review of mindfulness apps for children and found out of 2000 mindfulness-based apps only 3% of apps on the app store are deemed suitable for children<sup>77</sup>. Among those deemed suitable for children, they found that apps ranked very low in engagement and aesthetics<sup>77</sup>. Similarly, a review of 29 mental health apps for adolescents (including 7 that offered mindfulness exercises) has shown that there is a lack of fit between youth preferences and how the apps deliver their content<sup>87</sup>. The authors state that “*Youth mental health promotion apps are not tailorable to any meaningful degree, they are barely interactive, rely heavily on static text, and they do not make meaningful use of visual media*” (p.12)<sup>87</sup>. Yet one limitation of the study was they didn’t include any adolescents in the study but used youth psychologists and literature to arrive at youth preferences. Engaging adolescents in the development of technology for mind-body approaches can help inform design of tools that meet their needs.

Previous work in HCI and mind-body technology has employed expert-centered approaches where researchers have worked with mindfulness teachers, experts, and practitioners to evaluate existing apps<sup>88</sup> or to solicit feedback on the design of mind-body technology<sup>89</sup>. Work by Lukoff et al. with mindfulness teachers show that there is a mismatch between the practice of mindfulness and existing features and design in apps<sup>88</sup>. For example, social comparison a feature present in many mind-body apps does not support the principles of mindfulness where the focus is on social support and not social comparison<sup>88</sup>. It is important to note that all of this work involves mindfulness

teachers and experts who work with adults and not specifically mindfulness experts for kids or adolescents. Research with mindfulness experts who work with kids recommends that in-person teachers utilize appropriate metaphors to make it enjoyable, and to ensure mindfulness is not very complicated for children<sup>90</sup>. Yet there is lack of work involving mindfulness experts who work with adolescents to understand their perspectives on mind-body technology.

## **2.7. Research gaps in mind-body technology for adolescents**

Based on the above review and analysis of literature, I identified three key research areas that warrant further investigation.

The first research area that motivates Aim 1 of this thesis is exploring parental mediation strategies of adolescent bedtime technology use. I describe adolescent bedtime media use (Aim 1.1), I describe parental mediation strategies of adolescent bedtime technology use (Aim 1.2) and finally, I describe challenge that parents face in implementing bedtime mediation strategies (Aim 1.3). With the emergence of new media, it is crucial to explore parental mediation practices particularly in the context of bedtime media use. Additionally, research on challenges parents face in regulating media use and areas of conflict between adolescents and parents could help in design of effective interventions for mediating bedtime technology use.

The second research area that motivates Aim 2 of this thesis is to explore needs, interest and preferences for digital mind-body tools for adolescents. Prior work with technology-based mind-body approaches for adolescents has shown poor engagement and adherence. Thus, understanding adolescent's current knowledge about mind-body approaches, their perceived challenges in learning and practicing these approaches and their interest in utilizing technology to learn and practice mind-body approaches can serve as a foundation for designing mind-body technologies for adolescents. For Aims 1 and 2 I involve parent-adolescent dyads inspired by the socio-ecological framework (described in section 1.2.2) and to triangulate findings and to obtain greater context to the results.

The third research area that motivates Aim 3 of this thesis is involving adolescents in the design of mind-body technology. Much of the work in digital mind-body approaches has focused on adults. There is a lack of work engaging adolescents in design of mind-body technologies and lack of knowledge about their perceptions on mind-body technologies.

## **Chapter 3 “*The biggest challenge was to limit the screen time and make that not the babysitter*” – exploring parental mediation strategies of adolescent technology use at bedtime.**

In this chapter, I explore adolescent bedtime media use and parental mediation strategies of adolescent bedtime technology use. This work had the following sub-aims. I specifically:

- Describe adolescent bedtime media use (1.1)
- Describe parental mediation strategies of adolescent bedtime technology use (1.2)
- Describe parental concerns about bedtime media use and the challenge that parents face in implementing bedtime mediation strategies (1.3)

### **3.1 Abstract**

With the increasing and pervasive presence of media at bedtime for adolescents there is a need for research on parental mediation of bedtime media use. Using interviews and surveys with 11 parent-adolescent dyads, the goal of this study was to describe adolescent bedtime media use, parental mediation strategies of adolescent bedtime technology use and the challenges that parents face in implementing bedtime mediation strategies. Adolescent participants (aged 10-14) reported using smartphones and television before going to sleep primarily for watching videos or tv programs, listening to music, and playing games. Parent and adolescent participants described a range of mediation practices at bedtime. I found families used active mediation to discuss features about media, online content and safety, and about the media-related rules in the family. I found limited co-use and diversionary efforts in participants. Restrictive and investigative were the most prevalent type of mediation approaches that participants described and technology itself was used for these two mediation approaches. Parent participants talked about various challenges with implementing mediation strategies including resistance from adolescents and technology-related challenges (e.g., evolving technology, not foolproof solution). Insights gained from this study will help inform design of strategies for parents to develop better mediation strategies for adolescents at bedtime.

## 3.2 Introduction

Today's adolescents grow up in media-rich homes where they have daily contact with a wide range of digital tools like smartphones, tablets, television, video games. Nearly 95% of U.S. teens ages 13-17 have access to smartphones and about 45% say they are online 'almost constantly'<sup>27</sup>. With the pervasive use of media, it is not surprising that adolescents use media before bedtime increasingly. In a nationwide study of 255 U.S. adolescents, 97% responded to using media before sleep, with almost 50% reported using 3 or 4 technologies before sleep<sup>91</sup>. Similarly, a study in 2019 with 1000 U.S. adolescents showed that 68% of adolescents kept their mobile device either in bed or within reach at night<sup>7</sup>. The study further reported that 70% of adolescents used their devices within 30 minutes of falling asleep at night. The American Academy of Pediatrics has issued a number of policy statements regarding electronic media use for adolescents, including adolescents not sleeping with devices in their bedrooms, avoiding exposure to electronic devices 1 hour before bedtime, and parents setting up media use plan for their families<sup>92</sup>.

With the pervasive presence of media use at bedtime, the relationship between technology and sleep is of increased interest as research indicates that 31.2% of adolescents report shorter sleep duration and only 23.8% report a regular bedtime<sup>43</sup>. Further research has shown that sleep in adolescents was significantly impacted by COVID-19 pandemic<sup>93</sup>. A systematic review reported a 54% prevalence of sleep disturbance among adolescents during the pandemic<sup>94</sup>. Another systematic review demonstrated evidence for associations between electronic media use, sleep duration and problems falling asleep<sup>2</sup>. The review further identified "*the lack of studies measuring the electronic media use at bedtime or during the night in the age group of 13–15-year-olds (pg.13)*". With the growing presence of media in adolescents' lives and its impact on sleep, there is a need for further research on interventions to reduce bedtime media use in adolescents.

Current approaches to reducing bedtime media use among young adults include automated monitoring of media usage, education, establishing media habits with children<sup>4,95</sup>. Most of these approaches rely on parental mediation behaviors. Parental mediation has been defined as strategies/practices that parent's use to control, supervise or interpret content to mitigate the negative effects on children's physical, psychological, and emotional health<sup>51</sup>. Various factors influence parental mediation, including parent-related factors (e.g., parent age, gender, parent's

belief, parent's digital skills, family dynamics ) and child-related factors (e.g., age, gender, child technology use patterns, child's self-regulation, and digital skills)<sup>29,52</sup>. To effectively design an intervention to reduce bedtime media use among adolescents it is important to consider parental mediations strategies, the role of parenting, and family dynamics.

Parental mediation practices of media use have been primarily rooted in television studies<sup>51,53</sup>. With the rapid growth in technology, there have been studies that have proposed newer mediation strategies for new media like video games. Overall, six types of meditation strategies have been distinguished in the mediation literature,<sup>51,53</sup> namely no mediation, active mediation, co-use, restrictive, investigative, and diversionary. These are defined as:

No mediation – In this strategy, parents take no action or have any rules or strategies to limit or encourage adolescent media use<sup>51</sup>. Studies have shown that no mediation is a rarely examined approach in parental mediation literature and no mediation has been associated with elevated rates of problematic internet use and problematic online gaming in adolescents<sup>96</sup>.

Active mediation – In this strategy, parents engage in media-related discussion with their adolescents<sup>51</sup>. Studies have shown that using an active mediation strategy was found to protect adolescents from problematic internet use<sup>96</sup> and excessive phone use<sup>97</sup>. However, studies have also shown no link between active mediation and problematic online gaming adolescents<sup>96</sup>. Jiow et al has proposed “discursive mediation” as the discussions parents have with children about video gaming as a new active-mediation strategy<sup>53</sup> and Clark et has proposed “participatory learning” where children and parents interact together with and through media<sup>51</sup> as a new active mediation strategy.

Co-use – In this strategy, parents engage in shared media experiences with adolescents<sup>51</sup>. Even though co-use has been shown as an effective mediation strategy for television viewing<sup>51</sup>, this has not be shown to have an impact on adolescent screen use or internet use or gaming<sup>96</sup>. Co-use has also been called “*active co-use*” where parents sit with children and help them use internet<sup>98</sup> or “*Joint media engagement*” where parents and children share media experiences together<sup>99</sup>.

Restrictive mediation – In this strategy, parents set rules and boundaries about youth's media use<sup>51</sup>. Jiow et al has proposed “*gatekeeping*” as the actions parents take to regulate children's access and exposure to video gaming as a new restrictive mediation strategy<sup>53</sup>. This has been the most studied

mediation strategy studied in the literature even though has been shown to prevent adolescents from excessive TV watching it impacts on internet use and online gaming is mixed alternating between beneficial, harmful and ineffective<sup>96</sup>.

Investigative mediation – Refers to the information seeking, and skill acquisition activities parents undertake<sup>53</sup>. Investigative mediation is a newer mediation strategy based on video gaming literature<sup>53</sup> and there is a lack of studies evaluating the effect of these strategies on adolescent technology use.

Diversionsary – Refers to parents’ active efforts to distract their kids away from media<sup>53</sup>. Similar to investigative mediation, diversionsary mediation is also based on video gaming literature<sup>53</sup> with a lack of evaluation studies.

In sum, with the emergence of new media and technology it is necessary to keep exploring parental mediation practices. For example, studies have shown that parents are more accepting of allowing mobile devices at bedtime than while dining with family at home<sup>100</sup>. As families use different types of media beyond television there is need for more research on how parental mediation fits within digitally saturated home environments<sup>54,55</sup>. In this study, I sought to expand the parental mediation literature in the context of bedtime media use and with newer technologies (smart speakers, smartphones, laptops).

Research has shown that parental mediation strategies are often sources of tension between parents and adolescents. Parents often struggle to enforce the rules and have also reported various barriers to implement these mediation strategies including their busy lifestyles, lack of skills, lack of parental control, difficulty keeping up with expert recommendations<sup>14</sup>. Hiniker et al has shown that children are more likely to follow rules that constrain technology activities (e.g., no using certain applications) than rules that constrain technology use in certain contexts (e.g. no phone at dinner table)<sup>101</sup>. However, parents in the same study reported that contextual boundaries are harder to enforce than technology restrictions<sup>101</sup>. Understanding the challenges parents face in implementing mediation strategies can help in the design of interventions that target bedtime media use in adolescents.

### **3.3 Objective**

The goal of this study was to describe parental mediation strategies of adolescent bedtime technology use. I sought to answer the following research questions 1) how do adolescents use technology at bedtime 2) what mediation strategy do parents employ for adolescent bedtime media use and 3) what challenges do parents face in implementing bedtime mediation strategies. I focus on adolescents ages 10-14 as adolescents at this age are slowly gaining independence in sleep and technology use.

This work had the following sub-aims. I specifically:

- Describe adolescent bedtime media use (1.1)
- Describe parental mediation strategies of adolescent bedtime technology use (1.2)
- Describe parental concerns about bedtime media use and the challenge that parents face in implementing bedtime mediation strategies (1.3)

### **3.4 Methods**

I conducted individual surveys and 1:1 semi-structured interviews with parent-adolescent dyads. By understanding both adolescent and parent perspectives, I was able to obtain greater context to data obtained and was able to triangulate the findings<sup>102</sup>. Study procedures were approved by the University of Washington Institutional Review Board.

**Recruitment:** I recruited parent-adolescent dyads. The inclusion criteria for adolescents to participate in the study were being 10-14 years of age, the ability to speak and read English, and self-reporting more than one hour of technology usage during the three hours before going to bed. The inclusion criteria for parent participants to participate in the study were being a parent of an adolescent participant in the study. Participation was limited to one child and one parent per family. COVID-19 restrictions led to fully web-based recruitment and data collection from January 2021 to May 2021. I recruited a convenience sample by posting flyers to social networks (i.e., Facebook) and professional networks (i.e., university listservs). To improve the response to recruitment, I added snowball sampling (i.e., asking participants to recommend new participants). I analyzed data concurrent with data collection and recruited participants until saturation was reached.<sup>25</sup>

Interested parents were invited to contact the study team after screening for inclusion criteria. I obtained consent from parents and assent from adolescents for their participation.

Data Collection: I emailed parents both the parent online survey (Appendix C) and the adolescent online survey. (Appendix D). After completion of survey, I scheduled one-on-one virtual interviews via Zoom with participants. The parent interview guide and adolescent interview guide are provided in Appendix E and Appendix F. Table 1 outlines the metrics collected for each RQ and how those metrics were collected. Note that a subset of interview questions was analyzed separately for Aim 2 (See Chapter 4).

Survey questions for adolescents included demographics (i.e., age, race, ethnicity, bedtime in the past 7 days, how long it takes for you to fall asleep), technology use<sup>103</sup>, mediation strategies<sup>103,104</sup>, media conflicts and impact of COVID-19 on rules. Survey questions for parents included demographics (i.e., age, race, ethnicity, bedtime in the past 7 days, how long does it take for you to fall asleep), parent technology use, adolescent technology use, mediation strategies, media conflicts, and impact of covid on rules.

I conducted semi-structured interviews with the parent and adolescent separately to allow for free expression regarding their perspective on technology use and media rules. Each interview lasted between 30-40 minutes. Both the adolescent and parent interview guide included questions guided by the study aims including their technology use at bedtime, the rules about technology at bedtime, and media conflict. The parent interviews also had additional questions on challenges with implementing the strategies.

*Table 3-1 Study metrics collected for each RQ and data collection method*

Aims	Study Metrics	Data Collection Method
1.1	<b>Technology Use by adolescents and parents<sup>103</sup></b>	
	a) For each of the device listed [TV, laptop, smartphone) indicate if a) I have or use this device b) I have or use this device before going to sleep and c) I use this device in my bedroom	Parent and Adolescent Survey
	b) Which media-related activities do you engage in at bedtime?	Parent and Adolescent Survey

	c) What technology do you usually use at home at bedtime?	Parent and Adolescent Interview
	d) Impact of covid on mediation strategies	
	a. How have media rules changes since the pandemic (More rules or enforcement, Stayed the same, Less rules or relaxed rules)	Parent and Adolescent Survey
	b. Are any of mediation strategies/rules different during/since COVID-19	Parent and Adolescent Interview
1.2	<b>Mediation Strategies</b> <sup>103,104</sup>	
	a) What rules about Media do you have in your home (4-point scale no rules about this – rules about this and always enforced)	Parent and Adolescent Survey
	i. How much time you can spend <ul style="list-style-type: none"> <li>• watching shows, movies or videos</li> <li>• playing games</li> <li>• listening to music</li> <li>• looking at websites</li> </ul> ii. Where you watch media in the house <ul style="list-style-type: none"> <li>• Shows, movies or videos</li> <li>• Play games</li> <li>• Use social media, text or chat</li> <li>• Use computer</li> </ul> iii. How early in the morning you can use media iv. How late in the evening you can use media for fun v. How late in the evening you can use media for school vi. Media devices can state in the adolescent bedroom at night	
	b) What strategies/rules, if any do your family use to manage your child's technology use particularly at bedtime?	Parent and Adolescent Interview
	c) Media Conflict	
	a) How often do you and your parents have fights or conflicts about your media use? – 5-point scale (never – all the time)	Parent and Adolescent Survey
	i. About when I use media ii. About what media content (apps, videos, games, websites,) I use or watch iii. About what time of day I use media	

	iv. About how many hours I use media v. About who I connect with online	
1.3	<b>Parental concerns about bedtime media use and challenges in implementing mediation strategies</b>	
	a) What have been the challenges in implementing these strategies?	Parent Interview
	b) Parent concerns about adolescent bedtime media use?	Parent Interview

Data Analysis: I summarized survey data using descriptive statistics. I transcribed verbatim all audio-recorded interviews. I deductively coded the data with a high-level a priori coding schema<sup>26</sup> structured by the aims and based on the interview guides and prior literature on parental mediation<sup>51,53</sup>: technology use (1.1), mediation strategies (no mediation, active mediation, co-use, restrictive, investigative and diversionary) and media conflict (1.2), and parental concerns about bedtime media use and challenges with implementing mediation strategies (1.3). I analyzed the transcripts aided by Dedoose software.<sup>27</sup> I discussed the codes with a second coder collaboratively and refined the codebook as needed. The second coder coded a random selection of qualitative excerpts (20% of the interview data) to assess reliability (Cohen's K = 0.98).

### 3.5 Results

After characterizing the participant sample and describing adolescent technology use at bedtime (1.1), I describe the bedtime mediation practices participants described (1.2), and challenges parent participants expressed with implementing the rules (1.3).

#### 3.5.1 Demographics

Twenty-two participants completed the study, including 11 adolescents (C1-C11) and 11 parents (P1-P11) (Table 3.2). The sample was predominantly White and Not Hispanic or Latino. Parents were female and college-educated or greater. More adolescents were male. Parent participants ranged in age from 35-58 (Mean=45, SD =7), and adolescent participants ranged in age from 10-14 (Mean=12, SD=2). Both parents and adolescent participants reported their bedtime as after 9 pm with some adolescent participants reporting going to bed past 10:30 pm (3/11), and 36% of adolescent (4/11) reported a sleep onset (time taken to fall asleep) > 15 minutes.

Table 3-2 Participant Demographics

<b>Table 3.2.</b> <b>Participants</b>	<b>Parents</b> <b>n=11 (%)</b>	<b>Adolescent</b> <b>n=11 (%)</b>
Sex		
Male	-	7 (64%)
Female	11 (100%)	3 (25)%
Other	-	1 (9%)
Race		
White	8 (73%)	8 (73%)
Asian	2 (18%)	2 (18%)
Other	1 (9)	1 (9%)
Ethnicity		
Hispanic/Latino	2 (18%)	3 (27%)
Not Hispanic/Latino	9 (82%)	7 (64%)
Decline to state	-	1 (9%)
Education		
High school degree	-	
College degree	6 (55%)	
Advanced degree	3 (27%)	
Doctorate degree	2 (18%)	

### ***3.5.2 Adolescent Technology Use at Bedtime (1.1)***

All parent participants reported using laptops, smartphones and televisions. These were the most commonly used devices reported by parents. Adolescent participants reported using laptops (11/11), televisions (10/11), and smart speakers (9/11) and smartphones (9/11), tablets or readers (6/11), and gaming consoles (6/11). Among this technology use, adolescent participants reported using smartphones (6/11) and tv (7/11) before going to sleep. The top 3 activities that adolescent participants reported engaging in before bedtime were watching videos or tv programs (11/11), listening to music (6/11), and playing games (online/on gaming devices) (10/11).

