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Sleep Well 24 (SWELL24):
Promoting healthy sleep-wake behaviors across a 24-hour cycle in frail older adults

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Background, Rationale and Context

Healthy sleep-wake patterns are critical in preventing disability, supporting rehabilitation, and preserving functional independence in older adults. However, two-thirds of older adults meet clinical criteria for insomnia, defined as difficulty falling or staying asleep accompanied by impairments in daytime function. Less than one-half of older adults with insomnia engage in regular exercise. In our prior work, we found frail older adults, defined as individuals with multiple chronic conditions, and competing cognitive and functional limitations, more commonly endorsed daytime consequences of poor sleep rather than nighttime symptoms. Furthermore, these daytime consequences prohibited older adults from participating in chronic disease management and/or rehabilitation activities. Evidence-based interventions exist for improving nighttime sleep and daytime activity behaviors; yet these behaviors are typically assessed and treated in isolation.

This two-part proposal uses a sequential mixed methods design to describe sleep-wake behaviors across a 24-hour period (Part I, Aim 1) and finalize daytime components for initial evaluation in a pilot trial (Part II, Aim 2).

Objectives

***Part I, Aim 1*. To describe older adults' sleep-wake behaviors across a 24-hour cycle, including association with functional status, and to explore preferences for treatment.** *Approach*: Older adults utilizing WFBH primary care services who endorse poor sleep and low activity will participate in an in-person sleep and activity assessment examining sleep-wake behaviors (i.e. nighttime sleep behaviors, daytime physical activity, and sedentary time), functional performance status, and overall health. Daily sleep-activity diaries will explore the physical and social contexts in which poor sleep-wake behaviors occur. Open-ended assessment items will explore older adults' perceptions of sleep-wake behaviors and preferences for participating in a sleep-activity behavioral intervention.

***Part II, Aim 2*. To finalize daytime intervention components for a comprehensive sleep-wake intervention for frail older adults and explore feasibility and acceptability using a pilot trial.** *Approach:* An enhanced intervention addressing both nighttime and daytime activities will be developed based on prior evidence and further informed by data gathered in Part I. A successive cohort design will be utilized to evaluate and refine key intervention components and gather feedback on older adults' experiences.

Methods and Measures

Design

This two-part study includes an observational sequential mixed methods design (Part I followed by a non-randomized pilot trial of a brief sleep-activity intervention - Part II). All participants enrolled in the pilot trial will receive the intervention, all activities will be unblinded. Note that participants will be recruited from the Principal Investigator's ongoing work distributing a patient-facing survey, *How Are You Sleeping?.* Note that this survey has received separate IRB approval (AMAZE Sleep Cohort: IRB00090470). In brief, all survey respondents who meet clinical criteria for chronic insomnia and who do not opt out of future contact are entered into the recruitment pool for multiple studies.

Part I, Aim 1. Older adults obtaining primary care via Atrium Health Wake Forest Baptist (AHWFB) will participate in a comprehensive sleep health assessment. This two-part, in-person visit will consist of validated sleep-health assessments, objective sleep-activity monitoring (via sleep watch (e.g., Fitbit) and daily diary), and a subset of physical performance measures. At the conclusion of the second visit, older adults will be asked to respond to a brief set of open-ended questions on treatment preferences. We plan to enroll up 40 older adults in this aim. Eligibility criteria is described below.

Part II, Aim 2. A one-arm, non-randomized pilot study will be conducted using a successive cohort design. Each cohort will include four to six participants. All participants will receive the intervention in a group setting. After each cohort, the study team will review intervention session notes and other study materials to determine whether what, if any, refinements should be made to the intervention content or study procedures. Participants will be older adults who are currently receiving primary care at AHWFB, meet criteria for poor sleep and low activity, and live within the greater Winston-Salem region. Specific inclusion and exclusion criteria are described below.

The intervention includes a four-session, in-person program delivered by a Master's-level provider. All participants will complete a sleep-health assessment before the intervention identical to Part I, Aim 1 (*NOTE: If a participant was enrolled and completed Aim1 assessments, only select assessments will be collected during the pre-intervention assessment, including the Insomnia Severity Index, sleep watch, and a sleep-activity diary. These materials may be sent to the participant via postal mail prior to session 1.)* Prior to enrollment, study staff will review each participant's sleep-health assessment, daily diary and actigraph (if applicable). This review will help to evaluate a participant's "fit" for the intervention (i.e., no unaddressed health concerns that may negatively limit participation in the group-based intervention).

