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A feasibility study to understand the components of behavioral sleep extension

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ABSTRACT

Objectives: The goal of this study was to examine the contribution of sleep extension intervention components (wearable sleep tracker and coaching) on sleep extension outcomes.
Patient involvement: This study collected open ended qualitative responses of treatment preference, acceptability, and feasibility as a key outcome.
Methods: Adults aged 25 to 65 years with sleep duration <7 h and BMI ≥ 25 were randomized into one of four groups: Self-Management (control), Fitbit, Telephone Coaching, or Fitbit + Coaching. Self-report questionnaires and actigraphy were completed at baseline, post-intervention (6 weeks), and 12-weeks. Analyses used mixed models.
Results: Among the 38 adults randomized, the Fitbit + Coaching group had larger but non-significant improvements in sleep duration compared with the self-management group. The coaching group demonstrated significant improvements in sleep-related impairment. All groups demonstrated feasibility and acceptability but the Fitbit + Coaching group reported themes of accountability.
Conclusions: Results suggest that sleep extension interventions are feasible and acceptable but components affect the pattern of sleep and other outcomes.
Practical implications: Sleep extension is feasible and acceptable; the combination of coaching and the wearable device may lead to larger changes in sleep due to enhanced accountability.

1. Introduction

In 2017, nearly 33% of Americans reported <6 h of sleep per night [2]. Short sleep duration (defined as sleep <7 h) is associated with obesity, metabolic disease, cardiovascular disease, mood disturbance, and increased mortality [1]. A growing number of experimental studies have demonstrated that short-term sleep extension may have health benefits including improving insulin sensitivity among prediabetic adults, reducing sugar, carbohydrate, and fat consumption in overweight individuals, lowering blood pressure, improving sleep disturbance, sleep-related impairment, and reducing fatigue in adults [3]. Together, these experimental studies demonstrate that sleep extension is a promising intervention for improving health.

Research in our laboratory has focused on developing sleep extension strategies focused on motivating sustained behavior change. Although the causes of short sleep duration are multifactorial, our group has primarily focused on the potentially modifiable aspects of short sleep duration due to inadequate sleep opportunity: low motivation or awareness of sleep need, inadequate planning for adequate time in bed and bedtime procrastination, particularly due to screen time. Our sleep-extension intervention was developed using user-centered design techniques, including interviews, user testing and brief field testing before moving to a randomized pilot trial among patients with elevated blood pressure. Our intervention includes three components: A wearable sleep tracker, brief telephone coaching and weekly educational content. We have demonstrated that using technology-assisted intervention is well-liked, feasible and improves sleep duration, daytime sleepiness, sleep related-impairment, and more [4,5].

The goal of this project is to understand the components of this intervention, specifically the wearable sleep tracker and remote coaching. Research conducted by the Pew Foundation demonstrated that approximately one in five U.S adults (21%) regularly use wearable fitness trackers [6] and that sleep is one of the most popular features of these devices. Our intervention has paired the sleep tracker with brief remote coaching because tracking behavior alone may not be sufficient to change behavior. Coaching is added to technology interventions to increase adherence, through a process called “supportive accountability” [7]. This theory proposes that individuals will adhere to a technology intervention because they are being held accountable by a knowledgeable and supportive individual. Given that

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sleep extension interventions are relatively novel, it is unknown whether coaching is needed to change behavior.

Therefore, the goal of this study is to evaluate the feasibility of the specific components of our behavioral sleep extension intervention: coaching and a wearable sleep tracker. We predict that the combination of a wearable sleep tracker and coaching will be the highest rated intervention strategy and most effective at increasing sleep duration due to the use of a well-liked technology and the support of a coach.

2. Methods

2.1. Participants

The inclusion criteria included the following: Age 25 to 65 years, average sleep duration <7 h measured by wrist actigraphy, BMI > 25 kg/m^2, and a smartphone user. The BMI criteria was chosen because the sleep extension intervention is being developed to test among adults with elevated cardiometabolic risk factors. Exclusion criteria included the following: high risk or presence of sleep disorders (obstructive sleep apnea, restless leg syndrome, insomnia), assessed via self-report of questionnaires; history of cognitive or neurological disorders, major psychiatric disorder (e.g., bipolar I, schizophrenia), current alcohol or substance abuse, unstable or serious medical illnesses, shift work >1 time per month, or traveled over two time zones within the last 6 months, inability to read and write English, pregnancy or desirable to become pregnant during the study period, significant environmental factors disturbing sleep (excessive awakenings per evening due to caregiving responsibilities); and the use of hypnotic or stimulant medications. This study was approved by the University of Utah Institutional Review Board (IRB_00117330) and all participants provided written informed consent. The study was registered on http://clinicaltrials.gov (NCT04759755).

