COVER PAGE

Documents

Detailed Protocol and Statistical Analysis Plan

Study Title

Phase 3: Adapting Sleep and Yoga Interventions for Maximal Effectiveness in Low Income Populations

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DETAILED PROTOCOL

Adapting Sleep and Yoga Interventions for Maximal Effectiveness in Low Income Populations: Phase 3

Version 2

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I. Background and Significance (including progress report and preliminary studies).

Sleep problems, characterized by short sleep duration or poor quality (termed “inadequate sleep”), not only cause distress, reduce well-being, and impact cognition, but also are significant risk factors for chronic pain as well as for incident depression, cardiovascular disease, stroke,

diabetes, obesity, cancer and for premature mortality. Inadequate sleep is highly prevalent in minority and low-socioeconomic (SES) populations who also are at increased risk for multiple chronic diseases. Thus, inadequate sleep may serve as an important mediator of health disparities.

Inadequate sleep is often attributable to and perpetuated by poor sleep hygiene (nighttime behaviors and environments that impair sleep) and/or to hyper-arousal (inappropriate central nervous system activation secondary to stress). As such, fundamental to improving sleep is the practice of core elements of sleep hygiene as well as use of behavioral strategies that reduce arousal. Extensive research has established the efficacy of mind-body behavioral interventions, including yoga, for reducing stress and hyper-arousal. Furthermore, members of our team and others have generated data supporting the efficacy of yoga for improving sleep. However, there has been sparse research on adapting and evaluating behavioral interventions for sleep for minority and low-SES groups who have a high prevalence of inadequate sleep; in particular, modifying the content and delivery of these therapies to fit the social context in which these populations live and work has been sorely neglected.

Our prior work, detailed in the following paragraph, allowed us to to develop and adapt a sleep health promotion and yoga intervention for use in a low-SES urban population who have a high prevalence of inadequate sleep. We now propose to conduct a randomized controlled trial (RCT) to compare a sleep hygiene (**SH**) intervention to an intervention that combines sleep hygiene with a yoga (**Y**) intervention, with the objective of reducing stress and arousal and to improve sleep quality and extend sleep duration. The ultimate objective is to generate high level evidence to guide the use of sleep hygiene and yoga interventions for improving sleep duration and quality, and thus for improving health and well-being in under-served populations.

In year one, during our ***Phase 1*** work, we conducted qualitative research to investigate beliefs and understandings around sleep, sleep hygiene, and yoga, as well as to better understand barriers and opportunities to improve sleep through sleep hygiene and yoga. We conducted two focus groups with 16 adult participants and 3 key informant interviews. Participants were recruited from member residents of the [redacted] association, a low-income housing association in Boston. We recently published findings from Phase 1 (http://www.sciencedirect.com/science/article/pii/S1744388117302967); these findings were used to develop a culturally appropriate and effective pilot intervention for the second phase of the study In ***Phase 2***, we conducted pilot testing of our adapted SH and Y interventions. Quantitative and qualitative assessments were used to assess feasibility, acceptability, and intervention usefulness. The two pilot interventions were adapted for our target population, to promote intervention uptake and adherence and to increase the likelihood of success of a future trial. Participants were recruited from [redacted] for the first pilot (n=15) and participants were recruited from [redacted] housing for the second pilot (n=8). Findings in Phases 1 & 2, informed the protocol and intervention materials for **Phase 3.** This Phase 3 study will consist of a 40 person, 12-week feasibility trial. We will randomize adults with short sleep duration to SH versus SH+Y interventions. Outcome measures include the uptake, feasibility, and adherence to the intervention, as well as the short-term effects on sleep duration and potential mediators.

Importance of Sleep for Health and Well Being. Sleep is now understood to play a fundamental role in multiple aspects of health and wellness, including mental health; cardiovascular, metabolic, and neuroendocrine physiology; and pain, vitality, and quality of life. Sleep curtailment has been shown to adversely impact the hypothalamic-pituitary-adrenal axis; reduce clearance of cortisol; alter secretion of vasoactive hormones and blood pressure control; and to adversely influence appetite-regulating hormones, insulin sensitivity, and inflammation.

Sleep curtailment results in impaired vigilance and altered mood, increasing negative affect, irritability, anger, and stress, and enhancing sensitivity to pain. Curtailed sleep impairs the ability of the brain to clear toxic metabolites, providing a mechanistic link between sleep deprivation and dementia. Prospective studies have shown that inadequate sleep duration and/or quality are risk factors for incident and recurrent major depressive episodes; incident obesity, diabetes, cardiovascular disease and premature mortality. The public health burden of sleep disturbances is also evident by associations with increased health care costs. These significant health concerns and their impact on the health care system motivated the Joint Task Force of the Sleep Research Society and American Academy of Sleep Medicine to recommend research that develops and tests interventions for improving sleep in the population, particularly in low-SES groups at high risk for sleep problems and their attendant co-morbidities. The current proposal aims is to conduct the foundational research needed to address this research gap.

Sleep Duration and Quality. There are multiple dimensions of sleep relevant to health, including sleep duration, sleep architecture, and sleep disturbances (both perceived and objectively measured). Sleep duration and quality are influenced by sleep behaviors (e.g., activities surrounding bedtime, sleep schedules), primary sleep disorders (e.g., sleep apnea; primary insomnia); and co-morbidities (e.g., depression; COPD, etc.). We highlight sleep duration as a fundamental target for improving sleep in the community, noting that improving sleep duration is a Healthy People 2020 goal, as well as a cornerstone of most sleep interventions regardless of etiology of the sleep disturbance (e.g., for sleep apnea, CPAP efficacy requires nightly CPAP use patterns that depend on adequate sleep duration). Since short sleep duration (<6-7 hours/night) is found in approximately 40% of the adult population, this approach addresses a common deleterious health behavior. Since risk factors for inadequate sleep duration overlap with those for poor sleep quality, our proposed interventions address not only sleep duration, but also sleep quality. We will specifically target two major contributors to inadequate sleep: a) poor sleep hygiene (bedtime practices that impair sleep) and b) hyper-arousal (inappropriate central nervous system activation secondary to stress, resulting in insomnia symptoms: problems falling asleep, maintaining sleep and early morning awakenings). Given the associations among sleep and multiple health parameters, interventions for fundamentally improving sleep should provide an effective strategy for improving multiple dimensions of health and well-being.

