DOCUMENTATION

for

SLEEP DATA

in

MIDUS REFRESHER BIOMARKER PROJECT (P4)

University of Wisconsin ♦ Institute on Aging
September 2017

INTRODUCTION

This document provides an overview of sleep quality data collected in the MIDUS-Refresher (MR) Biomarker Project (P4). It provides comprehensive information regarding methods used to collect sleep data as well as additional information regarding administrative, constructed scales, and computed variables that are available. Information about the construction and usage of these variables is also provided.

Data users are also encouraged to review the Refresher Biomarker (P4) Readme Data File Notes. This document provides information about naming conventions, as well as administrative and filter variables included in the data file. It also includes information about how we handled missing values and other issues that arose over the course of the study. For example, there are instances when variables were added or sections of an instrument were expanded for data entry purposes to accommodate additional information provided by the respondent.

This document will be periodically revised and updated as more information is gathered, and researchers continue to work with the MIDUS-Refresher Biomarker data. If there are suggestions or comments, please contact midus_help@aging.wisc.edu.

TABLE OF CONTENTS

SECTION A

OVERVIEW OF DATA FILE AND COLLECTION PROTOCOLS

OVERVIEW OF DATA FILE AND COLLECTION PROTOCOLS

The Biomarker Project (P4) includes multiple types of sleep data from the following sources:
- Pittsburgh Sleep Quality Inventory (PSQ)
- Daily Sleep Diary
- Actiwatch® Activity Monitor

As described in the "MR Biomarker Project (P4) Readme Data File Notes", the variable naming convention organizes variables according to the method used for data collection. We have followed this convention with respect to the sleep data, thus analysts using PSQ, Actiwatch®, and Daily Sleep Diary data will need to pull variables from different sections of the data file as indicated below.

The PSQ is implemented at all 3 Biomarker sites. The Actiwatch® and Daily Sleep Diary are administered only at the UW-Madison (Site 2) location to facilitate linkages with Neuroscience (Project 5) data that are also collected at the same location. The following provides general information and also indicates where additional details can be found.

New at Refresher: All three data sources include time variables which are converted to a 24 hour clock with a restricted numeric format that allows leading zeros to be displayed. See 'the Refresher Biomarker (P4) Readme Data File Notes' for details about how time variables are handled in the date set.

Pittsburgh Sleep Quality Inventory (PSQ):
A copy of the PSQ appears in Section B (below). Variable names have been added to the instrument just below the question number or to the right of a "____" provided for participants to record responses. It is a self-administered questionnaire completed during the clinic visit, or just prior to the visit while the participant was still at home. It is also a standalone instrument thus the variable names begin with their own unique 4 character set "RA4S".

This set of variables appears in the data file immediately after the items from the Self-Administered Questionnaire Booklet. Scale construction information appears in the "Documentation of Psychosocial Constructs & Composite Variables".

Daily Sleep Diary:
A copy of the Daily Sleep Diary follows the PSQ in Section B (below). Variable names are inserted just below the question number or to the right of an item. Participants completed the diary at home during the Actiwatch® data collection period (see Section C for more information). The Diary is a standalone instrument, thus, the variable names begin with their own unique 4 character set "RA4A".

Note: At MIDUS 2 the time variables are on a 12 hour clock. In the Refresher they are reported using a 24 hour clock. Thus, 11:00 p.m. is reported at 23:00.

This set of variables appears in the data file immediately after the biomarker assay data from the blood, urine and saliva samples.

