Utilizing Actigraphy Data and Multi-Dimensional Sleep Domains

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For:

WHI Investigator Meeting

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Objectives

- Brief overview of sleep actigraphy data collection in WHISPER
- Discuss how objective (actigraphic) sleep and circadian measures compliment subjective measures of sleep
- Sleep as a multi-dimensional exposure and approaches to analysis
- Opportunities

Actigraphy in WHISPER

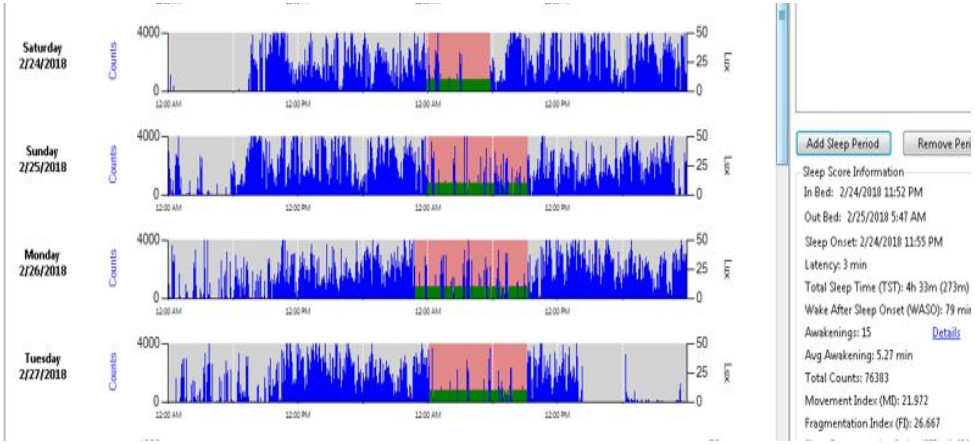
- Gt9X Link Device
- 3 axis accelerometer
- Worn on non-dominant wrist for 4 days and 4 nights
- Participants keep a diary of sleep times, and watch removals

Key Sleep and Circadian Exposures from Actigraphy

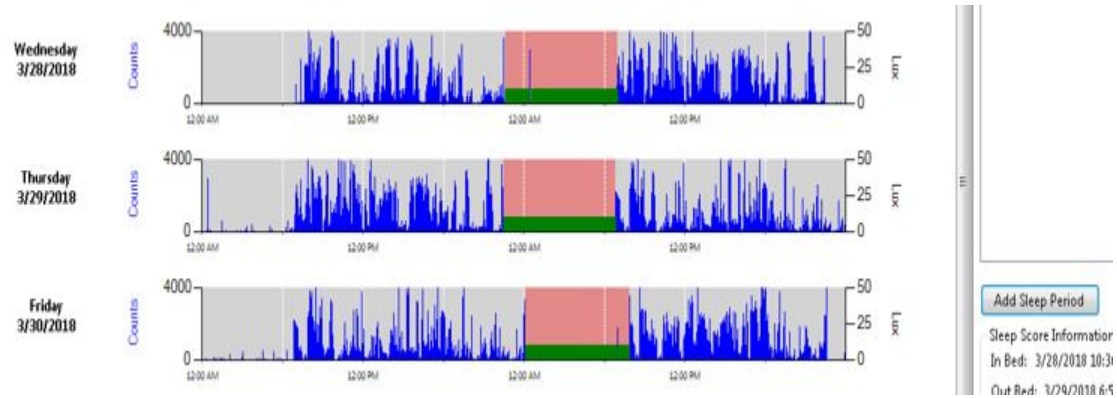
- 'Traditional' night-time sleep-wake variables (averaged over all nights of recording):
  - Total sleep time (min)
  - Wake after sleep onset (min)
  - Sleep efficiency (%)
  - Sleep latency (min)
- Daytime Napping behavior
- Rest-activity rhythms (24 hour patterns):
  - Extended cosine model
  - Non-parametric methods