#### ***3.5.2.1 Impact of COVID on rules***

In the survey 5/11 adolescent participants reported that compared to pre-pandemic times, media rules had stayed the same, 3/11 reported that they had less rules or relaxed rules, and 4/11 reported more rules or enforcement. In contrast, 6/11 parents reported fewer rules or relaxed rules, 4/11 parents reported media rules stayed the same and only 1 parent reported more rules or enforcement. During the interview parent participants clarified the challenges with screen time during COVID-19 as parent P1: described:

*“Well, it used to be that she had like an amount of time per day on the screen, but once COVID hit and we're basically on the screen all day. It didn't really help so that was harder to enforce. so now it's more that she has a limit, where she has to turn off all technology at nine o'clock at night, and then we have one day a week, which is Sunday where unless we have a special exception, we try not to use any technology for the whole day.”*

### **3.5.3 Mediation Strategies (1.2)**

In this section, I describe participants responses to the six types of meditation practices in families around bedtime and the media-related conflicts participants shared. For each of the mediation strategy I synthesize the essence of each mediation strategy and then provide some supporting quotes.

#### *3.5.3.1 No Mediation*

None of the parent participants or adolescent participants talked about having no rules for media use at bedtime. Some families talked about not having any rules for certain devices like smart speakers, as parent P11 stated:

*“I don't see him [referring to child] use it very often. We have Alexa downstairs and we use that mostly just for music and occasionally to look something up if our phone isn't handy we'll ask her a question. But I yeah, we haven't really needed to set limits with that, because it does doesn't seem to be a big... he doesn't use it very much. He used to use it for music, but I don't even hear that anymore.”*

#### *3.5.3.2 Active/Discursive*

Parents and adolescent participants talked about primarily engaging in three types of media-related discussion: 1) adolescent sharing features about media 2) regarding online content and safety, and 3) about the media-related rules in the family.

Parents and adolescent participants indicated media-related discussions were primarily youth discussing or showing features of media with the parents. As parent P7 indicated:

*“When it comes to how to do things I mean a lot of times it's him showing me something. You know and I'm sure it's just from watching adults do it over and over again, but like how to use technology, a lot of times it's him showing me something.”* Similarly, adolescent C12 indicated: *“We do talk about them [technology] a little bit. It's more about me telling the cool features of them [the technology].”*

Some parent participants also shared that they also had discussions with their children regarding online content and safety. As parent P3 indicated

*“We talk a lot about like inappropriate YouTube comments and content that will absolutely come up and how often it happens.”*

Parents and adolescent participants also talked about discussing the strategies, such as explaining the rules or reason for rules, setting up new rules, or about what happens when rules are not followed. For example, parent P7 indicated:

*“sometimes too it's just a conversation with my son. I mean if we can come to some kind of agreement on the strategy and he sticks to it, then we'll give it a try, but if he's not going to then... then it'll be all up to me.”*

Similarly, parent P13 said about media-related rules:

*“we talk about it and he voices his complaints and we discuss our reasons for it.”* Adolescent C1 indicated: *“yeah I mean they told us not to use our phones too much and stuff.”*

### 3.5.3.3 Co-use

Parent and adolescent participants reported very limited co-use of media and even when co-use was present it was primarily for playing games, connecting with extended family and watching television.

Parents and adolescents reported very limited co-use of media at bedtime primarily due to difference in interests. Even when co-use of media existed it was primarily only for playing games or watching television. As Parent P13 stated:

*“occasionally we will research things like a recipe or research information if we have questions, but for the most part, I don't do online games with him I'll do board games with him, but I won't do online games with him and I mean he'll use his phone to communicate with me, but we don't sit down side by side and do rarely do we do things with technology together.”(P13).*

Similarly, parent P12 remarked about their co-use of television:

*“Oh, my gosh it's an interest. I never played games with them either. I watch TV with them watch movies and stuff but I don't remember ever teaching him anything about using a computer or their iPad or anything. I think they just figured it out”. (P12)*

Adolescent C5 also talked about not wanting to do things with technology with parents:

*“They let me do my stuff on my own how so they're not really there. We don't do much together, except on Fridays, we watch a movie that's all. There aren't too much things that I want them to do with new technology, because I don't have any reason for them to do anything with the technologies.”*

Parent participants also talked about co-using television with adolescents at nighttime to “wind down” as parent P3 stated:

*“we have them turn it off [technology] between eight and nine sort of depending on the evening. And then you know it's either reading or sometimes watching a TV show or something to just like wind down, but like off of the mobile or computer devices games.”*

Similarly, parent P14 indicated *“relaxation that we have is the TV it is our downtime.”*

#### 3.5.3.4 Investigative

Parent participants described information-seeking activities they used to investigate their child's media use. Parents employed different investigative strategies for different types of media and different types of activities. For activities like online gaming or when youth were on their personal laptop parent participants talked about sitting with their child or staying nearby to keep an eye on. Similarly for devices like smartphones parent participants talked about doing 'spot checks' and audits for investigating. Most parents relied on technology for investigative activities like utilizing monitoring software or adding their child's messaging account to their own phones. All parents also talked about information seeking from sources like attending seminars, talking to their peers, and using information from schools, and searching on the internet for mediation strategies.

Parent participants indicated that they sometimes sit with their child or be nearby to keep an eye on what their children do. For example, parent P13 stated that:

*“so for the when he does Minecraft and he's social with other people he has to use the computer that's in a common space so most of the time it's easily heard what he's communicating or what he's doing.”*

Some parent participants also talked about doing “spot checks” for investigating media use. As parent P13 stated:

*“aside from just doing spot checks and audits I can't really monitor what he does on that 24X7 in terms of software downloads or content he's accessing via web pages or any any games yeah.”*

Most parent participants indicated using technology itself for the monitoring/investigation. On laptops, parents used monitoring software that provided updates on child's use and behavior. As parent P5 stated:

*“We do have notifications set up to know which sites they have been browsing not that we go check on it daily it's only that Okay, at least, we know we can tap on that if we ever have it out or want to watch what they are watching”*

For messaging platforms like Discord, parents added their child's account to the parents' phone. For example, parent P3 stated:

*“So it [Discord-messaging platform] shows up on my phone, so my husband has my daughter's account, I have my son's account on our phones, and so we show them we are like “Look, we can see everything you say, be smart about this.”*

Parent participants also talked about other investigative mediation activities like attending seminars, talking to their peers, and using information from schools, and searching on the internet for mediation strategies. For example, parent P1 stated:

*“We've actually gone to a couple of you know, seminars like specifically related to kids and technology use”.*

Parent participants about seeking information from their peers and family to learn more about mediation strategies. Parent P7 shared:

*“I have three older sisters with older kids so they've kind of been there, done that so I'll ask them sometimes”.*

Similarly, Parent P5 shared:

*“sometimes people say you know what I set this up for my kid. It works I'm able to limit their laptop time or TV time. It's [mediation strategy] more from friends which they have done in practice that sometimes I might take help off”*

Parent participants also talked about receiving information from schools that helped with mediation strategies. As parent P4 indicated:

*“her [child's] teacher has been really good about sending out articles and just different support from the school district, with the technology department they've really put out a lot of things about you know what to talk about cyber bullying and different. You know, Internet safety things so we really tried to do that with her”.*

Parents also talked about searching on the internet for information about their mediation strategies. For example, parent P6 shared:

*“I just do a Google search and see how they are you know controlling. Like is there any settings in Gmail account in the laptop so like we can prevent kids from going to you know search [the internet]”*

### 3.5.3.5 Diversionary

Parents participants talked about their efforts to divert their kids away from media by asking them to play board games, or read books or do other activities (e.g., sports, practice musical instruments) or other media activities (e.g. coding, programming). Similarly, adolescent participants also talked about their parents' efforts to divert them away from media or from one media activity to another.

As parent P12 mentioned:

*"I'm trying to get them to not use technology, I try to play like a board game, or something with them instead".*

Similarly, adolescents C5 mentioned:

*"They [parents] always encouraged me to use less electronics and try to do more on other extracurricular ways of stuff. If they want me to search something or learn about something they will have a bunch of books, so they always tell me to go and check out my books."*

Most parent participants talked about diverting their kids away from one type media to another, including reading on a Kindle or other educational content or platforms.

Parent P1 talked about diverting their kids to learn programming or language

*"I definitely encourage her to learn programming or she's also on online Spanish class or she did online guitar lesson so."*

Parent P5 indicated:

*"So, given a choice, if my kid wants to watch TV and do something I probably prefer them playing an online chess game or finishing some online ..there are certain websites that they have some workable action I mean tasks and worksheets that they can do. And those are the things I would rather let them do with the technology, rather than sit and watch TV shows."*

P11 indicated:

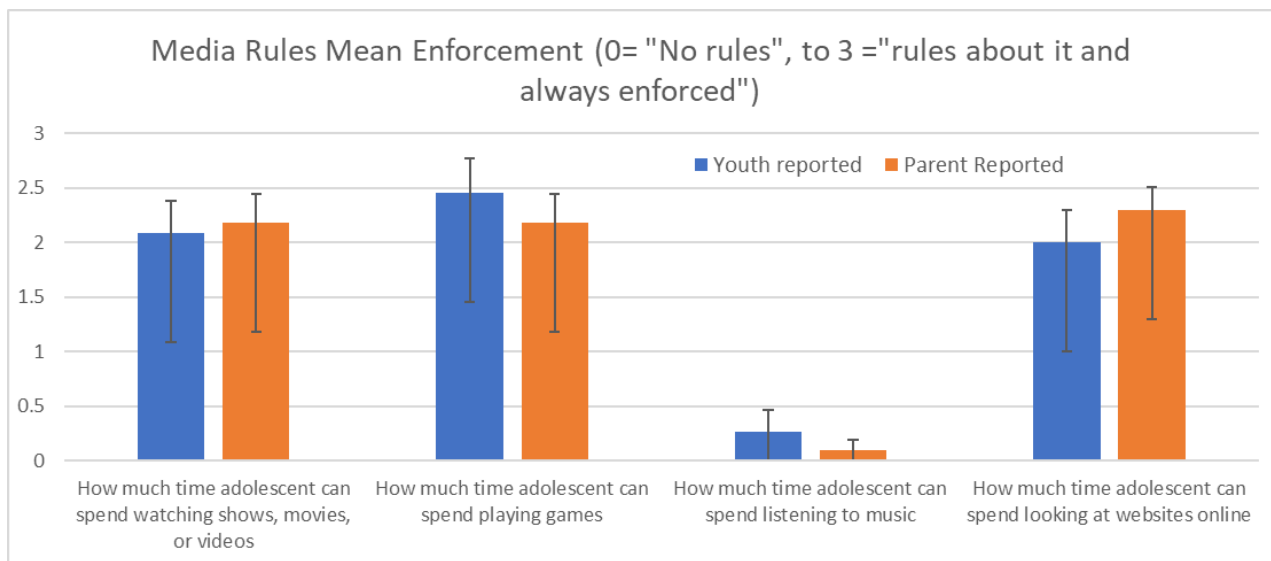
*"So things like that, where he wants to work on you know, computer skills, programming skills we are more lenient with you know we don't count that as screen time necessarily if he wants to do things like that. and he uses email and chat with family members, sometimes*

*to keep in touch so that's always encouraged.” Their child C11 reiterated: “They encouraged me to like you know code and you know even like socialize with friends online. I think that's like really good skill to have so”*

### 3.5.3.6 Restrictive/Gatekeeping

Survey data indicated that families had restrictive rules around how much time adolescents can use media (Figure 3.1), where they can use media (Figure 3.2) and how early or late they can use media for fun or for school (Figure 3.3).

Parents and adolescent participants indicated that families had no rules regarding how much time adolescents can spend listening to music (Figure 3.1). Adolescent and parent participants reported that they had rules enforced about 1) how much time adolescents spend watching shows, movies or videos, 2) how much time adolescents can spend playing games and 3) how much time adolescents can spend looking at websites online. Parent and adolescent participants were in agreement on rules related to how much time adolescents can use media.



*Figure 3.1: Media Rules Enforcement. How much time adolescents can use media.*

Parent participants reported that they had rules they enforced sometimes about where adolescents watch shows, play games, use social media and use computers to search or look at things online (Figure 3.2). However, compared to parent participants, adolescent participants reported less

enforcement of rules around where adolescents watch shows, play games and use social media (Figure 3.2).

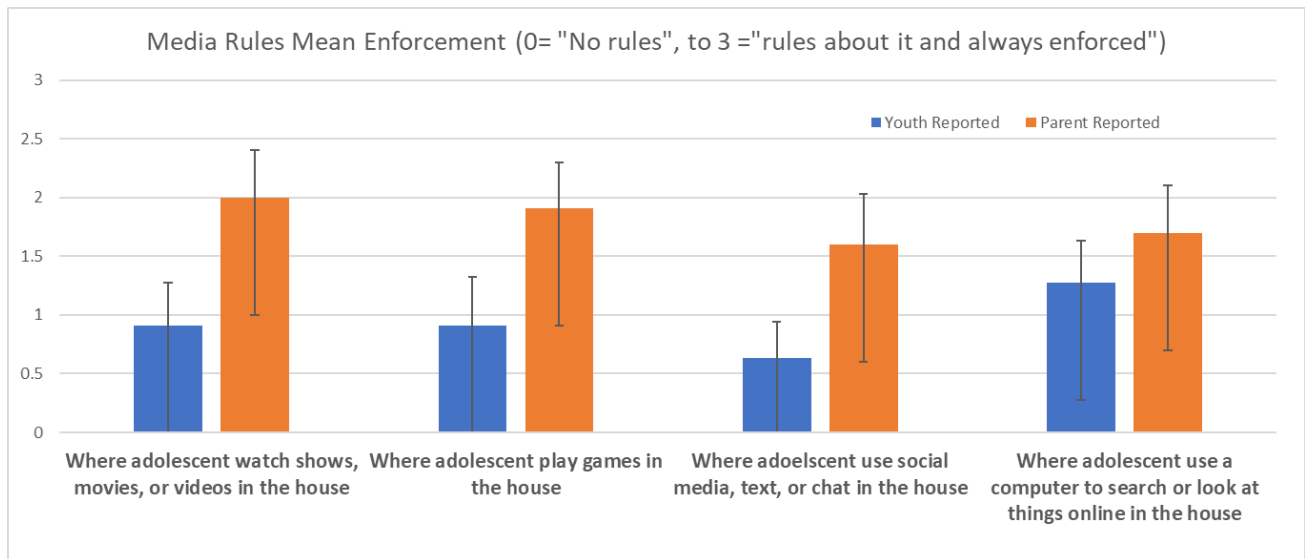
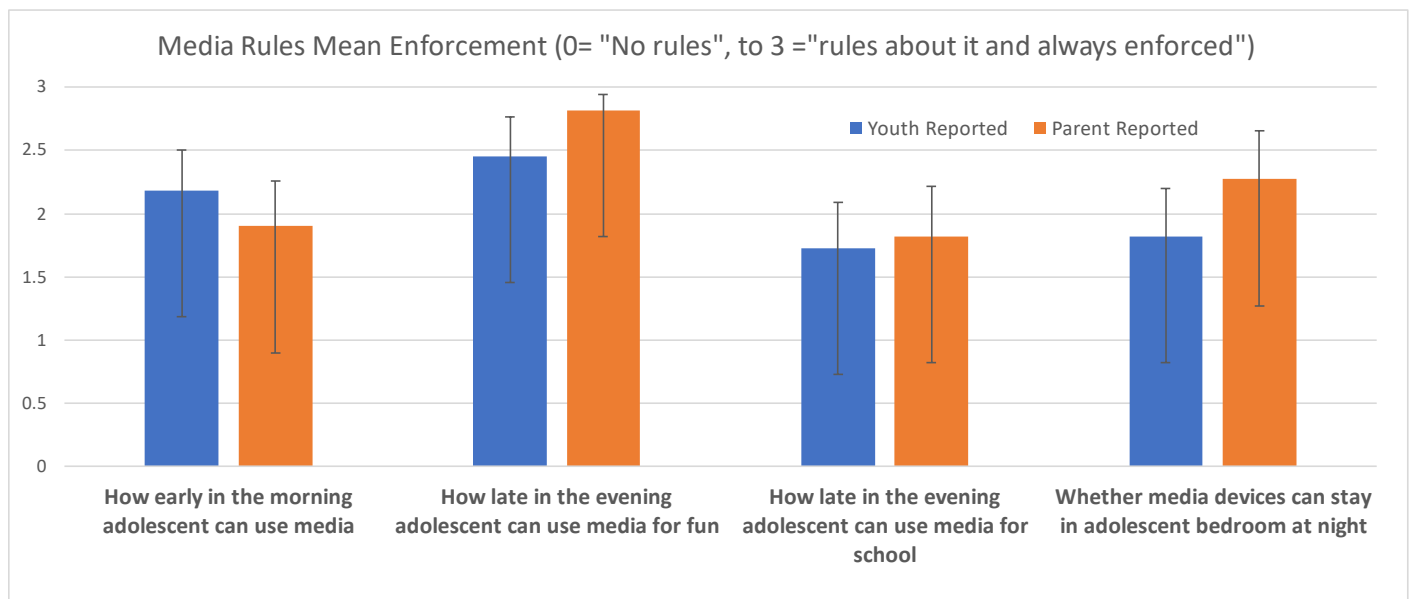


Figure 3.2: Media Rules Enforcement. Where adolescents use media in the house

Parents and adolescent participants indicated that families had rules enforced regarding how early in the morning and how late in the evening adolescents can use media for fun and school and whether media devices can stay in adolescent’s bedrooms (Figure 3.3). Dyads reported more enforcement of rules for how late in the evening adolescents can use media for fun versus using media for school.



*Figure 3.3: Media Rules Enforcement: How late and early adolescents can use media.*

During interviews participants indicated different ways through which the restrictions were implemented including limiting media use for certain hours during the evening, parents regularly enforcing the limits, setting context-based limits (e.g., no technology at dinner). Participants also talked about using technology to enforce these restrictions like automatically shut down the internet, automatically set device or activity limit, and to automatically limit content.

During interviews, dyads indicated enforcing rules around using technology only during certain times in the evening or only using technology for this many hours a day. Adolescent C4 indicated:

*“Yeah I am not allowed to have screen time past like 8:30 or like early in the morning.”*

During the interview, some dyads indicated not having a set limit on screentime but parents having to enforce it regularly as adolescent C4 indicated:

*“We don't really have that many limits on screen time but like I just play and then my mom tells me to get off of it then I do, so we don't really have time limits really.”* Their parent P4 also reiterated this saying: *“I tried to I did the timers for a little bit of time, but honestly that's really the only time in the evening, where I get to kind of have a break, and you know, let them be occupied with what they want to do”*

Dyads also talked about context limits like no technology at dinner time or no technology until chorus or homework or physical activity is done. Parent P2 remarked:

*“It's always been no phones at the dinner table, and we all adhere to that, I mean we might run go look something up but mostly we sit down as a family to eat and no electronics at the dinner table at all”.*

Parent participants also reported using a Fitbit to track the youth's active minutes so they can earn screen time as Parent P13 described:

*“So during the week with school, he has to earn his screen time by doing active minutes of exercise and moving his body, so we actually have a Fitbit and we track it and if he doesn't move his body enough, then he doesn't earn screen time.”*

Most families talked about using technology itself to enforce these limits. Technology was primarily used in three ways to 1) automatically shut down the internet 2) automatically set device or activity limit, and 3) automatically limit content.