2.2. Procedure (Fig. 1)

This was a randomized pilot study that utilized a 2 × 2 factorial design. Participants were randomized to one of four groups: self-management (control), Fitbit, coaching (weekly phone call), or Fitbit + coaching.

2.3. Data collection

Study data were collected and managed using REDCap electronic data capture tools hosted at University of Utah Health. REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies, providing (1) an intuitive interface for validated data entry; (2) audit trails for tracking data manipulation and export procedures; (3) automated export procedures for seamless data downloads to common statistical analyses packages; and (4) procedures for importing data from external sources.

2.4. Recruitment

Participants were recruited via flyers posted in and around the University of Utah undergraduate campus and University of Utah School of Medicine, and through targeted letters to primary care patients who met basic study criteria (BMI, age, no diagnosis of sleep apnea). After letters were mailed to potentially eligible patients, study staff followed up with phone call and/or email to provide study information and conduct further screening if the patient was interested.

2.5. Prescreening

We verified inclusion criteria based on a two-step screening process. First, participants completed a brief prescreening either through an online link or over the phone to assess self-reported sleep duration, medications and comorbid sleep, medical and psychiatric conditions. We administered questionnaires to assess for risk for sleep disorders. Those who met the initial prescreening criteria were scheduled for a one-hour baseline/screening visit at the Behavioral Sleep and Medicine laboratory at the University of Utah.

2.6. Inclusion assessment

The second step of the screening process that was used to verify to inclusion criteria also served as the baseline study visit. Participants completed informed consent, additional baseline study questionnaires, and study staff collected standardized anthropomorphic measurements of height and weight. At the end of the visit, staff trained participants on the use of the Actiwatch Spectrum Plus (Phillips Respironics, Murrysville, Pennsylvania, United States), and then participants completed 7-days actigraphy at home. At the end of the 7-day period, the participant returned the actigraphy to the lab for download (either dropped off, picked up by staff or mailed). After review of actigraphy, participants were randomized to their study group.

2.7. Randomization

Participants were randomized on a 1:1:1:1 ratio: (1) sleep tracker, (2) telephone sleep coaching, or (3) a combination of both sleep tracker

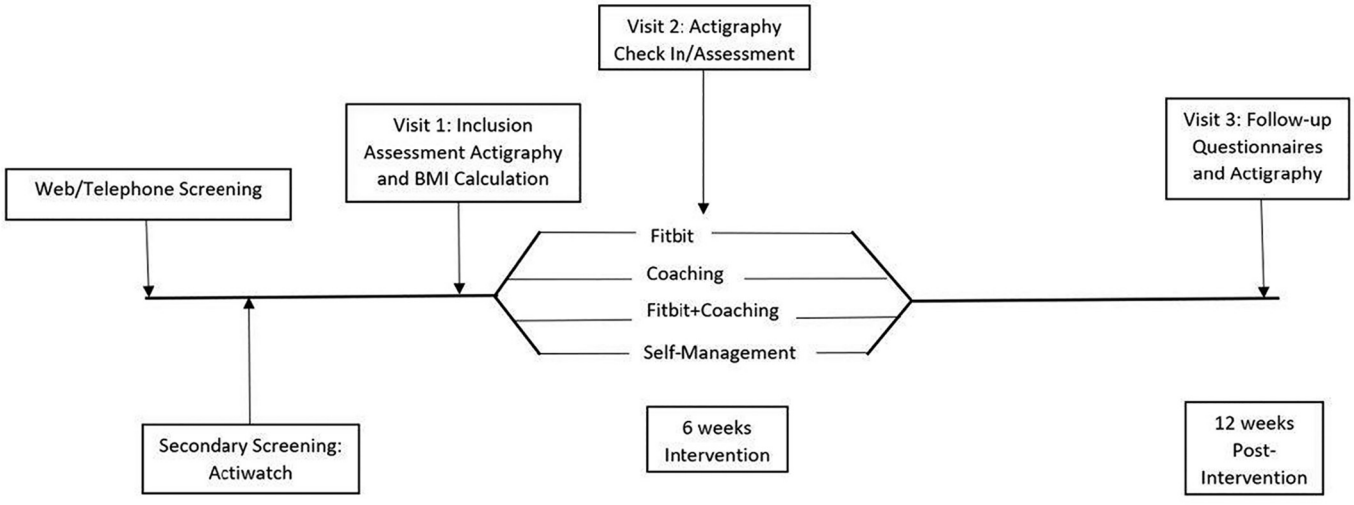

Fig. 1. Procedure.

and sleep coaching to the (4) self-management control group, using a random number generator in random permutated blocks of 4 and 6. Assignments were stratified by sex, to ensure equal enrollment of men and women in each group. The assignment letters were prepared by the study staff and placed in sealed envelopes to ensure that the allocation sequence was blinded.