Poor Sleep Efficiency vs High Sleep Efficiency

Efficiency of 66.5%



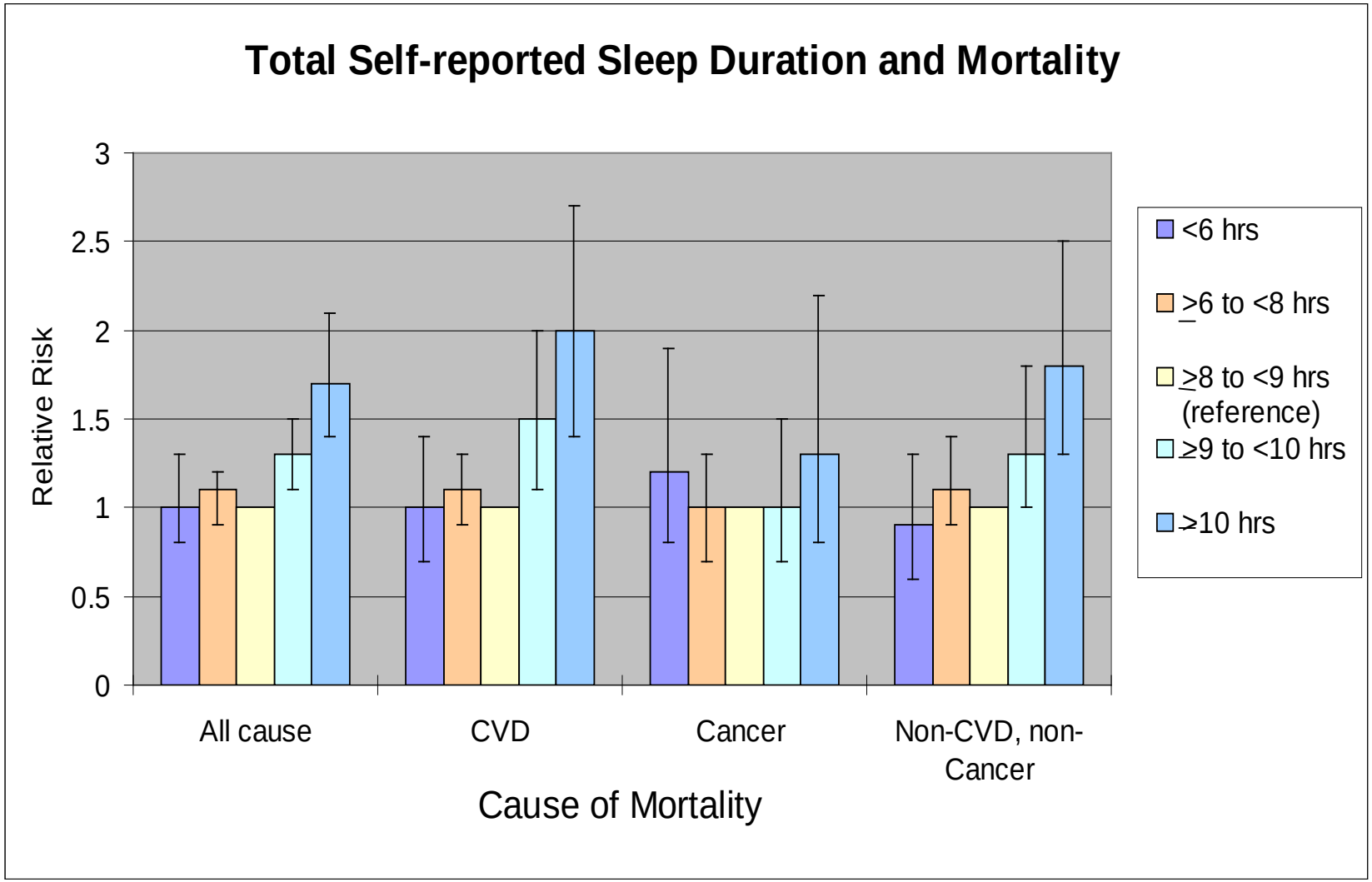
Efficiency of 98.1%



Objective vs Subjective Sleep

- Poorly correlated, particularly in older adults
  - Correlation ~ 0.2 for night-time sleep duration based on data from the Study of Osteoporotic Fractures
- Associations with outcomes may differ
  - Subjective sleep tends to associate more strongly with depression and anxiety
  - Objective sleep more strongly related to some physical health outcomes
- Subjective and objective sleep may capture different information about health and well-being

Self-Reported 24-hour Sleep Duration and Risk of Mortality in Older Women



Stone et al. J Am Geriatr Soc, 2009

Actigraphic Sleep Duration and Risk of Mortality in Older Women

	All-Cause	Cardiovascular
SOF women		
Number of deaths	997	343
Actigraphy TST		
<=5 hrs	1.80 (1.45, 2.23)	2.30 (1.61, 3.28)
>5 to <=7 hrs	1.02 (0.88, 1.19)	1.20 (0.92, 1.57)
>7 to <= 8 hrs	1.00 (referent)	1.00 (referent)
>8 hrs	1.33 (1.10, 1.6)	1.43 (1.02, 2)

Actigraphic Correlates of Self-Reported Long Sleep in Older Men (MrOS Sleep Study)