Participants talked about using technology to shut down the internet at certain times for example adolescent C7:

*“And then my mom she has it’s like a browser Blocker and it goes off at nine o’clock and it blocks all your electronics and turns their Internet off.”*

Participants also talked about using technology to automatically set device limits or activity limits. Adolescent C12 indicated:

*“Well there is two hours..., if I use YouTube I use the total and the one hour....the other one piece it’s like only it’s the one they have for all iphones like you just look it up with like settings and stuff um and that one just shuts down the Apps on your phone”.*

Similarly, Parent P1 indicated about using the phone’s setting to control device use:

*“I mean she has like an iPhone and the family controls on the iPhone are pretty straightforward and easy to use, so I can just set it to shut down at nine o’clock you don’t have to like worry about enforcing that and then.”*

Similarly, adolescent C1 also indicated:

*“Okay um we also have like screen time on our phone it won’t Let us use our phone after like 10pm.”*

Participants also talked about using technology to automatically limit content and downloads– For TV particularly for PG-13 content parent participants relied on setting up kids account on platforms like Netflix. Parent P6 indicated:

*“Because in Netflix if I set up a kid’s account it won’t allow him to watch PG 13 it will Maximum allow him to go up to PG you can search movie and select a movie that is PG but if it is PG 13 he cannot play it will ask for pin and he has to come to me”.*

Similarly, parents also used the phone’s account settings to limit game downloads as adolescent C12 remarked:

*“[on the] phone I can download stuff that's downloaded on my mom's device and stuff like we have the family thing, so I can download stuff that has already been purchased on other devices, but besides that, then I need like my parents approval”*

Dyads also talked about taking away screen time as a penalty for going over these rules. As parent P13 indicated:

*“In terms of screen time we give him an allotted amount and if he goes over we let him kind of self-regulate with gentle reminders for when he's getting close, but if he.. there have been a couple of times, where he blatantly has gone over his limits and then he loses his screen time for the next day as.”*

Similarly, parent P3 also indicated:

*“You know things like If you're caught on it at night when you're supposed to be sleeping or after we've told you once to turn it off it's not a discussion, and if that happens, they lose it for you know the next day or two and that's a pretty high stakes punishment.”*

Some dyads also talked about keeping the youth's devices outside the kid's bedroom at night. As adolescent C4 remarked:

*“Usually about like a few minutes before I go to bed my mom takes all of my devices and puts them in her room to like charge. “*

Similarly, parent P14 stated:

*“I put like or restriction time so at nine o'clock all the technology, locked out I put the family [unclear] I collect all phones and all the things and just the TV is allowed.”*

### *3.5.3.7 Child's Thoughts on Rules and Media-Related Conflicts*

Survey data indicated that parents and adolescents don't have a lot of media-related conflicts. (Figure 3.4) Participants reported the least number of conflicts related to who the adolescent connects with online.

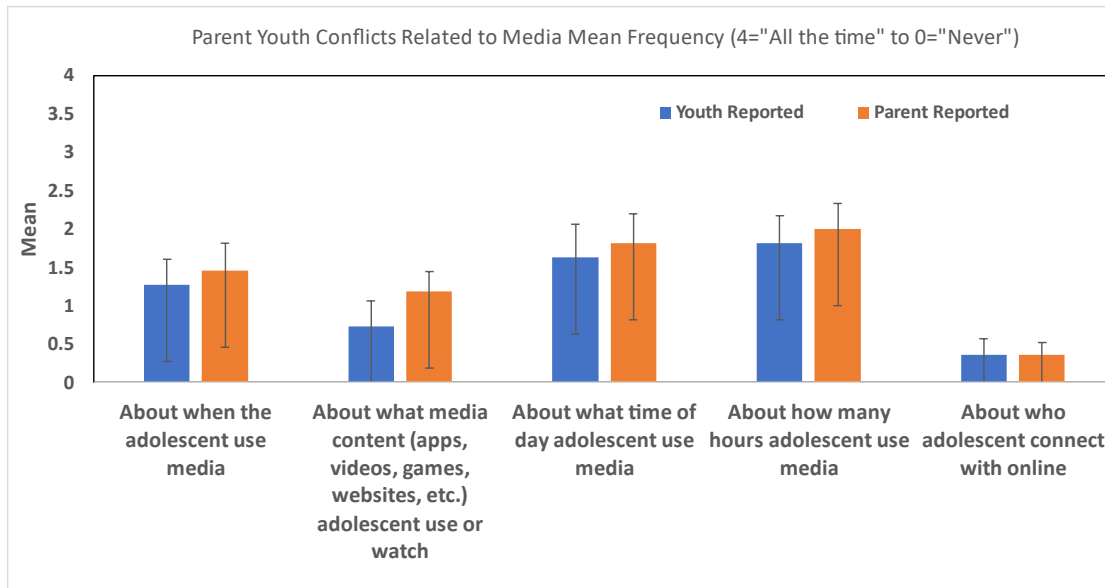


Figure 3.4: Parent-youth conflicts related to media

During the interviews, all adolescent participants indicated that they liked the family rules about media use and those mediation strategies worked for them. The biggest challenges that adolescents raised were abruptly stopping what they were doing. As adolescent C7 indicated:

*“It just feels like when it comes to like the all your electronics like the Internet turning off at like nine or 10 sometimes it's just frustrating because Like if I want to stay up sometimes when I'm not usually supposed to I can't like do anything”*

However, during interviews nearly all parent participants indicated their kids complained or didn't like the rules. As parent P1 stated:

*“She doesn't like the rule. Every day it's the same thing “nine o'clock is too early or she wants to install another APP” or I mean in general she doesn't argue too much about the rules. She would Definitely use technology later at night, that would be probably the number one rule she would want to break. For the rest of the stuff like video game consoles TV or anything I can pretty much easily see if she's on there, and just kick her out. And she doesn't complain, I mean she complains it but it's not it's usually not like a big confrontation.”*

### ***3.5.4 Parental concerns about bedtime media use and challenges they face in implementing mediation strategies (1.3)***

#### *3.5.4.1 Parent Concerns about Adolescent Technology Use at Bedtime*

The biggest concerns about using technology at bedtime that parent participants talked about was use of technology like watching tv, playing video games was its impact on sleep

As parent P6 summarized:

*“sometimes if he's more excited about what he's watching the episodes he asked for more and if I restrict he will become cranky like you know more dependent on TV to pass the time. So yeah and like if I stopped him, then he will just read book on those stuff, but it is taking a lot of time for him to relax himself and go to sleep”*

Similarly, parent P7 was concerned about using gaming consoles before bed

*“P7: I do, primarily with gaming consoles we have an xbox. My son just seems to get like a little too jacked up and wired so it's harder to get them to calm down and try and go to bed so yeah My biggest concern is primarily for my son when it comes to gaming.”*

Parent P11 also acknowledged concerns about technology use on sleep

*“P11: I guess I don't feel like it's a battle that I want to take on like I know that it's not good before bedtime. But, yeah it's just not something that I've you know it's like pick your battles and that's not a battle that I wanted to have.”*

#### **3.5.4.2 Challenges parents face in implementing mediation strategies**

Parent participants talked about many challenges with implementing mediation strategies including resistance from adolescents, and challenges when using technology itself for automatically shutting down internet or setting device or activity limits or limiting content including setting up the limits for devices in their households, the evolving nature of technology and the technological solution and constantly setting limits .

Parent participants talked about resistance and argument from adolescents as a big challenge to implementing the mediation strategy. As parent P7 remarked:

*“um I think just partly the personality of my son and the age, you know there's pushback with everything. More often than not it's an argument when it's time to get off technology, whether it's for dinner or to help out doing something or just because you know they've been on there enough, they need to do something else, they need to take a break.”*

Parent participants also talked about challenges when using technology itself for automatically shutting down internet or setting device or activity limits or limiting content.

Parent P12 talked about challenges with setting up limits on devices for their multi-device households:

*“I think we should have consultants that come by and help us with this stuff. I'm sure, it will only take somebody knew what was going on, like an hour or two hours to show me I don't really know how to see browser history. I like I said I use the preselected predetermine list of things that was on the APP that I chose the Circle, so there is some filtering going on and yeah, it's kind of hate saying it out loud, but I have no idea what”*

Similarly, parent P3 indicated:

*“but, honestly, it [parental controls installed on devices] was annoying for us, because we always have to unlock it [the device with parental control installed]”*

Parent P11 talked about challenges with using platforms to limit content.

*“Like how Netflix has different logins for the kids versus the adults but they can just as easily click on the adult one I don't think there's anything blocking them from it”*

Parent participants also talked about the challenges of constantly setting limits particularly evolving technology as parent P13 said:

*“ Like we are much more accepting of him doing Minecraft versus other games we don't have a true gaming console in our house, because my husband and I kind of think that's a slippery slope, and it would be a constant battle for trying to get our kids focus and constantly setting limits so that's, not even in our house.”*

Parent participants indicated the challenges with setting mediation strategies when the adolescent had a device that they were unfamiliar with as parent P13 indicated:

*“With the phone is the biggest challenge I'd have to say, because he has an apple versus an android so I really aside from just doing spot checks and audits I can't really monitor what he does on that 24X7 in terms of software downloads or content he's accessing via web pages or any games ”*

Parent participants also talked about their technology-based mediation strategies not being foolproof as parent said P12:

*“but the problem is so I have a two hour limit per day. But that's only Internet so, then they know that they can play games that aren't on the Internet for beyond that two hours, so I haven't addressed that issue very well if I'm not paying attention they'll just keep playing longer.”*

### **3.6 Discussion**

In this study I directly engaged with adolescents and parents to describe adolescent's use of technology at bedtime (1.1), the mediation strategies parent's employ for adolescent bedtime media use (1.2), and the parental concerns about bedtime media use and challenge parents face in implementing bedtime mediation strategies (1.3).

Overall, most adolescents used laptops, televisions, smart speakers, smartphones, tablets and gaming consoles regularly (1.1). They primarily reported using smartphones and television before going to sleep primarily for watching videos, listening to music and playing games.

Families employed a range of mediation practices at bedtime (1.2). None of the parent participants or adolescent participants talked about having no rules for media use at bedtime. Some families talked about not having any rules for certain devices like smart speakers. Our findings on smart speakers having no regulation are different from work by Beneteau et al. which showed that parents utilized active mediation and restrictive mediation for smart speakers following its introduction<sup>107</sup>. It is possible that over time mediation strategies from smart speakers reduce particularly when it is not used as often.

I also found very limited co-use in families even when co-use was present it was primarily for television viewing and playing games. This is similar to prior literature indicating co-use for primarily tv and games<sup>96</sup>. This is concerning given the call by the American Academy of Pediatrics

recommending the parent and children jointly engage in media<sup>11</sup>. Moreover, there have been studies encouraging more co-viewing or co-use with adolescents<sup>108</sup>. Future research should explore co-use particularly for newer technology like smartphones or tablets and methods to support parents and adolescents with co-use. It was interesting to note that families were no longer considering watching television as screen time and were using TV to wind down at night. This is concerning given that television viewing has been associated with less sleep in adolescents<sup>109</sup>.

I found parents utilized a variety of investigative activities including sitting nearby or doing spot checks on adolescent's smartphones. Parents primarily utilized technology itself for investigative activities. This is consistent with prior literature indicating parents monitor what young people do with media<sup>6,110</sup>. Parents also utilized a variety of information-seeking activities from peers, families and experts. Prior literature has shown that majority of parents get advice or information about screen time from doctors or medical professionals<sup>111</sup>. Yet in this study parents didn't talk about turning to doctors or providers for screen time information. American Academy of Pediatrics recommends that pediatricians and other health care professionals serve as a resource for families to help set up media use plan<sup>11</sup>.

I found very limited diversionary efforts in dyads. Instead, partly diversionary (move from one media or activity to another media or activity) efforts were more prevalent. Parents were diverting adolescents towards more educational or learning content. This concept of partly diversionary needs to be further explored in the parental mediation literature.

Restrictive mediation was the most prevalent category that dyads talked about related to mediation of bedtime technology use. Parents had restrictive limits on length of media use, location of device use, and how late adolescents can use media for fun or school. Dyads also talked about using technology itself for setting limits and taking away media or media time as punishment. Using technology to limit internet access or "digital grounding" has been found in prior literature<sup>6,106,110</sup>.

Parents and adolescents reported very few conflicts related to technology use. This is consistent with prior literature indicating that conflicts over technology use particularly with mobile devices are less common now<sup>7</sup>. Studies show that parents who believed their children were addicted to media are more likely to have conflicts with their children<sup>7</sup>. Since I did not recruit specifically for

adolescents with technology addiction it is possible that parents didn't perceive their child having any technology addiction and the need to argue.

Parents reported that the impact of technology on sleep was the biggest concern about using technology at bedtime. These findings are consistent with prior literature on adolescent technology use at bedtime<sup>6,105</sup>. Both adolescents and parents indicated that the adolescents spend longer time on technology than planned. This is consistent with prior literature with teens indicating they spend too much time on mobile devices<sup>7</sup>. Parents talked about various challenges with implementing the mediation strategies (1.3), including resistance from adolescents and technology-related challenges. For example, parents talked about the challenges with the evolving nature of technology and with setting up limits on devices for their multidevice households. Our findings are consistent with prior literature on parents reporting technology as a reason why parenting is harder<sup>112</sup>. The American Academy of Pediatrics recommends that parents set media use plan for their families, yet parents described many challenges with implementing these strategies. Future work should explore ways to help parents overcome these challenges, educating parents on technology-related mediation practices and tools available to monitor technology use.

Despite the rich data collected the study has some limitations. The sample was not diverse in many aspects. I recruited a convenience sample from a single region. The sample was predominantly White and Not Hispanic or Latino. And parents were all female and college-educated or greater. Future work should extend the work to include a broader audience. The study was conducted during the COVID-19 pandemic which had implications on adolescent screen time use and limits. Future work should evaluate the findings in a post-COVID world. Even though the participants were asked to focus on bedtime technology use and rules it was difficult for participants to articulate the rules specifically for the evening and sometimes participants talked about media rules during the day. Ethnographic studies can further shed light on additional mediation strategies at home. Asking both parents and adolescents about their technology use is also subject to social desirability bias where participants may present answers that are more socially acceptable and might have underreported their technology use. By talking to both parents and adolescents in the study I hoped to minimize this bias. A key strength of this study was interviewing parent-adolescent dyads which enhanced the validity of the findings.

### **3.7 Conclusion**

Given the growing presence of media in adolescents' life and its impact on sleep and the need for interventions to reduce bedtime media use among adolescents, our findings fill the critical gap in better understanding adolescent bedtime media use, parental mediation strategies of adolescent bedtime technology use and the challenges that parents face in implementing bedtime mediation strategies. Future research should focus on developing strategies for addressing the challenges parents identified and helping parents with mediation practices for adolescent bedtime media use.

## **Chapter 4 Exploring needs, interests and preferences for digital mind-body tools for adolescents<sup>1</sup>**

In this chapter, I describe the work and findings of Aim 2 where I explore parent and adolescent interest in the use of mind-body technology to mitigate the effects of media use on sleep. Specifically, I

- Describe parents and adolescents' current exposure to mind-body approaches (2.1)
- Describe the challenges that adolescents face in learning and practicing mind-body approaches (2.2)
- Describe parents and adolescents' interest and preferences in using technology for learning and practicing mind-body approaches

### **4.1 Abstract**

Sleep problems are common among adolescents and research on mind-body interventions for sleep is promising. Although technology-based mind-body interventions have been shown to help early adolescents with practicing mind-body approaches, engagement and adherence has been a challenge. Using a Human-Centered Design framework with semi-structured interviews with parent-adolescent dyads, I describe exposure to, interest in, and preferences for digital mind-body technology for sleep. Identified challenges (e.g., 'establish routine', 'busy schedule) and preferences (e.g., age-appropriate content) reflect mind-body technology needs that impact engagement. Based on these findings, I recommend that a technology-based mind-body approach for early adolescents be designed to 1) provide content customized for adolescents 2) include functionalities that engage adolescents like games and rewards, and 3) allow for granular sharing controls. These recommendations provide a foundation for designing digital mind-body tools for adolescents.

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## 4.2 Introduction

The American Academy of Pediatrics recommends 8-10 hours of sleep for children ages 13-18 and 9-12 hours of sleep for children ages 6-12 for optimal health. Yet 58% of middle school students and 73% of high school students do not get enough sleep<sup>43</sup>. A study published in 2019 found that only 5% of US adolescents meet recommendations for sleep, physical activity, and screen time concurrently<sup>113</sup>. Moreover, due to the COVID-19 pandemic sleep problems in adults and children has exacerbated. A systematic review shows that the pooled prevalence in sleep disturbances during the pandemic among children was more than two times the prevalence reported before the pandemic<sup>94</sup>. Lack of sleep and poor sleep can lead to many health concerns in adolescents. For example, sleep disturbance in childhood is known to lead to both short-term and long-term health consequences like obesity, depression, and substance use<sup>47</sup>. Hence there is an increasing need for interventions that target sleep health in adolescents.

Research on use of mind-body interventions for sleep is promising. Mind-body approaches are techniques that focus on the interactions between mind, body and behavior. They include a large and diverse group of procedures and techniques. Examples include yoga, acupuncture, tai chi, breathing exercises, meditation, and biofeedback. These approaches have been shown to help treat or self-manage various conditions like chronic pain, headache, anxiety, and stress as well as sleep in children and adolescents<sup>19,63-65</sup>. Systematic reviews show that mind-body approaches can help improve sleep outcomes including sleep quality, sleep onset latency, and sleep efficiency in adolescents<sup>62,68,114</sup>. Many existing mind-body approaches for adolescents have been delivered in person<sup>62</sup>, in group settings<sup>21</sup>, or at schools<sup>114</sup>. However, in-person sessions may be infeasible for many adolescents, due to busy schedules, dependence on adults for driving to in-person sessions, and high cost. Moreover, the goal of mind-body approaches is for adolescents to learn the skills and incorporate them in their daily life. Thus, a technology-based approach can make mind-body interventions readily accessible and scalable<sup>23,66</sup>.

Research exploring technology-based mind-body interventions in adolescents shows promise<sup>21,115</sup>. Lahtinen et al studied the effect of a digital app-based mindfulness-based intervention and demonstrated efficacy in reducing anxiety and depression in adolescents<sup>74</sup>. However, research with technology-based mind-body interventions in adolescents has shown poor engagement and

adherence<sup>21,75,76,116</sup>. In an online mindfulness-based intervention for adolescents, only 15 out of 95 (i.e., 16%) logged into the online module out of which only 1 person completed the entire mindfulness session<sup>75</sup>. A review of mobile mindfulness-based apps for children found that 50% of apps had “inadequate” or “poor” ratings for engagement (defined as how fun, interesting, customizable, interactive and fun the apps are for children)<sup>77</sup>. Research indicates that a combination of factors influence individual engagement with digital tools including personal factors (their knowledge, interest, attitudes), intrapersonal factors (peers, family), technology-related factors (e.g., usability)<sup>117</sup>. Thus, in addition to understanding the technology-related factors that adolescents will prefer and use we also need to understand personal factors (i.e., adolescents’ prior experience, their interest in using digital mind-body tools) and interpersonal factors (adolescents’ preferences for sharing/using mind-body tools with parents) that play a role in adolescents engagement with digital tools. Given the promise of mind-body approaches for adolescents, there have been calls to engage adolescents to understand their needs, interests and preferences in mind-body technologies.<sup>23</sup> This study seeks to address this gap using the principles of human-centered design.

As previously introduced, Human-Centered Design (HCD) is a methodological approach that emphasizes participation of technology users in the design process<sup>26</sup>. The approach involves a multi-stage iterative problem-solving process in which the needs, desires and limitations of users are inquired and analyzed. One of the first steps in the HCD process is ‘understanding and specifying the context of use’ including characteristics of users, their tasks and the environment in which the tool is used. This informs ‘user requirements’ that the tool must support to meet users’ needs. Based on these requirements we then build prototypes, which we test with users to evaluate against the requirements, iterating to earlier phases as needed. HCD helps ensure that the developed tool will be engaging, acceptable, usable, and meet the needs of users. Currently, there is lack of research utilizing HCD in the design of mind-body technologies for adolescents.

### **4.3 Objective**

Using HCD as a methodological framework the objective of this study is to explore needs, interests and preferences for digital mind-body tools for adolescents. The study seeks to address the following research questions 1) what are parents and adolescents current exposure to mind-body

approaches 2) what are potential challenges adolescents face in learning mind-body approaches and 3) what are parents and adolescents interests and preferences in using technology for learning and practice these approaches for better sleep. I focused on early adolescence (ages 10-14) in this study because during this stage of adolescence most children are still dependent on their parents for many aspects of their life yet are slowly learning and gaining independence over media use and sleep. The support of parents and peers can have an impact on adolescent engagement with technology<sup>23</sup>. In this study, I interview parents and early adolescents to understand both their perspectives on mind-body technologies for adolescents. I focus on five common mind-body approaches: meditation, relaxation, yoga, art therapy, and music therapy. We chose these approaches based on three criteria that we derived based on existing literature<sup>41</sup> namely 1) adolescents should be able to practice the approach on their own at home; 2) the approach should not require any kind of specialized equipment; and 3) the approach should not involve any special setting/movements/postures (e.g., Tai chi).