Sleep Problems Disproportionately Afflict Low-Income and Minority Groups. Inadequate sleep, including longer sleep latency and shorter sleep duration, is prevalent among low-SES and racial/ethnic minorities groups, and likely reflects the influence of a number of chronic stressors: occupational and financial strain, discrimination, contextual (e.g., neighborhood) factors, as well as the effects of anxiety and depression. The disproportionate burden of inadequate sleep in minority groups is evident in data from the Multiethnic Study of Atherosclerosis (MESA). In a MESA sleep ancillary study that we conducted using actigraphy and polysomnography in 2200 MESA participants, adjusted analyses indicated that African Americans had a 5.01 (95% C.I.: 3.67, 6.84) increased odds of short sleep (<6 hours) and a 1.78 (1.15, 2.75) increased odds of low sleep efficiency (<85%) compared to whites; insomnia symptoms were reported by 25% of African Americans and 26.5% of Hispanics. Additionally, the high burden of inadequate sleep in minority groups likely contributes to their disparate burden of disease. For example, data from NHANES indicate that blacks are at risk of more severe consequences, such as diabetes, from disordered sleep compared to non-Hispanic whites. Despite the abundant epidemiological data quantifying the high prevalence of inadequate sleep in minority and low-income groups, there has been scant research aimed at adapting and testing interventions to improve sleep in these high-risk population groups. Since low-SES

groups often experience multi-level psychosocial, family, neighborhood, and occupational stressors, there is a need to tailor sleep interventions to be feasible for individuals facing multiple, chronic stressors and adverse sleeping environments. There are also opportunities to build upon the strengths of the community, such as the strong role of spirituality, and its role as a stress buffer and source of resiliency. Thus, for Phase 3, we propose to test a socio-contextually appropriate community-based sleep intervention that proves to be a durable approach for improving sleep quality and duration, and thus for alleviating recalcitrant health disparities.

Sleep Interventions. Behavioral sleep therapies, delivered as single or multi-modality interventions, are efficacious in improving sleep in patients with sleep disorders managed in clinical settings. However, such therapies have not been adapted nor tested for use in more general populations or in community settings. Our preliminary work with residents in low-income Boston housing has identified a high prevalence of poor sleep hygiene as well as chronic and daily stress; thus, supporting the need for community-based interventions that jointly address the inter-connecting influences of poor sleep and stress. *We posit that a yoga intervention will improve sleep by positively influencing stress responses, affect, resilience, and self-efficacy, resulting in: a) improved adherence to sleep hygiene recommendations; and 2) reducing physiological arousal, a key mechanism for initiation and perpetuation of insomnia symptoms.*

In summary, inadequate sleep is highly prevalent in low-SES and minority groups and associated with multiple health problems. The root causes of inadequate sleep are often related to behavioral practices and stress, both of which may be favorably impacted using socio-contextually appropriate sleep hygiene recommendations and mind-body practices such as yoga. We will conduct a preliminary RCT that will address the role of sleep behavioral interventions in a high-risk community. This evidence is needed to guide mind-body therapies in low-SES communities in which such strategies are under-utilized to improve health.

II. Specific aims (research objectives)

We have assembled a multidisciplinary team of experts in sleep medicine, complementary and integrative health, behavioral medicine, community engagement, social epidemiology, and clinical trials to conduct a planning study to adapt behavioral sleep interventions for residents in urban low-income housing and to evaluate their uptake and fidelity. In Phase I, we conducted qualitative formative evaluation work. In Phase 3, we will deliver a 12-week RCT testing the feasibility of (1) an adapted sleep hygiene intervention and (2) yoga + adapted sleep hygiene intervention.

A. A Sleep Hygiene (SH) Intervention, addressing: beliefs and attitudes towards sleep; challenges for adhering to sleep hygiene recommendations given chaotic family routines, work schedules and bedroom conditions; strategies for overcoming barriers, such as positive affirmation, at-home diaries, social support; environmental changes that facilitate the right choices for good sleep (“choice architecture”); and prioritization of recommendations most likely to be efficacious.
B. A Yoga (Y) Intervention, reflecting feedback from our focus group participants on: intervention intensity/duration and class format; tailored home-based recommendations for bedtime practice combining meditation, breathing and postures; tools to assess and enhance adherence; race/ethnicity concordance of the instructor and student; and use of peer yoga assistants.

Aims 1 and 2 of the study are to conduct a 40 person 12 week RCT of SH vs SH-Y to inform the design of a future large scale RCT.

The main goals of **aim 1** are to evaluate the feasibility of recruiting from our target community, randomizing individuals to interventions delivered in community rooms with home-based practices, and delivering the targeted interventions with high adherence and fidelity. We will evaluate the:

- Reach of the target population: The number of potentially eligible individuals approached to participate will be tracked as well as the characteristics of individuals who do and do not choose to participate, and differences will be assessed. Reasons for choosing not to participate will be assessed using open ended questions (e.g., burden, perception of yoga, needs, etc.).
- Adoption and adherence: We will assess the proportion of individuals that sustain participation throughout the intervention, and quantify attendance at classes and home-practices through logs and interim phone interviews. We will describe patterns of dropout rates and adherence to the interventions by key demographic factors and by moderating and mediating factors.
- Implementation-consistency of delivery of the intervention: We will use a checklist of core intervention elements documenting the degree to which core elements of the intervention was delivered as specified in the protocol.