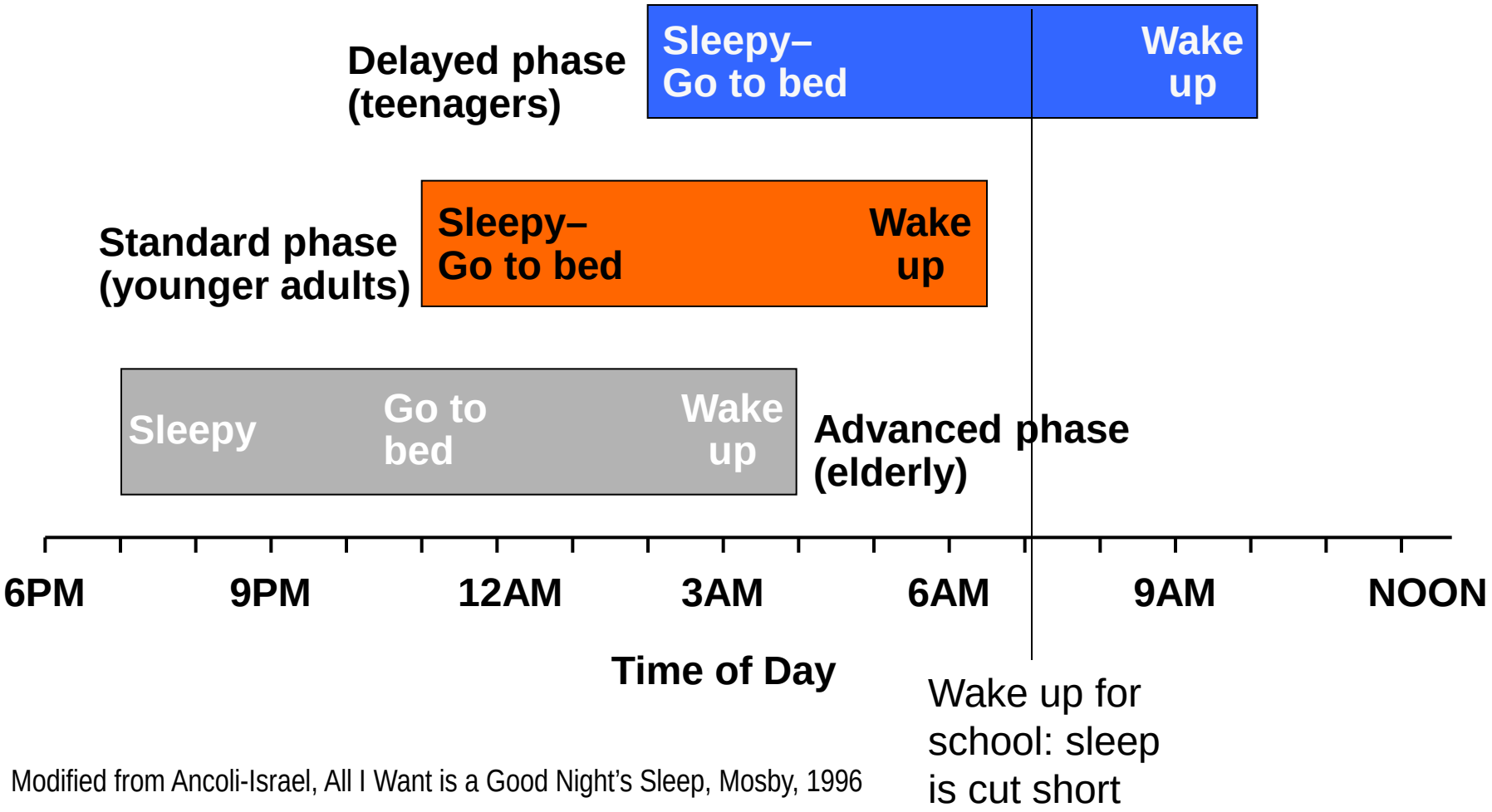
- Actigraphic total sleep time (TST) and time-in-bed (TIB) predict long sleep duration (9 or more hours per night)
- In multivariate models including both TST and TIB:
  - TIB (per 30 min): OR=1.71 (95% CI 1.53-1.91)
  - TST (per 30 min): OR=1.03 (95% CI 0.94 – 1.11)

Patel et al. 2012; SLEEP 35(5)

Actigraphy for Studying Disruption of Circadian Rhythms in Aging