Each session will be approximately 30-45 minutes in length, and include education and coaching on developing healthy nighttime sleep and daytime activity behaviors. Participants will complete daily sleep-activity diaries throughout the course of the intervention, and study staff will review these weekly with each participant either via phone call or in person within 24 hours of each following session. At the end of each session, the Interventionist will complete a detailed Session Note that will track material covered, personalized recommendations, and any questions asked. All participants will complete a sleep-health assessment after the intervention (including select assessments: SF-12, Geriatric Pain Measure, PHQ-9, Pittsburgh Sleep Quality Index, Insomnia Severity Index, Epworth Sleepiness Scale, Flinders Fatigue Scale). Participants will also be asked to provide feedback on their experience receiving SWELL.

Setting
Older adults utilizing outpatient primary care clinics belonging to AHWFB. All activities will take place within a clinical setting. Participants will be asked to monitor their sleep-activity behaviors while at home.

Subjects selection criteria
This study will focus on older adults with clinically significant insomnia disorder (per DSM-V and International Classification of Sleep Disorders [ICSD] Diagnostic Criteria), as identified by a patient-reported survey (described elsewhere). Additional eligibility criteria are described below.

Inclusion Criteria

Older adults
Older adults who return a completed survey, do not opt out of further contact, and who meet clinical diagnostic criteria for insomnia will be invited to participate in an in-person assessment. Eligibility criteria for all study phases will include the following:

1. Age 65 or over;
2. One or more outpatient primary care visits to Wake Forest Baptist Health in the prior 12 months;
3. Meets DSM-5 diagnostic criteria for Insomnia Disorder;
4. Less than 30 minutes of daily activity or less than 150 minutes total weekly activity for one month or longer, as reported on brief telephone screener;
5. Able to ambulate safely (with or without an assistive device);
6. Able to follow study directions;
7. Able to communicate and follow study instructions;
8. English speaking.

Exclusion Criteria
Exclusion criteria for patient participants include one or more of the following:

1. Untreated organic sleep disorder (e.g., central or obstructive sleep apnea, restless leg syndrome);
2. Serious or unstable medical or psychiatric condition that would prevent participation in a behavioral intervention (e.g., terminal illness, uncontrolled psychiatric disorder, substance abuse disorder);
3. Lack of decision-making capacity, as documented in medical record;
4. Referred to institutional care and/or currently residing in a nursing home or other residential facility.

Sample Size
Up to 40 older adults meeting DSM-V diagnostic criteria for insomnia will be invited to complete an in-person sleep health assessment (Aim 1).

Up to 12 older adults will be recruited to participate in the pilot trial (Aim 2).

Interventions and Interactions

This two-phased study consists of an observational aim (descriptive data collection only) (Part I) followed by an intervention-based aim (Part II). Interactions and interventions of the three study aims are described below. Note: prior to beginning Aim 1 or Aim 2, all patient participants will complete a telephone eligibility screener that will include brief questions on sleep and activity.

Observational Aims (Interaction Only):

Part I, Aim 1: (Sleep Health Assessment): Older survey respondents who meet clinical criteria for insomnia will be invited to participate in an two-part in-person sleep and health assessment. Data collection activities are described in the table below.

Overview of In-Person Sleep Health Assessment	
Visit 1: Health Assessment	**Visit 2: Sleep and Activity Assessment**
Health and demographic assessments Demographics questionnaire Health: SF-12[1], Charlson Comorbidity Index[2], Geriatric Pain Measure[4] , PHQ-9[5] Function: Self-reported measures: ADLs/IADLs[6]	*Sleep measures* Pittsburgh Sleep Quality Index,[38] Insomnia Severity Index,[39] STOP Questionnaire for Sleep Apnea,[40] Epworth Sleepiness Scale[41], Flinders Fatigue Scale[3]
Open-ended items • Definitions and perceptions of functional independence • How are nighttime sleep and daytime activity behaviors related? • How do sleep and activity behaviors impact overall function? • What other outcomes matter to you?	*Open-ended items* • Preferences for health promotion programs: mode of delivery, type of provider, dose, support between sessions • Social and physical environment (barriers and facilitators to daily movement and activity)
Sleep watch and daily diary Three to five days of continuous daytime and nighttime sleep watch monitoring[36] plus daily sleep-activity diary[37] (Wake-up prompts: sleep-wake schedule, nighttime awakenings, overall sleep quality. Morning, Midday, Afternoon/Evening, & Bedtime prompts: daytime activity, sedentary time, mood, pain, fatigue levels)	*Functional assessment* Functional performance tests: Short Performance Physical Battery (SPPB)[7]

