

LARGE SCALE SLEEP EVALUATION MADE POSSIBLE BY MOBILE TECHNOLOGY AND FITNESS HEART RATE MONITORS

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Introduction

Sleep is a vital human function; healthy sleep is essential for general health, quality of life, and optimal daytime performance. The vast majority of sleep disorders, including Circadian Rhythm Disorders, Insomnia, and Insufficient Sleep need a diagnostic procedure that includes multiple nights, making the usual diagnostic tools inefficient. Even obstructive sleep apnea may vary in its severity from night to night, in direct relation to personal behavior such as sleep deprivation and alcohol consumption. Thus, proper diagnosis demands sleep in the home environment and evaluation of multiple nights. Heart Rate Variability analysis became a well recognized non-invasive measure of the autonomic nervous system fluctuations and allows to evaluate sleep architecture and patterns, including detection of autonomic arousals. Off the shelf Heart Rate monitors-fitness belts are popular nowadays and connect readily with smartphones.

Mobile technology can be used as an aid to sleep self-evaluation, as an initial step in understanding one's sleep needs, pattern, quality and structure in connection with subjective complaints regarding difficulties related to sleep and daytime performance, fatigue or sleepiness. We aimed at evaluating sleep duration, quality, and efficiency in the general population

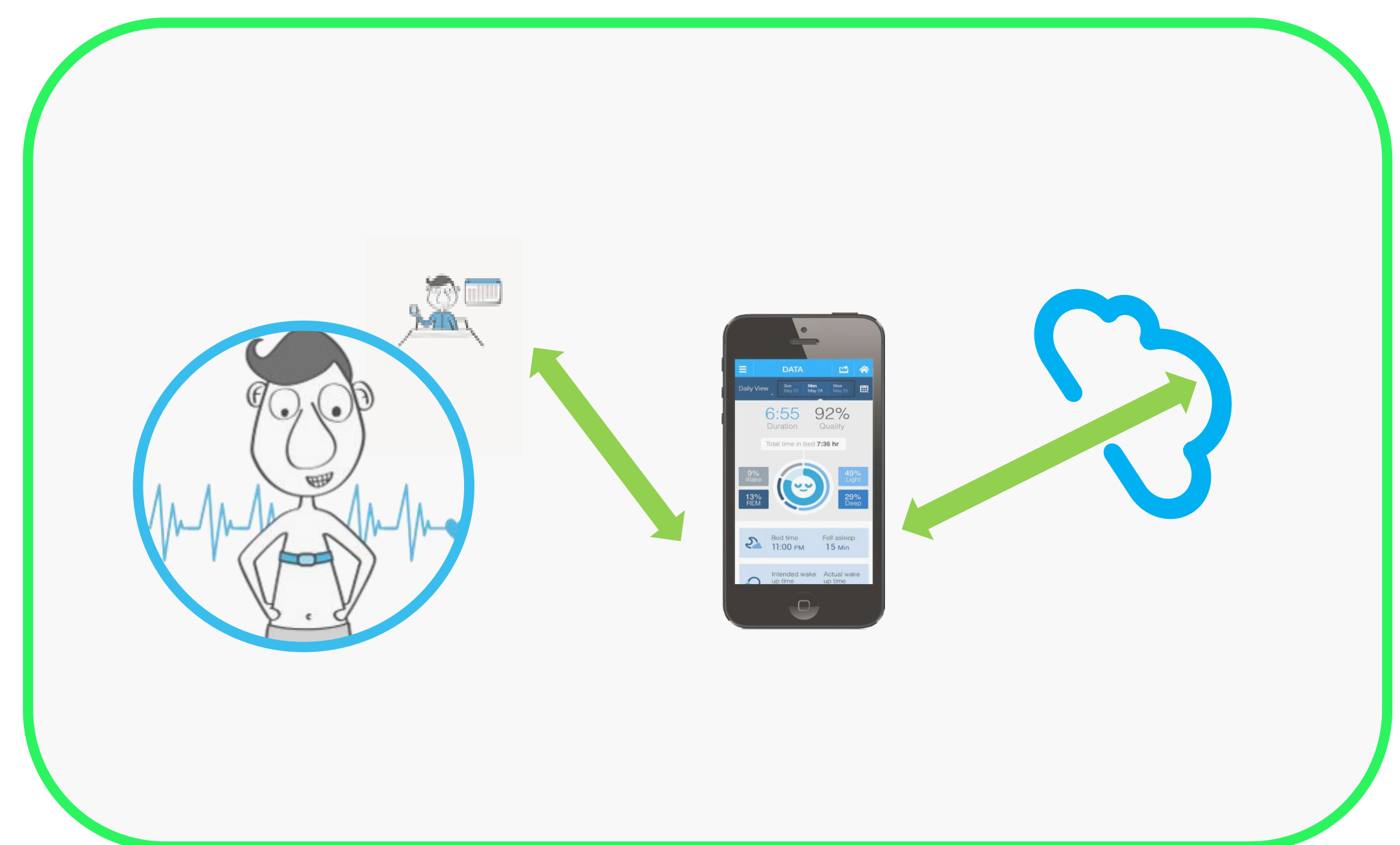
Methods

We used:

1. A mobile application (SleepRate) to collect information regarding sleep related concerns and problems, sleep schedule, subjective nightly information regarding sleep quality, and environmental sound recordings using the built in microphone.
2. A validated proprietary sleep measurement software based on Heart Rate Variability to evaluate sleep architecture and fragmentation.
3. A cloud based data analysis and integration.

The application was offered to users interested in evaluating their sleep and getting personalized advice on how to improve it, if needed.

Data have been collected between January 23rd and July 31st 2014.



Results

The total number of tracked nights was 14984 (2398 users, 99% based in the US). 12478 nights (2352 users) were simple tracking nights. 51.6% of nights included objective sleep evaluation based on instantaneous Heart Rate monitoring using a H7 Polar fitness belt. 2506 nights (233 users) were nights with the user engaged in a sleep assessment and sleep improvement plan.

1. 999 assessment valid nights from 229 users.