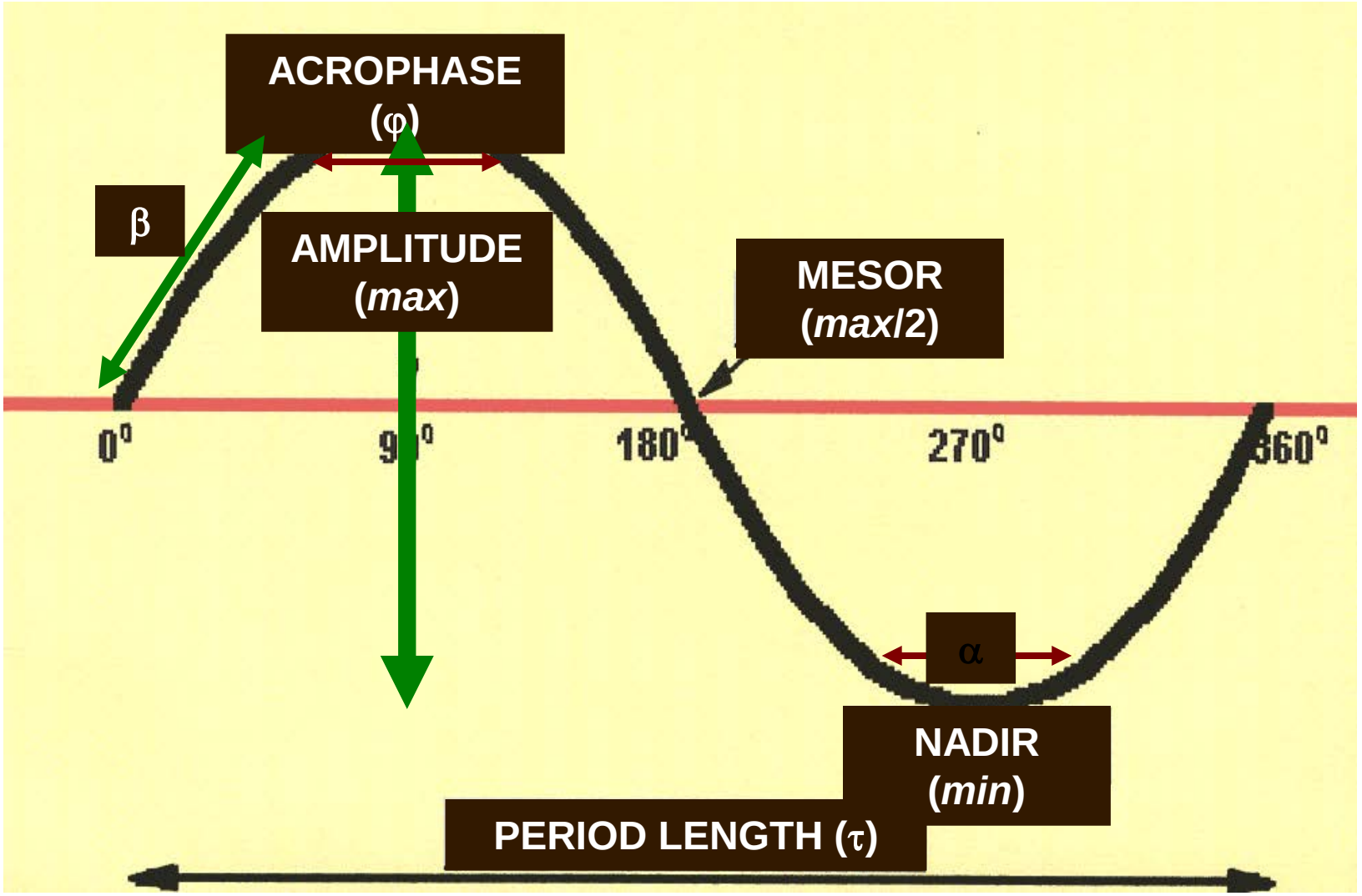
- Many biological processes follow ~24 hour pattern, including sleep-wake cycles
- Disrupted rhythms contribute to age-related outcomes including dementia, cardiovascular disease and mortality
  - Overall strengh, timing, and regularity of rhythms are disrupted with aging
- Actigraphy is a convenient method to assess 24-hour patterns of activity