Actiwatch® Activity Monitor:
Details of the Actiwatch® data collection and processing protocol appear in Section C. Actiwatch® data are collected for 7 consecutive days beginning in the morning on the Tuesday

after the day the respondent returns home following the CRU visit. The data collection period ends at the time the respondent wakes up on the following Tuesday. For each respondent, we report data for 7 rest periods, which include 7 sleep periods, and 6 activity periods occurring between the first and last rest/sleep periods. The Actiwatch® variable names begin with "RA4W" and include the following measures:

- Data collection period start and end date
- For each Rest, Sleep and Active period:
    - Start Date, Day, and Time
    - End Date, Day and Time
    - Total activity counts
    - Average Activity Counts/Minute
    - Maximum Activity Counts
    - % Invalid Activity Counts
    - % Invalid Sleep/Wake Time
    - Wake Time
    - % Wake Time
    - # Wake Bouts
    - Average Wake Bouts
    - Sleep Time
    - % Sleep Time
    - # Sleep Bouts
    - Average Sleep Bouts

- The above information is used to compute the following summary statistics (see Actiwatch® protocol for computation details) for each Sleep period:
    - Sleep Onset Latency (in minutes)
    - Time Dozing Before Rising (Snooze Time, in minutes)
    - Sleep Efficiency (%)
    - Wake after Sleep Onset (WSO, in minutes)

The data set also includes the administrative variables that can be used to identify cases with missing or imputed data. These variables are described in Section C below.

Additional information about Filter variables may be found in the "MR Biomarker Project (P4) Readme Data File Notes".

SECTION B

SURVEY INSTRUMENTS

Pittsburgh Sleep Quality Inventory (PSQ)

Daily Sleep Diary

SECTION C

<u>ACTIWATCH® DATA COLLECTION AND PROCESSING</u>

ACTIWATCH® DATA COLLECTION AND PROCESSING

This section describes the protocol for collecting and processing activity data collected via the Actiwatch® system. These data were only collected from individuals who participated in the Refresher Biomarker (P4) project at the University of Wisconsin-Madison (Site2).

Overview
Biomarker subjects who completed a visit to the Clinical Research Unit (CRU) at site 2 (UW) were invited to participate in a 7 day sleep study. The protocol required that participants wear the Mini Mitter Actiwatch®-64 or the Actiwatch®-2 activity monitor, continuously, for 7 consecutive days and also complete a paper and pencil Daily Sleep Diary over the same time period.

At the end of the CRU visit, the participant received a postage paid envelope containing the daily sleep diary, a pre-programmed Actiwatch®, along with a cover letter and instructions for wearing the watch, completing the daily diary, and then returning the materials at the end of the collection period. Participants also received a reminder call the day before the sleep data collection period began. Details about collecting and processing the diary and watch data are provided separately below.

Daily Sleep Diary (self-report)
A. Data Collection: The Daily Sleep Diary is a 7 page self-administered questionnaire (see Section B above) that includes two sets of questions:
- a. Before Bed – the participant was asked to complete this section before going to sleep. The items assess:
  - Alertness through the day
  - Exercise
  - Napping
  - Consumption of caffeinated and alcoholic beverages
  - Use of medications that are not regularly taken every day.
- b. Upon Awakening – the participant was asked to complete this section soon after waking up, waiting no more than 10 minutes. The items assess:
  - Use of medications or supplements to help sleep
  - Time to bed
  - Time to fall asleep
  - Difficulty falling asleep
  - Wakefulness during the night (4 items)
  - Time awoke for the day and did not return to sleep
  - Time out of bed for the day
  - Overall quality of sleep (4 items)

The date for each day of data collection was written on the form before it was given to the participant.

B. Data Processing:
- a. As a standalone instrument, the Daily Sleep Diary was reviewed by designated staff prior and then data entered using the SPSS Data Entry double entry blind verification system.

b. Data were then cleaned (i.e. checked for inconsistencies or other errors and corrected as needed) according to standardized procedures.
c. The times recorded at Questions 8 (What time did you go to bed and begin trying to go to sleep?) and 15 (What time did you wake up for the day and not return to sleep?) were extracted from the cleaned data file and used to mark Rest and Exclusion intervals in the Actiwatch® (see below).