Aim 2 goals also are to assess the feasibility of collecting a range of baseline, outcome, process and mediator data and to generate data to support use of specific measures in a later trial, including patterns of missingness of data, distributions of data, correlations between outcomes, baseline factors and mediators, and evaluation of "dose-response" associations between time in intervention and sleep duration and efficiency. We therefore will evaluate:

III. Subject selection

a. Inclusion/ exclusion criteria:

Inclusion Criteria:

- Ages 18-75 years old
- Verbally proficient in English
- Self-reported average (over the prior month) weekday sleep duration of < 6 hours
- Reside in [redacted]

Exclusionary conditions:

- Severe physical conditions preventing participation in yoga, including major surgery or head injury in the prior 3 months, or unstable vertebral injury with inability to sit or lie down for 5 or more minutes; or glaucoma
- Major psychiatric disease (e.g. schizophrenia, depression, PTSD) requiring hospitalization in the last year; or disease severity that, in the opinion of the investigator, would make it difficult for the participant to partake in the study activities.
- Severe sleep disorders: self-report of physician diagnosed insomnia requiring hypnotics more than 2X/week.
- Needing an assistive device such as a walker or cane, frequent falls, history of stroke resulting in weakness or numbness interfering with moving easily, or other problems causing ongoing balance issues and difficulty walking

- Yoga class participation in last 6 weeks
- Known pregnancy.

Recruitment: A total sample of 40 subjects will be recruited for the 12-week RCT pilot, with 20 participants in each arm. Recruitment materials (flyers, brochures, letters/ mailings) will be distributed by a study coordinator, community partners and residential coordinators. In addition, we will send an opt-out letter and call participants. An opt-out letter with a brief explanation of the study will be sent to residents by residential coordinators. Residents who do not opt-out may receive a phone call from study staff with more information about the study. If interested, they will be screened for eligibility. Eligible candidates can then choose if they wanted to be consented to enroll in the study. We will purposively recruit participants for characteristics of interest to ensure representation from different racial/ethnic groups and gender. Individuals will undergo a brief phone or in-person interview to determine initial eligibility (with a HIPAA waiver). Eligible candidates will be invited to a consent visit. Eligible participants will then determine if they want to consent to enroll in the study.

b. Source of subjects and recruitment methods

Source of subjects: Participants will be recruited from low income [redacted] housing units [redacted]

IV. Subject enrollment

a. Methods of enrollment, including procedures for patient registration and/or randomization

The study coordinator will contact potential participants to conduct a short screener to assess eligibility and interest in participating (with a HIPAA waiver). The screener includes questions on average sleep duration (inclusion criterion), selected medical conditions and prior hospitalizations and other questions addressing exclusionary conditions, including use of hypnotic medications. Careful tracking of refusal rates and eligibility status will describe recruitment yields by gender and race. After eligibility screening and consent, each participant will be randomized into one of two conditions: the sleep hygiene condition or the sleep hygiene plus yoga condition.

b. Procedures for obtaining informed consent (including timing of consent process) & c. Treatment assignment, and randomization (if applicable)

[redacted] collection of formal questionnaire and objective data at BWH (221 Longwood Ave), BWH's Wellness Center, [redacted]. Following consent, participants will begin the baseline assessment. They will complete baseline questionnaires, and be randomized to one of two interventions using a customized web-based randomization module (www.slice.partners.org). Participants will receive an actigraph and actigraphy diary to

track sleep for 1-week. The joint consent-baseline visit is estimated to take maximum 90 minutes.

V. Study Procedures

a. Study visits and parameters to be measured (eg. Lab tests, x-rays, other testings)

Study Timeline

Week -6 to -1	Week 0 to 6		T1 week 7	T2 week 8	T3 week 9	T4 week 10	T5 week 11	T6 week 12	T7 week 13	T8 week 14	T9 week 15	T10 week 16	T11 week 17	T12 week 18	Week 19
Screening phone calls (~15 mins)	-Consent -Baseline visit (assessments and measures) -Randomization (~90 mins)	YOGA+SH	SH1 Group (~90 mins)	SH2 Group (~90 mins)	Yoga 1 (~60 mins)	Phone call (~5-15mins) Yoga 2 (~60 mins)	Yoga 3 (~60 mins)	Yoga 4 (~60 mins)	Yoga 5 (~60 mins)	Phone call (~5-15mins) Yoga 6 (~60 mins)	Yoga 7 (~60 mins)	Yoga 8 (~60 mins)	Home yoga only	-Follow-up (assessments and measures) (~90 mins)	Optional focus group (~60 mins)
		Incentives	$10 @ week 12 + Light dinner	$10 @ week 12 + Light dinner	$10 @ week 12 + Light snacks	$10 @ week 12 + Light snacks	$10 @ week 12 + Light snacks	$10 @ week 12 + Light snacks	$10 @ week 12 + Light snacks	$10 @ week 12 + Light snacks	$10 @ week 12 + Light snacks	$10 + Light snacks	$0	$10 + $10 for every attended visit (up to $135)	
		SH	SH1 Group (~90 mins)	SH2 Group (~90 mins)	N/A	Phone call (~5-15mins)		N/A	N/A	Phone call (~5-15mins)		N/A	N/A	-Follow-up (assessments and measures) (~90 mins)	
$0	$25	Incentives	$10 @ week 12	$10 @ week 12	$0	$10		$0	$0	$10		$0	$0	$10 + $10 for every visit (up to $75)	Light dinner
	Participants complete 8 days of actigraphy & actigraphy log												Participants complete 8 days of actigraphy & actigraphy log		

Participants will attend several study visits.

