

# Self Sleep Assessment and Improvement: A dream made true by mobile technology

Baharav A.<sup>1,2</sup>, Eyal S.<sup>2</sup>

<sup>1</sup>Sleep Laboratory, Wingate Institute, Netanya

<sup>2</sup>SleepRate LTD, Petach Tiqva, Israel

## Background

The modern society is always “on”. Sufficient sleep has become a luxury. Poor sleep resulting from hyper intense activity, frequent long distance flights, shift work, overwhelming media, and prevalent sleep related disorders (OSA, PLMS) is an emerging epidemic. The availability of sleep diagnostics and treatment is limited, the costs are high, the procedures are cumbersome for people who either perceive sleep as a luxury, or are not aware of having a real problem. Thus most poor sleepers remain undiagnosed and untreated.

## Methods

A smartphone is used to obtain mandatory objective and subjective information regarding sleep. The information is uploaded and processed in the cloud, and nightly sleep metrics as well as a comprehensive report is returned after 5 tracked out of 9 consecutive nights.

### Subjective inputs

1. General sleep questionnaires regarding: (a) Insomnia, (b) Delayed Circadian Tendency, (c) Hyperarousal, (d) Misbeliefs regarding sleep, and (e) Sleep habits
2. Main sleep concerns including: (a) Difficulty falling asleep, (b) Difficulty maintaining sleep, (c) Waking up earlier than intended, (e) Feeling not-rested in the morning, (f) Feeling hard to get up in the morning, (g) Feeling sleepy during the day, (h) Snoring, (i) Willing to learn about own sleep
3. Previous night sleep quality perception

### Objective inputs

1. Go to bed, wake up and alarm set times
2. Mean HR and HR trends and Night time stress based on data acquired from available accurate off the shelf heart rate monitors (e.g. Polar H7)
3. Sleep structure based on HRV proprietary and validated analysis, including Falling asleep time, number of awakenings, WASO, Light Sleep, SWS, REM, Sleep efficiency, Arousal Index (autonomic) Snoring and noise causing awakenings detection

## Results

Based on 97 subjects who completed assessment between January 23<sup>rd</sup> and May 22<sup>nd</sup> 2014