2.8. Interventions

There were 3 intervention groups and 1 control group. All participants in the intervention groups received a weekly educational email with content about the importance of sleep and strategies to increase sleep duration based on materials from the American Academy of Sleep Medicine and National Sleep Foundation [14,15], as used in our previous protocols [4,5]. Table 1 provides an overview of the educational content.

Additional details of each group are described below.

1. Wearable sleep tracker: Participants in this group received the Fitbit Flex 2 and were instructed to wear the device both day and night and charge weekly. Participants downloaded the Fitbit Application on their smartphone and were provided a study log-in.
2. Brief Telephone Coaching: In this group, participants received brief weekly 1:1 sleep coaching from the Study Coach (KB) for the initial six weeks. The first coaching session was a 20-min engagement session, which included introduction to the study, rationale for the program, review of baseline sleep data, clarifying roles of the coach and setting the participants' goals for the program. Participants were encouraged to increase time in bed by at least 1 h with a goal of at least 8 h of time in bed. In the remaining weeks, the coaching consisted of a brief phone call (approximately 5 min) to review the weekly data and troubleshoot any barriers toward their goals. As described in our prior publication [5], coaches use strategies of CBT such as goal setting, self-monitoring and feedback, as well as motivational enhancement (e.g., eliciting change talk) in the coaching sessions. Sessions did not specifically use techniques from cognitive behavioral therapy for insomnia (CBT—I), but if participants report extended awakenings in the night (>30 min), they were instructed to use stimulus control (get out of bed when awake).
3. Participants in the Fitbit + Coaching group received the Fitbit device and weekly telephone coaching. Their coach also received a log-in to the participants Fitbit account to view and discuss their progress.

2.9. Control group – self management

Participants assigned to self-management control group were instructed to maintain their baseline sleep schedule throughout the study but were not monitored or given specific instructions beyond the verbal request. Instructions were given to follow similar condition to previous sleep extension studies including those in our lab [4,16] They were eligible to receive the intervention components at the end of the study (email content, coaching and Fitbit). The control group was an essential to understand sleep changes related to study enrollment alone.

Table 1
Educational materials.

Week	Content
1	Introduction and basics of sleep: Introduction to the program, how much sleep do you need, impact of insufficient sleep
2	Delayed bedtimes: What is bedtime procrastination and strategies to avoid bedtime procrastination
3	Dealing with weekends and challenges to sleep: The importance of a regular sleep/ wake schedule
4	Stress and sleep: What is stress, how reduce stress and improve your sleep*
5	Your sleep environment: Creating a healthy environment for better quality sleep*
6	Maintaining your gains: being aware of triggers, tracking your success and returning to your goals after a lapse.

* Includes stimulus control instructions (getting out of bed if awake in the night, removing non-sleep activities from the bed and bedroom).

2.10. Blinding

Due to the size of this pilot study, participants, coaches, and research assistants were not blinded.

2.11. Sample size determination

The goal was to recruit a sample size of 15 participants per group, as this was determined reasonable to provide adequate data on feasibility [17]. The study was prematurely ended in March 2020 with 38 randomized participants due to the COVID-19 Pandemic.

2.12. Measures

2.12.1. Screening measures

The STOP questionnaire was administered to screen for high risk of obstructive sleep apnea (OSA). In this 4-item question, participants who answer positively to two of the four yes/no questions (snoring, tired, observed apneas or high blood pressure) are considered high risk for OSA [8].

Insomnia Severity index (ISI) was administered to screen for insomnia symptoms. In this 7-item questionnaire, participants respond on 5-point items ranging from 0 (no problem) to 4 (very severe problem). Scores range from 0 to 28. Participants with scores ≥ 22 were excluded due to severe insomnia symptoms [9].

International Restless Legs Questionnaire (IRLSQ) was administered to screen for symptoms of RLS. On this 10-item questionnaire, participants respond to questions about the presence and severity of RLS symptoms using a Likert scale from 4 (very severe) to 0 (none) [10].