Research visits

All participants will be asked to attend 2 research visits: a baseline and follow-up visits. Research visits will occur at the [redacted]

To begin, participants will be screened for participation over the phone. Participants will then meet with a trained research staff to complete written informed consent. Following consent, participants will be administered questionnaires, undergo several physical measurements, and be instructed on use of wrist actigraphs and 1-week actigraphy diaries. We estimate this visit will take 90 minutes. Participants will return their actigraphy diaries and actigraphs approximately one week later. The final research visit will be a follow-up endpoint visit to repeat measures. Study staff will repeat anthropometry and questionnaires. We estimate this visit will take 60 minutes. We will make every attempt to re-study all individuals at the 12-week visit, regardless of adherence to interventions. Actigraphs and actigraphy diaries will be distributed for participants to wear and complete for 1 week.

Intervention visits

Participants in both arms will attend two SH group sessions led by a sleep expert. The first one will focus on sleep hygiene education. The second visit, one week later, will allow participants to check-in about their goal setting and trouble-shoot in a socially supportive setting. Both groups will receive 2 interim phone calls to review SH progress and assess sleep quality. The staff member making the call with review the participants' sleep logs prior to speaking with the participant to inform the conversation. The staff member will attempt to contact participants up to 3 times and the answer rate will be documented. The SH+Y arm will attend 8 in-person beginner yoga classes after the SH-group visits. They will receive materials (handbook, audio recordings, yoga props) to support the at-home yoga practice for the following 10 weeks; the final 2 weeks will provide the researchers with insight into the short-term sustainability of yoga home practice.

For both groups, interim phone calls are made at 4-5 and 8-9 weeks to reinforce participation, collect information on study process measures (yoga practices; SH), assess self-reported sleep duration, and ascertain adverse events.

The measurement schedule and questionnaire names are outlined in the study timeline graphic that appears above. Measurements will solicit demographic and health history information. Information on outcomes related to the intervention will be collected (sleep quality, sleep related impairment, sleep knowledge and beliefs). Questionnaires will also provide information on potential mediators such as anxiety, mood, stress response, self-efficacy and mindfulness. Participants will also receive a sleep log (SH arm) or sleep and yoga log (SH-Y arm), asking them to record their daily sleep times, sleep related behaviors (and time spent in yoga). Participants will complete the log daily for the entirety of the intervention. The log will provide information for researchers on sleep habits and home-yoga practice; in addition, the log promotes the intervention behavior change goals, functioning as a self-monitoring tool.

Finally, at the end of the intervention, participants will be asked to complete a questionnaire that will ask about acceptability and effectiveness of specific components of the SH and yoga interventions, respectively for the SH and SH+Y arms. Surveys also will include questions related to the clarity and acceptability of the intervention materials including message attention, processing, comprehension and perceived ability to complete the suggested behavioral modifications and burden. Barriers to implementation and suggestions for further adaptation will be solicited, in addition to information on how participants' health habits and mood may have changed.

Participants will be invited to 1-2 focus groups to gather a broader range of qualitative data from the target population that will aid in the refinement of a future protocol.

Dosing: We will plot self-reported sleep duration (reports from self-reported data) to explore sleep duration vs time dose-response relationships (linear trends, thresholds, plateau in response).

Ongoing contact: Research staff will maintain telephone and text message (SMS) contact with participants across the study period, providing appointment reminders to reinforce the protocol and interventions and to answer questions. Participants will be contacted through SMS software (e.g. "Red Oxygen"). The text messages will not contain PHI (see RISO approval letter). Participants will also have the option to opt-in to receiving an SMS at their choice interval reminding them to complete a sleep diary and to practice yoga at home. Participants will be asked to contact staff should they experience change in health, accidents, or injuries over the

course of the intervention period (i.e., soliciting information on possible adverse events) and to report possible problems to research staff at each study visit.

Data Collection. Research staff will be trained and certified in all study procedures and will oversee or directly administer surveys following a standardized protocol. All forms will use a de-identified tracking number. The only linkage with the de-identified number and participant name, address, and other contact information will be in a recruitment log maintained securely by the research coordinator.

Interventions: Sleep Hygiene (SH) Intervention: Initially based on studies of the effects of caffeine and alcohol on sleep and on clinical observations of patients with poor sleep, sleep hygiene lists are psychoeducational lists of recommendations designed to improve sleep. Addressing sleep hygiene entails an examination of sleep habits, behaviors, and environmental factors and helping individuals avoid issues that interfere with normal sleep patterns and engage in behaviors that promote good sleep. There is a range of recommendations. To consolidate the varying sleep hygiene lists used across the literature, the International Classification of Sleep Disorders diagnostic category for "Inadequate Sleep Hygiene" was used to guide the standardized sleep hygiene factors that will be discussed over the course of the intervention. In addition, we reviewed results of our Phase I qualitative research, Phase 2 pilot results, and the literature to create prototypes for a culturally-appropriate sleep hygiene presentation and handout. The discussion of these potential challenges for an individual's sleep will occur over the course of two one-hour group sessions (week 1 and week 2) that are designed to be interactive. Sleep hygiene concepts will be discussed by a trained staff member (a sleep behavioral psychologist or a trained post-doctoral fellow), and participants will be encouraged to identify specific facets of sleep hygiene that they deem to be most problematic for their own sleep. The core components of SH, adapted as appropriate, will include regularization of wake times and avoiding naps in the evening, avoidance of substances that impair sleep, optimization of the sleep environment (temperature, noise), getting light during the day and doing adequate physical activity. At the end of the session, instructors lead participants through the completion of a daily sleep (& yoga) log. A handout will be provided to all participants following the group session, which will include a sleep (& yoga) log and an overview of all sleep hygiene concepts discussed. In the second SH session, the instructor will lead an informal group discussion prompting participants to share challenges, experiences, sleep and sleep hygiene goals. The instructor will encourage cross-talk among participants, facilitating 'social support'. A research staff member will observe the group class and grade clarity in instruction.

