SleepHealth Mobile App Study: Bringing the Sleep Lab to You

Sean Deering,1,2 Adam Amdur,2
Joe Borelli, MD,2 Will Headapohl,2 Darrel Drobnich & Carl Stepnowsky, PhD1,2,3

1Health Services Research & Development Unit, VASDHS; 2American Sleep Apnea Association; 3Department of Medicine, UCSD

Introduction

Conducting research using personal smartphones is a novel approach to the study of health and disease that is only beginning to be meaningfully explored.

The SleepHealth Mobile App utilizes Apple's open source ResearchKit framework to deploy an app-based research study directly to participant smartphones. The aim of the current study was two-fold:
1) To explore methodological considerations of the use of a mobile app research study, and
2) To develop a better understanding of the relationship between sleep habits and daytime function during the course of their day-to-day life (or, "in the field").

Methods

The SleepHealth Mobile App study launched March 2, 2016 on the Apple App Store. Users downloaded the app, learned about the study via the app and related website (www.sleephealth.org/sleephealthapp), and signed up using an electronic informed consent process. Once consented, participants were instructed to do the following:

1) Complete one-time surveys providing information about themselves, their sleep and medical history, and their physical health.

2) Complete daily activities including AM and PM Check-ins, Journals, and assessments of sleep quality and alertness.

The focus of each survey/activity is as follows:

One-Time Surveys:
About Me: Background information about participants (e.g., daily activities, smoking/drinking habits).

Sleep Habits: Average time taken to fall asleep, number of naps, whether participant is a morning or evening person, etc.

My Family: Household size, language spoken at home, number of minors living at home.

Sleep Assessment: Questions about sleep quality and potential sleep problems.

Research Interest: A series of questions gauging participant interest in research and future research studies.

My Health: A detailed survey with questions related to physical health and beliefs about the likelihood of developing specific health conditions.

Recurring Surveys:
Sleepiness Checker: The Karolinska Sleepiness Scale, a single-item questionnaire anchored by 0 (extremely alert) and 9 (extremely sleepy).

Sleep Quality Checker: A single-item scale used to assess sleep quality from the previous night, anchored by 1 (very poor sleep) and 5 (very good sleep).

AM/PM Check-ins: Based on the consensus sleep diary items.

AM/PM Journals: Free text field where participants could journal about their days and nights.

Activities:
Alertness Checker: The 3-minute Psychomotor Vigilance Task, an objective assessment of alertness measuring reaction time and lapses of attention.

Nap Tracker: A utility to record nap timing and duration.

Figure 1. The consent screen and daily activity dashboard. Participants with Apple Watch could access certain facets of the study on the Apple Watch Display.

Results

Over the course of one year, the app was viewed **53,853** times and downloaded **19,370 times** (38% conversion), resulting in **8,739** total enrolled participants (45% conversion). Of note, 71% of our sample reported that they had never participated in a research study before.

Figure 2. One year enrollment broken down by month. Enrollment was highest immediately following launch, and dropped of significantly a short time after.
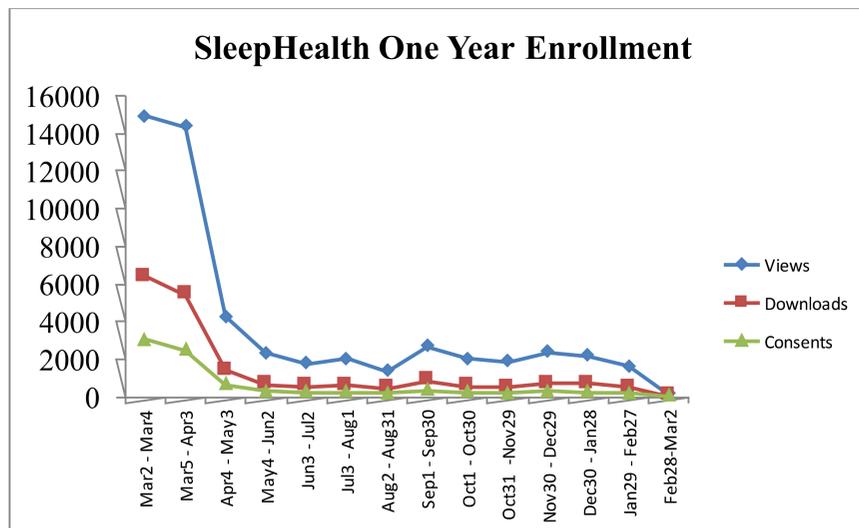
Sex: The sample was made up of approximately 76% males and 24% females.