Depressive symptoms were assessed via the Patient Health Quesitonairre-8. (PHQ-8). This 8-item measure has the same items as the 9-item questionnaire, but the suicide ideation item is removed. The PHQ-8 scores range from 0 to 24, with the scores equal to or greater than 10, indicating elevated depressive symptoms. Participants completed the PHQ-8 at screening/baseline and again at the end of the intervention to assess for change in mood [11].

Demographics, Health History, and Medications: Participants provided their age sex, race, ethnicity, income, marital status, current medical conditions and medications subjectively.

2.12.2. Outcome measures

Sleep Measures: Objective sleep wake pattern was measured using 7 days of wrist actigraphy using the Actiwatch Spectrum Plus conducted at the inclusion assessment/baseline visit, at the 6-week post-intervention visit, and again at the 12-week follow-up visit. Actiwatches were set with default settings for 30-s epochs and scored by the research staff using a standardized protocol in Acitware software (version 6.0 Phillips Respironics). Variables calculated included sleep onset time, sleep offset time, total sleep time (TST), wake after sleep onset (WASO), time in bed (TIB), and sleep efficiency (SE). Participants needed at least 4 valid days to be included in the analyses. The pre and post variables were calculated using matched days to account for a similar number of work and free days in each time period.

Other Physical Measures: Participants' height and weight was recorded using a standardized protocol at baseline, 6-week follow-up and 12-week follow-up. BMI was calculated as weight in kg divided by height in m^2.

Patient-Reported Outcomes: Daytime sleepiness was measured using the Epworth Sleepiness Scale (ESS). In this 8-item questionnaire, participants respond from 0 to 3 the likelihood of falling asleep in different situations in daily life. Scores ranged from 0 to 24 and scores greater than or equal to 10 are considered excessive daytime sleepiness. Participants completed ESS using a standardized protocol at baseline, 6-week follow-up and 12-week follow-up.

Sleep quality and daytime sleepiness were measured using the Patient-reported Outcomes Information System (PROMIS), Sleep Disturbance and Sleep Related Impairment scales. These scales were developed as part of the National Institute of Health Roadmap initiative. Scores are presented as t scores, with average of 50 and standard deviation of 10. Scores greater than or equal to 60 are considered elevated. Participants completed PROMIS using a standardized protocol at baseline, 6-week follow-up and 12-week follow-up.

Adherence and Usage: Adherence and usage were measured using attendance to the phone coaching sessions (Coaching and Fitbit/Coaching groups) and days with Fitbit usage (Fitbit and Fitbit/Coaching groups). Participants were asked to complete free text questions to solicit their feedback on the appearance, layout, reading level, content helpfulness of lessons and coaching sessions and intervention. They also rated from 1 (not at all) to 5 (very much) how much they enjoyed the intervention and how easy it was to participate in the intervention.

2.13. Data analysis

Data were analyzed in R version 4.0.3 using descriptive statistics and mixed models. Numeric variables are summarized with mean and standard deviation (SD). Categorical variables are described with number and percent. All models are linear regression with outcomes taken at the primary endpoint, 6 weeks (post-intervention). Group assignment was examined as a predictor with covariates race, full-time works status, marital status, health, sex, ethnicity, diabetes, high blood pressure, and baseline measurements. We evaluated differences in study groups compared with the self-management (reference) group after adjusting for the covariates. For all models, the coefficients and 95% confidence intervals (CI) are given for group assignment. Analyses were conducted as intention-to-treat and all available data were analyzed in the mixed models. Models with *P*-values less than 0.05 on two-tailed tests were considered to be statistically significant.

3. Results

3.1. Participants

A total of 467 participants initiated the web-based prescreening and 60 completed the in-person inclusion assessment visit (Fig. 2). Baseline participant data is presented in Table 2. The final sample included 38 participants. 51% of the population identified as males, average age was 44.5 years (SD = 10.6 years).