International Classification of Sleep Disorders: *Inadequate Sleep Hygiene*	
Daytime napping	Variable bed times and wake times
Extended amount of time in bed	Use of alcohol, tobacco, or caffeine before bed
Exercising too close to bed time	Use of bed for non-sleep related activities
Sleeping on uncomfortable bed	Bedroom too bright, hot/cold, or stuffy
Cognitive arousal before bedtime	Allowing mental activities to occur in bed
Exciting/emotional activities close to bed time	

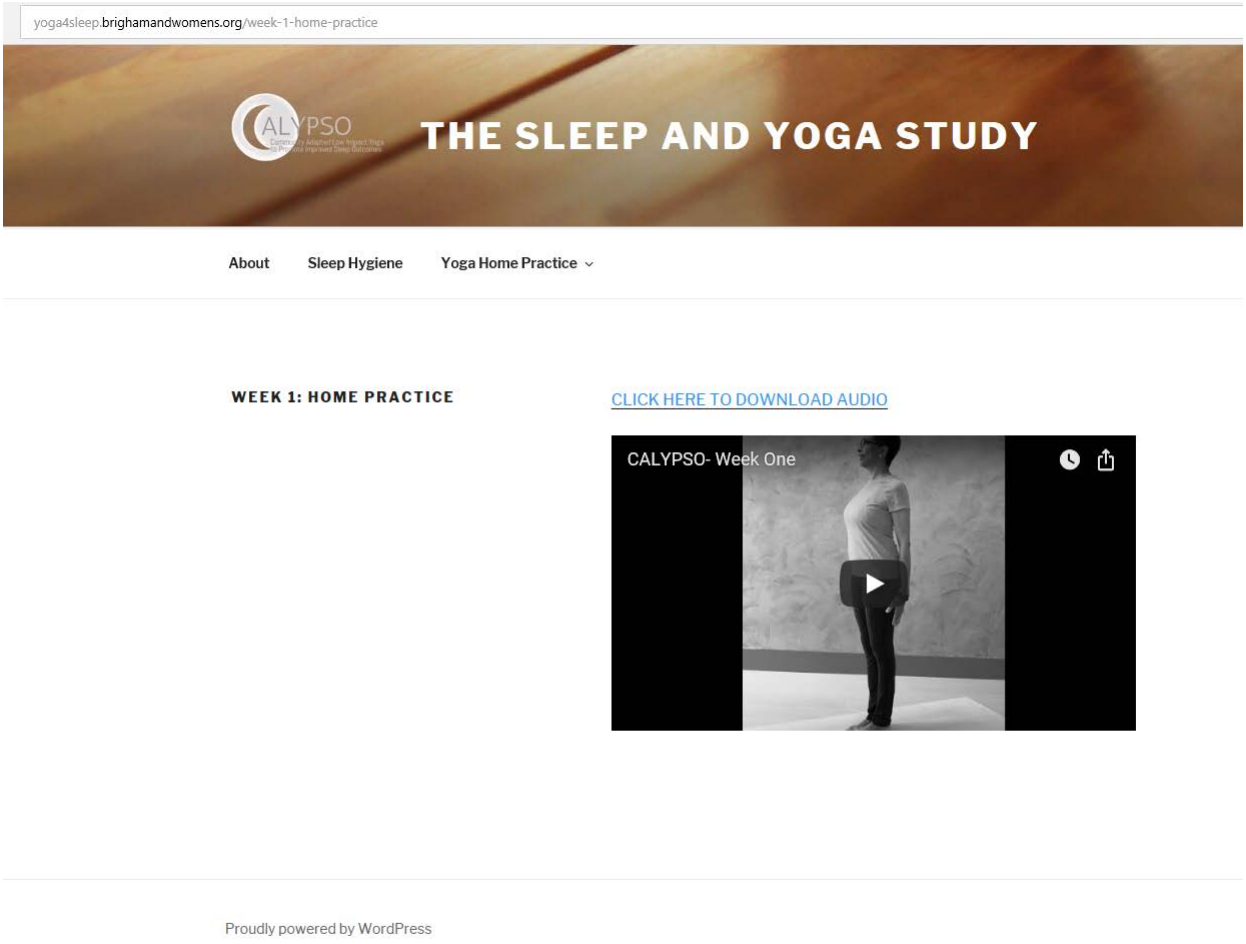
Following the group session, all participants will receive an individual phone call at week 4-5 and weeks 8-9 from trained study staff to discuss their experiences with implementing behavioral and environmental changes to their sleep practices, as guided by the results of their own Sleep Hygiene Checklist. Building on individual strengths as well as by following principles of "choice architecture", we will attempt to identify opportunities to change the home environment or solicit support from family members to make it easy for participants to "default" to the desired sleep habits (e.g., by moving electronics from the bedroom). Challenges to implementation will be discussed and addressed during this 10-15-minute phone conversation.

Participants will be asked to continue to complete the paper logs for the duration of the 12-week intervention.