The purpose of the study is to explore needs, interests and preferences for digital mind-body tools for adolescents. Specifically, I

- Describe parents and adolescents' current exposure to mind-body approaches (2.1)
- Describe the challenges that adolescents face in learning and practicing mind-body approaches (2.2)
- Describe parents and adolescents' interest and preferences in using technology for learning and practicing mind-body approaches

#### **4.4 Methods**

I conducted individual surveys and semi-structured interviews with parent-adolescent dyads. Study procedures were approved by University of Washington Institutional Review Board. The study participants were the same dyads as outlined in Chapter 3. Here I describe the data collection and data analysis procedures applied to interview transcripts that are specific to the research questions for Aim 2.

Data Collection: Both the adolescent and parent’s interview guide included questions guided by the study objectives including their exposure to mind-body approaches, challenges in learning these approaches, and interest in using technology to learn mind-body approaches.

Data Analysis: I deductively coded the data with a high level a priori coding schema<sup>118</sup> based on the interview guide: Parent exposure to mind-body approaches (2.1), adolescent exposure to mind-body approaches (2.1), challenges in adolescent learning these approaches (2.2), parents and adolescents’ interest and preferences in using technology for learning and practicing mind-body approaches (2.3). I analyzed the transcripts utilizing the coding schema using Dedoose<sup>119</sup>. I discussed the codes collaboratively with a collaborator and refined the codebook as needed. The collaborator coded a random selection of excerpts (20% of the data) to assess reliability (Cohen’s  $K = 0.98$ ).

## **4.5 Results**

### **4.5.1 Demographics**

Participant demographics are outlined in Chapter 3.5.1

### **4.5.2 Exposure to Mind-Body Approaches (2.1)**

Overall, all parents (11/11) had heard about at least one of the 5 mind-body approaches (i.e., meditation, relaxation, yoga, art therapy and music therapy) and most parents (10/11) had either practiced at least one of these techniques in the past or were currently practicing them. Parents described several reasons for starting to practice these techniques primarily being pregnancy, stress, and the COVID-19 pandemic. Some parents also described using technology to practice these techniques for example, parent P3 shared:

*“So I use the Calm app in particular during Covid I had a really hard time sleeping in large part, because we would have meetings on till nine or 10 at night. Or we would be running trials with people in the east coast, so that meetings will start at four in the morning and so my sleep wake schedule was even worse than it typically is. And so I bought the Calm app then and really helped me to turn off at night when I would go straight from a meeting until 10pm to like ‘oh my God, I need to go to bed, because I have to be up at four’. And so that was really great.”*

Like parents, most adolescents (10/11) had heard about at least one of the 5 approaches and some adolescents (5/11) had either practiced these approaches in the past or were currently practicing them. Adolescents had learned mind-body approaches either from their parents or through school (teachers or counselors). For example, adolescent C11 described:

*“It was mostly in like middle school so like my social studies teacher will have like a video on that like talks about like meditation like doing it like we do that before tests and then in the seventh grade we would also do like in start of class.”*

In addition to learning these approaches in person some of the adolescents also described utilizing technology to learn about these approaches as well, as stated by adolescent C7:

*“Well, one time me and my mom did this peloton meditation before bed.”*

Among adolescents who practiced these approaches some adolescents really like doing meditation as C2 described:

*“Oh they're [meditation] really good they're really nice and calming for when I go to sleep sometimes, I'll fall accidentally fall asleep, while listening to it, but its overall just really nice. It gets rid of my stress easily because I get stressed out because of school and my anxiety and it's just really easy for me just to let that all go.”*

#### **4.5.3 Challenges adolescents face in learning mind-body approaches (2.2)**

Although participants expressed interest in mind-body approaches for sleep, both parents and the adolescent described many challenges adolescents have/will have in learning and practicing these approaches routinely. Challenges parents mentioned include lack of time, remembering to do it, and the adolescent prioritizing other interests. For example, parent P3 shared:

*“It's more of like the choice of what she [their child] does before bed. I think that the 10 minute meditation or the 10 minute app it's not that they push back on the app it's that it's in place of something else, they want to do at nighttime because I think it's the last thing you do until the day is over; you know that's the pushback at night.”*

Parents also indicated that the length of time to practice the session was also a challenge and adolescents would be more open to doing the mind-body approach if it was shorter rather than an hour-long session. Parent P6 shared:

*“Yeah actually that's [mind-body approach] a good idea. I don't know how long the session will be, but if it is like a one-hour session, it might be challenging for them [adolescent], but if they are just you know asked to do 10 minutes every day and that might be useful for them definitely.”*

Parents also felt that showing adolescents the benefits of doing mind-body approaches was a big challenge. As parent P10 shared:

*“So probably the biggest challenge is showing him the benefits of it and convincing him that it was worth his time and effort.”*

Adolescents also described challenges with practicing meditation like “*finding it hard to focus*” (C3), “*sitting still*” (C14), having “*patience*” (C12), and finding it “*boring*” (C13). As adolescent C11 described:

*“Yeah, so for meditation a lot of times, people say like think of nothing but I, I kind of have a hard time with that like whenever we're meditating I'm like thinking through all the things that we have to do during the day.”*

Adolescents also described lack of interest or prioritizing other interests (e.g., sports) as another reason for not practicing these approaches. For example, Adolescent C10 shared:

*“I just rather do other things like I'd rather go play some sports or go talk to my friends.”*

#### **4.5.4. Interest in learning mind-body approaches digitally (2.3)**

Both parents and adolescents were very supportive of adolescents learning these approaches for better sleep. Parents compared learning mind-body approaches to life skills like learning a language or swimming or brushing teeth. For example, Parent P5 stated:

*“So I would totally be in favor of people learning this because it's a life skill that's going to help them for the rest of their life it's like, why do we teach people swimming like that, if you're able to teach this yoga and meditation soon enough that is going to help them in the long run.”*

Many adolescents were also supportive of the idea of adolescents their age learning these approaches. Adolescent C3 described:

*“I think it's good to learn meditation because that's one thing that could help you with like calming down or like falling asleep, or it can also help it can also work as a coping method.”*

Similarly, adolescent C8 described:

*“I think it's good I mean you know if you're in a stressful situation you can you know kind of just get peace of mind for even for a few moments if you think I think it would be nice.”*

Parents and adolescents were also very supportive of the idea of adolescents learning mind-body approaches digitally. As parent P6 described:

*“I think like if it [mind-body approach] is digital, they'll give it a try they learn it and maybe if they are teaching them for like 30 minutes at least 10 minutes they'll focus and learn something.”*

Similarly, adolescent C11 described:

*“I think it's like really great like I've heard of like Apps that have stuff like that help people with like meditation and relaxing I think that's really great. Like I think technologies are very good way to keep people to do it. And, like the videos can like help a lot like just to get your mind off of things and it's like always it's a different experience doing it through technology than like in person.”*

Adolescents also indicated that technology provided the flexibility to learn at their own pace.

Adolescent C7 described:

*“Similar to school I feel like it's how because you know, when it comes to like help videos you don't have to watch it with the teacher, you can just watch it by yourself, or like when you're doing your work, you can just mute your video and your mic and you can just work by yourself, instead of having to consistently be contributing to the conversation.”*

Parents and adolescents both felt that the chances of the adolescent trying and practicing mind-body approaches are higher if it is incorporated into their lives and spaces that they are already familiar with. For example, adolescent C14 suggested incorporating mind-body approaches into Instagram.

Moreover, parent P8 suggested that having their child's friend or his school counselor use a mind-body app with the child first before they try it on their own could be beneficial:

*"I mean, he likes having his friends on if there was a way to wrap that into a meditation APP I don't know if his friends would go for it. Or if like his school counselor had used an APP with him. I think he would be more likely to continue that at home. If he had had some success with it, you know kind of guided live through it first."*

Even though parents and adolescents were very supportive of using technology to learn these approaches they also described some challenges when using technology to learn these approaches like not having the same experience as in person. As adolescent C7 described:

*"One thing I didn't like [about the digital mind-body approach], though, is that, throughout the whole time she [the digital instructor] was talking and talking and then was kind of preventing me from actually like meditating because every time I would like, open an eye just to see what she was talking about."*

#### **4.5.5. Preferences for digital mind-body tools (2.3)**

Parents and adolescents described their preferences for digital mind-body tools for adolescents that I grouped into three areas namely content, functionality and sharing.

Content: Parents and adolescents indicated their preferences on the content of mind-body technology to engage adolescents, including ensuring content is age-appropriate, providing a variety of content to choose from, and receiving feedback.

Parents and adolescents shared that they preferred mind-body approaches that were tailored to their age group. One potential way suggested found in a popular app that one family had tried was utilizing stories or structuring the mind-body approach around a storyline:

*"I like it more because they [the app] have like kind of like a storyline that they listen to and then they're like somebody asks you to like imagine what you see in the storyline."*  
(adolescent C3)

*"Because they're [app] much more story-based they're sort of like a really boring fairy tale or very repetitive, and so I think the kids like that a little bit better. But I find if they watch*

*something even if it's the same thing, like with clouds going by and they just they don't fall asleep, in the same way.” (parent P3)*

Another parent, P11, described the need to ensure the content is age-appropriate:

*“I think for him the apps that I tried to have him do before he felt like were geared towards kids that were too young. So, maybe some of the ones that are actually geared towards you know more adults would actually work better for him. Because I think that's part of why he didn't stay engaged with those other apps. They were probably geared towards like you know, maybe eight year old's or 10 year old's.”*

Parents and adolescents mentioned that learning via technology provides the flexibility to access teachings from different instructors, including those matching individual preferences and flexibility to join group vs private sessions:

*“Because like people everybody teaches it in different ways, like that can be reflected through technology, so you can learn a bunch of different ways, instead of having like the same person teaching it to you, over and over again.” (adolescent C11)*

Parent participants also indicated that having virtual group sessions or classes where the adolescents were part of group instruction with adolescents their age can help their adolescents learn and engage with the session. However, parents also pointed out that having a group session would also need to be monitored:

*“Instead of us asking them [adolescent] to watch a YouTube video and sit in front of TV and do yoga it's better you know if it is like a group instruction and all kids are doing it, they will try to the do it.” (parent P6)*

*“I think one thing that he really likes is interaction with people and if there was an app that had maybe like a live class type of thing I wonder if he would be more open to using it and I would definitely have to monitor that because you know I don't necessarily know the person, but if it's through a company a reputable company then I'm probably more likely to trust.. trust it.” (parent P8)*

Adolescents and parents indicated that receiving feedback on if the way they were performing the approach correctly was challenging when learning mind-body approaches digitally. As adolescent C6 described:

*“It [technology] was a little harder because in person they can show you how to do, and like make you do, but online you just have to like follow it and keep on doing it until you get it.”*

Similarly, parent P13 described:

*“It's harder to do it on your own if you are a complete newbie and don't have a lot of experience or other experienced people around you to tell whether you're doing it correct or incorrect or are just winging it kind of.”*

Functionality: Parents and adolescents also shared specific functionalities, like rewards and reminders, that can help engage adolescents with technology-based mind-body approach.

Many parents and adolescents indicated that most adolescents will be interested in the reward or benefit of doing the approach and they also provided some ideas on how the rewards can be structured like winning coins, prizes like stickers or toys. Parent P9 described adding the mind-body approach to something the adolescent already like to use:

*“If you could attach the app to one of the apps they [adolescents] wanted to use, and they would have to use play for five minutes before they could get access to another app I've never heard of an app that does that, but why couldn't it. You know, like it was a password to get into another app was to do you're meditating although you couldn't actually make them meditate, could encourage them to say, well, you can't do your app for five minutes, so you might as well just sit and think about nothing.”*

Adolescent C7 also described maybe having access to a puzzle as a reward for completing the mind-body approach:

*“Maybe like something to build upon like maybe like a picture for like each meditating each meditation class when you go back to the next one, you earn that other piece of the picture, or something or like a figurine or something like you earn another piece of the figurine.”*

Adolescents also described having games as part of the digital mind-body approach could also motivate adolescents their age learn these approaches:

*“I think it'd be kind of cool if, like there was like do like five or 10 minutes of meditation and you can play this like almost exclusive game that you have to meditate for... And you can play that or like as a selection of games as like exclusive to that exercise I think that'd be for people who like to play games like me I think that'd be interesting incentive okay.”* (adolescent C8)

*“Maybe like a game section like if you do like a certain my yoga you can like play like a game for a few minutes and then can like motivate kids to like want to do it.”* (adolescent C4)

Adolescents also suggested that having a digital approach can help with setting reminders and notifications to perform the approach daily.

*“It could be like a calendar on the app to like Remind you to do it there could be notifications to like yoga in five minutes or something.”* (adolescent C4)

*“I feel like doing it without the technology would be a little struggle...it's easier, with my phone because I'll have a reminder saying, make sure you remember to listen to this and it will be easier.”* (adolescent C2)

Parents and adolescents also indicated that while practicing mind-body approaches via technology the possibility of being distracted was higher and so limiting distractions was key. Adolescent C3 indicated:

*“I like the apps a little bit more because, like they're not like they're not all on video so it's a lot easier for me not to get distracted.”*

Sharing: Parents and adolescents expressed mixed interest in sharing information regarding the digital mind-body technology, co-using and/or sharing progress from digital mind-body-based technology with others, such as parents and friends.

The parents were very supportive of using digital mind-body technology along with their adolescents and wanted to observe, participate and even try out some of the approaches. Parents

were concerned about privacy of their adolescents particularly in group sessions. Some parents were not sure if their adolescents would want them to co-use a digital tool. As parent P9 described:

*“I think it would be fun to have some encouragement inside something like that, for some of the time to be with other family members or even other friends. But I wouldn't want it to be contingent.”*

Some adolescents were comfortable co-using the technology with their parents and sharing information regarding their use of the technology with their parents while others didn't feel comfortable sharing. As adolescent C9 stated:

*“I feel like it'd be a little weird to have them [parents] there because, like, I feel like just the practice of, the... yeah just the practice of doing it would make me feel awkward and if I had my parents like they're doing it, I think I just would kind of want to stop doing it.”*

When adolescents were asked if they would share information about their use of mind-body technologies with friends, I received mixed interest. Most adolescents showed guarded interest in sharing information with friends. One adolescent indicated that they would share the information with their friends only if the technology was interactive and didn't feel like a personal “going to a therapist” (C12) session.

A few adolescents also indicated that they would only share this information on mind-body approaches when their friends ask for it or indicate that they need help. For example, adolescent C10 indicated:

*“I'm Like. Maybe, I won't just like bring up like oh look at this app like if they were asking me like I'm just having like trouble doing this thing and then I would probably like share with them like this is what I do.”*

Some adolescents were only interested in sharing information on the approach broadly without providing any details on their own status or progress with the approach. For example, adolescent C7 indicated:

*“I would probably share the app I wouldn't share my progress, because just based on the way that kids are nowadays, they're probably not going to care at all, I mean maybe they'll be intrigued in the app, but I don't think they'll care about my progress.”*

Hesitation to share information regarding mind-body approaches with peers could be due to potential stigma associated with practicing these approaches. During interviews, all the parents openly shared their history of practicing these approaches, while many adolescents were hesitant about such sharing. Some adolescents shared that they associated practicing these approaches with therapy. Some example quotes include:

*“I wouldn't call it therapy because that kind of makes it sounds weird to kids.” (C9), “it shouldn't feel like a personal like I'm going to therapist.”(C12),*

and

*” I wouldn't just like just bring it up like I guess I wouldn't really talk about it like that.” (C10)*

#### **4.6 Discussion**

Guided by principles of HCD I directly engage adolescents to understand their perspectives on learning mind-body approaches for sleep and using technology to learn these approaches I identify interests and preferences adolescents have in learning and practicing mind-body approaches. Overall, most parents and adolescents had some exposure to mind-body approaches and were enthusiastic about adolescents learning mind-body approaches to develop better sleep habits. When designing technology for mind-body approaches for adolescents it is valuable to consider features that reduce barriers (e.g., ‘*establish routine*’, ‘*busy schedule*’, ‘*sitting still*’, ‘*boring*’) and enhance the motivators for adolescents e.g., showing them the benefits. These findings contribute insight into the potential use of technology-based mind-body approach among adolescents to develop better sleep habits.

The findings, based on perspectives of parents as well as adolescents, carry implications for the design of digital mind-body technology to address inadequate sleep among adolescents. First, parents and adolescent participants preferred mind-body approaches that are tailored to engage adolescents with customized content that includes age-appropriate materials, feedback to support learning and variety of teachings. This finding is consistent with prior research indicating that mindfulness interventions for children should have simple instructions, short activities and rely on metaphors and images that children can relate to<sup>120</sup>. Similarly, the lack of feedback to support

learning in existing digital mindfulness systems had also been documented<sup>80,121</sup>. Yet there is lack of research focused on understanding acceptable and effective adaptation of content of mind-body approaches for adolescents in the technology space. Additional work with adolescents is needed to understand further their preferences for effective adaptations of mind-body approaches.

Second, parents and adolescent participants felt that to attract and engage adolescents in the mind-body approaches incorporating functionalities like gamification (e.g., games, badges, rewards) could help. This result expands on previous research with adolescents for other health issues like physical activity and nutrition<sup>122,123</sup> where gamification features like games, rewards, badges have shown to increase engagement and sustain technology use. However, the findings of this study contrast with findings by Lukoff et al whose work with mindfulness teachers/experts emphasize that addition of gamification to mindfulness apps undermined the tenets of mindfulness (i.e., mindfulness practice is not achievement-oriented but process-oriented)<sup>88</sup>. They recommend that when designing mindfulness tools to strive for coherence with underlying principles of mindfulness while exploring features of technologies. Future work is needed to explore these tensions and align interests of adolescents in engagement with mind-body technologies.

Finally, findings indicate that adolescents are guarded in sharing information about their use of mind-body approaches or progress in performing these approaches with peers. Adolescents might experience stigma associated with these approaches. Previous research shows stigma associated with children for seeking help for mental health issues<sup>124</sup>. Yet research investigating stigma around mind-body approaches among adolescents is lacking. It is possible that adolescents relate learning mind-body approaches to stigmatizing ‘therapy’ and hence were apprehensive about sharing information with friends. Yet sharing health information with social networks or peers for comparison is a common feature supported by many mindfulness-based apps<sup>77,88</sup>. Prior research with adolescents shows that social support and input from parents, healthcare providers, and peers who engage in shared co-use via technology can help empower adolescents in self-management of overweight and obesity<sup>125</sup>. However, stigma associated with mind-body approaches could impact use of sharing features. Future research should further explore these issues to understand how to effectively engage parents and other stakeholders in the use of mind-body technology to support adolescents.

Based on the findings I recommend that a technology-based mind-body approach for adolescents be designed to: 1) provide content that is customized for adolescents, 2) include functionalities that engage adolescents like games and rewards, 3) and allow for granular sharing controls i.e., control over what information is shared and with whom. Our results suggest that a well-designed mind-body technology could potentially increase accessibility of mind-body approaches for adolescents and support better sleep for adolescents thus enhancing their wellbeing. Facilitating engagement in digital technologies is multifaceted and complex and involves a combination of personal, interpersonal and technology-related factors.<sup>21</sup> When designing technology for adolescent care needs to be taken to match these factors to design features that adolescents prefer and most likely engage with. For example, our results indicate that adolescents were guarded in sharing information regarding mind-body approaches with peers, even though sharing personal health information has been shown to be of interest in adolescents with diabetes<sup>126</sup>. Our findings offer a first step by offering guidance for design of mind-body technologies for adolescents.