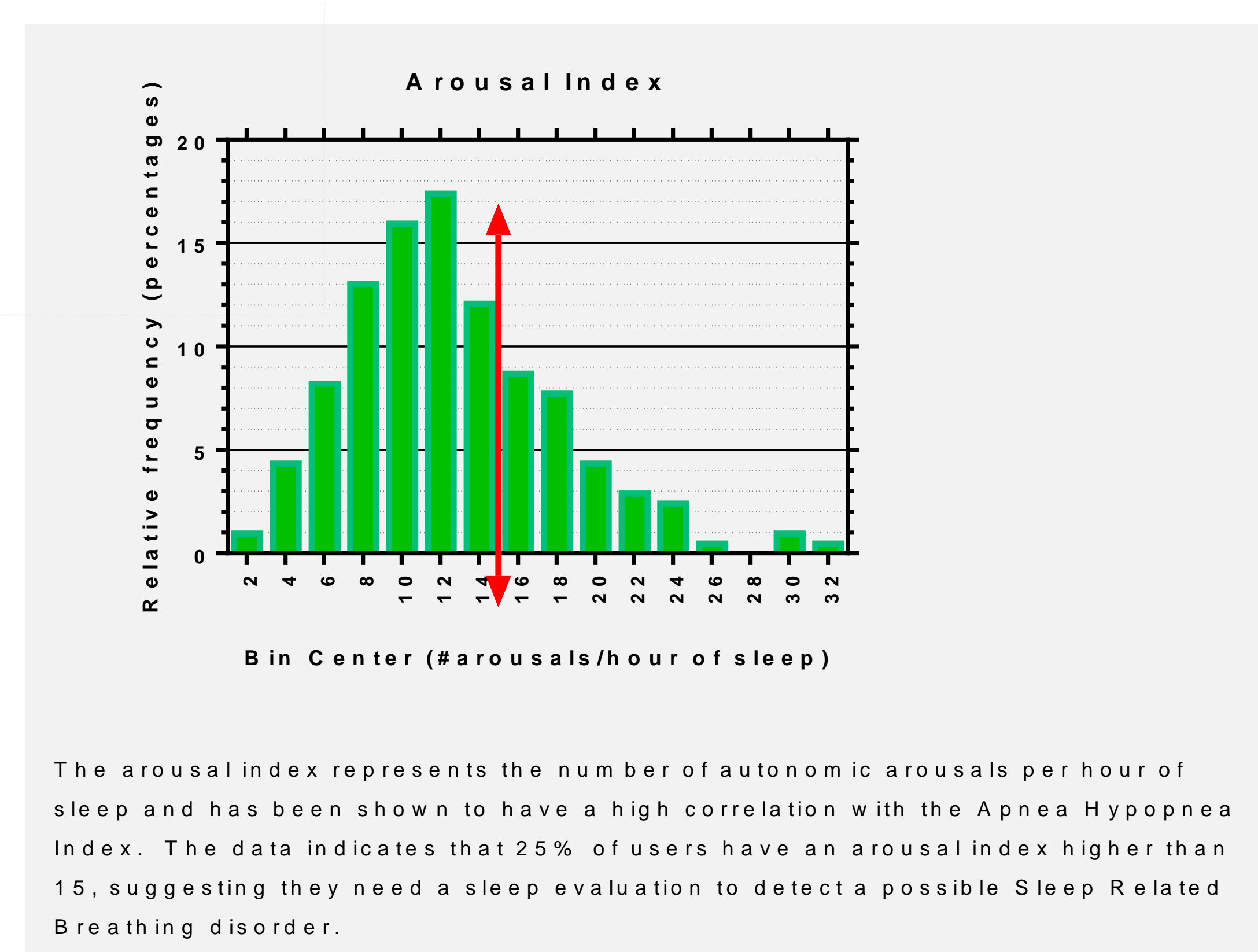
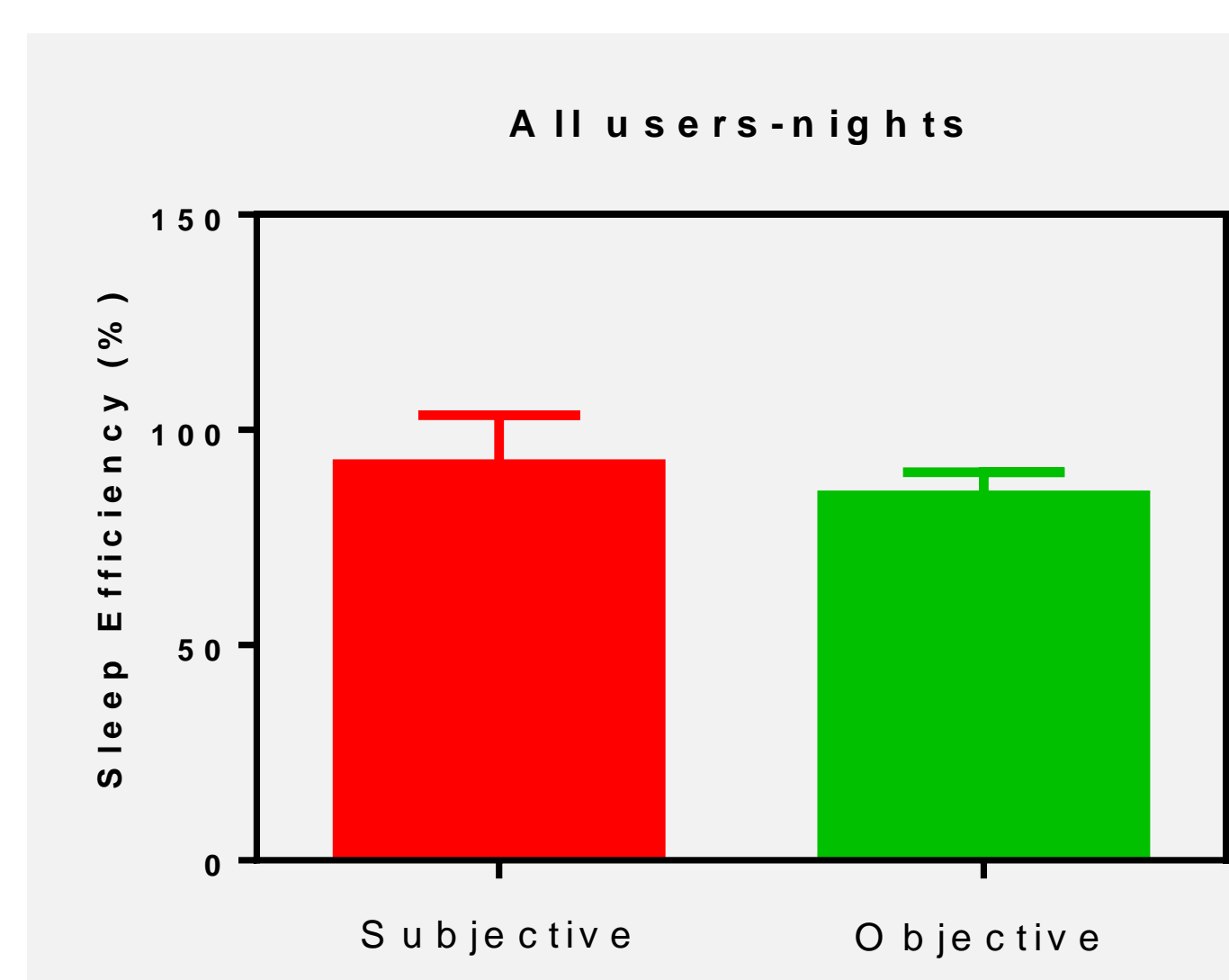