3.2. Satisfaction and feasibility

A summary of participant feedback is presented in Table 3. In general, participants in all groups reported that their group assignment and intervention format was easy to follow and enjoyable. When asked which their first preference for group assignment, the Fitbit + Coaching group and the Fitbit-only group assignments were most preferred (Fig. 3). The open-ended responses revealed that participants felt they learned about their sleep through the program. For some participants, the coaching was difficult to schedule, and they would have liked more coaching. Many participants enjoyed the Fitbit and found the information useful, however one participant found that viewing their data was stressful. Feasibility ratings are reported in Fig. 4. Most participants found the interventions to be easy or very easy. One participant found the coaching very difficult, due to scheduling problems. Adherence to behavioral intervention we determined that those in the Fitbit adherence data were available for the 6 week intervention period and demonstrated excellent adherence. The Fitbit group wore the device 88.2% of days and the Fitbit + Coaching group wore the device 93.9% of days. In the coaching group, 10 out of 12 participants completed 100% of the sessions (one participant missed two sessions and one participant missed 3 sessions, due to scheduling difficulties). In the Fitbit + coaching group 9 out of 10 participants attended 100% of coaching sessions (one participant missed one session due to vacation). At the end of the study, all self-management and coaching participants received the Fitbit and educational materials but only one participant from the self-management group requested to complete the coaching sessions. (See Fig. 5.)

3.3. Evaluation of preliminary efficacy of sleep, patient reported outcomes and BMI changes (Table 4)

There were no statistically significant changes between control group and experimental groups between the baseline and 12-week follow up in sleep variables. However, the Fitbit + coaching group experienced the greatest improvement in sleep duration (0.41 h, 95% CI: −0.08, 0.90, $p = 0.11$; Fig. 2). The Coaching-Only group demonstrated a significant reduction in sleep-related impairment compared to the self-management group (−8.94, 95% CI: −14.96, −2.92, $p = 0.006$). There were no other differences in sleep disturbance or sleep related impairment. We observed a non-significant trend toward reduction in BMI among participants in the Fitbit-Only group ($-0.61/kg^2$, 95% CI: −1.30,0.09, $p = 0.096$) compared to participants in the control group- self-management.

4. Discussion

4.1. Discussion

The goal of our pilot study was to better understand the feasibility and acceptance of the components of sleep extension interventions. Although the relationships between short sleep duration with adverse health outcomes (cardiometabolic disease, depression) is widely recognized, little is known about interventions to extend sleep duration. This study demonstrated that sleep extension is feasible and acceptable to participants through using a variety of methods. Despite the small sample size, we were able to observe some patterns among the findings that may be useful for planning future interventions. Furthermore, as we continue to develop and refine our interventions, the continued open-ended feedback from our participants is critical to the success of our intervention in the future.

The main findings were that the interventions were rated as feasible and participants completed a high percentage of study activities (coaching sessions and Fitbit wear time). All groups demonstrated increased sleep duration compared to the self-management group (told to keep their sleep schedule the same), with the greatest (but statistically non-significant) improvement seen in the Fitbit + coaching. Use of a self-management control group allowed us to compare the interventions to a condition that was told to keep their sleep schedule the same. Our group and others have used this condition as a comparison to sleep extension and even without specifically monitoring those participants, they had little change in their sleep. This group demonstrates that there was not a “Hawthorne effect” (i.e., improvement in sleep just due to enrolling into a study). However, it might not have been the same comparison as no intervention at all. Results of our study, along with the qualitative feedback, suggest that coaching may be an important component of our intervention due to providing “supportive accountability” [7] to participants, in that they are interacting with a coach who can view and hold them accountable to their goals and behaviors. Consistent with our original design of the “Sleep Bunny” intervention, the feedback from this study suggests that participants found that the experience of using the wearable device and working with a coach was an enjoyable and informative method to discover their own sleep patterns, receive feedback and then be accountable to another individual for their goals in the program.

As with our previous studies, the sleep technology (Ftibit) was well liked and in fact both Fitbit groups (with and without coaching) were liked more than coaching alone. However, unlike our previous studies, in this study we had one participant who reported stress as a result of using the sleep tracker. Although it appears this is rare, we previously reported a clinical case series of patients who had negative effects from sleep tracking and called it “Orthosomnia” or an unhealthy preoccupation over their