Actiwatch®-64/ Actiwatch®-2

A. Data Collection: The Actiwatch® monitor (regardless of version) collects data via a built-in motion sensor that can be programmed to detect the number of movements in a specified time interval beginning at a specified date and time. Data collection proceeds as follows:
a. Staff programmed each watch to:
   * Begin collecting data at 7:00 a.m. on the Tuesday after the day the respondent returns home following their CRU visit.
   * Detect the number of movements per epoch (30 second intervals).

See Appendix A & B (Section D) for more information about how sleep statistics were computed using activity counts per epoch as well as definitions of key terms.

b. Participants were instructed to:
   * Put the Actiwatch® on when they wake up on the designated day
   * Begin completing the Daily Sleep Diary before going to bed on that day. They also received a reminder phone call the day before the data collection period began.
c. The data collection period ended at the time the respondent woke up on the following Tuesday, one week later.

Data was downloaded from the Actiwatch® and stored in the Actiwatch® database for processing upon receipt in the project office.

Note: The Actiwatch® has an event marker button on the side that users can push to indicate when they go to bed and when they wake up for the day. Participants were instructed to push the event marker button right before going to sleep and at rising. Compliance with this instruction varies quite a bit from participant to participant.

B. Data Processing: In Actiware Software
The Actiware 6 software is used to generate summary statistics about a respondent's sleep. To compute these statistics, the program requires that intervals demarking rest and exclusion periods be specified for each day in the study period.
a. Marking Intervals: We defined these intervals using information from the Daily Sleep Diary as follows:
   * Rest Interval: Time spent in bed on a given day as reported by the respondent:
     o Start date & time – The date recorded at the top of the page for a given day in the collection period and the response to Question 8 for that day. (What time did you go to bed and begin trying to go to sleep?)

- o End date & time – The date recorded at the top of the page for the next day along with Question 15 for the current day. (What time did you wake up for the day and not return to sleep?)

- Exclusion Periods: These are activity periods the program should exclude when generating summary statistics.
  - o Front End Exclusion period - extends from the programmed start time (7:00 a.m. on the first day of the collection period) to beginning of the first rest period (Time to bed - Day 1, Q8).
  - o Back End Exclusion period – extends from the end of the last rest period (Awake Time – Day 7 Q15) to the time that staff end the data collection period by transferring data to the Actiwatch® database. This period may be several days in length.

b. Data Cleaning: Sometimes respondents provided incomplete information (forgot to put the watch on, took it off too early etc), or had experiences during the data collection period (e.g. travel to a different time zone, worked an extra shift, etc.) which made it difficult to mark Rest and Exclusion periods. Problematic cases were flagged for review and intervals were marked, or deleted, as appropriate according to the following guidelines. These guidelines were also used to create administrative filter variables (see below) that allow users to identify cases with missing or imputed data:

Note: Across the following:
   "time" = the time specified at Q8 and/or Q15 on a given day in the Daily Sleep Diary.
   "event marker time" = the time flagged when the participant pushed the event marker button.

- If the responses to Q8 and/or Q15 are 'missing' for a given day:
  - o Use the event marker times if they are available and appear to be reliable.
  - o Impute the appropriate mean times as follows:
    - i. If data is missing for a weekday, impute the mean using the other weekday values if valid data is available for at least 3 weekdays.
    - ii. If data is missing for a weekend impute the mean using the other day of the weekend.
  - o If event marker times aren't apparent and means cannot be calculated, consult question #2 in the Pittsburgh Sleep Questionnaire (PSQ) and insert the beginning of a missing rest period 'x' numbers of minutes (per PSQ Q2) before the last activity count preceding the sleep period. If the end of the rest period cannot be calculated, we designate the first epoch that has activity as the end of the rest period.

- If the time listed is reported as a range, use the midpoint of the range or the event marker time whichever is more accurate.

- If the time listed differs quite a bit from the watch data, do not adjust.