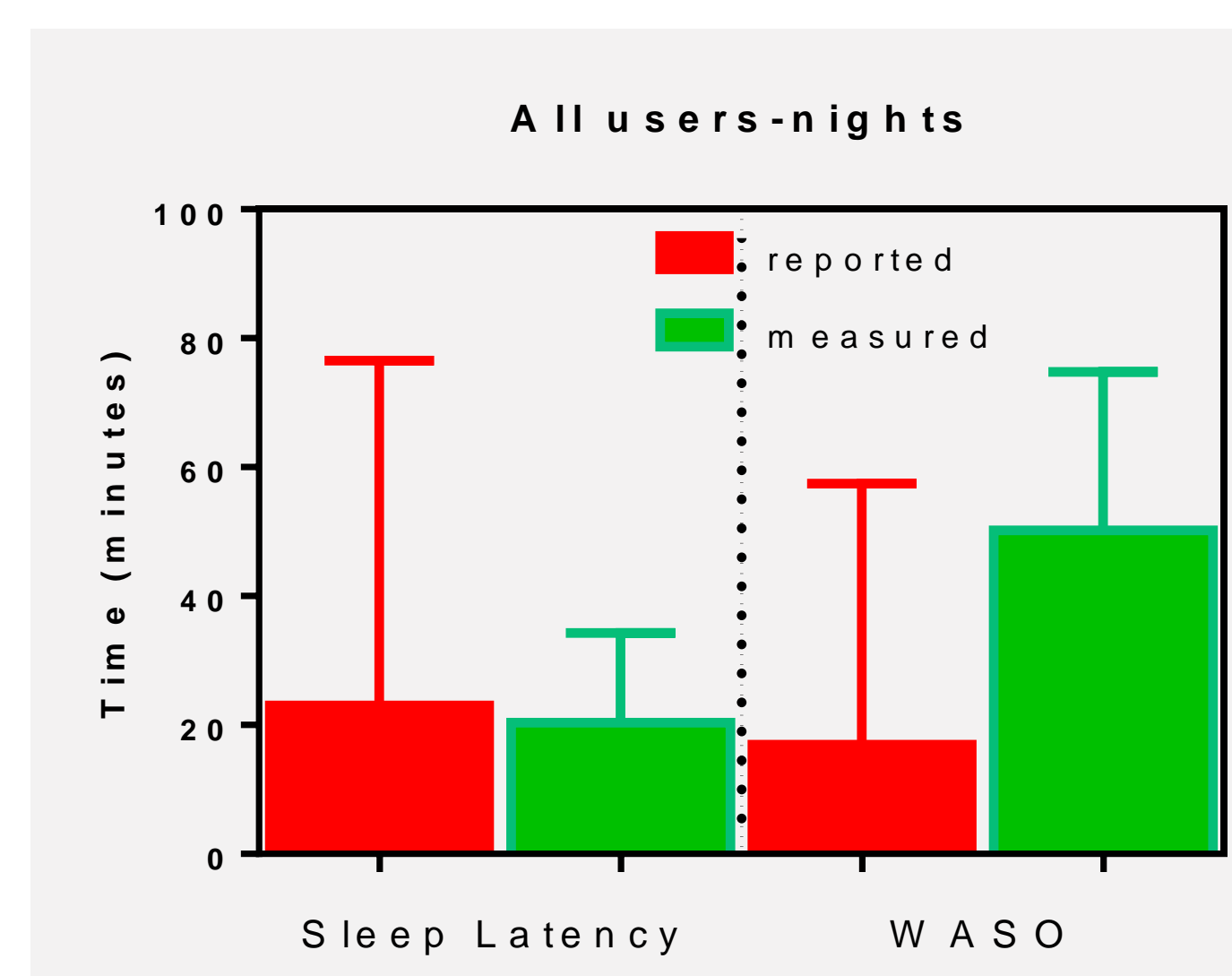
Users demographics: age 41.3 years (SD 15.5); male 133/ female 54/ not disclosed 42.