Changes in Sleep Timing in Different Age Groups

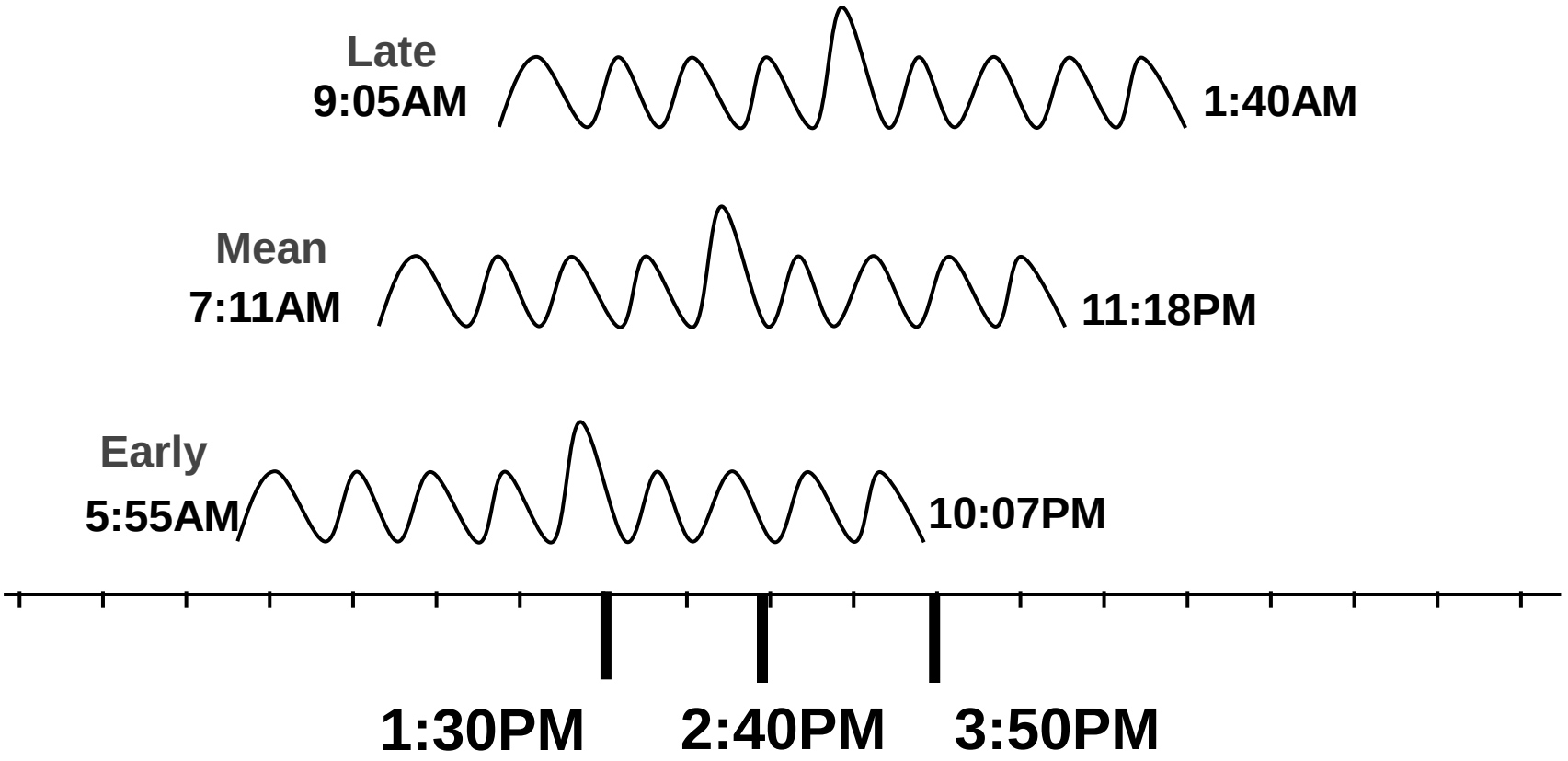


Modified from Ancoli-Israel, All I Want is a Good Night's Sleep, Mosby, 1996

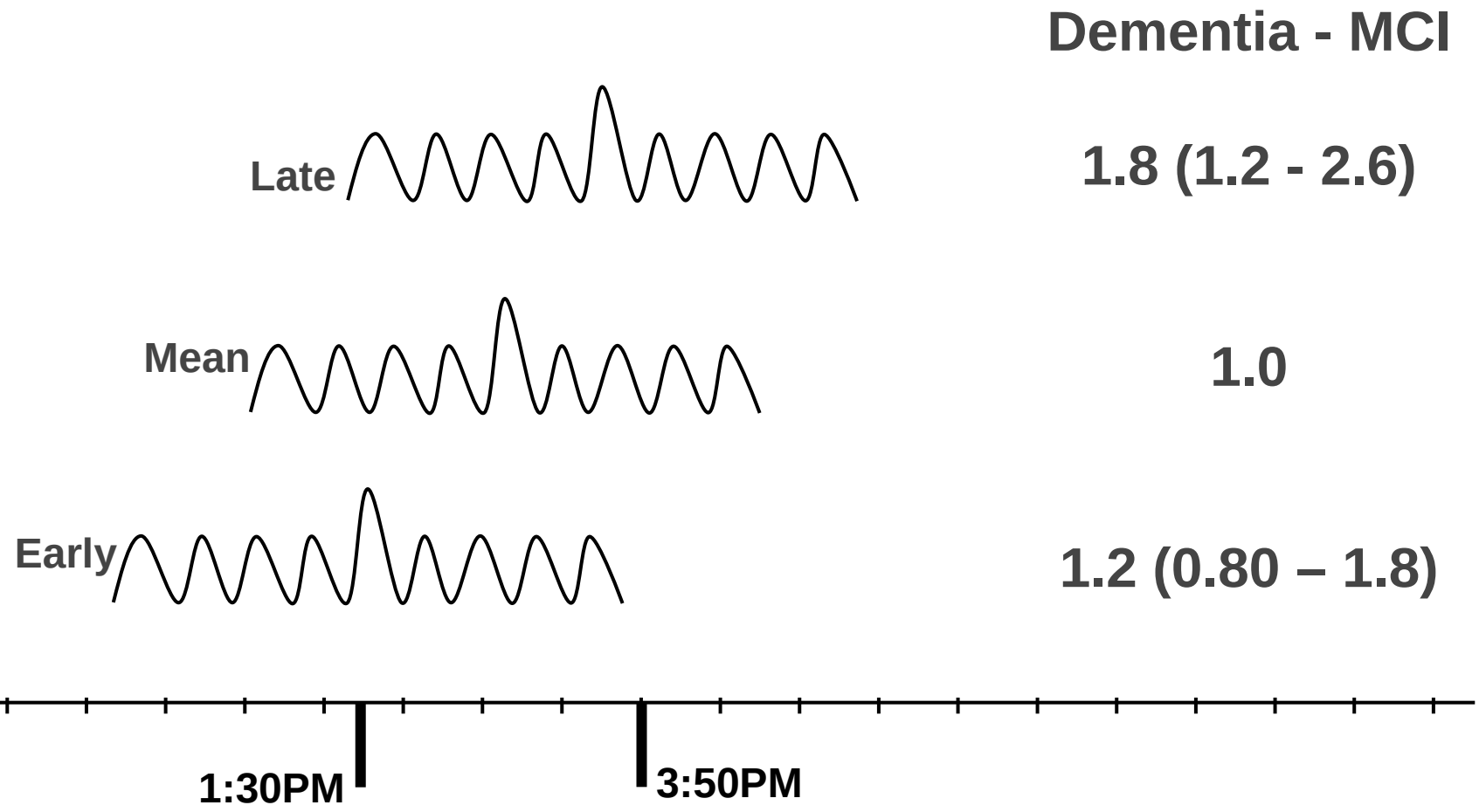
5-Parameter Extension of the Cosinor Model