Findings provide a foundation for designing digital mind-body tools for adolescents. Yet, they should be evaluated in the context of some limitations. The sample of parents and adolescents was primarily white and non-Hispanic/Latino. Parents were mothers with college or graduate degrees. Future research is needed with additional demographic groups to understand whether the study results extend to other groups. Future research should include adolescents with sleep problems to understand further their motivations for using mind-body technology. In an effort to understand broader implications for mind-body approaches for adolescent sleep, I did not focus on a specific interactive system however it is important to note that participants often referred to their use of mobile apps and YouTube videos when describing how they were exposed to mind-body approaches. Additional work is needed to understand and account for family technology practices. Future work should also evaluate the feasibility and effectiveness of digital mind-body tools for adolescents. Despite these limitations, this study has several strengths, including utilizing a HCD approach that directly engaged adolescents and parents via semi-structured interviews to obtain their detailed perspectives on digital mind-body tools for adolescents.

## **4.7 Conclusion**

Given that sleep problems are increasing in adolescents and the need for mind-body interventions for adolescents, but the lack of existing guidance in designing digital mind-body tools for adolescents, our findings fill a gap in better understanding the perspectives of parents and adolescents. I describe exposure to, interest in, and preferences for digital mind-body technology for adolescents. Parents and adolescents expressed interest in using mind-body technology and expressed preferences for design of features for content, functionality and sharing. Mind-body technology that are designed to meet these needs and preferences have the potential to enhance engagement by facilitating accessible, convenient and scalable interventions for improving sleep among adolescents. Future work should explore the transferability of these findings in a larger group of participants.

## **Chapter 5 “Meditation for me is just an app in my phone”– co-designing mind-body technologies for sleep with adolescents.<sup>2</sup>**

In this chapter, I describe the work and findings of Aim 3: Formulate design implications for the design of digital mind-body technology for adolescents through the use of co-design. Specifically I will

- Engage with adolescents through co-design and
- Examine adolescent perceptions on mind-body technologies for sleep (3.1)

### **5.1 Abstract**

Sleep is critical for well-being, yet adolescents do not get enough sleep. Mind-body approaches can help. Despite the potential of technology to support mind-body approaches for sleep, there is a lack of research on adolescent preferences for digital mind-body technology. I use co-design to engage with adolescents in the design of mind-body technology and examine adolescent perceptions of mind-body technologies for sleep. From our analysis of design sessions with 16 adolescents, four major themes emerged: system behavior, modality, content, and context. In light of these key findings, I recommend that technology-based mind-body approaches to sleep for adolescents be designed to 1) serve multiple functions while avoiding distractions, 2) provide intelligent content while maintaining privacy and trust, 3) provide a variety of content with the ability to customize and personalize, 4) offer multiple modalities for interaction with technology, and 5) consider the context of adolescent and their families. Findings provide a foundation for designing mind-body technologies for adolescent sleep.

### **5.1 Introduction**

Sleep is critical for the overall health and well-being of children, yet only 35% of children (ages 4 months to 14 years) in United States get sufficient sleep<sup>43</sup>. The rate of sleep problems increases with age, with studies showing that 73% of high school students do not get sufficient sleep<sup>43</sup>. Poor sleep and lack of sleep have been linked to adverse outcomes in adolescents, including poor

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<sup>2</sup> A version of this chapter has been submitted for consideration for American Medical Informatics Association (AMIA) conference 2023.

cognition, psychosocial health, cardiometabolic health, and obesity<sup>47,127</sup>. Hence there is a need for interventions that target sleep in adolescents.

Mind-body approaches that focus on the interaction between mind, body and behavior (e.g., yoga, breathing exercises, meditation) have been shown to help treat sleep disorders and aid in sleep self-management in adolescents<sup>21,64,68,128</sup>. Mind-body approaches may improve sleep through several mechanisms including increased mind-body awareness, self-regulation, acceptance, and attention control<sup>17,66</sup>. Many existing mind-body approaches for adolescents have been delivered in person<sup>62</sup>, in group settings<sup>21</sup>, and in schools<sup>68,69</sup>. Yet each of these options have challenges. In-person and group sessions are expensive, have high drop-out rates, and are not accessible to all adolescents<sup>21,62,69</sup>. Additionally, delivery of mind-body approaches in school has been met with challenges including implementation and training, and are not available widely<sup>22</sup>. A technology-based approach could deliver mind-body approaches digitally to adolescents making them readily portable, accessible, and scalable<sup>23</sup> and easier to integrate into daily lives and bedtime routines.

Despite the potential for technology to support mind-body approaches<sup>23,74</sup>, there is very little work in technology-based mind-body interventions for adolescents in general<sup>74,75</sup> and even less focused on adolescent sleep<sup>21</sup>. A scoping review of mind-body approaches for adolescent sleep by Garbers et al found that only one of twelve studies utilized technology to deliver the mind-body approach to adolescents<sup>21</sup>. Over the last decade, there has been increased focus on research on digitally mediated mind-body practices to support mind-body approaches for sleep but most of these have focused on adults<sup>129</sup>. For example, there has been a focus on supporting mind-body approaches through apps<sup>66,77,78</sup>, interactive technologies like virtual reality<sup>80,81</sup>, and intelligent chatbots<sup>83</sup>. The commercial mobile app space also has been flooded with mindfulness apps for adults.

Systematic review of mindfulness-based apps have shown that a majority of apps are non-evidence based and even when scientific evidence supporting their effectiveness exists it is only for adult population<sup>77</sup>. Thus, adolescents are left to use mind-body technology that are not specifically designed for their needs and preferences. Even though we know little about adolescent preferences for mind-body technologies for sleep systematic reviews of digital interventions for mental health have shown that adolescents prefer features like video, limited text, the ability to personalize, ability to connect with others<sup>41</sup>. However, an explorative review of 29 mental health apps from the

app store for adolescents (including 7 that offered mindfulness exercises) demonstrated that there is an incompatibility between youth preferences and how apps deliver content<sup>87</sup>. The authors state that “*Youth mental health promotion apps did not appear to align with young people’s preferences. Instead, young people are presented with a myriad of apps with minimal functionality.*” (p.12)<sup>87</sup>. Yet one limitation of this review was that adolescents were not directly consulted about app design. Instead, youth preferences were indirectly inferred from the opinions of youth psychologists and literature<sup>87</sup>. Talking with adolescents to understand their preferences can help inform the design of tools that better meet their needs.

Digital tools work best when they are designed considering the needs of target users<sup>130</sup>. Prior research with technology-based mind-body interventions in adolescents shows poor engagement and adherence<sup>74,75</sup>. For example, Lahtinen et al found an app-based mindfulness intervention demonstrated efficacy in reducing anxiety and depression in adolescents yet had a high attrition rate of 41%<sup>74</sup>. Similarly, Antonson et al found in a study of an internet-based intervention for adolescents that only 20 of 282 participants (7%) logged on to the internet intervention and only one participant completed the entire intervention<sup>75</sup>.

Given the potential of mind-body approaches to improve sleep for adolescents, there have been calls to engage adolescents to understand their needs, interests, and preferences in mind-body technologies<sup>131</sup>. Yet, there is a lack of knowledge about how adolescents think about mind-body technology and how to design mind-body technologies in ways that meet their preferences. I conducted a study to address this gap using the principles of co-design.

Participatory design and co-design are methods commonly used in human-computer interaction (HCI) research when designing technologies, including those used by children and adolescents. Participatory design prioritizes the perspective of adolescents by voicing their needs and preferences in the design of technology<sup>132,133</sup>. Druin states that “*the better we can understand children as people and users of new technologies, the better we can serve their needs (p. 2)*”<sup>133</sup>. Cooperative Inquiry (CI) is a co-design method grounded in HCI research and theories of cooperative design, participatory design, contextual inquiry, activity theory, and situated action<sup>132</sup>. In CI method youth and adults are considered as equal and equitable design partners<sup>132,133</sup>. CI allows researchers to collect rich data from youth and has been used in the design of various

technologies, including intelligent surfaces<sup>134</sup>, social robots<sup>135</sup>, and conversational agents<sup>136</sup>. CI involves a collection of design methods that can be adapted to best fit a research team's needs<sup>137</sup>. CI encourages practices that create equitable interactions and balance the power structure between adults and children in the design process. Practices include adults and children addressing each other on a first-name basis, eating snacks together, sitting at the same level for activities, and using informal language<sup>132,133</sup>. I focus on early adolescence (ages 10-15 years) as that is a key development phase where adolescents foster skills in self-regulation<sup>138</sup> and carry new skills to adulthood. Moreover, many adolescents are early adopters of technology and are interested in using technologies to support their mental health and wellbeing<sup>139</sup>.

The purpose of this co-design study is to formulate design implications for the design of mind-body technology for sleep. Specifically, I will

- examine adolescent perceptions on mind-body technologies for sleep (3.1)

## 5.2 Methods

The purpose of this co-design study is to engage with adolescents in design of mind-body technology and examine adolescent perceptions on mind-body technologies for sleep. The study design is based on the concepts of CI by Druin, in which co-design participants are considered experts in their knowledge domain and children are treated as equals to adults in the design process<sup>132</sup>. Following the CI approach, I conducted two 60-minute virtual co-design sessions with 16 adolescents with pre- and post-surveys (Figure 1). All research procedures were approved by the University of Washington Institutional Review Board. I recruited a team of 4 collaborators to conduct this work.



Figure 5.1 Study Design

### Recruitment

Inclusion criteria for participating were: 1) adolescents between the ages of 10-15 years, and 2) having interest and/or experience in using mind-body approaches. I recruited a convenience sample of participants via two methods. The first recruitment method was to contact parents of

adolescents who previously participated in a randomized control trial testing a mind-body approach intervention with adolescents who have sleep problems<sup>140</sup>. I distributed study flyers to parents of adolescents who completed the trial and consented to be contacted for future studies. The second method of recruitment was to distribute study flyers to parents of adolescents through professional networks (e.g., university parenting listservs). Parents of adolescents were invited to contact the study team after screening to provide consent and study enrollment. The adolescents provided assent for their participation in the study.

### *Pre-survey*

I asked adolescents to complete a pre-survey that included demographic questions (i.e., age, sex, race, ethnicity), their experience with technology, and their experience with mind-body approaches.

### *Co-Design Sessions*

I conducted two design sessions remotely over Zoom. I moderated each session (SS) and other collaborators helped and participated in session activities. Each design session consisted of three parts based on the principles of CI: **social time, design activity, and discussion**. First, social time allowed for the participants to arrive, get settled, and interact to build rapport. I then asked a “question of the day” before introductions. The question of the day was open-ended, easily answerable by participants, and was used to level the power dynamic between adolescents and adults<sup>35</sup> who participated in the session. Second, we focused on one design activity per session. Finally, during the discussion, the entire group reflected on their experience of the design activity.

*Design Session 1 (DS1, August 2022):* The goal of DS1 was to elicit information regarding adolescents’ opinions on existing technologies for learning and practicing mind-body approaches for sleep. I began DS1 with **social time** by asking the adolescent participants to type their names and the name of the last book they read in the chat (question of the day) before starting introductions. For the **design activity**, we used Line Judging<sup>35,36</sup> in which I asked the adolescent and adult research participants (members of the research team) to share their opinions on selected technologies for mind-body approaches. Line judging is a technique used to support children in evaluating multiple designs in an engaging way and when conducted in person it allows children to vote on a spectrum (i.e., from “really like” to “really dislike”) using their bodies<sup>35</sup>. I modified

the procedure to accommodate the online space by asking participants to type their votes in the chat window<sup>36</sup>. From a selection of technologies identified in literature review and available commercially, I presented five categories used for mind-body approaches for sleep: apps, smart speakers, smartwatches, other wearables (e.g., headbands, headsets, sleep masks), and standalone bedside devices (e.g., portable speakers). For each technology, I provided a short description of how it can support learning and practicing mind-body approaches for sleep. After each description I asked the participants to share their vote in the chat window as “Really Like”, “Really Dislike” and “Not Sure” and then share the reason for their vote. Participants also had the option to change their vote if their opinion changed during the design activity. At the end of the design activity, I asked participants to pick their favorite option of all the technologies presented. Finally, I concluded DS1 with a *discussion* to hear about participants’ experience with the design activity and to identify any additional technologies that could help participants learn mind-body approaches for sleep. Appendix G includes the slides presented during Session DS1.

*Design Session 2 (DS2, September 2022)*: The goal of DS2 was to ask adolescents to design their own technology to help them learn mind-body approaches for sleep. I used a modified online Comicboarding technique<sup>36</sup> where adolescents create a story together. Using Google Slides I

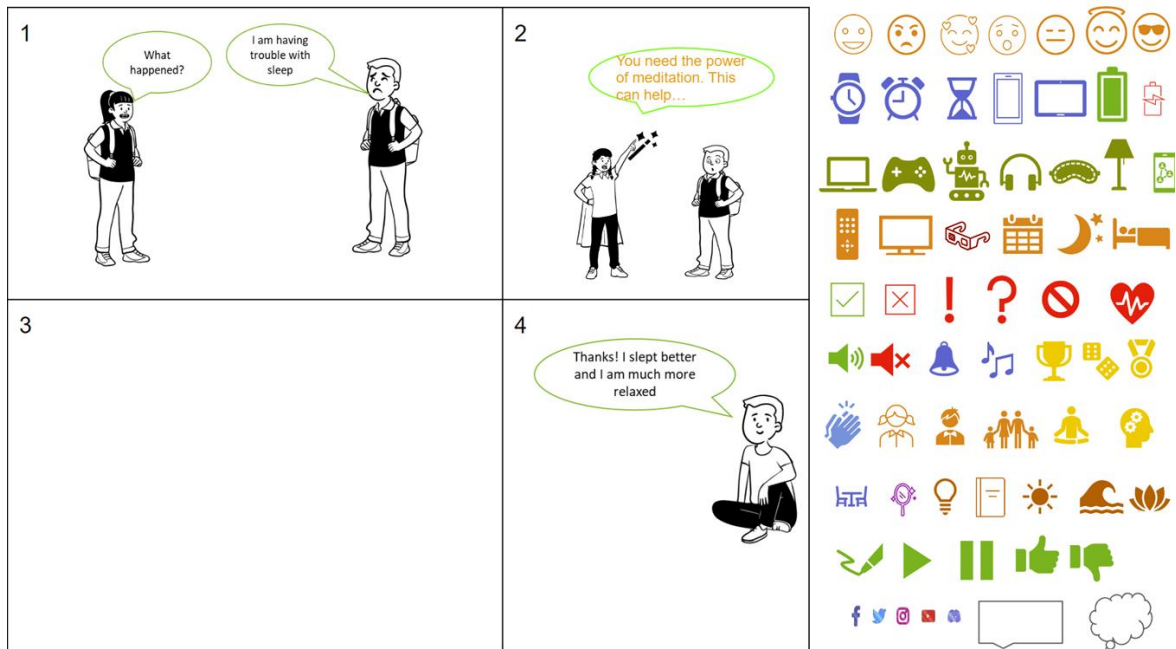


Figure 5.2. Comic board (left) and emojis (right). Box 3 of the comic board was empty for adolescents to fill in.



provided templates with stock images and emojis that participants could ‘drag and drop’ into the





comicboard. Adult researchers (members of the research team) looked up images online if needed. I began the session with *social time* by asking the adolescents to describe their day using stock images and emojis from a sample slide (question of the day) (Appendix H a). The intent was to familiarize participants with the Google Slides functions such as ‘drag and drop’. Next, for the *design activity*, I created two smaller groups to design a technology for mind-body approach for better sleep. I provided the adolescents with a scenario as a starting point (Figure 2) and asked them to complete box 3. First, I asked adolescents to comicboard individually. Subsequently, each group was asked to comicboard together. After that, the groups rejoined and one adolescent from each group presented their group’s comicboard to everybody in the session. (Appendix H b,c,d present example comicboards completed by participants). In the discussion to conclude DS2, I asked participants to share their opinions about the designs presented.

### Post-survey

After DS2 I met with the collaborators to identify the main design ideas from the comicboards presented during the session. I then created an anonymous online post-survey that included 6 mind-body technologies designed during DS2 (Table 1). The survey asked the adolescents one open-ended question for each of the 6 design ideas: “What do you like or dislike about this idea?”

Table 5-1 Summary of mind-body technologies designed during DS2

Mind-body Technology	How can it help with mind-body approaches for sleep?	Additional features
1. An app for a phone 	<ul style="list-style-type: none"> <li>Plays audio such as guided meditations, nature sounds, and calming music</li> </ul>	<ul style="list-style-type: none"> <li>Reminds youth to do mind-body approach regularly</li> <li>Tracks one’s heart rate and sleep</li> <li>Gives youth rewards and badges</li> <li>Works without the need for internet</li> </ul>
2. A smart speaker 	<ul style="list-style-type: none"> <li>Talks and interacts with youth</li> <li>Guides youth through mind-body approaches</li> </ul>	<ul style="list-style-type: none"> <li>Contains a variety of mind-body activities</li> <li>Designed with cool shapes and colors</li> <li>Asks questions like: “Good Morning, do you want to listen to a breathing exercise?”</li> </ul>

<p>3. A fidget ball/cube</p> 	<ul style="list-style-type: none"> <li>• Offers multiple options and approaches to support mind-body activities to calm down</li> </ul>	<ul style="list-style-type: none"> <li>• Uses soft material(s)</li> <li>• Uses appealing color(s)</li> </ul>
<p>4. A neck speaker</p> 	<ul style="list-style-type: none"> <li>• Plays guided meditations near one's ear to listen to and fall asleep</li> </ul>	<ul style="list-style-type: none"> <li>• Has buttons to play, pause, and control volume</li> <li>• Allows comfortable overnight wear, even if you lay on your side</li> </ul>
<p>5. A virtual reality headset</p> 	<ul style="list-style-type: none"> <li>• Plays guided meditation and music while showing calming pictures</li> </ul>	<ul style="list-style-type: none"> <li>• Can be designed to be lightweight</li> </ul>
<p>6. A robot</p> 	<ul style="list-style-type: none"> <li>• Talks and interacts with youth</li> <li>• Guides youth through meditation while also playing music</li> </ul>	<ul style="list-style-type: none"> <li>• Includes a variety of voices</li> <li>• Learns the routine and makes suggestions: "I noticed you didn't sleep well yesterday – try this meditation today."</li> </ul>

*Data Analysis*

I describe pre-survey data using descriptive statistics. After completing the design sessions, I transcribed the Zoom recordings. The recordings consisted of approximately 350 minutes of video data (excluding social time). I along with the study collaborators analyzed the data, which included the participants' line judging votes, chats, discussions, comic board artifacts, and post-survey responses. I used affinity diagramming, an inductive approach used to organize ideas into themes and concepts<sup>141</sup>. We visually represented each utterance from the design session in each sticky note. To create the affinity diagram, we iteratively organized the sticky notes into themes over the course of several discussions.

**5.3 Results**

**5.3.1 Participants**

Sixteen adolescents ages 10-15 years participated in two virtual design sessions (Table 5.2). Twelve participants completed both sessions and four participants completed only one session. All 16 participants completed the pre-survey, and 12 participants completed the post-survey. Most participants reported regularly using smartphones (10/16) laptops and laptops (11/16). Participants

had experience with breathing exercises (8/16), relaxation approaches (7/16), meditation (6/16), and yoga (6/16). Participants described learning these approaches from their parents (7/16) and school (4/16). While 7/16 participants reported using YouTube for practicing and learning mind-body approaches, 6/16 reported not using any technology to practice and learn mind-body approaches.

