



# Efficacy of a Smart Textile Shirt: Developing a Sleep Health Screening Tool for Military Populations

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## OBJECTIVES

### Development of a high-throughput sleep health screening tool



- Sleep disruption, in general, is pervasive in military populations and has myriad health and readiness implications.
- Between 2001 and 2012, there was a 25-fold increase in the number of veterans and military retirees receiving compensation for sleep apnea.

- Current standards require expensive overnight studies using polysomnography (PSG). While actigraphy is cost-effective, convenient, and thus widely-used as an alternative to PSG, it is limited both in its relative accuracy and in dimensionality.
- There is a need for a cost-effective and multi-dimensional sleep health screening tool that can be employed in the field.

## METHODS

### Smart Textile Shirt (STS)



A quick-dry, breathable, smart textile shirt with heart rate, activity, and respiration sensors was evaluated in active-duty U.S. Navy service members via:

- An in-lab overnight study with polysomnography (PSG; n=7).
- An in-home 3-5 day study with actigraphy (ACT; n=8).
- A 10-item questionnaire that assessed shirt comfort and ease of use (n=12).

### In-lab data analyses

- PSG data – one rest interval (lights off/on), scored for sleep manually according to R&K 1968 classification (Compumedics USA, Inc.).
- STS data – one rest interval (lights off/on), scored for sleep utilizing the manufacturer's algorithm (Carré Technologies, Inc.).

### In-home data analyses

- Actigraphy data – two rest intervals (diary-based, and ACT-generated), each scored for sleep utilizing the manufacturer's algorithm (Phillips-Respironics).
- STS data – two rest intervals (diary-based, and STS-generated), each scored for sleep utilizing the manufacturer's algorithm (Carré Technologies, Inc.).
- Data were then averaged to yield one value for each metric per individual.

As a preliminary analysis for both experiments, differences in derived sleep parameters were evaluated across devices with paired *t*-tests.

## RESULTS

### Smart Textile Shirt (STS) comfort and ease of use:

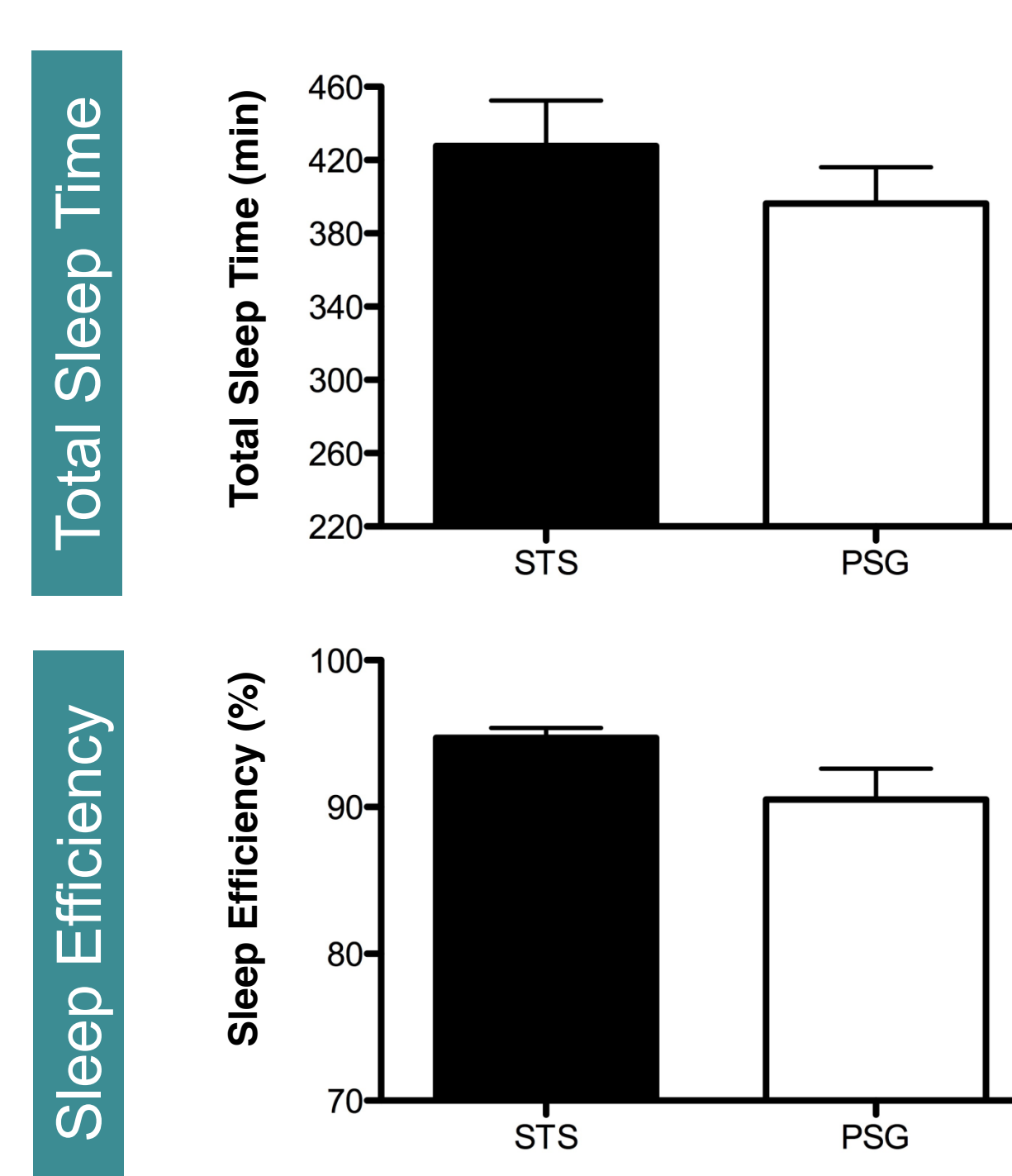
- 100% of subjects from both experiments reported the shirt was somewhat (50.0%) or very (50.0%) comfortable.
- 83% were able to don & doff the shirt off independently in <1 minute (versus ~90 min with tech for PSG).