Yoga Intervention (Y). After the two weeks of SH intervention, participants randomized to the SH+Y arm of the intervention will be invited to participate in one hour, once weekly, group sessions, for the subsequent 8 weeks. (Yoga classes will be offered at two different times per week, to provide flexibility in attendance.) A healthy snack (e.g., fruit) will be served after each yoga class). The main goal of the classes is to help increase participants' skill and comfort with a set of yoga postures (see Yoga manual) and to help participants adopt a safe, daily/nightly yoga practice**.** Each class will follow a similar format: check-in, active yoga poses, calming yoga poses, breathing and deep relaxation. Poses increase in difficulty with each subsequent segment. Instructors will encourage participants to practice daily at home on non-class days, with emphasis on nightly breathing exercises and relaxing and restorative postures. Participants will receive reinforcing materials such as yoga mat, yoga blankets and a handbook illustrating the protocol; this content will also be available via downloadable audio MP3 or YouTube video. To accommodate a range of physical abilities, teachers will use pre-specified variations of poses (e.g., chair based, using wall for support) as well as props (e.g., blankets). The nighttime breathing exercise will be observed by the teacher during each class to ensure participant fidelity. Participants will be asked to record the amount of yoga they actually practice at home as well as sleep patterns using the daily logs (Table 1). Class instruction will be led or supervised by Dr. Jarvis Chen, an experienced yoga instructor. Additional trained instructors may work under his supervision as needed to accommodate the study schedule. A research staff member will observe each class and grade clarity in instruction and ability of participants to follow instructions and perform the maneuvers.

We will audio record the SH group session and yoga sessions to serve as a resource for future staff leading these sessions in subsequent iterations of the study. The audio recordings will be stored on secure computers and will only be available for approved study staff to access. Only participant first names will be used in the group sessions, and therefore, on the recordings. Participants will be notified that they are being recorded for internal study purposes; participants will have the choice to veto the recording at any time and/or have the choice to be referred to by a fake name throughout the session, further reducing their identifiability.

Study information (schedule) and resources (yoga handbook and audio recordings) will be available to access through a BWH website: http://yoga4sleep.brighamandwomens.org/. The image below is an example of a resource landing page.



b. Drugs to be used

N/A

c. Devices to be used

Participants will be instructed to use a wrist actigraph for 7 consecutive days and nights to measure sleep duration and sleep quality. The actigraph (GTX3+) is a triaxial device with a sampling rate of 100 Hz. It also has a light sensor that quantifies light spectra and intensity. The actigraphs can be worn continuously, even while bathing, and only need to be removed during prolonged period under water or with rigorous contact sports. Participants will be asked to complete a short actigraphy diary concurrently that can be completed in one minute or less that is used to help edit the actigraphy data.

d. Procedures/ surgical interventions, etc.

N/A

e. Data to be collected and when the data is to be collected

The study coordinator will be trained and certified in all study procedures and will administer surveys and make measurements following a standardized protocol.

Measures:

- *Height (calibrated stadiometer)
- Weight (calibrated scale)
- Blood pressure scale
- Pulse
- Actigraphy (1-week) + Actigraphy diary

Assessments:

1. *Demographics and Health History
2. Sleep Hygiene Scale
3. Intervention Feedback Scales (SH; yoga)
4. *STOP Sleep Apnea assessment
5. Women's Insomnia Severity Rating Scale
6. Dysfunctional Beliefs and Attitudes about Sleep-16
7. Spielberg State-Trait Anxiety Inventory
8. Physician Health Questionnaire-8
9. Perceived Stress Scale
10. PROMIS Sleep Disturbance Scale
11. PROMIS Sleep Related Impairment questionnaire
12. Sleep Self-Efficacy Scale
13. Five Facet Mindfulness Questionnaire
14. ***Exit interview form
15. **Sleep (and yoga) log
16. **Adverse Event Assessment

**no 12-week follow-up*
***collected for the duration of the 12-week intervention*
****collected at follow-up only*

Baseline and Endpoint Measurements: A baseline and 12-week endpoint research visits will be scheduled at the community research site [redacted] Data collection will include the following:

- Blood pressure and heart rate: Participants will be asked to rest for 5 mins, and sitting blood pressure and heart rate will be measured (x3) using a calibrated automatic sphygmomanometer and be instructed on home actigraphy use.
- Anthropometry measurements will be obtained using standardized procedures to measure:height (calibrated stadiometer) and weight (calibrated digital scale).
- Questionnaires- Subjects will be administered a 45-70min survey battery, consisting of the following instruments:
    - Demographics and health history; Women's Insomnia Severity Rating Scale; PROMIS Sleep Disturbance Scale; PROMIS sleep related impairment questionnaire
    - Dysfunctional Beliefs and Attitudes about Sleep-16; Sleep Hygiene Index; Spielberg State-Trait Anxiety Inventory; Physician Health Questionnaire-8; Perceived Stress Scale; Sleep Self-Efficacy Scale; Five Facet Mindfulness

Questionnaire (FFMQ), short form (24 questions); yoga feedback scale (for SH+Y arm); sleep hygiene feedback scale (both arms)

- Actigraphy and diaries: Participants will be instructed to use a wrist actigraphs for 7 consecutive days and nights on their non-dominant wrist. An actigraphs is a battery powered device that can be worn continuously, even while bathing, and only need to be removed during prolonged period under water or with rigorous contact sports. It measures movement, from which sleep wake time is estimated. Participants will be asked to complete a short actigraphy diary concurrently that can be completed in one minute or less that is used to help edit the actigraphy data.
- Sleep (and Yoga) Logs: Following the first SH education session, participants will complete a daily sleep monitoring log for the duration of the 12-week study. Participants randomized to yoga will receive a log that includes an additional prompt to log their daily yoga practice time and duration.