Table 5-2 – Participant Demographics

	n=16 (%)
<b>Sex</b>	
Male	7 (47%)
Female	9 (53%)
<b>Race</b>	
White	10 (63%)
Asian	2 (13%)
Mixed Race (White-Asian)	4 (25%)
<b>Ethnicity</b>	
Not Hispanic/Latino	16 (100%)
<b>Mind-Body Approach Experience</b>	
Less than 6 months	6 (38%)
About 6 months to a year	2 (13%)
Greater than a year	4 (25%)
Have never practiced	4 (25%)

### 5.3.2 Participant perceptions of mind-body technology for sleep (3.1)

Four themes emerged that reflect participants’ perceptions about mind-body technologies for adolescent sleep: 1) Expected system behavior, 2) Modality, 3) Content, and 4) Context.

#### 5.3.2.1. Expected System Behavior: What do adolescents expect from mind-body technologies?

Participants expected mind-body technologies to be multifunctional, to be distraction-free, to be privacy- and trust-enhancing, and reflect intelligence.

**Multifunctional:** Adolescent participants preferred technologies that supported multiple mind-body approaches more than technologies that supported only one mind-body approach. As P16 indicated: *“It [a smartwatch] helps with sleep, activities, physical and mental activities to be specific. And it’s just like a phone on your wrist.”* Similarly, P11 liked an app for mind-body approaches: *“There are lots of options. You can play music, or you could listen to something which is talking about how it helps you sleep.”* P1 described a multifunctional device that involved different senses and practices: *“Maybe it also like is a light and maybe it also makes sound machine noises and maybe it also has like lots of different types of meditation or mind practices and, maybe it would give more motivation to actually get into it.”*

**Distraction-free:** Even though participants preferred multifunctional technology, they were also concerned about being easily distracted by functions unrelated to mind-body practices. P15 summarized preference with wearables: *“They [wearables] are definitely a lot less distracting because there’s not like a screen that you can touch or get distracted or you’re using an app that you’re not supposed to.”* Multiple participants were particularly wary of distractions on smartphones. P14 remarked: *“You could also get distracted like you could go to email. You could start watching like YouTube, not what you’re supposed to do.”* Additionally, P8 shared: *“I dislike that it could tempt the user to get on the device.”*

**Privacy- and trust-enhancing:** Participants highlighted their distrust toward unknown brands and the importance of privacy. When discussing wearables, P6 stated: *“I trust, like Apple and Google...but it is just like these companies that are making these weird, these random I don’t know, like headband things. It just... doesn’t feel right.”*

Participants were also concerned about the technology tracking them and invading their privacy. P10 liked standalone devices because *“it doesn’t feel like a robot is watching me sleep.”* Similarly, P1 said: *“[It’s] weird that they [technology] can understand what I’m thinking... they can track things about me...they know how to calm me down. They are just creepy.”*

**Reflect intelligence:** Participants were interested in technologies that understood the participant and responded intelligently. When talking about designing a robot P11 imagined: *“I think it will be cool if the robot kind of interacts with me, depending on my mood and asks ‘how is your day’. And I reply, ‘I’m tired’. It will be cool if the robot replies ‘Maybe try this [mind-body activity]*

today. This can help you.” Similarly, P1 talked about a robot that could track sleep patterns: “It’s good, like when it tracks my breathing and then also maybe like my sleep then I can like track my progress and maybe see what I need to do.” Participants also talked about their annoyance when technology was not intelligent. P7 shared their experiences with existing technology: “I often get irritated after attempting to use a smart speaker for mind-body approaches because I often have to repeat myself or ask it several times. And it is more difficult in my opinion because it is not as easy to specify what I would like.”

5.3.2.2 Modality: What modality would adolescents use to interact with mind-body technology for sleep?

Participants included a variety of input and output modalities for interacting with the mind-body technologies.

**Input:** Speech and touch were the most common modalities participants preferred for interacting with mind-body technologies. Some participants described fidget cubes and physical buttons on devices like wearables and neck speakers. Some participants preferred voice interactions due to its convenience and ease of use. P7 said about smart speakers: “I just like how I don’t really have to do anything except talk to it.”

**Output:** Participants mentioned a wide variety of output modalities including voice, sounds, visuals, and videos for mind-body technologies for sleep. Some participants expressed interest in having a voice guide them through meditation. P7 suggested an app or podcast that would provide “just guided meditations. And maybe some breathing exercises.” Adolescents also mentioned a variety of preferred sounds, including “rain sounds” (P7), “white noise” (P16), “calming music” (P7), “relaxing music” (P13), and “lo-fi, music with no words” (P16). Lastly, P11 described what they might see while using a virtual reality headset: “I think it should be like pictures that you see, calming pictures that you think are calming.”

5.3.2.3. Content: What content do adolescents prefer in mind-body technologies?

Participants envisioned that mind-body technologies could offer personalized and customized content, rewards, reminders, and content that is cost- and ad-free.

**Personalized and customized:** Participants preferred that technologies provide them with a variety of mind-body content tailored for them. Participants also expressed the preference for personalized support for many mind-body approaches that could “*guide you through the meditation*” (P12), “*calm all your thoughts*” (P12), and “*be a stress reliever*” (P5). P1 talked about an intelligent smart speaker named “Anna” in their design that recognized the participant and provided a personalized mind-body approach for the participant: “*Hey Anna, let's do this type of meditation. Or maybe it'll ask me, 'What, what meditation would you like to do?'*” Participants also preferred the ability to customize a voice, music, and colors. For example, P14 felt that a mind-body technology “*should have lots of different voices and varieties so that you don't have to just listen to one thing like if you don't like it, or if it's like annoying, you can like, change it.*” Similarly, P15 talked about customizing a wearable device: “*I like it because it seems that there are a lot of different [mind-body activities] that you can choose from.*”

**Rewards:** Participants indicated an interest in receiving rewards to stay motivated. P1 indicated interest in receiving rewards for “*achievement cause like it keeps, it brings you back. A lot of times, if I'm working towards something, I have a lot of motivation to go back and continue and do then I can get farther along. And then like I get them [rewards]. It's a sense of like accomplishment and like pride.*” Similarly, P4 appreciated rewards as motivation: “*I think it would help if there was some sort of incentive. I'm not sure how you'd be able to do that on an app. But maybe you get some sort of reward for doing enough lessons, or, if you like, keep up the streak of doing the mindfulness lessons for a certain amount of days sort of like on 'Duolingo.'*”

**Reminders:** A common challenge that participants indicated with practicing mind-body approaches was remembering to do the mind-body activity regularly. Some participants wanted the technology to provide reminders and notifications. When talking about wearable devices P14 remarked: “*I bet you'd forget to do it [mind-body approach]. Well, if you had your like phone or computer or a smartwatch, and it sent like notifications you'd remember to do it, and you'd save time for that.*” P8 talked about how smartwatch reminders could help: “*The notifications can remind me during the day, whenever I need them, and help me when need them. And when I don't.*”

**Cost- and ad-free:** Participants also shared their feelings about cost and advertisements on existing smartphone apps. P13 talked about the extra cost to eliminate Spotify ads: “*You can get*

*premium. And if you don't have premium, then those ads. So I can see how it could be a little annoying if like you're just like listening [mind-body approach] and then all of a sudden like an ad comes on.” P10 also indicated that ads can be annoying: “Sometimes you are listening to really great music, and it just says, ‘Do you want car insurance?’”*

#### 5.3.2.4. Context: What is the importance of context in designing mind-body technologies?

When considering mind-body technologies for sleep, participants indicated that they should be able to use the technology without disturbing other sleeping family members, without relying on the internet, and without sacrificing comfort. Adolescent P4 imagined *“something near the head so it’s not noisy for other people”* and felt that smart speakers *“can be too distracting for other people sleeping.”* Participants also talked about the ability to use technology without the internet as P10 indicated *“It doesn't have to connect to the internet like Audible, or if you're still listening to some music, then you can pause and play it even if there's no internet”*.

Adolescents indicated their preference for comfort if the technology is worn during sleep. As P14 remarked, a *“headset would be a nice idea, but it might be a little uncomfortable to sleep with. But if there was a way to make it so that it was like comfortable when you sleep. That would be a good idea.”* Similarly, P4 said: *“I like to listen to it [mind-body approaches] on headphones, but I always find that when I'm trying to fall asleep the headphones are very uncomfortable because I don't sleep on my back. So maybe some device that would just make it more comfortable to listen to the podcast and sleep, or, you know, lie on your side.”* Even with devices that were on their bedside participants preferred technology that was comfortable to sleep next to as P16 stated: *“It [standalone devices] just doesn’t look very pleasant to sleep next to I guess.”*

## 5.4 Discussion

Given the promise and need for digital mind-body approaches for adolescent sleep, there is a lack of involvement of adolescents in the design of mind-body technologies. Through co-design sessions grounded in CI principles, four themes emerged that reflect participants’ perceptions about designing mind-body technologies for sleep: 1) Expected system behavior (multifunctional, distraction-free, privacy- and trust-enhancing, and reflect intelligence, 2) Modality (variety of input and output modalities), 3) Content (personalized and customized content, rewards, reminders, and content that is cost- and ad-free), and 4) Context (consider adolescent context at

bedtime). Our findings, based on perspectives of adolescents, carry implications for the design of digital mind-body technology for sleep in adolescents.

First, adolescents had expectations about how mind-body technologies might behave. Adolescents preferred technologies that support multiple activities and functions rather than a separate technology just for the mind-body approach. Yet at the same time, adolescents were concerned about being distracted by devices that support multiple functions, particularly smartphones. Research on adolescent concerns about distraction by technology is lacking. There is extensive literature on the concept of media multitasking or task switching where adolescents multitask with different devices or between media and other activities there is very little work investigating the concept of adolescent switching between different activities (e.g., different apps) on a single media or ‘task switching’<sup>142,143</sup>. Previous work with adolescents has shown that adolescents multitasked with their smartphones and switch to different apps due to notifications, messages, social media prompts, or boredom with a particular activity<sup>143</sup>. Central to learning and practicing mind-body approaches is developing self-regulation. Experts suggest that self-regulation that arises out of learning mind-body approaches can transfer to other aspects of daily life including technology use and task switching<sup>17</sup>.

Second, adolescents had expectations about the intelligence and accuracy of mind-body technology for sleep. They preferred to interact with highly intelligent technology. Their expectations of advanced intelligence are consistent with prior literature regarding adolescents’ interactions with conversational agents<sup>136</sup> and augmented reality<sup>134</sup>. Adults’ experiences with using artificial intelligence-enabled conversational agents for mind-body approaches such as Wysa have shown promise<sup>78,83</sup>. Wysa, an emotionally intelligent chatbot, detects negative moods of users and suggests mindfulness exercises to relieve stress<sup>78</sup>. While some users of Wysa had good experiences, some users expected the chatbot to understand them better and to avoid repeating themselves<sup>78</sup>.

Third, adolescents shared their feelings about trust and privacy of technology. Adolescents’ concern for privacy is consistent with prior literature on children and “creepy technologies”<sup>144</sup> and social robots<sup>135</sup>. Similar to prior work, participants in our study did not discuss concerns about data

mining or identity theft<sup>144</sup>. Instead, their concerns focused on distrust of brands, tracking, and lack of privacy.

Fourth, adolescents talked about their preference for mind-body technology having different modalities like voice, sounds, visuals, and videos. Previous research with mind-body approaches on smartphone apps has shown that these tools have very limited modalities and interaction options<sup>87</sup>. Future work might explore further adolescents' interaction preferences and modalities and engagement with mind-body technologies for sleep.

Fifth, adolescents indicated a preference for specific content in mind-body technologies. Adolescents want to customize and personalize the mind-body technology experience. This supports prior research that personalization and customization are important factors for engagement with technology for adolescents<sup>41</sup>. Other studies suggest that existing mental health apps for youth offer very low customization and choice<sup>87,129</sup>. Thus, future work should further explore adolescent preferences for content and design. Additionally, the adolescents were interested in rewards and reminders to practice mind-body approaches. Previous research has demonstrated that features like gamification and reminders increase engagement and sustained technology use<sup>123</sup>. Yet mindfulness teachers and experts believe that principles of mindfulness are process-oriented and are not aligned with achievement-oriented features like rewards or games<sup>88</sup>. Yet adolescents had preferences for extrinsic rewards like points, games rather than intrinsic rewards like mindfulness, increased body awareness. More work is needed on how mind-body technology can foster and educate adolescents on intrinsic rewards.

Finally, adolescents acknowledged that mind-body technology for sleep should fit well within their context and daily lives. Solutions should reduce disturbances to family members who may be sleeping, work without internet, and be comfortable to wear or sleep next to at night. Our findings iterate the call for design supporting family-centered informatics<sup>145</sup> that takes into account family and adolescent activities, routines, and norms. Further work is needed to understand the challenges families face in helping foster healthy routines including practicing mind-body approaches for adolescents as they increasingly gain independence around sleep and media use habits.

In light of these key findings, I recommend that technology-based mind-body approaches to sleep for adolescents be designed to: 1) serve multiple functions while avoiding distractions; 2) provide

accurate and intelligent content while maintaining privacy and trust; 3) provide a variety of content with the ability to customize and personalize; 4) offer multiple modalities including voice, sound, touch, videos for interaction with technology; and 5) consider the context of adolescents and their families i.e their technology use, parental mediation practices and bedtime routines. Research has shown that there is a lack of fit between adolescent preferences and technologies designed for youth<sup>23</sup>. Our findings provide a summary of adolescents' perspectives that may improve the fit between the design of mind-body technology and youth preferences for mind-body technologies.

Despite the rich data collected in our study, there are limitations. First, the adolescents did not interact with or perform mind-body approaches with the technologies during co-design sessions. While I solicited their initial reactions to a selection of technologies, we were not able to capture their impressions on the usability of existing commercial mind-body technologies. Future research should explore the usability of existing mind-body technologies for adolescents in the context of improving sleep. In addition, I recruited a convenience sample of participants from one metropolitan area in the USA and the adolescents' economic, social, and cultural backgrounds were fairly homogenous. Lastly, four adolescents did not complete the study after DS1. Our next step is to extend the scope of this research by recruiting a larger more diverse sample of adolescents with various levels of experience with mind-body approaches (intermediate to expert) to explore their perspectives. Another future direction is to evaluate the feasibility and effectiveness of a digital mind-body tool designed for sleep with adolescents. Despite these limitations, this study has several strengths including using co-design that directly engaged adolescents to obtain their detailed preferences on digital mind-body technology for adolescent sleep.

## **5.5 Conclusion**

Given that mind-body approaches have been found to reduce sleep problems in adolescents and that existing design guidance for digital mind-body tools only addresses adults, our findings fill a gap in engaging with adolescents in design of mind-body technology and also examine adolescent perceptions on mind-body technologies for sleep. Adolescents expressed preferences for system behavior, modality, content, and context of digital mind-body sleep interventions. Mind-body technologies that are designed to meet these needs and preferences have the potential to improve

sleep among adolescents. Future work should explore the transferability of these findings in a larger group of participants.

## Chapter 6 Conclusion

In this concluding chapter, I summarize how I fulfilled each aim of this dissertation. I then provide a summary of the key contributions and address limitations of the research and point to opportunities for future research. Finally, I share a concluding statement about my work in technology-based mind-body approaches for sleep.

### 6.1 Fulfillment of dissertation aims

The findings presented in this dissertation address the following three aims:

**Aim 1: Explore parental mediation strategies of adolescent bedtime technology use.** I conducted interviews and surveys with parent-adolescent dyads (n=11) to identify the range of technology that adolescents use at bedtime (1.1), the strategies that parents employ for mediating bedtime media use of adolescents (1.2), and the challenges parents face in developing these mediation strategies (1.3). I found that adolescent participants reported using smartphones and television before going to sleep primarily for watching videos or tv programs, listening to music, and playing games. Parent participants employed a range of mediation practices at bedtime. I found families used active mediation to discuss features about media, online content and safety, and about the media-related rules in the family. I found limited co-use and diversionary efforts in participants. Restrictive and investigative were the most prevalent type of mediation approaches that participants described and technology itself was used for these mediation approaches. Parent participants talked about various challenges with implementing mediation strategies including resistance from adolescents and technology-related challenges.

**Aim 2: Describe parent and adolescent interest in the use of mind-body technology to mitigate the effects of media use on sleep.** I conducted interviews with parent-adolescent dyads (n=11) to describe parent and adolescent current exposure to mind-body approaches (2.1), challenges adolescents face in learning and practicing mind-body approaches (2.2) and their interest preferences for (2.3) digital mind-body technology for sleep. Overall, most parents and adolescents had some exposure to mind-body approaches and were enthusiastic about adolescents learning mind-body approaches to develop better sleep habits. I identified challenges (e.g., ‘establish routine’, ‘busy schedule) and preferences (e.g., age-appropriate content) for mind-body

technology. Parents and adolescents indicated their preferences on the content of mind-body technology (e.g., age appropriate), functionalities (e.g. rewards and reminders) and guarded sharing controls.

**Aim 3: Formulate design implications for the design of digital mind-body technology for adolescents.** I conducted co-design sessions with adolescents (n=16) to engage with adolescents in design of mind-body technology and examine adolescent perceptions on mind-body technologies for sleep (3.1). Four themes emerged that reflect participants' perceptions about designing mind-body technologies for sleep: 1) Expected system behavior (i.e., multifunctional, distraction-free, privacy- and trust-enhancing, and reflect intelligence, 2) Modality (i.e., variety of input and output modalities), 3) Content (i.e., personalized and customized content, rewards, reminders, and content that is cost- and ad-free), and 4) Context (i.e., consider adolescent context at bedtime).

Given that sleep problems are increasing in adolescents and the potential of mind-body approaches in reducing the harm from media use but the lack of involvement of adolescents in design of mind-body technologies. In this work I investigate user needs, preferences and formulate design implications for digital mind body technology for sleep in adolescents. In my first Aim (Chapter 3), I used surveys and interviews with parent-adolescent dyads to adolescent bedtime media use and parental mediation strategies of adolescent bedtime technology use. I found that interventions for adolescent bedtime media use should consider the technology that adolescents use at bedtime (laptops, televisions, smart speakers, smartphones) and the parental mediation strategies in their household (e.g., using restrictive limits to technology use at bedtime like shutting down the internet). In my second Aim (Chapter 4), I used surveys and interviews with parent-adolescent dyads to describe parent and adolescent interest in the use of mind-body technology for sleep. I found that parents and adolescents were supportive and enthusiastic about adolescents learning and utilizing digital mind-body technology to develop better sleep habits. I also found that participants preferred mind-body technology that included functionalities (rewards, reminders) and were guarded in sharing their use of mind-body approaches with peers. In my third aim (Chapter 5) I examine adolescent perceptions on mind-body technologies for sleep. I found that technology-based mind-body approaches to sleep for adolescents be designed to: 1) serve multiple functions while avoiding distractions; 2) provide accurate and intelligent content while

maintaining privacy and trust; 3) provide a variety of content with the ability to customize and personalize; 4) offer multiple modalities including voice, sound, touch, videos for interaction with technology; and 5) consider the context of adolescents and their families i.e. their technology use, parental mediation practices and bedtime routines. Design of mind-body technology that meets adolescent needs has the potential enhance engagement and make mind-body approaches more accessible, convenient, and scalable.

## 6.2 Summary of Key Contributions

In fulfilling the three dissertation aims above, I make the following specific contributions to the fields of biomedical informatics, adolescent health and communication.

### Contributions to biomedical informatics

I make two main contributions to the areas of consumer health informatics in the field of biomedical informatics: 1) documenting adolescent and parent interest in utilizing mind-body approaches for sleep, 2) generating design guidelines that provide guidance on how mind-body technologies can best meet needs and perceptions and context of adolescents 3) describing advantages and limitations of online co-design methods for adolescents.

First, I document adolescent and parent interest in use of mind-body technology. In Aim 2 (Chapter 4), I demonstrate that parents and adolescents were interested and supportive of learning and practicing mind-body approaches utilizing technology. Prior research shows that user interest and attitudes towards digital tools are important factors for engagement with digital tools<sup>117</sup>. The contribution of this work is to take the first step in demonstrating adolescent and parent interest in mind-body technology, a key factor that impacts engagement.