- Time zone and Daylight Savings Time adjustments:
  - The time zone specified should always be the time zone of residence (e.g. the time zone the respondent lives in). If the respondent travels out of this time zone during the watch period then:
    i. Times in the diary should correspond to the time zone of residence.
    ii. Rest intervals in the Actiwatch® file should be marked to correspond to the time zone of residence.
  - If the data collection period includes the Daylight Savings Time transition date, adjust the times as appropriate to match the approximate sleep period.

- If data collection doesn't start on a Tuesday,
  - The Daily Sleep Diary data will be adjusted so that order of the days is consistent with the rest of the data.

c. The above criteria were subsequently used to create the following filter variables which identify cases with missing or imputed values, as well as those affected by issues such as Time Zone changes or Daylight Savings Time adjustments.

- RA4AWAVL – categorical variable indicating whether daily sleep diary and/or Actiwatch® data are available for a given case.
- RA4AWIMPU – dichotomous Yes/No variable indicating whether there is missing data in the Daily Sleep Diary which required that rest intervals be marked by using imputed values.
- RA4AWMARK – dichotomous Yes/No variable indicating whether there is a discrepancy between the daily sleep diary (self-reported) and Actiwatch® data that required rest intervals be marked by using imputed values.
- RA4AWDAYS – indicates the number of days of sleep data available for a given respondent. All participants are expected to have 7 days of sleep data.
- RA4AWPART – dichotomous Yes/No variable indicating whether there is there is partial watch data. A case is flagged as having partial data if the respondent did not wear the watch for the full 7 days of the collection period because they: 1) took it off for a few hours, 2) forgot to put it on until a day or two into the collection period, 3) or took it off a day or two early.
- RA4AWIDIO – dichotomous Yes/No variable indicating whether or not the respondent had an idiosyncratic sleep pattern. Sometimes this is due to the respondents work schedule, but may be due to an illness (self or family member), or traveling.
- RA4AWTMZN –dichotomous Yes/No variable indicating whether or not the respondent traveled and slept outside their usual time zone during the data collection period or if the watch data collection period include a Daylight Savings Time change.
- RA4AWLAG – indicates the number of days between the date the CRU visit was completed and the date the watch data collection began.

d. <u>Generating Summary Statistics:</u> The Actiware 6 software has the capacity to generate a variety of statistics about sleep and activity. Currently we generate the following:
  - Sleep Onset Latency (in minutes)

- Time Dozing Before Rising (Snooze Time, in minutes)
- Sleep Efficiency (%)
- Wake after Sleep Onset (WSO, in minutes)

Definitions of these terms and details about computation can be found in the Section D (Appendices) at the end of this document.

SECTION D

APPENDIX A: ACTIWATCH® COMPUTATIONS

The following information is taken from the Actiware® Software Version 6.0

Sleep/Wake Analysis:

Actiware scores all epochs as either sleep or wake. Whether a particular epoch is scored as wake or sleep is determined by comparing activity counts for the epoch in question and those immediately surrounding it to a threshold value (Wake Threshold Value) set by the researcher. If the number of counts exceeds that threshold, the epoch is scored as wake. If it falls below, or is equal to, the threshold, the epoch is scored as sleep.

        Sleep = Total Activity Counts <= Wake Threshold Value

        Wake = Total Activity Counts > Wake Threshold Value

MIDUS uses a 30 second sampling epoch.

Calculating Total Activity Counts:

Actiware calculates total activity counts based on the sampling epoch. For instance, assume a 1-minute sampling epoch and the following activity values on and surrounding the time 12:00.

Time	Corresponding Activity Data
11:58	100
11:59	42
12:00	20
12:01	13
12:02	67

The total activity value for the 12:00 epoch would be: $100 * (1/25) + 42 * (1/5) + 20 + 13 * (1/5) + 67 * (1/25) = 37.68$.

If this value is less than or equal to the wake threshold value (next paragraph), then the epoch would be scored as sleep.

The total number of activity counts calculated above is compared to the wake threshold value selected by the researcher. These thresholds are listed in the table below.