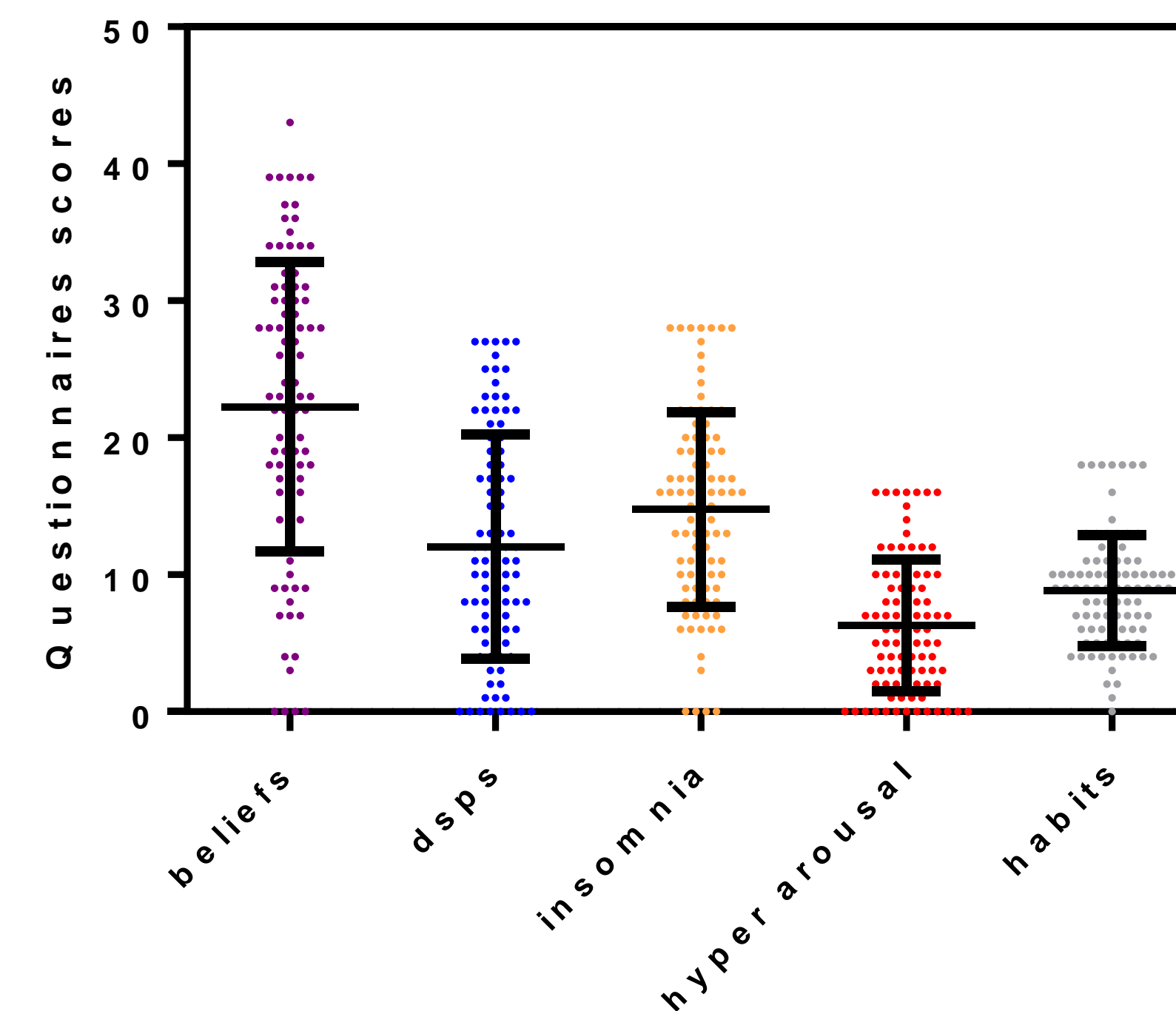
Age: 44.5 years (SD 12.3; range 20-72),

Sex: Male 79%/21% Female

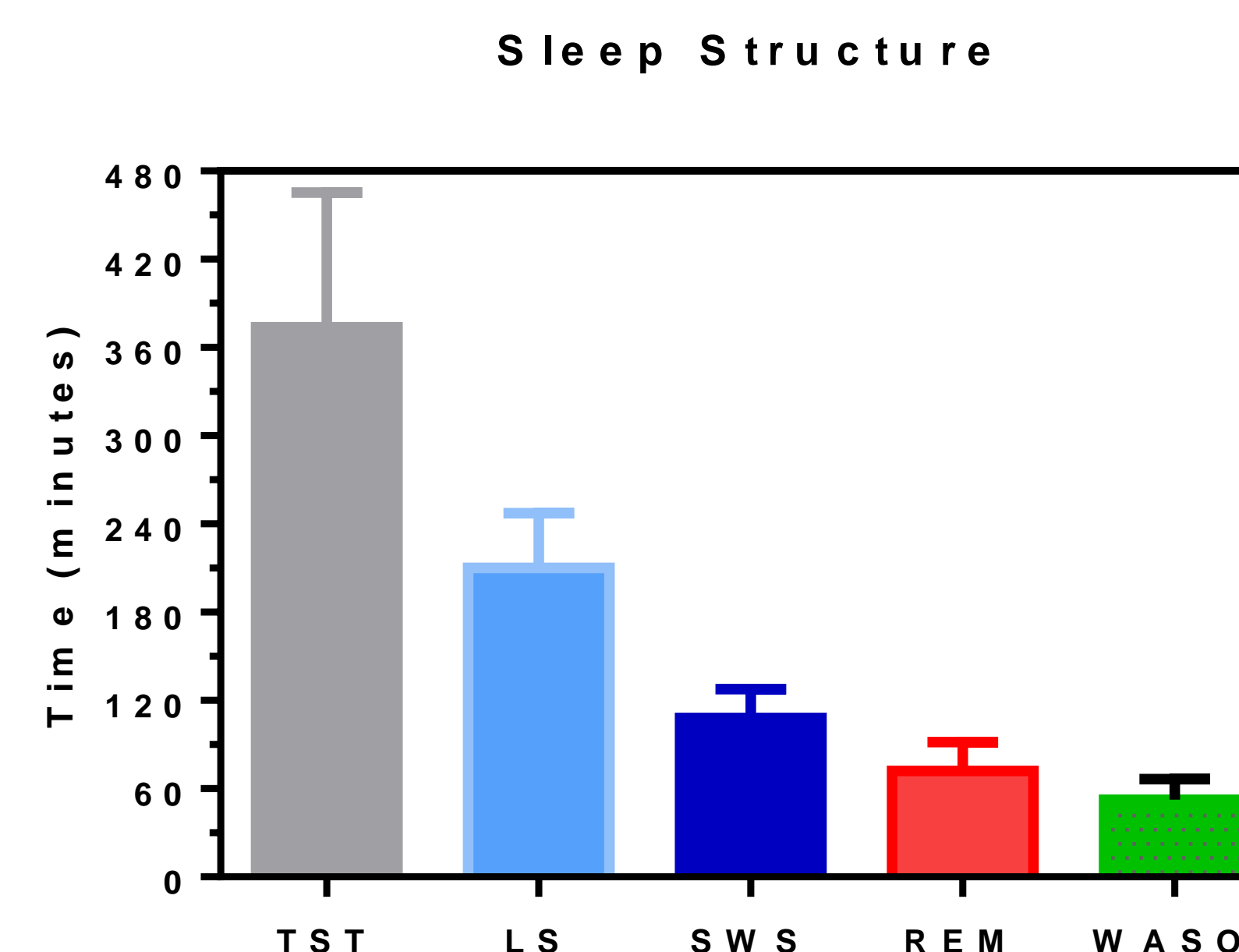
### Main concerns regarding sleep

- a. Difficulty falling asleep: 41%
- b. Difficulty maintaining sleep: 69%
- c. Waking up earlier than intended: 54%
- d. Feeling not-rested in the morning: 82%
- e. Feeling hard to get up in the morning: 59%
- f. Feeling sleepy during the day: 76%
- g. Snoring: 51%
- h. Willing to learn about own sleep: 93%