Second, I generate design implications that incorporate adolescent perceptions and begin to map the unexplored space of mind-body technology for adolescent sleep (Chapter 5). To date prior research on digital mind-body technologies has focused on adults<sup>129</sup>. By employing HCD as a guiding framework I have taken an adolescent-centered view to document their interest in mind-body approaches, their challenges with practicing mind-body approaches and their perspectives on mind-body technology. My results indicate types of technology that could make mind-body

approaches more accessible to adolescents. For example, my work surfaced that smart speakers are a device that many adolescent participants use at bedtime, was one device with no mediation strategy (Chapter 3), and supports the preferences of adolescents (chapter 5). Thus, the design of smart speaker-based mind-body technology for adolescents is one potential direction for improving the accessibility of mind-body digital approaches in ways that reflect the specific needs and preferences of adolescents.

Furthermore, across all three aims a common theme was the need for digital interventions for adolescent bedtime media use to consider the context of adolescents and their families. For example, in Aim 1 (Chapter 3), a common restrictive mediation strategy in families was the shutdown of the internet in the household at bedtime. During the co-design session participants also expressed the desire for mind-body technology to be able to work without relying on the internet (Chapter 6). In addition, during the co-design session participants also suggested that technology at nighttime not disturb other sleeping family members. This take away suggests future informatics research and practice on the design of digital interventions for sleep should consider the context of adolescents and their families.

Third, I provide methods for engaging and collecting data effectively in the online space. In Aim 3 (Chapter 5), I adapted and modified co-design approaches that have traditionally been done in person to accommodate the online space. For example, for line judging I asked participants to type their votes in the chat window of zoom. Similarly, for comicboarding I provided templates with emojis that participants could ‘drag and drop’ into the comicboard. Using these methods, I engaged with adolescents and was able to elicit the perceptions of adolescents about mind-body technologies. During the design activity utilizing emojis allowed the sessions to be fun and informal for collecting data while allowing participants to express their feelings about mind-body approaches. The contribution of this work is to add to the existing literature on co-design methods for online space by describing the advantages of these specific codesign methods and describing the challenges I encountered.

Contributions to adolescent health

I make one main contribution to the field of adolescent health: 1) identifying that adolescents are guarded in sharing information about their use of mind-body approaches.

First, I identify that adolescents are guarded in sharing information about their use of mind body approaches. In Aim 2, I establish that unlike parents, adolescent participants were guarded in sharing information about their use of mind-body approaches or progress in performing these approaches with peers (Chapter 4). Hesitation to share information regarding mind-body approaches with peers could be due to potential stigma associated with practicing these approaches. During interviews, all the parents shared their history of practicing these approaches, while many adolescents were hesitant about sharing their history with practicing these approaches. Moreover adolescents also indicated mixed interest in sharing information regarding digital mind-body technology with peers (Chapter 4). Some adolescents shared that they associated practicing these approaches with mental health therapy. It is possible that adolescents relate learning mind-body approaches to stigmatizing ‘therapy’ and hence were apprehensive about sharing information with friends for fear of discrimination and bullying. This finding is novel given there is a lack of research investigating stigma around mind-body approaches among adolescents.

#### Contributions to the field communication studies

I make three main contributions to parental mediation in the field of communication studies: 1) I advance knowledge about parental mediation practices with newer technology than television studies, 2) identify that television viewing was not being considered as “screen time” but rather an activity for winding down or co-use, and 3) identifying challenges that parents face in implementing mediation strategies for adolescent technology use at bedtime.

First, based on results from Aim 1, I contribute a rich understanding of adolescent technology use at bedtime and parental mediation practices at bedtime (Chapter 3). I extend the parental mediation literature in the field of communication by identifying mediation practices that are used in a limited manner like co-use and diversionary. I also document ways in which parents use technology for restrictive and investigative mediation efforts like shutting down the internet and monitoring

technology use. Given that most of the parental mediation literature is quantitative and primarily focuses on internet use<sup>56</sup> I extend prior research by utilizing qualitative methods and contribute knowledge about parental mediation practices with newer digital technology not covered in prior research, including smart speakers.

Second, during the interviews in Aim 1 (Chapter 3), parents and adolescents talked about watching television at nighttime to wind down after the day. Was television not considered screen time in these families? This finding is concerning given that television viewing has been associated with less sleep in adolescents<sup>109</sup>. It is possible that television viewing was the only opportunity for parents to co-use technology with their children so they didn't restrict that activity. These findings shed light on the evolving nature of technology and mediation practices and how co-use was particularly restricted to older technologies like television. This finding contributes to the field of communication by identifying the need for family-based interventions for co-use of newer technologies like smartphones.

Third, in Aim 1 (Chapter 3), I identify challenges that parents face when implementing mediation strategies for adolescent bedtime media use. I document how parents in this participant sample who have multi-device households struggle to implement mediation strategies for bedtime and the various resources they utilize for seeking information regarding parental mediation. It was surprising that parents didn't talk about seeking information on mediation strategies from their child's healthcare providers. Instead they sought information from peers, seminars and schools. This insight about challenges parents face in implementing mediation strategies contributes knowledge to the field of communication and could serve as a starting point for development of educational tools and interventions to support parents in overcoming the challenges.

### 6.3. Limitations

While this dissertation contributes new knowledge about the needs, preferences and implications for design of digital mind-body technology for adolescents' sleep, I acknowledge some limitations

to the studies described in this dissertation. Here I discuss 5 main limitations across the Aims of this project.

### **Limitation 1. Transferability of findings**

All studies in the project recruited a convenience sample of participants from one metropolitan area in the USA and the participants' economic, social, and cultural backgrounds were fairly homogenous. The sample was largely white. And parents were all female and college-educated or greater (Aims 1 and 2). I only recruited one parent and one adolescent per family (Aims 1 and 2). All the parents that participated in the family were women and I didn't speak to their partners. Some parent participants acknowledged some parts of mediation that their partner took a primary role in, like co-using video games with the adolescent and setting up technology based restrictive limits in the family. Including the partners in the Aims 1 and 2 (Chapter 3 and Chapter 4) might have impacted the mediation strategies and challenges with mediation strategies I could have identified. Moreover, in the Aim 2 and Aim 3 both parents (Chapter 4) and adolescent participants (Chapter 4 and Chapter 5) had knowledge and access to a wide range of technology. For example, most participants knew about smartwatches and talked about their perceptions about self-tracking. My findings on adolescent perceptions to mind-body technology in aim 3 (Chapter 5) might be different if I had recruited a sample that is more diverse with respect to their access to technology. Technology use, parental mediation, exposure to mind-body approaches vary across communities. The work I present here is not representative, and thus findings may not be transferable to other groups. However, my results have generated useful questions for future researchers to investigate in new study populations, participants with more diverse racial and ethnic backgrounds and participants with low socioeconomic status.

### **Limitation 2. Impact of pandemic on technology use, parental mediation, study design**

The studies in this project were conducted during the COVID-19 pandemic which impacted adolescent screen time use and limits (Chapter 3). Because schools were online, many families I engaged with described having limits on the number of hours of screen time per day, and had to make changes to that rule as kids were using technology for schooling and socializing. In Aim 1 (Chapter 3), I asked parents and adolescents about their bedtime technology use and

mediation strategies at a time when these practices were so different from pre-pandemic times. Although I attempted to capture the differences in technology use and meditations by asking participants how different the rules and technology use was changed due to the pandemic, I was unable to fully capture how much the mediation strategies evolved or changed due to COVID-related changes in technology use. Was restrictive mediation more or less prevalent due to changes in use of technology? Were more parents using technology to monitor and set restrictive limits due to changes in adolescent bedtime media use during the pandemic? At the same time I note some advantages. There were several challenges with conducting design sessions online. For example, when line judging is conducted in person participants are able to see what other participants' votes are. This allows everyone to know the votes and build rapport and some additional camaraderie. But for my study, since participants voted on the chat in Zoom, they were not able to see this as easily as in person. This lack of visibility of other participant votes might limit discussion and building camaraderie, particularly when working with larger samples of participants. Similarly, for the comicboarding session when participants logged into the Zoom session via their phones they had difficulty with switching between the google doc and the zoom screen. So many needed additional help completing their comicboards.

Another challenge with the virtual space particularly, when participants had their cameras off, was to determine if participants were paying attention to the concepts and technologies presented or were they not at their desk or were they doing something else. I am not sure if recording the session for data capture and analysis was one of the reasons for participants choosing to turn off their cameras.

Despite these challenges there are some potential benefits to conducting this research during COVID-19 pandemic. Because adolescents had started using Google slides and Zoom for schoolwork, they may have become more comfortable using these technologies, particularly for the design sessions (Chapter 5). Online methods also made it easier to conduct multiple sessions and reach participants who may have not been able to participate in person and thus made participation in research studies more accessible and convenient for adolescents and parents. The work I presented here highlights some of the complexities of conducting research studies online

with adolescents and points to useful areas for future researchers to investigate including how to effectively modify the online space to support data collection while maintaining privacy of adolescents, what features of online tools hinder or facilitate conversation?

### **Limitation 3. Lack of adolescent interaction with mind-body technology**

During the co-design sessions, the adolescents did not interact with or perform mind-body approaches with the technologies .(Chapter 5). While I solicited their initial reactions to a selection of technologies, I was not able to capture their impressions on the usability of mind-body technologies. Adolescent's perceptions about mind-body technologies could differ after using the technology or with repeated use for a longer period of time. Other HCI approaches like usability testing through think aloud<sup>146</sup> or cognitive walkthrough<sup>146</sup>, Wizard of Oz testing<sup>146</sup>, or field testing over short periods of time<sup>146</sup> is an important direction for future work.

### **Limitation 4. Lack of data from other stakeholders in the socio-ecological model**

I utilized a socio-ecological model to guide data collection and included only parent-adolescent dyads at individual and interpersonal levels in this dissertation. There are other stakeholders at other levels, including peers (interpersonal level) and teachers, counselors and mental health providers (organizational and community level). These stakeholders may have important perspectives on mind-body sleep technology for adolescents that were beyond the scope of this dissertation. Talking with these stakeholders could have provided some additional insights into the challenges adolescents described with mind-body approaches (Chapter 4) and ways to design technology-based mind-body approaches to reduce these barriers.

### **Limitation 5. Biases due to desirability and positionality**

Finally, adolescents might have had difficulties sharing their views in the interviews (Chapter 3 and Chapter 4) due to social desirability bias where participants may present answers that are more socially acceptable and might have underreported their technology use. By talking to both parents and adolescents in the study I hoped to minimize this bias.

Moreover across all three aims I was the primary instrument of data collection and analysis. My positionality as a qualitative researcher, a mom, immigrant women of color with a graduate education may have influenced the way I collected and interpreted the data. While my own perspective helped enrich the study by providing me with knowledge and experience to conduct the study and also build a comfortable relationship for participants to share their opinions with me. I also took steps to reduce biases due to my positionality, including pilot testing the interview protocols (Chapter 3 and Chapter 4), having a second coder code a random selection of qualitative excerpts (20% of the interview data) (Chapter 3 and Chapter 4), having collaborators observe and participate in design sessions (Chapter 5), collectively analyzing data using affinity diagramming with collaborators (Chapter 5) . Nonetheless, it is not possible to remove potential biases altogether.

## 6.4 Future Work

In this section, I point to potential areas for future work for researchers and practitioners in biomedical informatics, adolescent health, and communications.

### 6.4.1 Opportunities for biomedical informatics researchers

I found that adolescents have interest in learning and practicing mind-body approaches via technology and have preferences around content, functionality and sharing (Chapter 4) and perceptions around mind-body technology including system behavior, modalities, content, and context. Future consumer health informatics research should extend these design recommendations after including a more diverse population of adolescents and parents. For example, including participants with more diverse racial and ethnic backgrounds and participants with low socioeconomic status. Future research should also focus on allowing adolescents to interact with the technology and practice mind-body approaches with the technology. For example, utilizing methods like think aloud could allow the participants to practice the mind-body approach with technology and then obtain their perceptions.

An important next step for research is to continue to the next stages of HCD to produce design solutions that incorporate the findings from this dissertation and the design implications that I

propose. My work surfaced that smart speakers are a device that adolescents use at bedtime (chapter 3), it was one device with no mediation strategy (Chapter 3), and support the preferences of adolescents (Chapter 4 and Chapter 5). Researchers should explore the design of a smart speaker-based mind-body technology for adolescents and conduct an evaluation with a sample of adolescents with sleep problems to understand its feasibility. Future researchers should advance my findings by investigating how adolescents interact and engage with a digital smart speaker-based mind-body program and measure its impact on reducing media-induced arousal.

Another avenue for future research is engaging other stakeholder groups at additional levels of the socio-ecological framework, including the organizational and community level, to learn their perspectives on the design of mind-body technology. I think it would be important to engage with mind-body therapists and teachers who specifically work with adolescents to understand more on their perspectives on insights gained from this dissertation on mind-body technology, including age-appropriate content of mind-body approaches and rewards for mind-body approaches. For example, future research could look at conducting interviews with mind-body therapists and ask them about their thoughts on mindbody technologies for adolescent sleep and the design implications generated by this study.

Another area for future research in consumer health informatics is to explore further the complexities of conducting research studies online with adolescents. To conduct remote design sessions during COVID 19 and obtain participant ideas on mind-body technology, I utilized a modified version of line judging (DS1) and comicboarding (DS2) (Chapter 5). Future research could look at how to effectively modify the online space to support data collection while maintaining privacy of adolescents, what features of online tools hinder or facilitate conversation and data collection.

#### 6.4.2. Opportunities for researchers for adolescent health

I found that adolescents participants were guarded in sharing information about their use of mind-body approaches or progress in performing these approaches with peers. Some adolescents shared that they associated practicing these approaches with therapy (Chapter 4). Previous research shows

stigma associated with children seeking help for mental health issues<sup>124</sup>. Yet research investigating stigma around mind-body approaches among adolescents is lacking. It is possible that adolescents relate learning mind-body approaches to stigmatizing ‘therapy’ and hence were apprehensive about sharing information with friends. Thus, future research investigating reasons for stigma and potential approaches to reduce stigma will be essential for increasing awareness and adoption about mind-body approaches.

#### 6.4.3 Opportunities for researchers and practitioners for communication

In this dissertation, I found that mediation practices like co-use had only limited use in families (Chapter 3). This is concerning given the call by the American Academy of Pediatrics recommending parents and children jointly engage in media<sup>11</sup>. With the pervasive use of media in households future research should explore ways to support joint media engagement between parents and adolescents. How can newer technologies, like smartphones, where each person has their own device support joint media engagement?

I also found that parents described a lot of challenges with implementing mediation strategies for their families. The American Academy of Pediatrics recommends that parents set media use plans for their families, yet parents in Aim 1 (Chapter 3) described many challenges with implementing these strategies. Thus, more efforts by practitioners to educate and support parents in mediating technologies particularly with newer technologies like smartphones is warranted.

#### 6.5 Conclusion

Over the course of this dissertation, I have demonstrated the opportunities and value of using a harm-reduction model-based approach for reducing the impact of media use on adolescent sleep. I present how mind-body approaches could serve as a harm reduction-based intervention to mitigate media-induced arousal in adolescents. I demonstrate the potential of digital technology to deliver mind-body approaches to adolescents. I utilize a socio-ecological inspired research design to engage parent-youth dyads to understand their perspectives.

The three aims I present in this dissertation utilizing HCD as a guiding framework, sought to understand both parent and adolescent perspectives on bedtime technology use and mind-body technologies. Involving adolescents and parents yielded previously unidentified opportunities for mind-body technologies.

Adolescence is considered a key phase in the development of children and is very important for laying foundations for adulthood. Learning and practicing mind-body approaches could be a life skill that adolescents can use to mitigate the effects of media use on sleep problems and potentially other health problems. Engaging adolescents in the development of technology for mind-body approaches can help design tools that meet their needs and that works within their family context. Mind-body technology that is designed with adolescent involvement can help maximize engagement and make mind-body approaches more accessible to adolescents at scale.

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# APPENDICES

**Appendix A:** Table of Mind body approaches. Rows with bold text indicate the mind-body approach that match the criteria and was utilized in the dissertation.

Type of approach	Definition <sup>38-40</sup>	Requires specific physical setting/position?	Requires specialized equipment?	Can youth practice these at home by themselves?
<b>Meditation</b>	<b>The act of engaging in mental exercise to reach a heightened level of spiritual awareness or mindfulness. A group of techniques, most of which started in Eastern religious or spiritual traditions. In meditation, individuals learn to focus their attention and suspend the stream of thoughts that normally occupy the mind. This practice is believed to result in a state of greater physical relaxation, mental calmness, and psychological balance. Practicing meditation can change how a person relates to the flow of emotions and thoughts in the mind.</b>	<b>No</b>	<b>No</b>	<b>Yes</b>
<b>Yoga</b>	<b>A combination of breathing exercises, meditation, and physical postures, of Hindu origin, used to achieve a state of relaxation and balance of mind, body, and spirit.</b>	<b>No</b>	<b>No</b>	<b>Yes</b>
Taichi and Qi Gong	Tai chi and qi gong are centuries-old, related mind and body practices. They involve certain postures and gentle movements with mental focus, breathing, and relaxation.	Yes	No	No

Type of approach	Definition <sup>38-40</sup>	Requires specific physical setting/position?	Requires specialized equipment?	Can youth practice these at home by themselves?
Acupuncture	Acupuncture is a technique in which practitioners stimulate specific points on the body—most often by inserting thin needles through the skin	Yes	Yes	No
<b>Relaxation</b>	<b>Relaxation techniques include a number of practices such as progressive relaxation, guided imagery, biofeedback, self-hypnosis, and deep breathing exercises. The goal is similar in all: to produce the body's natural relaxation response, characterized by slower breathing, lower blood pressure, and a feeling of increased well-being.</b>	<b>No</b>	<b>No</b>	<b>Yes</b>
Feldenkrais Method	The Feldenkrais method (FM), founded by a physicist and engineer, is a system that uses movement exploration for somatic learning through 2 major techniques	Yes	No	No
Alexander Technique	The Alexander Technique teaches “use of the self” to become aware of bodily tension and learn to pause instead of reacting to situations, thereby reducing stress and neuromuscular tension.	Yes	No	No
Pilates	Pilates is low-impact exercise based on holistic movement principles including concentration, centering, control, breathing, precision, and flow	Yes	No	No

Type of approach	Definition <sup>38-40</sup>	Requires specific physical setting/position?	Requires specialized equipment?	Can youth practice these at home by themselves?
Structural Integration	Structural Integration (SI) is a process-based approach to somatic education, typically involving manual therapy, that explores the possibility of change in how you use and experience your body. Through education, awareness, and therapeutic touch, you can release painful, stressful patterns of tension	Yes	No	No
Chiropractic and Osteopathic Manipulation	Osteopathic manipulative treatment is used to alleviate somatic dysfunction by applying manually guided forces to improve physiologic function and support homeostasis.	Yes	No	No
Aromatherapy	Aromatherapy uses the scent of concentrated plant oils, known as essential oils, to improve feelings of well-being. It is a popular complementary therapy used to relieve stress and produce other pleasant sensations.	No	Yes	Yes
Massage Therapy	Massage uses touch in a sensitive and respectful way, taking account of physical symptoms, wellbeing, and your lifestyle.	Yes	No	No
Art Therapy	<b>Art therapy (AT) is the therapeutic use of art making, within a professional relationship, by people who experience illness, trauma, or challenges in living, and by people who seek personal development. Through creating art and reflecting on</b>	No	No	Yes

Type of approach	Definition <sup>38-40</sup>	Requires specific physical setting/position?	Requires specialized equipment?	Can youth practice these at home by themselves?
	<b>the art products and processes, people can increase awareness of self and others; cope with symptoms, stress, and traumatic experiences; enhance cognitive abilities; and enjoy the life-affirming pleasures of making art</b>			
<b>Music Therapy</b>	<b>Clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program</b>	<b>No</b>	<b>No</b>	<b>Yes</b>

## Appendix B – Advisory Board Members

1) Becca Calhoun BA,MPH

Director of Community Programs and Training at UW Center for Child & Family Well-Being

2) Dr.Justin Kappel MD, MPH

Family Medicine Specialist

3) Grin Lord, PSYD, ABPP

Clinical Psychologist who provides psychotherapy of adolescents

4) Kim Armstrong

Co-founder and Co-Director of Space Between non-profit with a mission of facilitating human and school transformation through mindfulness practices.