Education: 1% of the sample did not graduate from high school. 9% of the sample were high school graduates or had received their GED. 31% of the sample reported having some college education. 28% of the sample were four-year college graduates, and 30% of the sample had education beyond a four-year college degree.

Sleep: 40% of participants believed that they had a sleep problem, and about 40% had expressed this belief to a clinician. 50% reported that they did not take naps, and about 60% reported that they were very dependent on their alarm clocks, suggesting that they may be sleep deprived. 55% of those queried reported that they had flexible work hours.

Table 1. Sample characteristics including age, weight, height, BMI, average time slept, and hours of sleep needed.

	Mean	SD	Range
Age (years)	36.8	12.7	18 - 87
Weight (pounds)	190.4	49.5	55 - 399
Height (inches)	68.9	3.8	38 - 90
BMI	28.2	6.9	8.4 – 70.8
Hours of Sleep Weeknights	6.8	1.2	3 - 12.2
Hours of Sleep Weekends	8	1.5	3 - 16
Hours of Sleep Needed	7.5	1.2	3 - 12

Figure 3. Number of unique participants who completed each one-time survey by order of administration. Survey completion decreased dramatically by order.
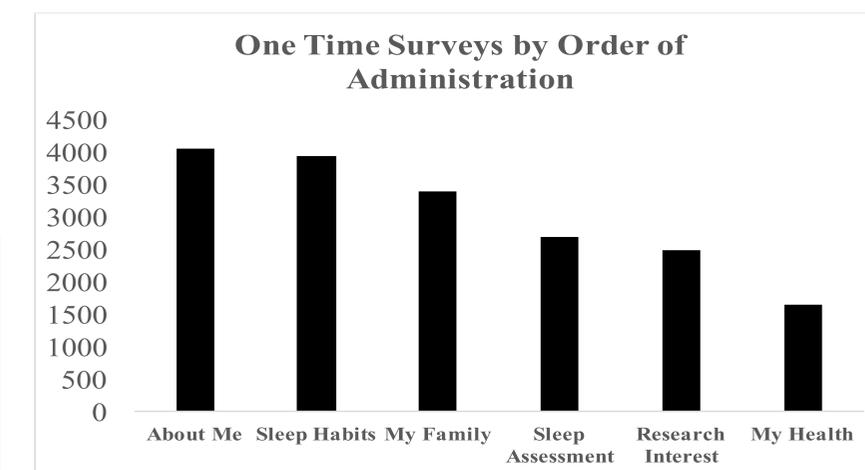
Discussion

Our experience to date shows that use of a mobile application to conduct a study of sleep and daytime functioning is feasible and scalable. A great deal of data can be collected in a relatively short amount of time, however, there are limitations. Due to the novelty of this approach, much remains to be learned from a methodological standpoint.

Advantages of using the ResearchKit platform are ability to query participants on a daily basis outside of a traditional laboratory setting, participant reach, relative ease of deployability, and lower cost.

Limitations associated with field research apply, e.g., less control over the timing, completeness, and quality of the data collected. Anticipating potential problems and designing an app to avoid or limit these problems at outset is highly recommended. In addition, studies using the ResearchKit platform are currently limited to Apple users.

Future Directions

Future versions of the app will be cross-platform and web-integrated in order to reach a broader audience and to improve usability. It will also support additional sleep metrics as well as utilize additional wearable technologies.