Intervention Aim (Treatment):

Part II, Aim 2 (Sleep Health Education Program). A one-arm, non-randomized pilot study will be conducted using a successive cohort design. Each cohort will include four to six participants . Participants will be older adults who are currently receiving primary care at AHWFB, meet criteria for poor sleep and low activity, and live within the greater Winston-Salem region. Specific inclusion and exclusion criteria are described below. All participants will receive the intervention in a small-group setting. Group sessions will be conducted in-person or virtually. Participants will complete pre- and post-program assessments in addition to daily sleep-activity diaries throughout the course of the intervention. Note: all assessments will be identical to those used in Aim 1 – if a participant has completed Aim 1, an abbreviated assessment will be administered to include the Insomnia Severity Index and a daily sleep diary. The intervention includes a four-session program delivered by a Master's-level provider. Each session will be approximately 30-45 minutes in length. Each session will include education and coaching on developing healthy nighttime sleep and daytime activity behaviors. At the end of each session, the Interventionist will complete a detailed Session Note that will track material covered, personalized recommendations, and any questions asked. All participants will complete a post-intervention assessment (including select assessments: SF-12, Geriatric Pain Measure, PHQ-9, Pittsburgh Sleep Quality Index, Insomnia Severity Index, Epworth Sleepiness Scale, Flinders Fatigue Scale). Participants will also be asked to provide feedback on their experience receiving

SWELL. After each cohort, the study team will review intervention session notes and study assessments to determine whether what, if any, refinements should be made to the intervention content or study procedures.

The behavioral intervention is based on the Principal Investigator's prior work developing and testing an evidence-based behavioral sleep intervention for older adults.[8] In short, the prior intervention focused solely on improving nighttime sleep problems. An overview of the proposed content is provided below. Final content, including daytime activity components of the intervention, will be refined during the course of the study (based on Aims 1 and 2 findings and feedback). Sample content is included as an attachment to this application.

Visit	***Timing***	***Activities***	***Data Collection***	***Time Required***
Baseline	Week 0 (Visit 1) Week 1 (Visit 2)	Pre-Intervention Assessment	Quantitative assessments, sleep watch, and sleep-activity diary Note: Assessments identical to those described in Aim 1.* *If participant completed Aim 1, Visit 1 and 2 will be collapsed and only select questionnaires will be administered (see abbreviated pre-program assessment attached).	60 minutes
Session 1	Week 2	SWELL24 Session 1 Sleep and activity: Understanding a 24 hour cycle	Sleep-activity diary	30 minutes
Session 2	Week 3	SWELL24 Session 2 Following a regular sleep-wake schedule, including tips for daytime engagement	Sleep-activity diary	30 minutes
Session 3	Week 4	SWELL24 Session 3 Optimizing daytime routines and activities	Sleep-activity diary	30 minutes
Session 4	Week 5	SWELL24 Session 4 Relapse prevention and long-term strategies	Sleep-activity diary Give sleep watch and sleep diary to return at post-intervention assessment.	30 minutes
Post-Treatment	Week 6	Post-Intervention Assessment	Quantitative assessments, review sleep watch and sleep-activity diary. Note: Select assessments administered in Aim 2: SF-12, Geriatric Pain Measure, PHQ-9, Pittsburgh Sleep Quality Index, Insomnia Severity Index, Epworth Sleepiness Scale, Flinders Fatigue Scale. At the end of the visit, participants will also be asked to provide feedback on their experience receiving SWELL24.	60 minutes

Outcome Measure(s)

Primary outcome: sleep efficiency (per sleep watch)
Secondary outcome: total daytime activity (per sleep watch); insomnia severity (per self-reported Insomnia Severity Index); daytime consequences (per self-reported assessment, daily diary)