Shifted rhythms

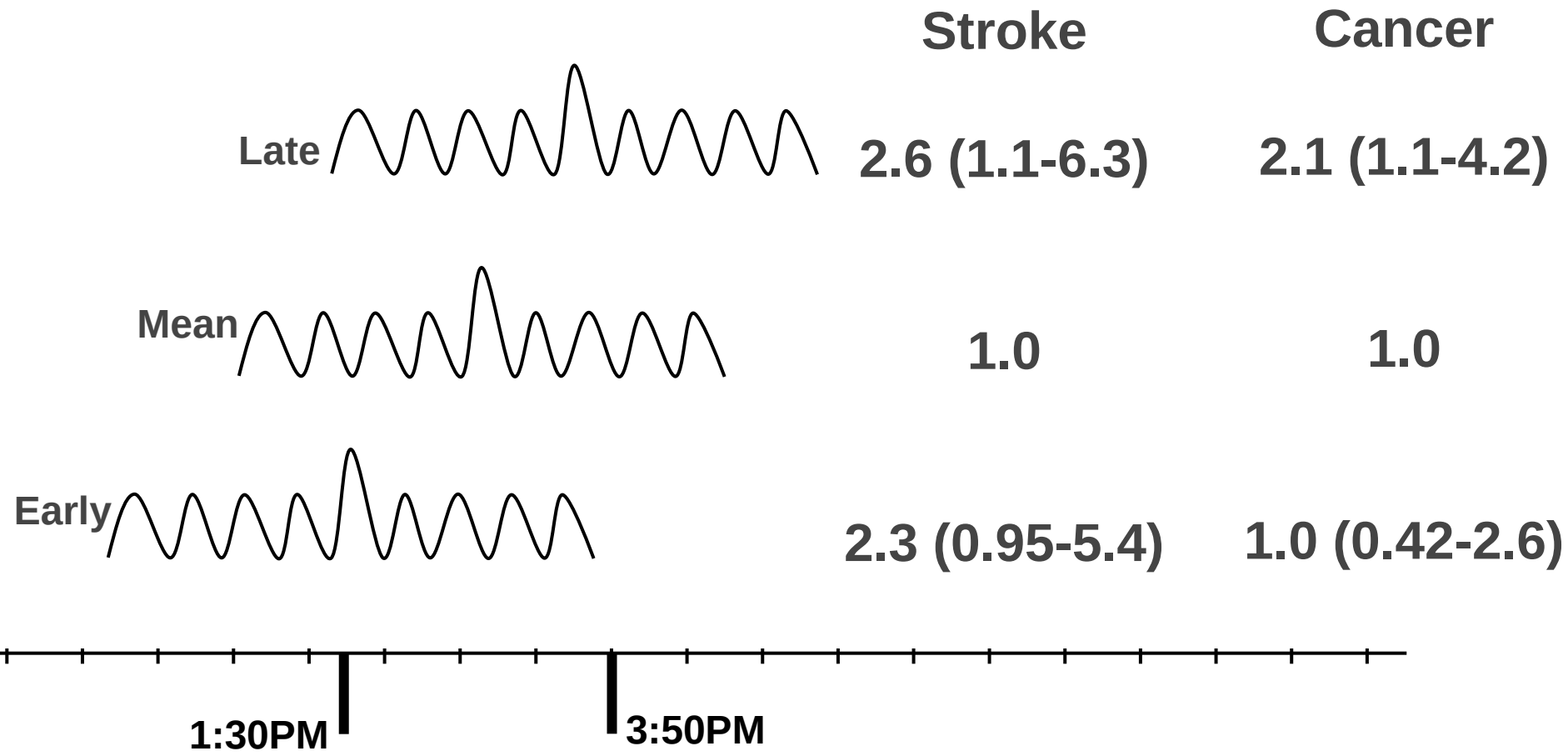


5 year Risk of Dementia or MCI in Older Women



Tranah et al. 2011, *Annals of Neurology*

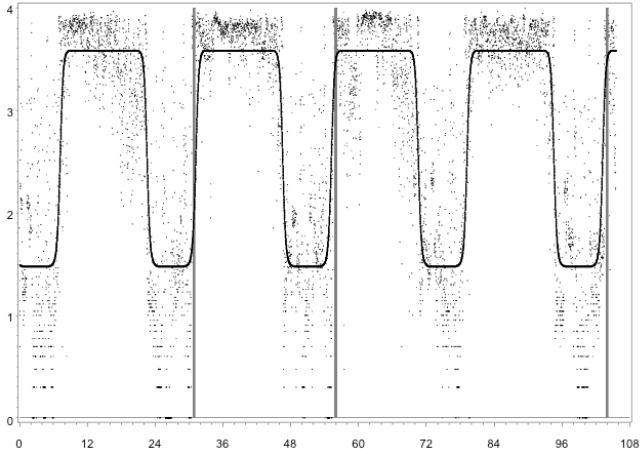
5 year Cause-specific Mortality in Older Women