## Appendix C – Parent Survey

### About You

1. What is your age \_\_\_\_\_
2. What is your gender?
  - Female
  - Male
  - Other
  - Decline to state
3. How do you describe your **race**? (Mark all that apply.)
  - White
  - Black or African American
  - Asian
  - Native Hawaiian/ Pacific Islander
  - American Indian/ Alaskan Native
  - Alaska Native
  - Other: \_\_\_\_\_
  - Decline to state
4. How do you describe your ethnicity? (Select one)
  - Hispanic or Latino

Not Hispanic or Latino

Decline to state

5. What is the highest level of education you completed? (Select one)

High school graduate

College graduate (BA or BA)

Advanced practice degree (e.g. MA, MS, ARNP, PA)

Doctorate degree (e.g., MD, PhD, PsyD, PhrMD)

Decline to state

### Technology Use

The following questions ask about YOUR media/technology use. Media/Technology can include devices like smartphones, tablets, computers, gaming consoles, televisions.

6. For each of the devices listed below kindly check all the boxes that apply

Device	I have or use this device	This device is located in my bedroom	I use this device in the two hours before going to sleep
Laptop	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Computer/Desktop/PC	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Smartphone	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tablet/E-Readers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Game console	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Television	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Audio Player (e.g.iPod, MP3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Smart Speaker (e.g. Alexa or Google Home)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
None of these	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

7. Thinking about the past few weeks which of these media related activities do you engage in typically after dinner until you go to sleep (Mark all that apply) \*

<input type="checkbox"/>	Watching television
<input type="checkbox"/>	Playing games on a Playstation or similar device
<input type="checkbox"/>	Listening to music

<input type="checkbox"/>	Surfing the internet
<input type="checkbox"/>	Playing games online
<input type="checkbox"/>	Reading an e-book (eg. via Kindle)
<input type="checkbox"/>	Reading emails/messages/social media posts/blogs (not actively responding)
<input type="checkbox"/>	Watching videos or TV programs online but not via a television (e.g. YouTube,)
<input type="checkbox"/>	Skyping or Face-Timing others
<input type="checkbox"/>	Interacting with other people via phone calls/emails/blogs
<input type="checkbox"/>	Sending messages via Facebook Messenger/ WhatsApp/ Viber
<input type="checkbox"/>	Interacting/responding with others via social media platforms (eg. Facebook/ Snapchat/ Instagram/ Twitter or similar)
<input type="checkbox"/>	Sending messages to others via text/ iMessage
<input type="checkbox"/>	I engage in other device related activities not listed
<input type="checkbox"/>	Work/School related activities
<input type="checkbox"/>	Others_____

8. Thinking about a time before the pandemic were the media related activities you selected in the above question (i.e after dinner and before bedtime) different?

Yes

No

### Child Technology Use

9. For each of the devices listed below kindly check all the boxes that apply

Device	My child has or uses this device	My child uses this device in their bedroom	My child uses this device in the two hours before going to sleep
Television	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Laptop	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Computer/Desktop/PC	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Smartphone	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tablet/E-Readers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Game console	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TV	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Audio Player (e.g.iPod, MP3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Smart Speaker (e.g. Alexa or Google Home)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
None of these	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10. Thinking about the past few weeks which of these media related activities do you engage in typically after dinner until you go to sleep (Mark all that apply) \*

<input type="checkbox"/>	Watching television
<input type="checkbox"/>	Playing games on a Playstation or similar device
<input type="checkbox"/>	Listening to music
<input type="checkbox"/>	Surfing the internet
<input type="checkbox"/>	Playing games online
<input type="checkbox"/>	Reading an e-book (eg. via Kindle)
<input type="checkbox"/>	Reading emails/messages/social media posts/blogs (not actively responding)
<input type="checkbox"/>	Watching videos or TV programs online but not via a television (e.g. YouTube,)
<input type="checkbox"/>	Skyping or Face-Timing others
<input type="checkbox"/>	Interacting with other people via phone calls/emails/blogs
<input type="checkbox"/>	Sending messages via Facebook Messenger/ WhatsApp/ Viber
<input type="checkbox"/>	Interacting/responding with others via social media platforms (eg. Facebook/ Snapchat/ Instagram/ Twitter or similar)
<input type="checkbox"/>	Sending messages to others via text/ iMessage
<input type="checkbox"/>	I engage in other device related activities not listed

<input type="checkbox"/>	Work/School related activities
<input type="checkbox"/>	Others _____

11. What rules about media use do you have for your child/children particularly around the time after dinner and before they go to sleep?

	We have rules about this and the rules are always enforced	We have rules about this, which are sometimes enforced	We have rules about this but the rules are rarely enforced	No rules about this
Which age ratings of movies, shows, or games are ok				
Which specific shows, movies, or videos they can watch				
Which specific games they play				
Which music they can listen to				
Which social media apps or sites they can use				
Which websites they can use				
<b>HOW MUCH TIME They CAN SPEND</b>				
... watching shows, movies, or videos				

... playing games				
... listening to music				
... using social media, chatting, or texting				
... looking at websites online				
<b>WHERE THEY YOU USE MEDIA IN THE HOUSE</b>				
Where they can watch shows, movies, or videos				
Where they can play games				
Where they can use social media, text, or chat				
Where they can use a computer to search or look at things online				
<b>WHEN THEY USE MEDIA</b>				
How early in the morning they can use media				
How late in the evening they can use media for fun				
How late in the evening they can use media for school				

Whether media devices can stay in their bedroom at night				
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12. How often does each statement apply to your child?

	Almost always	Often	Sometimes	Rarely	Never
Find that they spend longer time with the media than you planned					
You notice that when they turn off the device that they are really hungry					
You notice that when your child stops using the media that they severely must pee					
Your child doesn't notice how tired they were until they stop using the device					

13. How often do you and your child have fights or conflict about their media use?

	Never	A little of the time	Sometimes	Much of the time	All the time
About when they use media					
About what media content (apps, videos, games, websites.) they use or watch					
About what time of day they use media					

About how many hours they use media					
About who they connect with online					

14. How have media rules changed since the pandemic?

- More rules or enforcement
- Stayed the Same
- Less rules or relaxed rules.

## Appendix D – Adolescent Survey

### About You

1. What is your age \_\_\_\_\_
2. What is your gender?
  - Female
  - Male
  - Other
  - Decline to state
3. How do you describe your **race**? (Mark all that apply.)
  - White
  - Black or African American
  - Asian
  - Native Hawaiian/ Pacific Islander
  - American Indian/ Alaskan Native
  - Alaska Native
  - Other: \_\_\_\_\_
  - Decline to state
4. How do you describe your ethnicity? (Select one)
  - Hispanic or Latino

Not Hispanic or Latino

Decline to state

5. The following questions ask about YOUR media/technology use. Media/Technology can include devices like smartphones, tablets, computers, gaming consoles, televisions.

Device	I have or use this device	This device is located in my bedroom	I use this device in the two hours before going to sleep
Television			
Computer/Desktop/PC/Laptop	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Smartphone	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tablet/E-Readers (e.g. iPad)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Game console (e.g. PlayStation, Xbox, Nintendo)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TV	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Audio Player (e.g. iPod, MP3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Smart Speaker (e.g. Alexa or Google Home)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
None of these	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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6. Thinking about the past few weeks which of these media related activities do you engage in typically after dinner until you go to sleep (Mark all that apply)

Activity	
1. Watching television	<input type="checkbox"/>
2. Playing games on a Playstation or similar device	<input type="checkbox"/>
3. Listening to music	<input type="checkbox"/>
4. Surfing the internet	<input type="checkbox"/>
5. Playing games online	<input type="checkbox"/>
6. Reading an e-book (eg. via Kindle)	<input type="checkbox"/>
7. Reading emails/messages/social media posts/blogs (not actively responding)	<input type="checkbox"/>
8. Watching videos or TV programs online but not via a television (e.g. YouTube,)	<input type="checkbox"/>
9. Skyping or Face-Timing others	<input type="checkbox"/>
10. Interacting with other people via phone calls/emails/blogs	<input type="checkbox"/>
11. Sending messages via Facebook Messenger/ WhatsApp/ Viber	<input type="checkbox"/>
12. Interacting/responding with others via social media platforms (eg. Facebook/ Snapchat/ Instagram/ Twitter or similar)	<input type="checkbox"/>

13. Sending messages to others via text/ iMessage	<input type="checkbox"/>
14. I engage in other device related activities not listed	<input type="checkbox"/>
15. Work/School related activities	<input type="checkbox"/>
16. Others_____	<input type="checkbox"/>

7. Thinking about a time before the pandemic were the media related activities you selected in the above question (i.e after dinner and before bedtime) different?

- Yes
- No

8. What rules about media use do your parents have in your home particularly around the time after dinner and before you go to sleep??

	We have rules about this and the rules are always enforced	We have rules about this, which are sometimes enforced	We have rules about this but the rules are rarely enforced	No rules about this
Which age ratings of movies, shows, or games are ok				
Which specific shows, movies, or videos you can watch				

Which specific games you play				
Which music you can listen to				
Which social media apps or sites you can use				
Which websites you can use				
<b>HOW MUCH TIME YOU CAN SPEND</b>				
... watching shows, movies, or videos				
... playing games				
... listening to music				
... using social media, chatting, or texting				
... looking at websites online				
<b>WHERE YOU USE MEDIA IN THE HOUSE</b>				
Where you can watch shows, movies, or videos				
Where you can play games				
Where you can use social media, text, or chat				
Where you can use a computer to search or look at things online				
<b>WHEN YOU USE MEDIA</b>				

How early in the morning you can use media				
How late in the evening you can use media for fun				
How late in the evening you can use media for school				
Whether media devices can stay in your bedroom at night				

9. How often does each statement apply to you?

	Almost always	Often	Sometimes	Rarely	Never
Find that you spend longer time with the media than you planned					
I notice that when I turn off my device that I am really hungry					
I notice that when I turn off my device that I severely must pee					
I don't notice how tired I was until turn off the device					

10. How often do you and your parents have fights or conflict about their media use?

	Never	A little of the time	Sometimes	Much of the time	All the time
About when you use media					
About what media content (apps, videos, games, websites) you use or watch					
About what time of day you use media					
About how many hours you use media					
About who you connect with online					

11. How have media rules changed since the pandemic?

- More rules or enforcement
- Stayed the Same
- Less rules or relaxed rules.

## Appendix E – Parent Interview Protocol

### **TECHNOLOGY USE**

Let's begin by talking a little about digital technology use as well as some general technology use at home

1. Overall, what are your thoughts as a parent on children using digital technology (technology – tv, computer, laptop, gaming consoles) in general?
  - i. Benefits of technology use
  - ii. Challenges/Concerns
  - iii. Any issues/concerns with using technology at bedtime?
  - iv. How has technology use changed during/since COVID-19 pandemic

### **STRATEGIES TO MANAGE TECHNOLOGY USE**

Now let's chat a little bit about strategies to manage technology use.

1. What strategies, if any do your family use to manage your child's technology use particularly at bedtime? (e.g. monitoring screen time, content)
  - a. Are any of these strategies different during/since COVID-19?
2. What have been the challenges in implementing these strategies?
3. In addition to rules are there other parental controls/safety features installed on media devices in your home?
4. Have you used any existing tools/website/resources to help with strategies to manage technology use?
5. If your child needed to be completely in charge of setting limits on media use like time, length of use and manage that with regular activities like homework how well do you think they will be able to do that on their own?
  - a. Can you tell me more on about why you think they can/ cannot?

## **MIND-BODY APPROACHES**

Mind body approaches are techniques designed to enhance the mind's positive impact on the body. These approaches are all about becoming aware of what your mind and body are telling you about how you are feeling.

1. Have you used any mind body approaches/relaxation techniques like meditation, relaxation, yoga, art therapy and music therapy? Can you describe your experience with these approaches?
2. What has your child's exposure been to meditation, relaxation, yoga, art therapy and music therapy?

We are working on a mind body program to help kids learn how to manage their technology use and being more aware of their body and its response to technology use, we are thinking about different ways to provide these to families..

1. What are your thoughts on children learning mind body approaches like meditation to develop healthier habits particularly regarding media use?
2. If we were to ask your child to do the program (i.e meditation) everyday what do you think would be the challenges in doing that?

We are thinking about providing the program digitally to families.

1. How do you think technology can help your child learn these techniques?
2. If your child was interested in using a digital tool to help him or her regulate media use would you allow your child to use such applications?
3. If your child wanted you to be a co-user of an application that helped him or her mitigate media use, would you be willing to use the application? How do you see yourself using the application? Would you prefer to have a separate application of your own?

## Appendix F – Adolescent Interview Protocol

### **TECHNOLOGY USE**

Let's begin by talking a little about digital technology/media at home. By digital technology/media we mean mobile phones, computers, laptops, gaming consoles, televisions – electronic gadgets. Going forward I will be using the term technology/digital technology to refer to these devices.

1. What do you think of digital technology/technology? Are there things you really like about it? Are there things you don't like?
  - i. Tell me about the last time you used a media/technology? – who were you with, what did you do, was it fun? Was there anything not fun about it?
2. Now let's talk about technology use in your home particularly at bedtime?
  - a. What technology do you usually use at home at bedtime – (3 hours before bed)
  - b. What are some of the best things you get out of media use in the evenings especially at bedtime – (3 hours before bed)
  - ii. How has your use of technology at home at bedtime – (3 hours before bed) changed during/since COVID-19 pandemic

### **STRATEGIES TO MANAGE TECHNOLOGY USE**

Now let's chat a little bit about strategies to manage technology use. Families have many strategies they use to manage their technology use. To provide some context – some families have rules/time limits, no devices at this time, no watching these at certain times...

3. What strategies/rules, if any do you have at home for technology use at bedtime?
  - b. Are any of these strategies different during/since COVID-19?
4. Do you like the rules? Is there anything you do not like about the rules?
5. Are there any challenges with following the rules?

## MIND-BODY APPROACHES

1. Mind body approaches are techniques designed to enhance the mind's positive impact on the body. These approaches are all about becoming aware of what your mind and body are telling you about how you are feeling.
  - a. Have you used any mind body approaches/relaxation techniques like meditation, relaxation, yoga, art therapy and music therapy? Can you describe your experience with these approaches?

We are working on a mind body program to help kids learn how to manage their technology use and being more aware of their body and its response to technology use, we are thinking about different ways to provide the program to families..

2. Generally, what do you think about the idea learning learn approaches like meditation to develop healthier habits particularly regarding technology use?
3. If we were to ask you to do the program (i.e meditation) everyday what do you think would be the challenges in doing that?

We are thinking about providing the program digitally to families.

1. How do you think technology can help you learn these techniques? If we were to ask you to do the program (i.e meditation) everyday what do you think would be the challenges in doing that?
2. Would you like to be able to share information or progress you've made using the program technologically with your parents?
  - i. How do you see yourself using the program digitally with your parents? Would you prefer to have a separate application of your own?
3. Would you like to share information or progress you've made using the applications with anybody else? Friends, doctors?

# Appendix G – Design Session 1 Line Judging Slides

<p>1</p> <p>WELCOME</p>	<p>2</p> <p>As you're coming in, please do the following</p> <ul style="list-style-type: none"> <li>In the chat, type your name and the name of the last slide you read</li> </ul>	<p>3</p> <p>Introductions</p>	<p>4</p> <p>Rules for the day</p> <ul style="list-style-type: none"> <li>Safe Space</li> <li>One way</li> <li>Have fun!</li> </ul>
<p>5</p> <p>Pineapple on Pizza???</p>	<p>6</p> <p>MINDFULNESS</p>	<p>7</p> <p>Mindfulness</p>	<p>8</p> <p>Mindfulness</p> <ul style="list-style-type: none"> <li>Practicing mindfulness exercises can help when you're stressed when you have to do something difficult, or when you have to focus your attention.</li> <li>It's a lot like learning to play the piano. Each time you practice, you're training yourself to play a little bit better.</li> </ul> <p>Where to learn?</p> <ul style="list-style-type: none"> <li>School</li> <li>Parents</li> <li>around a class</li> <li>Technology</li> </ul>
<p>9</p> <p>Mind body technologies for sleep</p>	<p>10</p> <p>Apps</p>	<p>11</p> <p>Early mindfulness and mindfulness exercises</p>	<p>12</p>
<p>13</p> <p>Smart Speakers</p>	<p>14</p>	<p>15</p> <p>Smartwatches</p>	<p>16</p> <p>Smartwatch</p> <p>Tap to open</p>
<p>17</p> <p>Other Wearables</p>	<p>18</p>	<p>19</p> <p>Other Devices</p>	<p>20</p>
<p>21</p> <p>Virtual Reality</p>	<p>22</p>	<p>23</p> <p>Recap</p>	<p>24</p> <p>Next Steps</p> <ul style="list-style-type: none"> <li>Complete your survey</li> <li>See you all in the next session on</li> <li>Reach out at <a href="mailto:2020@stanford.edu">2020@stanford.edu</a></li> </ul>

# Appendix H – Design Session 2 – Comic Boarding

Describe your day using a single emoji

More emojis → Insert → Special Characters → Emojis

a) Comicboarding slide used for social time in design session 2

1

2

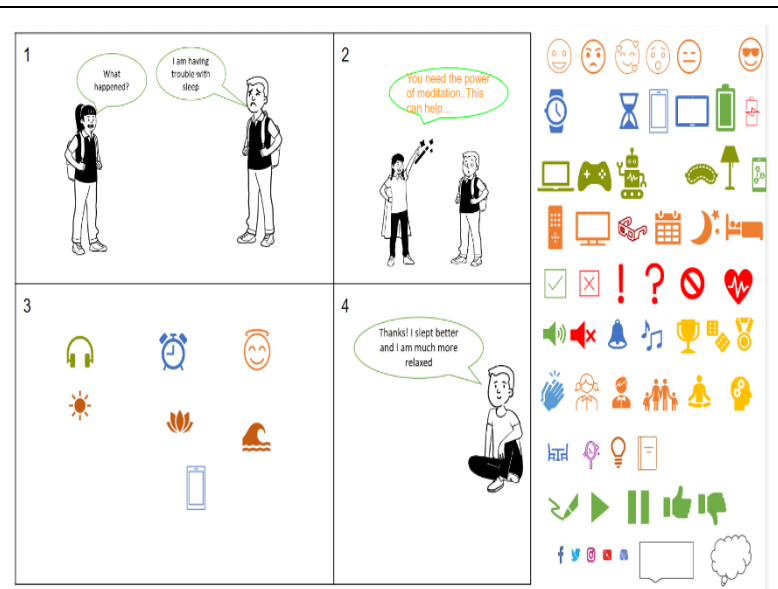
3

4

b) Comicboard completed by participant P11- *“I picked on headphones because music usually helps me sleep. Then I pick the on the phone, because usually doing some calm stretching also helps “*



c) Comicboard completed by participant P13 – “I wrote the person struggling to sleep could use headphones to listen to some sort of relaxing music while following certain breathing exercises being led over the top of the music. I was thinking this could be achieved through some sort of recording on a file or an app. You could have on your phone or an iPad or a computer, and maybe there could be different options if you wanted to do breathing or meditation with different background music too”



d) Comicboard completed by participant P3 – “So I think it's like meditation. You're like listening to calming music or something and maybe have a timer for 10 minutes for that meditation. And you're happy and you're thinking about peaceful things like sunny days, plants and oceans and stuff”