Wake Threshold Values

Wake Threshold Selection	Wake Threshold Value
Low	20
Medium*	40
High	80
Automatic	Computed automatically based on activity data
Custom	User-selectable value

*MIDUS Wake Threshold value used for all cases.

APPENDIX B: ACTIWATCH® DEFINITIONS

The following information is taken from the Actiware® Software Version 6.

Start Time
The time at the start of the given Rest, Active, Sleep, Custom, or Daily Interval (the start of the first epoch in the given interval).

End Time
The time at the end of the given Rest, Active, Sleep, Custom, or Daily Interval (the end of the last epoch in the given interval).

Interval Duration
The time elapsed between the Start Time and the End Time of the given interval, in minutes.

Total Activity
The sum of all valid physical activity counts [see Total Invalid Time, below] for all epochs from the Start Time to the End Time of the given interval.

Average Activity Per Minute
The average of all valid physical activity counts for all epochs from the Start Time to the End Time of the given interval divided by the Epoch Length in minutes.

Average Activity Per Epoch
The average of all valid physical activity counts for all epochs from the Start Time to the End Time of the given interval.

Standard Deviation of Activity
The standard deviation of all valid physical activity counts for all epochs from the Start Time to the End Time of the given interval. (The standard deviation is computed with (n – 1) rather than (n) in the denominator of the variance.)

Maximum Activity
The largest valid physical activity count for all epochs from the Start Time to the End Time of the given interval.

Total Invalid Time (Activity)
The epoch length in minutes multiplied by the total number of epochs for a given interval for which the physical activity count value is invalid. This may occur under multiple circumstances including excluded intervals, device error, communication error, data corruption, time the logger is in the docking station or time between data collection sessions.

Percent Invalid (Activity)
The total invalid time (activity) divided by interval duration multiplied by 100.

Total Invalid Time (Sleep/Wake)
The total number of epochs for a given interval for which the sleep/wake scoring algorithm did not have enough data to determine a sleep or wake score multiplied by the epoch length in minutes.

Percent Invalid (Sleep/Wake)
The percentage of epochs for a given interval for which the sleep/wake scores are invalid. Total invalid time (sleep/wake) divided by interval duration multiplied by 100.

Sleep Onset Latency
The time required for sleep to start after initiating the intent to sleep. The time between the start of a given rest interval and the sleep interval start time, in minutes, and is controlled by the sleep interval detection algorithm.

Snooze Time
The time required to become active after sleep end. The time between the end of a given sleep interval and the end of the rest interval and is controlled by the sleep interval detection algorithm.

Sleep Efficiency
The percentage of time spent in bed sleeping. Scored total sleep time divided by (interval duration minus total invalid time (sleep/wake)) of the given rest interval multiplied by 100.

Wake after Sleep Onset (WASO)
This is the total number of epochs between the Start Time and the End Time of the given Sleep interval scored as Wake by Actiware software multiplied by the epoch length in minutes.

Scored Total Wake Time
The total number of epochs between the Start Time and the End Time of the given interval scored as WAKE by Actiware software multiplied by the epoch length in minutes.

Percent Wake
The percentage of epochs in an interval that are scored as Wake. Scored total wake time divided by (interval duration minus total invalid time (sleep/wake)) multiplied by 100.

Number of Wake Bouts
The total number of continuous blocks of epochs where each epoch is scored as Wake for the given interval.

Average Wake Bout
The scored total Wake Time [see above] divided by the Number of Wake Bouts [see above], for the given interval.

Scored Total Sleep Time
The total number of epoch for the given interval scored as sleep by Actiware multiplied by the epoch length in minutes.

Percent Sleep
The percentage of epochs in an interval that are scored as sleep. Scored total sleep time divided by (interval duration minus total invalid time (sleep/wake)) multiplied by 100.

Number of Sleep Bouts
The total number of continuous blocks of epochs where each epoch is scored as SLEEP for the given interval.

Average of Sleep Bout
The scored total Sleep time [see above] divided by the number of Sleep Bouts [see above], for the given interval.