Main reported sleep concerns per user: Trouble falling asleep - 37%; Night time awakenings - 55%; Early awakenings - 50%; Waking up not rested - 77%; Feeling sleepy during the day-65%; Difficulty waking up-49%; Being told they snore - 41%. 86% of users were interested in learning more regarding their sleep.

Average total sleep time-6.4 hours (SD 0.97; range 3.2-11.0; 25% percentile 5.9; median 6.5; 75% percentile 7.1). Total time in bed-7.6 hours (SD 1.1 hours).

Assessment Sleep Variables	Sleep Latency		Wake After Sleep Onset		Sleep Efficiency	
	Measured	Reported	Measured	Reported	Objective	Subjective
Average	19 min	26 min	52 min	33 min	85%	87%
SD	8.4 min	24 min	18 min	33 min	4.1%	10%

2. All users/all nights do not include any sleep concerns or demographics: Average total sleep time-6.4 hours (SD 1.4).



Conclusions

1. The average total sleep time in the population engaged in sleep tracking as well as in those users who decided to evaluate their sleep is shorter than recommended: 6.4 hours on average versus 7-8.5 hours as recommended by the American National Sleep Foundation.
2. People who engaged in sleep self-evaluation, and a possible improvement plan if needed, have serious concerns regarding their sleep; for most the sleep is not satisfying, as 65% complain of waking up not rested.
3. Subjective sleep measures have a wider variability in the population than objective measures. People tend to overestimate their sleep latency, while they underestimate their time awake after sleep onset.
4. The objective sleep efficiency based on Heart Rate Variability measures of sleep is lower (with a lower SD) than the subjective sleep efficiency. This indicates that a suitable cu-off for the objective measure of Insomnia should be defined.
5. The Autonomic Arousal Index is a good candidate for screening the Sleep Related Breathing Disorders. Validation studies are needed.