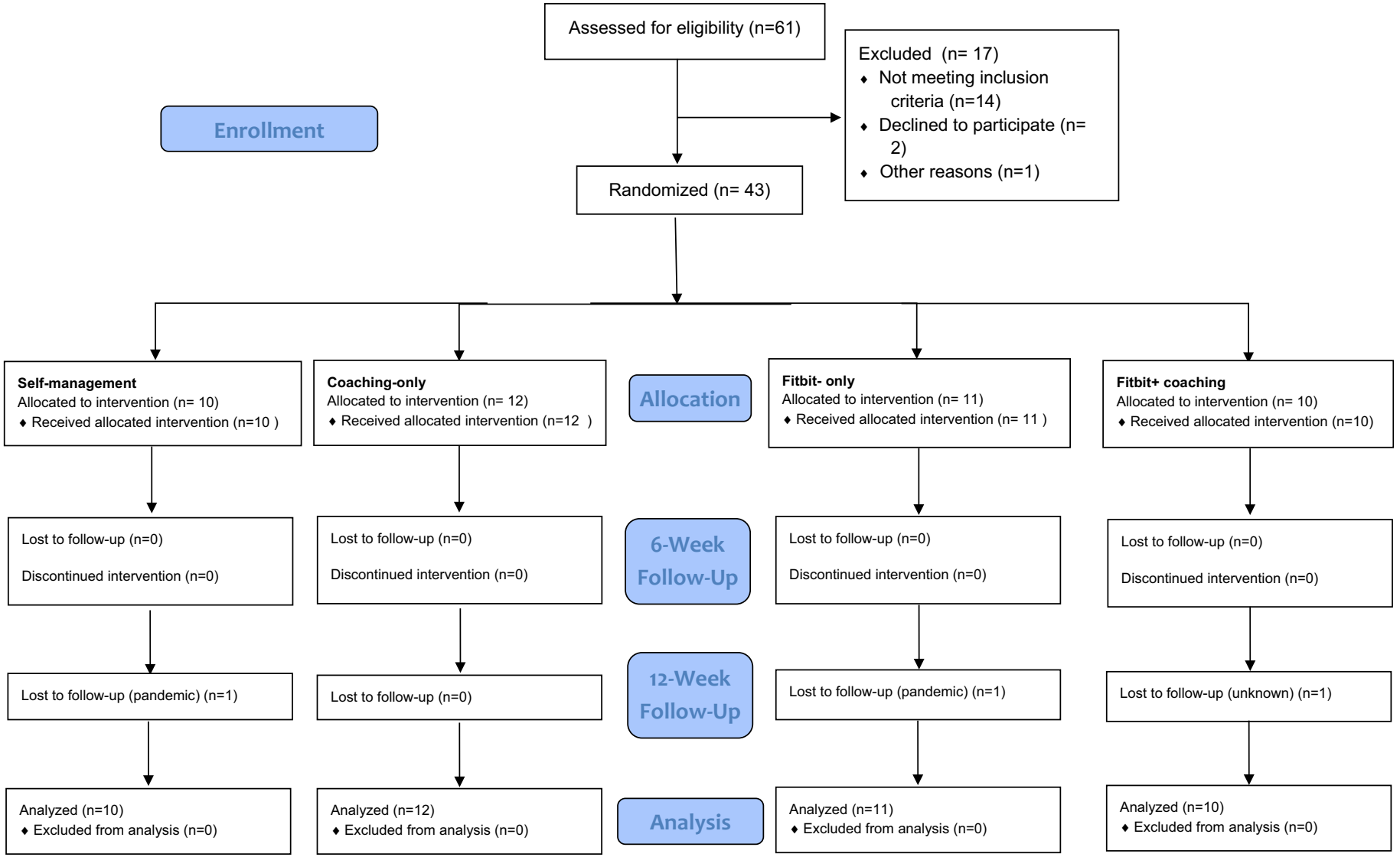

Fig. 2. Consort diagram.

Table 2
Participant Characteristics at Baseline (M) (SD) n (%).

	Self-management (n = 10)	Coaching-Only (n = 12)	Fitbit-Only (n = 11)	Fitbit + Coaching (n = 10)
Age	42 (SD = 12)	44 (SD = 12)	46 (SD = 11)	46 (SD = 11)
Sex				
Male	5 (50%)	7 (58%)	5 (45%)	5 (50%)
Female	5 (50%)	5 (42%)	6 (65%)	5 (50%)
Race				
White	9 (90%)	12 (100%)	6 (55%)	8 (80%)
American Indian/Alaskan Native	1 (10%)	0 (0%)	0 (0%)	0 (0%)
Asian	0 (0%)	0 (0%)	4 (36%)	2 (20%)
Unknown	0 (0%)	0 (0%)	1 (9%)	0 (0%)
Ethnicity				
Hispanic or Latino	1 (10%)	2 (17%)	3 (27%)	1 (10%)
Not Hispanic or Latino	9 (90%)	10 (83%)	8 (73%)	9 (90%)
Education				
Some college or associates (2 year) degree	3(30%)	1(8%)	3(27%)	2(20%)
Bachelor's (4 year) degree	2(20%)	5(42%)	6(55%)	4(40%)
Graduate degree or more	5(50%)	6(50%)	2(18%)	4(40%)
Sleep duration (mean)	6.4	6.2	6.2	6.2

Table 3
Qualitative themes.