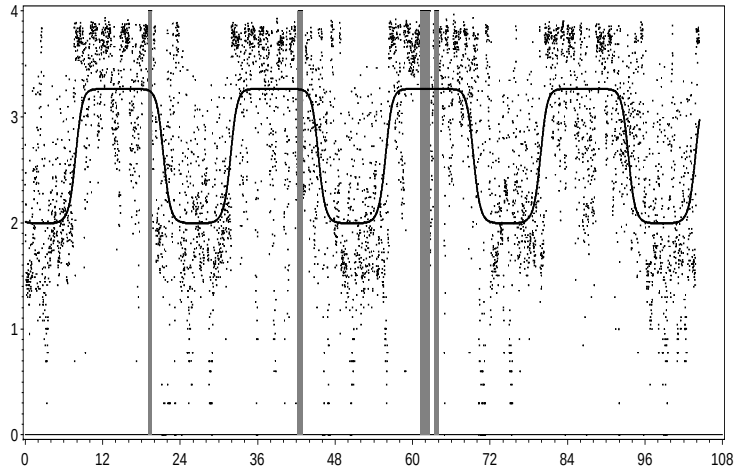
Tranah et al, 2010, *J Am Geriatr Soc*

Activity Rhythms and Survival

Strong



Weak



Activity Rhythms and Survival

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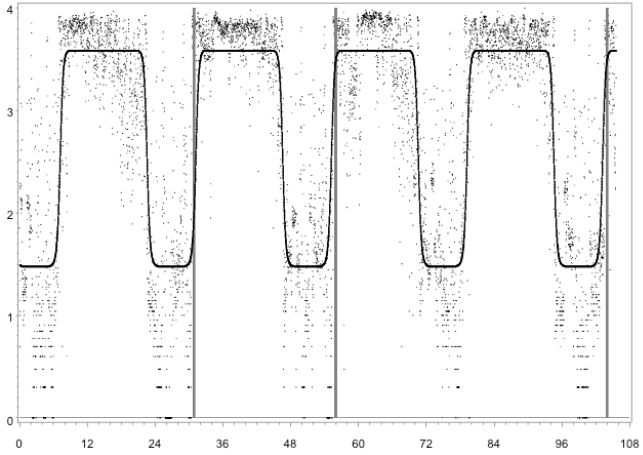

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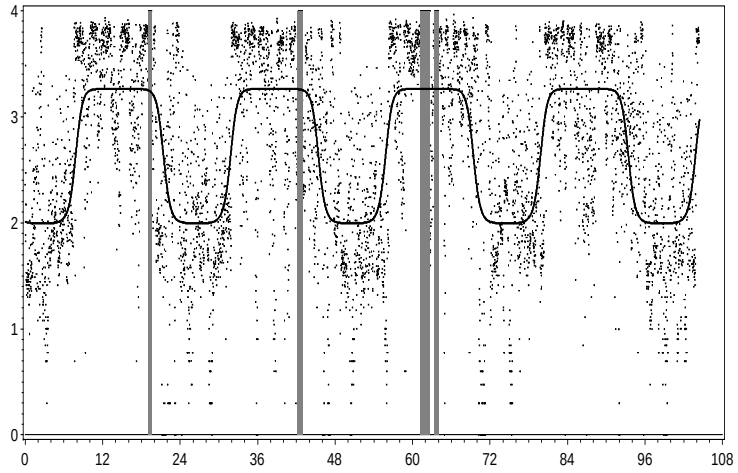
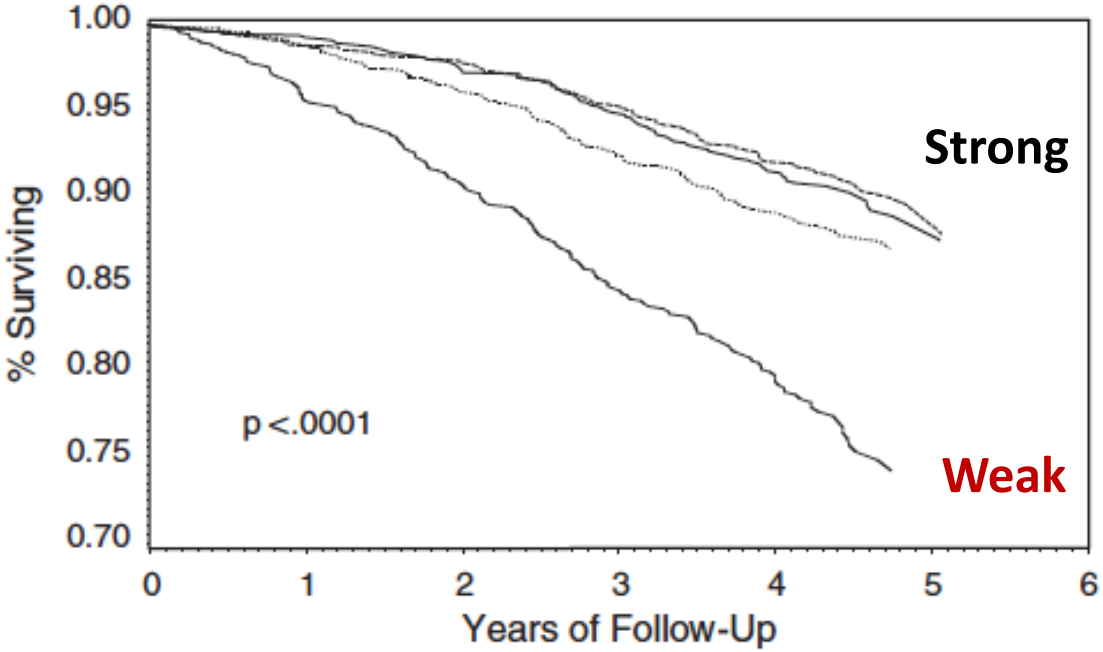




Tranah et al, 2010, *J Am Geriatr Soc*

Sleep Health

- ‘Good sleep’ is essential to health
  - Can’t be defined based on a single measure of sleep (e.g. sleep duration)

- Sleep is multi-dimensional
  - Duration
  - Latency
  - Quality (fragmentation, etc)
  - Satisfaction
  - Sleepiness
  - Timing
  - Regularity

- Many older adults are disrupted in more than one domain of sleep
  - Domains are correlated

Subjective Sleep Health and Incident Depressive Symptoms in Older Women

Sleep Health Score	Participants (%)	OR (95% CI)
0	34.1	1.00 (reference)
1	33.2	1.46 (1.06 – 2.01)
2	21.1	1.95 (1.40 – 2.73)
3	8.5	1.99 (1.29 – 3.08)
4 or 5	3.1	3.16 (1.82 – 5.48)