Analytical Plan

Aim 1: Sleep-Health Assessment

Descriptive statistics will be calculated for all validated assessments. Multivariate statistics will be used to identify predictors (i.e., clinical and demographic characteristics collected in quantitative assessments) of objective poor sleep and poor activity. To estimate the relationship between co-occurring poor sleep-activity behaviors and physical function, Pearson and Spearman correlations, along with their 95% confidence intervals, will be calculated for continuous measures of objective sleep and activity. To explore the relationship between poor sleep-wake behaviors on physical function, a series of regression models will be run to observe: (a) the relationship of poor objective sleep on physical function, (b) the relationship of poor objective activity on physical function, (c) the relationship of co-occurring poor sleep-poor activity on physical function, and whether in combination, the two behaviors predict physical function better than either one individually. We aim to enroll up to 40 older adults in this aim.

Aim 2: Pilot Feasibility Trial

The objective of the pilot feasibility trial is to gather preliminary information to inform a fully-powered randomized trial. To this end, the pilot trial is not powered to detect a statistically significant difference in treatment outcomes rather we are interested in detecting any signal indicating a treatment effect. In preparation for a larger trial, we will collect the following: *Retention rate*. This will be defined as the number of participants who completed all intervention sessions out of the total number enrolled. *Adherence to personalized recommendations*. Adherence to personalized behavioral recommendations is a key measure of acceptability. This information will be gathered through process notes recorded after each intervention session and in sleep and activity diaries completed on a daily basis. *Response to intervention:* In order to determine dose, sequencing and timing of intervention components to be used in a larger trial, participants will report daily sleep-wake behaviors using daily diary. In preparation for a full trial, we will evaluate whether selected functional measures are sensitive to change over the study period. Primary outcomes will include objective daytime activity and nighttime sleep efficiency, both will be obtained from the sleep watch. *Intervention acceptability.* Following the completion of the intervention, and at the end of the post-intervention assessment, semi-structured interview questions will be used to assess acceptability of the intervention and assessment visits.

Human Subjects Protection

Subject Recruitment Methods

Subjects will primarily be recruited via a patient-facing postal survey, *How Are You Sleeping*? Details of this survey are described in the following protocol: IRB00090479.

In brief, completed surveys in which subjects have not opted out of further contact will be eligible for recruitment into subsequent study aims. In order to ensure equal access to participation among all subject groups, our team will utilize a block approach to recruitment. In short, we will review 25 completed surveys at a time. Within each block, we will review

demographic characteristics to ensure women and minority participants are represented. We will oversample these groups, as needed.

All study recruitment will take place via personal telephone calls to research subjects. In each phase of the study, research staff will call eligible subjects, describe the purpose of the study and its goal, review expectations for participation, and answer any questions the subject might have. Each patient recruitment call will begin with a brief telephone screener to collect more detailed information on the patient's sleep and activity behaviors.

Note: Any participants who have completed Aim 1 sleep health assessments may be eligible for enrollment in the pilot trial (Aim 2). If a subject who has completed Aim 1 indicates interest in participating in the pilot trial, their assessment data will be reviewed prior to recruitment and enrollment into the pilot trial.

All protected health information used for recruitment purposes (e.g., name, gender, age, address, telephone number) will be stored in password-protected folders on designated server space. Study staff will indicate participants who do not agree to participate. All information will remain on file for the course of the study. Any information for individuals who did not agree to participate will be destroyed at the time of study completion.

Informed Consent

As described throughout this protocol, participants will be recruited from the Principal Investigator's ongoing work distributing a patient-facing survey, *How Are You Sleeping?* (IRB00090479).

All study activities for the proposed work, including in-person assessments (Aim 1) and pilot trial participation (Aim 2), will follow a series of progressive steps to obtain signed informed consent.

- *Step 1 – Telephone Screener:* Research staff will call eligible participants (defined as older adults who respond to How Are You Sleeping? survey, meet diagnostic criteria for insomnia, and do not opt out of future contact) to present the study, including its purpose and requirements for participation. If a subject indicates interest in participating, verbal consent will be obtained to proceed with a brief telephone screener. In short, this telephone screener will assess the following: age, type and location of residence, functional independence, no unaddressed medical concerns and/or upcoming treatments that would interfere with participation.
- *Step 2* – Scheduling an In-Person Study Visit:* For participants who are deemed eligible per the brief telephone screener, research staff will schedule an in-person visit, and explain the expectations of the visit, including the process of obtaining written informed consent. We will offer to mail a blank copy of the consent document if the subject wishes to review prior to the visit.
- *Step 3* – Consent Presentation and Signature:* At the start of the visit, research staff will use a brief slideshow to review all elements of the consent document. The research staff will then provide time for the subject to ask any questions about the study, its expectations, or elements of the consent document. To demonstrate understanding of the study and consent document, the research staff will ask the subject to respond to four brief questions (purpose of study, required activities, anticipated risks, and how to stop participation). Participants must provide a correct response to all questions to

proceed. Once the participant has correctly responded to all items on the consent capacity screener, they will be asked to sign the consent document.