Group Assignment	Themes	Example of Theme
Self-management	Feasible	• "I kept doing what I always do." • "My experience was as expected." • "Easy."
Coaching	Informative Indifference Supportive	• "They were comfortable and focused on helping me set goals - this was good." • "It was helpful to know that someone would be checking in with me." • "It was interesting, I did learn some helpful things, like that trying to wake and sleep at the same time every day helps. But overall, I didn't feel it helped make a huge difference." • "I thought my coach was very good and supportive. I had a hard time sticking to our set goals, but she was always good about adjusting goals."
Fitbit	Informative Stress	• "It was helpful, I learned a lot from the Fitbit records" • it made me aware of how much I wake up in the night, as my [poor] quality of sleep which was really interesting." • "Some improvement in sleep, healthier habits" • "My experience was slightly stressful. This study has made me realize the actual hours of sleep I receive."
Coaching + Fitbit	Accountability	• "Having someone to be accountable or that checks on you helps with your bedtime goal" • "It was such a valuable assignment to see my sleep pattern and habit was each night [using Fitbit] but to have a coach to talk with each week to discuss it and my goals was amazing. Kelly [the coach] was such an important part of my experience."

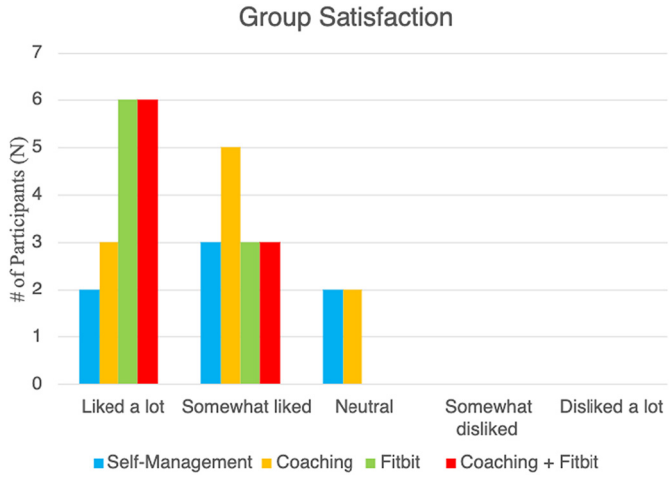

Fig. 3. Group satisfaction.

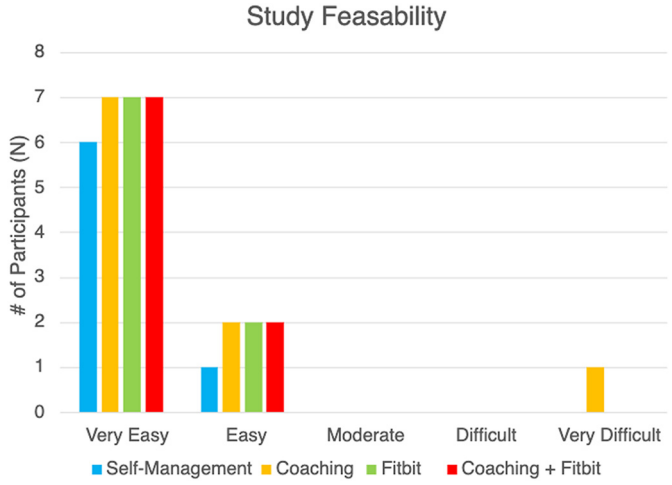

Fig. 4. Study feasibility ratings.

sleep [12]. In those cases, the clinicians felt their use of sleep trackers was counterproductive to participation in behavioral sleep treatment (cognitive behavioral therapy for insomnia). In our sleep extension development and pilot trials, this is the first patient who has reported a negative impact of sleep tracking, and thus in our opinion, it is quite rare. Therefore, although sleep tracking is well liked by most participants, it will be important to continue to be aware of potential for negative impacts of sleep tracking among some patients or participants.