VI. Biostatistical Analysis

a. Study endpoints and analytical approach

- Reach of the target population: The number of potentially eligible individuals approached to participate will be tracked as well as the characteristics of individuals who do and do not choose to participate, and differences will be assessed. Reasons for choosing not to participate will be assessed using open ended questions (e.g., burden, perception of yoga, needs, etc.).
- Adoption and adherence: We will assess the proportion of individuals that sustain participation throughout the intervention, and quantify attendance at classes and home-practices through sleep (and yoga) logs and interim phone interviews. We will describe patterns of dropout rates and adherence to the interventions by key demographic factors and by moderating and mediating factors.
- Implementation-consistency of delivery of the intervention: We will use a checklist of core intervention elements documenting the degree to which core elements of the intervention was delivered as specified in the protocol.
- Missingness: We will describe the proportion of missing data. For measurements with more than 10% missingness, we will interview staff and participants to identify reasons (e.g., clarity, burden, etc.).
- Data distributions: For each of the outcomes and candidate mediators, we will produce graphical displays and summary statistics such as means, medians, standard deviations, 95% CIs, ranges, and proportions to describe the baseline, follow-up and change values and their distributions. Intervention groups will be compared using the Wilcoxon rank-sum tests for continuous variables and Fisher's exact test for categorical variables. These analyses will provide us information on the variances for each measure and provide a range of effect sizes to use when developing the statistical plan for a later study.
- Correlations and potential mediators: Spearman’s correlation coefficients will quantify the magnitude of association among mediators and moderators, and between changes in mediators and changes in study outcomes. This will help identify potential redundancy in measures (if similar constructs are highly correlated) and will identify variables strongly correlated with outcomes, which would be candidates for use in a later trial.
- Dosing: We will plot self-reported sleep duration (from reports from objective and subjective assessments) to explore sleep duration vs time dose-response relationships (linear trends, thresholds, plateau in response).

- Preliminary evidence for intervention effectiveness: Our primary outcome will be change in sleep duration measured by actigraphy (and diary) between baseline and 12 weeks. We will conduct a repeated measures ANCOVA, modeling time, intervention group and a time*intervention interaction. We will also explore change in stress, anxiety, depressive symptoms, mindfulness, and sleep hygiene score as potential explanatory variables. Secondary outcomes include change in systolic and diastolic blood pressure and resting pulse and PROMIS sleep impairment and sleep disturbances and insomnia score.

d. Power analysis (sample size, evaluable subjects, etc.). The study is designed for feasibility and not powered to test the intervention effect. The SH+Y intervention will be considered as potentially efficacious if the estimates for the change scores (post-pre within and between group changes and their 95% CIs) are consistent with clinically significant improvements in sleep duration (actigraphy sleep increases by > 30 minutes), sleep quality improves by > 0.5 SD), or sleep hygiene (reduction in deviation in wake time relative to recommended wake time > 25%). We will consider inclusion of specific measurements (mediators) in a future RCT based on: <10% missingness; correlation of change score or baseline score with outcomes of >.20; absence of redundancy with a simpler metric (r<.80).

VII. Risks and Discomforts (stratify by common and uncommon)

Device complications/malfunctions. The actigraphy is battery powered with minimal risk. The main risk may be irritation under the band. This will be minimized by asking participants to remove the band and dry skin if the band gets wet.

A. COMMON/ POSSIBLE LIKELIHOOD

Discomfort in answering questions.
This study involves the completion of self- or interviewer-assisted written surveys, and it is possible that some people may feel uncomfortable answering some of the questions or asking the survey administrator for assistance in completing the questionnaire.

Minimization of risk: Surveys will be conducted by a trained member of the study staff. Those that are orally administered will occur in a private room or partitioned area. All participants can withdraw from the study. Participants will be informed that they may discontinue the survey at any time for any reason, and that they can skip any questions that they feel uncomfortable answering with no penalty to current or future health care. We have also selected validated instruments that have been widely used, and thus we anticipate the concern, while possible, will be minimized. We do not anticipate that any questions will be so upsetting to participants that extra support will be required. However, we will develop a referral sheet for additional resources in the unlikely event that this should occur.

Discomfort or bruising on the arm with blood pressure measurements
It is possible that inflation of the blood pressure cuff, may causes mild discomfort. This discomfort generally disappears within minutes of the cuff being released.

Minimization of risk: All cuffs will fit for each participant, selecting the most appropriate size. Participants will be instructed by trained study staff on how to remove/deflate the cuff should pain occur or should the cuff not deflate.

Sleep disruption associated with actigraphy

It is possible that by wearing special monitoring devices, participants may feel that their sleep is not as good as is typical.

Minimization of risk: Devices have been chosen that are as minimally intrusive as possible. Participants will be provided clear instructions by trained study staff on how to use these devices to minimize discomfort. They will be instructed how to remove and replace the devices if needed, or can discontinue the monitoring is necessary.

Yoga related Muscle strain/sprains/injury.
It is possible that yoga can cause muscle strain or sprain, including ankle injuries and back injury, with resultant pain and limitation of movement. Rarely, there may be nerve damage or risk of certain types of stroke.

Minimization of risk*:* Yoga will be taught by experienced instructors who are familiar with proper technique, contraindications, and ways to minimize injury. Class size will be small to allow for close interaction between the participant and instructor, and ensure use of correct postures to minimize injury. Injury also will be minimized by performing yoga in defined sequences and gradually increasing challenges. Participants will be excluded if recent (within 3 months) major surgery or head injury, glaucoma, history of significant vertebral injuries. Although participants who are known to be pregnant will be excluded, we will choose poses that are safe in pregnancy. Participants will be asked to refrain from eating before yoga classes. In the beginning of each class, participants will be encouraged to take stock of their current physical condition and check with the yoga instructor if experiencing pain before or during yoga. The instructor will make accommodations (such as use of yoga straps or blocks) to address individual needs.

Undiagnosed/untreated depression, insomnia or sleep apnea.