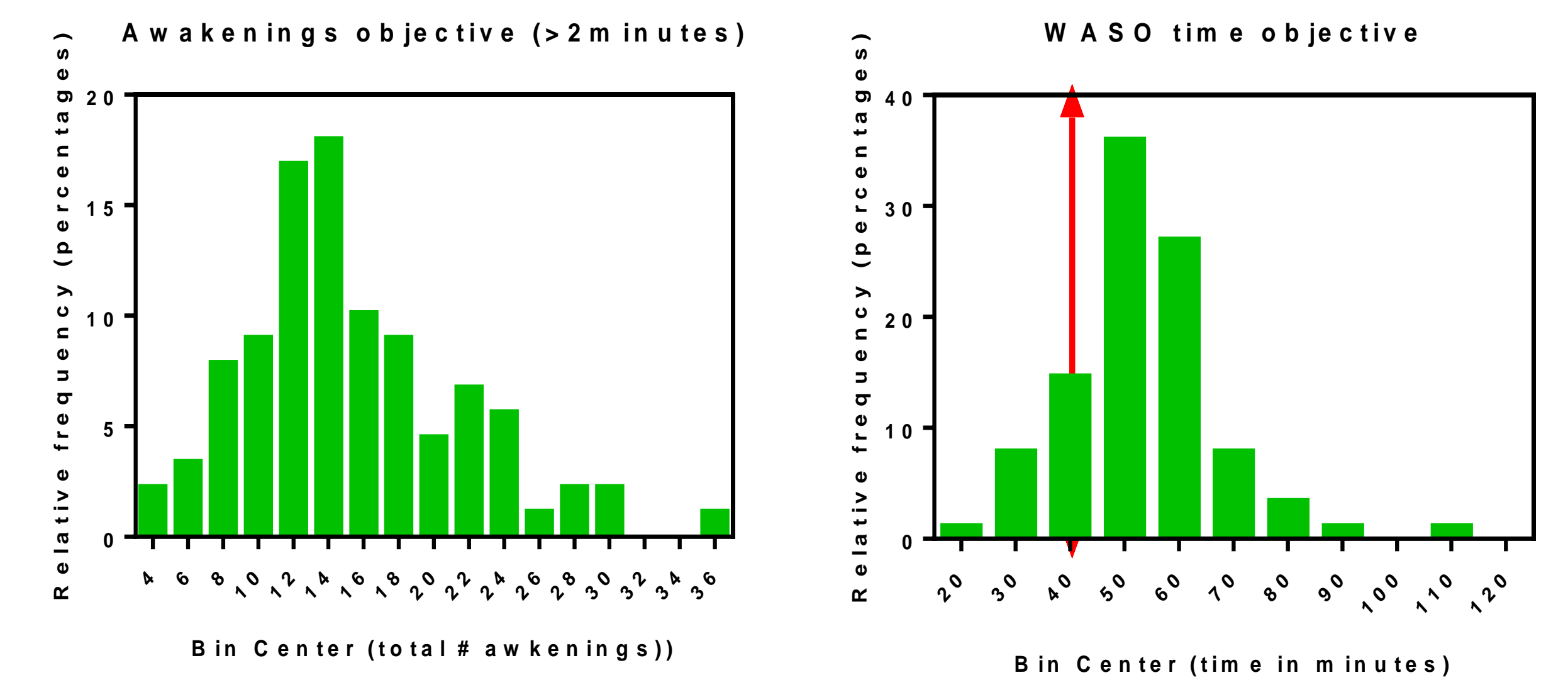
### Sleep Questionnaires:



### Objective Sleep Measures:



1. TST: 6.5 h (SD 1.1h)
2. Sleep Efficiency: 84.8% (SD 4.6%)
3. WASO: Median 52 minutes
4. Sleep Interruptions: (a) Awakenings of 2 minutes duration at least are frequent (median 14, 25% percentile 11, 75% percentile 18-see histogram in next frame); (b) Autonomic Arousals are frequent and connected to reduced sleep quality (objective&subjective).



### Correlations between subjective and objective measures:

1. Subjective Sleep Efficiency versus Objective Sleep Quality (Spearman,  $r = 0.66$ ,  $p$  (two-tailed)  $0.05$ ,  $n = 10$ )
2. Objective Sleep Quality versus Difficulty Falling Asleep concern (Spearman,  $r = -0.27$ ,  $p$  (two-tailed)  $0.0095$ ,  $n = 89$ )
3. Objective Sleep Quality versus DSPTS score (Spearman,  $r = -0.25$ ,  $p$  (two-tailed)  $0.01$ ,  $n = 89$ )
4. Perceived Falling Asleep time is generally overestimated compared to measured sleep onset
5. Perceived number of awakenings is underestimated compared to measured awakenings (of at least two minutes duration).

## Conclusions:

1. Sleep evaluation is easily achievable using mobile technology and off the shelf simple HR sensors.
2. Most subjects who chose to use a sleep evaluation and sleep improvement mobile application have multiple sleep related concerns that corroborate objective measures.
3. This self-sleep evaluation may serve a first step in sleep improvement.