**For participants enrolling in the pilot trial (Aim 2) who have also completed Aim 1:*

- The consent visit for Aim 2 *may* be completed virtually via REDCap through an online survey platform which can be accessed on a computer, mobile phone, or tablet. A virtual visit will be scheduled with a research staff member using a secure platform (e.g., Webex). The participant will be able to open the survey link during the visit, read and review the document with the research staff. When they get to the bottom of the document, they will be able to sign their name if they agree to participate. The REDCap eConsent Framework adds an extra certification page to the end of the survey with a read-only PDF copy of the informed consent document; they will be asked to confirm that all of the information in the document is correct and that by signing the form electronically, it is the equivalent of signing a physical document. The participant will receive a PDF copy of the signed informed consent. The survey responses will be stored in a REDCap project that is separate from any de-identified participant data. If the consent visit is completed virtually, then the pre-program assessment (Insomnia Severity Index) may be shared with the participant via an electronic REDCap survey during after consent has been obtained.

Confidentiality and Privacy

Confidentiality will be protected by collecting only information needed to assess study outcomes, minimizing to the fullest extent possible the collection of any information that could directly identify subjects, and maintaining all study information in a secure manner. To help ensure subject privacy and confidentiality, only a unique study identifier will appear on the data collection form. Any collected patient identifying information corresponding to the unique study identifier will be maintained on a linkage file, store separately from the data. The linkage file will be kept secure, with access limited to designated study personnel. Following data collection subject identifying information will be destroyed six years after the closure of the study. All identifying information will be physically destroyed. All remaining research records will be de-identified, consistent with data validation and study design, producing an anonymous analytical data set. Data access will be limited to study staff. Data and records will be kept locked and secured, with any electronic data password protected. No reference to any individual participant will appear in reports, presentations, or publications that may arise from the study.

Data and Safety Monitoring

The principal investigator will be responsible for the overall monitoring of the data and safety of study participants. The principal investigator will be assisted by other members of the study staff.

Reporting of Unanticipated Problems, Adverse Events or Deviations

Any unanticipated problems, serious and unexpected adverse events, deviations or protocol changes will be promptly reported by the principal investigator or designated member of the research team to the IRB and sponsor or appropriate government agency if appropriate.

Appendix

1. Telephone recruitment script
2. Informed consent document (older adults)
3. Sleep-health assessments (patient) [Aim 1, Aim 2]
4. Sleep-activity diary
5. Sample intervention materials

1. Ware JE, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: Construction of Scales and Preliminary Tests of Reliability and Validity. *Medical Care.* 1996;34(3):220-233.
2. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. *Journal of Chronic Disease.* 1987;40(5):373-383.
3. Gradisar M, Lack L, Richards H, et al. The Flinders Fatigue Scale: Preliminary Psychometric Properties and Clinical Sensitivity of a New Scale for Measuring Daytime Fatigue associated with Insomnia. *Journal of Clinical Sleep medicine.* 2007;3(7):722-728.
4. Ferrell BA, Stein WM, Beck JC. The Geriatric Pain Measure: Validity, Reliability, and Factor Analysis. *Journal of the American Geriatrics Society.* 2000;48:1669-1673.
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6. Duke University Center for the Study of Aging and Human Development. Duke Older Americans Resources and Services Program: An Information System for Functional Assessment. *Center Reports on Advances in Research.* 1985;9.
7. Guralnik JM, Simonsick EM, Ferrucci L, et al. A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. *Journal of Gerontology: Medical Sciences.* 1994;49(2):M85-M94.
8. Martin JL, Song Y, Hughes JM, et al. A four-session sleep intervention program improves sleep for older adult day health care participants: Results of a randomized controlled trial. *Sleep.* 2017;40(8):097.