1. Minimization of risk*: If any participant reports* suicidal ideation or has a PHQ-8 score > 19, the coordinator will page the PI or her designee and determine immediacy for referral, including, as appropriate, making arrangements to emergency room evaluation, timely clinic follow-up, or a new medical referral. If a Women's Insomnia Severity Rating Scale score is found to be >10 or a report of untreated sleep apnea is identified, the participant will be provided information on local sleep center resources, and the staff will offer to provide the participant's physician relevant information and/or directly facilitate specialty referral. If a blood pressure is measured to be > 180/110, the coordinator will communicate this to the PI or her designee within 24 hours and determine appropriateness for further action, including communicating with the participant's primary physician or making a new medical referral.

B. UNCOMMON/ RARE LIKELIHOOD

Loss of confidentiality.
It is possible that identifiable information may be inadvertently disclosed outside of the research arena through oral or written channels.

Minimization of risk: Confidentiality will be maintained by numerically coding data and by disguising identifying information. All information obtained from survey respondents and interviewees will be accessible only by authorized research staff. Special precautions will be

implemented to ensure the confidentiality of patient responses. We will assign all respondents a unique identification number. No individual names or housing site names will be used on the survey. The cross-list matching names and codes will be kept in locked file drawers and will only be accessible to study staff on password-protected computers. All data collected electronically will use encrypted methods that include secure methods of data transfer. We will ensure that any information shared with collaborators will have all identifiers removed to protect the confidentiality of respondents; only IDs will be used and the minimal amount of information needed will be shared.

VIII. Potential Benefits

The potential benefits and importance of the knowledge gained through this study are significant for both participants and for the scientific community, and outweigh the minimal risks posed to participants. Sleep related disparities are significant among low income and under-represented populations, and understanding the feasibility of potentially successful interventions to improve sleep outcomes offers the significant potential to identify levers for reducing these disparities. Participants will also receive feedback on their sleep patterns which will be helpful to them in managing their own health. With their permission, this information will be shared with their health care providers. Participants also may directly benefit from participation in the sleep hygiene and yoga interventions, with improved stress and sleep.

IX. Monitoring and quality assurance

Data safety and monitoring. The data from this project will be monitored by the study's Data and Safety and Monitoring Board (DSMB) which has been assembled and includes three external researchers with expertise in sleep medicine, yoga, clinical trials, and disparities research. The DSMB has already approved the Phase I and Phase 2 of study and tentatively approved this Year 3 RCT protocol. In Year 3, they will meet to review recruitment and retention, data integrity and adverse events. The DSMB Chair will also receive any reports of serious or unexpected adverse events in real time.

The DSMB will review the work and adverse event at mid-way point/ 6 weeks after intervention start and then again after the study concludes at 12 weeks.

A Data Safety Monitoring Plan will specify how to handle abnormal findings (blood pressure, depression), including physician evaluation and notification of participant and their physician, making arrangements for acute treatment, as appropriate. For example, significant abnormalities will be communicated by a physician by phone within 24 to 48 hours of identification (depending on severity). For individuals who endorse suicidal ideation, a physician will evaluate the individual and recommend appropriate action (e.g., referral to a known physician, emergency room referral).

Reporting of Serious Adverse Events (SAEs). The project director will be responsible for reporting SAEs to the NIH and BWH's IRB within 24 hours of first knowledge of the event via telephone, followed by completion of the corresponding case report form within 48 hours. Within the following 48 hours, the investigator will provide further information on the SAE in the form of a written narrative. This will include a copy of the completed SAE form, and any other diagnostic information that will assist the understanding of the event. Copies of all correspondence with the IRB will be maintained in the study regulatory binder.

On an ongoing basis, Dr. Redline will review the results of summary data to identify any values of concern.

Components of our Data Security Monitoring Plan: (1) secure/maintain IRB approval; (2) ensure that study staff and others with direct contact with participants and/or access to their identifiable data complete NIH human research certification, CITI, and other human research training programs, as required; (3) include human subjects' concerns as a standard agenda item for regular project meetings.

Research Material. Surveys and logs will be obtained from living human subjects, specifically for research purposes. Research data will be kept in a locked file cabinet or saved in password-protected computer files behind Partners firewall. Research data collection forms for all research information will be coded and will not contain information on participants. A master list, linking participant identifiers with the study code, will be kept separately from other research data and in a secure location, accessible only to study staff.

Participant Refusal. A record will be kept of the number of participants who are approached, but refuse to participate in the study. For tracking purposes, the reason for refusal, when obtained, will be documented.

Compensation. Participants randomized to the SH-only arm will receive $25 for the consent-baseline visit and up to $50 more for the subsequently completed visits ($10/each) to be distributed week12 at the endpoint visit, for a total of $75 in gift cards to Stop&Shop.

Participants randomized to the SH+Y arm will receive $25 for the consent-baseline visit and up to $110 more for the subsequently completed visits ($10/each) to be distributed week12 at the endpoint visit, for a total of $135 in gift cards to Stop&Shop. Participants will also receive a yoga mat, 3 yoga blankets and a yoga strap. A healthy snack will be offered after all the yoga classes.

In addition, a light dinner will be served at the SH1 and SH2 visits. To mitigate barriers to attending in-person visits, participants with young children will be offered complimentary childcare available through [redacted]. Additionally, when study sessions occur during dinner time, we will provide the children with a light dinner (e.g., pizza) at all group sessions.

Institutional Review Board. It is the responsibility of the Principal Investigator to provide the IRB with all pertinent material, including a copy of the informed consent given to participants. Approval of the protocol and the verbal informed consent form must be obtained prior to enrolling any participants in the study. The Principal Investigator also maintains the responsibility of initiating protocol re-approval, notification of protocol and/or consent form changes according to the appropriate IRB requirements.

Record Keeping. Participant study documents must be made available when necessary for safety and quality control and/or as required by law for regulatory purposes. These documents should be organized in binders or files (outlined below) and stored in accordance to security and record retention regulations and until further written notice by the NIH. All information obtained will be kept in locked files and password-protected computers. Audiotapes of any sessions will be kept for six years.

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