The results of this study are limited due to a small sample size, which limits generalizability and power for observing effects of the intervention. Although sleep extension interventions have been studied for similar periods and BMI changes can occur over a short period of time, our study was not powered to observe changes in these variables. In addition, it should be noted that short sleep duration is a heterogeneous condition with many possible contributors. Our screening criteria and intervention are focused on motivating participants to increase time in bed. Much

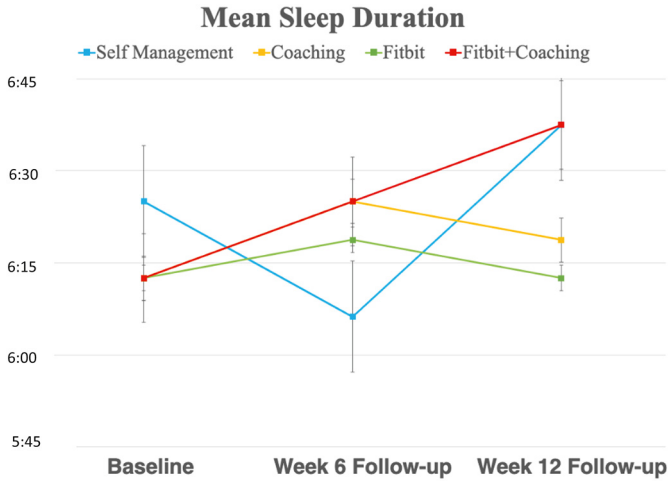

Fig. 5. Changes in sleep duration, measured by actigraphy.

Table 4
Changes in actigraphically recorded sleep, self-reported sleep and BMI from baseline to 6-week visit.

	Self-management	Coaching	p-value	Fitbit	p-value	Fitbit + Coaching	p-value
Sleep duration	*Ref*	0.38 (−0.11, 0.87)	0.13	0.35 (−0.13, 0.82)	0.16	0.41 (−0.08, 0.90)	0.11
Sleep onset time	*Ref*	−0.30 (−0.94, 0.34)	0.37	−0.12 (−0.74, 0.51)	0.71	−0.36 (−0.98, 0.27)	0.27
Sleep offset time	*Ref*	0.13 (−0.37, 0.63)	0.61	0.23 (−0.27, 0.73)	0.38	0.09 (−0.41, 0.59)	0.72
Time in bed	*Ref*	0.45 (−0.10, 1.00)	0.12	0.31 (−0.23, 0.84)	0.27	0.46 (−0.09, 1.01)	0.11
WASO	*Ref*	2.99 (−4.50, 10.47)	0.44	2.22 (−5.09, 9.53)	0.56	3.92 (−3.57, 11.40)	0.31
Sleep efficiency	*Ref*	−0.19 (−3.02, 2.63)	0.89	1.10 (−1.66, 3.87)	0.44	−0.41 (−3.23, 2.42)	0.78
Sleep disturbance	*Ref*	−2.27 (−7.55, 3.01)	0.40	1.53 (−3.75, 6.81)	0.57	−3.09 (−8.50, 2.32)	0.27
Sleep-related impairment	*Ref*	−8.94 (−14.96, −2.92)*	0.006	−1.27 (−7.29, 4.76)	0.68	−2.30 (−8.47, 3.87)	0.47
BMI	*Ref*	−0.37 (−1.13, 0.39)	0.35	−0.61 (−1.30, 0.09)†	0.096	−0.37 (−1.06, 0.33)	0.31

* $p < 0.01$ level (2-tailed).
† $p < 0.10$ level (2-tailed).

more work is needed to examine how to extend sleep among participants who have difficulty sleeping longer or those who do not view short sleep duration as a problem (e.g., lack the perception of daytime impairment). Finally, the study was prematurely ended in March 2020 due to the onset of the COVID-19 pandemic. During that time, most participants had major disruptions to their sleep schedules, and the study team decided that even though we could complete remote assessments, if possible, at that time it would not be a valid assessment of habitual sleep. We did complete 4 of the follow-up assessments March 2020 via mail, and a result, the final study endpoint may be affected by pandemic-related sleep changes. For example, studies have demonstrated that on average, adults during the COVID-19 pandemic had longer sleep duration yet poorer sleep quality [13].

4.2. Conclusion

In summary, our results suggest the combination of Fitbit + coaching is feasible and well-liked as a sleep-extension intervention. Qualitative themes suggest that enhanced accountability is one factor that may enhance this intervention combination. As we continue research in this area, we have much to learn about optimal methods of sleep extension behavior change, including the appropriate dose and duration of treatment, how to maintain sleep changes and how to adapt and use sleep extension to benefit health in different ages and medical disorders.

4.3. Practice implications

Individuals with short sleep duration can extend sleep duration using a variety of methods. Sleep extension was well-liked, and participants perceived the feedback from the wearable device and brief coaching enhanced their ability to change their sleep behaviors. In clinical practice, tracking sleep using a wearable device and setting goals with a provider may enhance the motivation for sleep behavior change.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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