Aggregate of 'poor sleep' across 5 subjective sleep domains:

- Satisfaction
- Sleepiness
- Timing
- Latency
- Duration

Furihata et al. 2017; SLEEP 40(3)

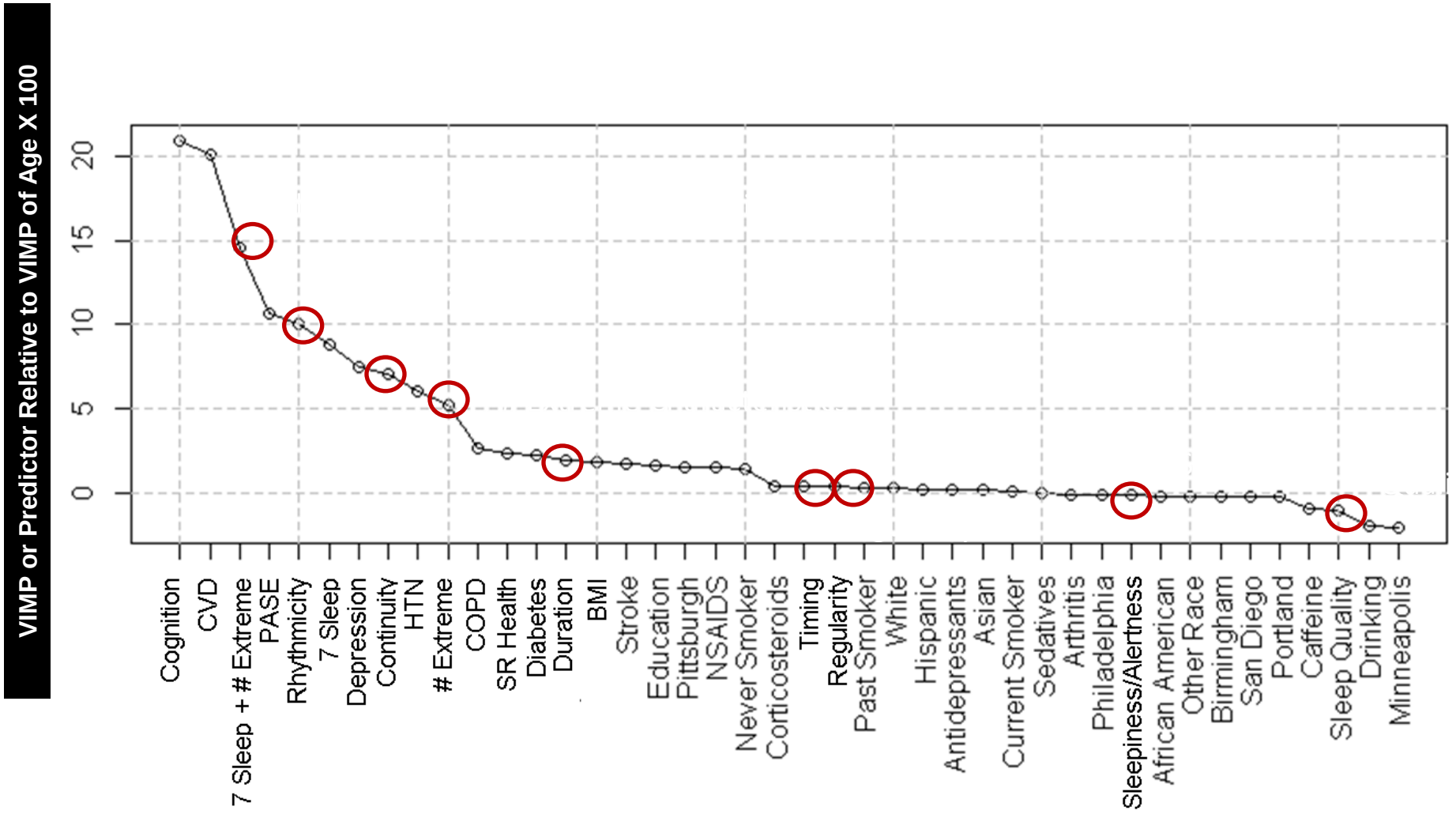
Selected Sleep Health Predictors

SLEEP HEALTH DOMAINS	REPRESENTATIVE SLEEP HEALTH CHARACTERISTICS
DURATION	Actigraphy Mean Total Sleep Time
TIMING	Actigraphy Mean Sleep Midpoint
CONTINUITY	Actigraphy Mean Wake After Sleep Onset
QUALITY	PSQI Sleep Quality Item
SLEEPINESS	Epworth Sleepiness Scale (ESS)
RHYTHMICITY	Pseudo-F (Fit of Cosine to Actigraphy)
REGULARITY	Actigraphy St. Dev. Wake Time

- **Created categorical versions to indicate extreme sleep characteristics**
- **Computed number of extreme characteristics**
- **Random Survival Forest analysis**

M. Wallace, Univ of Pittsburgh

Which Sleep Health Characteristics Predict Mortality in Older Men?



Opportunities in WHI

- WHISPER: Are sleep and circadian disruption related to cardiovascular disease, cancer and cognitive outcomes in older women?
- Sleep and circadian disruption and other age-related outcomes:
  - Falls and fractures
- Exploration of gender differences with MrOS cohort (analysis plans, ancillary studies)
- Wealth of objective and subjective sleep measures for analyses of multi-dimensional sleep health