COMFORT		During sleep	
Very comfortable		50.0%	
Somewhat comfortable		50.0%	
Somewhat uncomfortable		0%	
Very uncomfortable		0%	
EASE OF USE		Putting it on	Taking it off
< 30 sec		58.3%	83.3%
30-60 sec		25.0%	16.7%
60-120 sec		8.3%	0%
> 120 sec		8.3%	0%

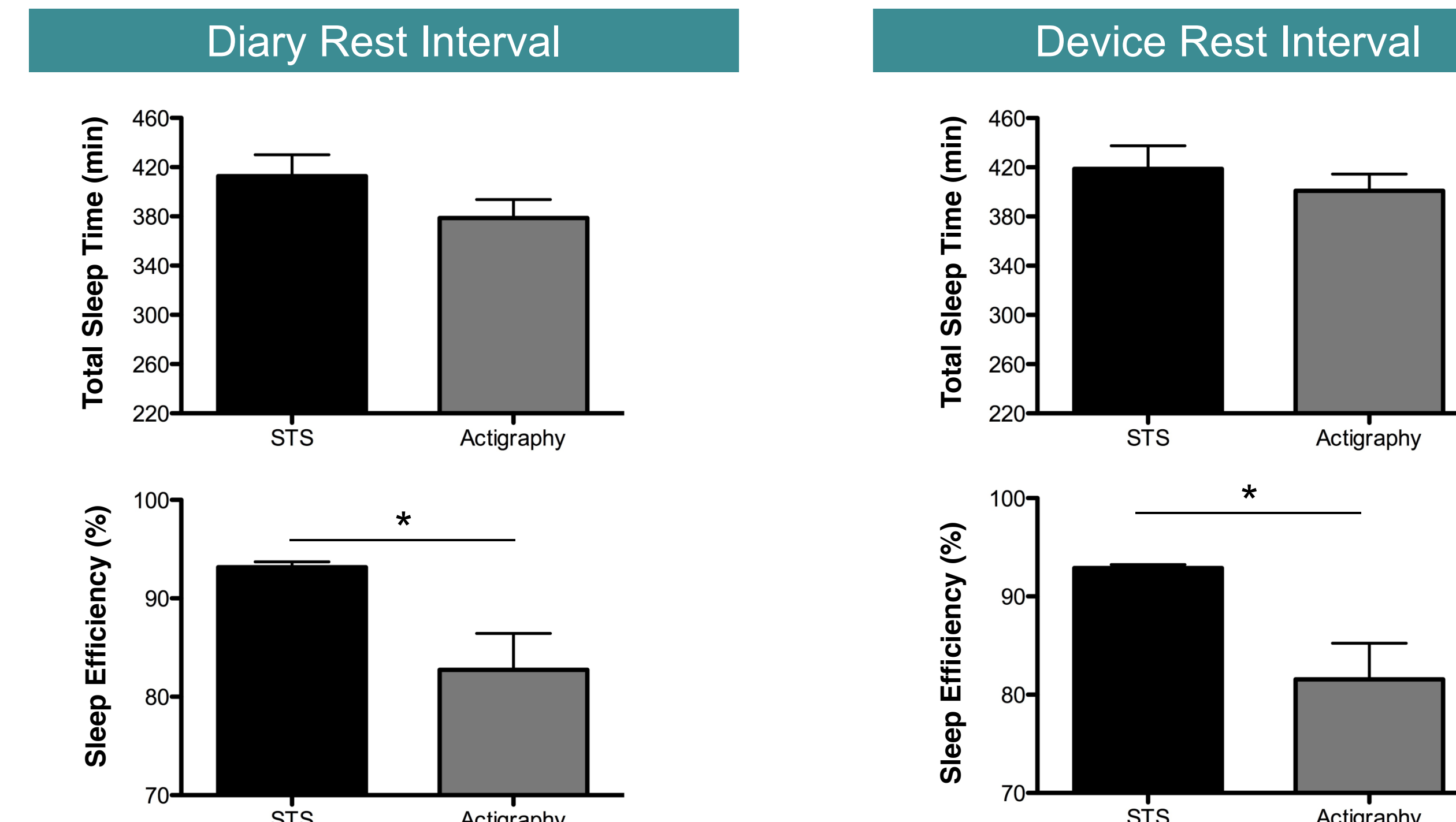
### Preliminary analysis of total sleep time (TST) and sleep efficiency (SE):

- No difference between the STS and PSG on either sleep metric ( $p>0.05$ ).
- Sleep efficiency was significantly higher for STS than actigraphy ( $p<0.05$ ).

### Smart Textile Shirt vs PSG



### Smart Textile Shirt vs Actigraphy



## FUTURE DIRECTIONS

The smart textile shirt shows promise as an alternative for sleep health assessment compared with standard polysomnography and/or actigraphy. However, indications are that the commercially-available algorithm for the STS likely over-estimates both sleep metrics that are provided to consumers. Further investigations, including epoch-by-epoch analyses and development of independent algorithms, are currently underway.

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