


You snooze, you lose—with some sleep trackers


February 17 2021

WVU Rockefeller Neuroscience Institute

EVALUATIONS OF COMMERCIAL SLEEP TECHNOLOGIES FOR OBJECTIVE MONITORING DURING ROUTINE SLEEPING CONDITIONS

PUBLICATION 

THE APPROACH



COMPARED TO EACH OF THE FOLLOWING*

APPLE WATCH, BEDDIT, FATIGUE SCIENCE READBOARD, FITBIT IONIC, GARMIN VIVOACTIVE 4, OURA RING, POLAR A370, WHOOP

THE DATA

Absolute Percent Error Executive Summary Statistics: All Devices

Metric	Device	n	MAPE	Min. (%)	Median (%)	Max. (%)	IQR
TST	Oura	69	7.99	0.13	5.01	33.83	7.27
	WHOOP	32	8.78	0.00	8.80	20.92	9.70
	Fitbit	27	8.90	0.33	4.34	50.07	6.95
	Fatigue Science	68	10.95	0.18	7.91	51.94	10.66
	Polar	19	10.89	0.70	10.19	38.34	8.93
	Beddit	38	11.11	0.15	10.43	23.77	8.87
	Sleepa	18	15.61	0.30	15.91	48.24	15.31
	Garmin	21	21.94	0.89	18.42	85.69	16.88
	SleepWatch	13	22.84	0.64	20.64	54.66	26.48
	Fitbit	27	25.94	0.55	23.50	78.17	22.41
TWT	Oura	60	38.93	1.37	31.67	118.13	42.88
	Fatigue Science	70	43.73	3.23	42.35	140.58	37.44
	IONIC	19	54.69	0.68	53.62	86.43	30.50
	WHOOP	33	60.34	3.83	49.31	100.00	33.97
	Beddit	40	62.37	2.13	66.74	173.35	31.40
	Garmin	18	87.22	27.80	69.42	100.00	11.58
	Fitbit	28	3.89	0.23	0.44	12.79	3.18
	Oura	60	5.42	0.51	4.79	19.21	4.74
	Fatigue Science	69	6.52	0.13	5.56	18.48	7.43
	Polar	19	9.03	0.04	5.55	23.48	8.49
SE	WHOOP	32	10.00	0.04	0.24	35.17	7.75
	Beddit	40	10.18	0.17	0.40	30.60	10.74
	Garmin	17	11.11	0.24	10.85	16.27	3.22

THE OUTCOME

Kendall's Coefficient of Concordance (W): All Devices

Device	Sum Rank
Fitbit	5
Oura	5
Fatigue Science	10
WHOOP	12
Polar	13
Beddit	18
Garmin	21
Kendall's W	0.873

KEY FINDINGS

- High variability in accuracy observed across different consumer sleep devices
- Total Sleep Time (TST), Total Wake Time (TWT), and Sleep Efficiency (SE) can be ranked for commercial devices and selected according to the end user's confidence in accuracy needed
- Sum ranking of accuracy for TST, TWT, and SE displayed in table above – Kendall's Coefficient demonstrates high stability in rankings
- Data for sleep staging metrics (available in full text) shows remarkable error for all devices
- Some commercial sleep devices may likely be used to understand TST, TWT, and SE, but should not be used for sleep staging
- Decision is up to the end-user and their preferred application(s)
- Due to the pace of development of consumer wearables, continuous and rapid testing should be done to keep up with advancements in hardware and algorithms

THE PROBLEM

Commercial wearable technologies are being released to the market at a rapid pace with little to no independent evaluations of accuracy being performed, especially in a natural sleep setting (i.e. not in a sleep laboratory). In this study, we aimed to evaluate multiple high selling commercial devices by simultaneously comparing them to a reference (EEG-based) device, the Advanced Brain Monitoring Sleep Profiler. Commercial devices were randomized with only 1 worn per wrist per night and directly compared to the reference. Analysis was specific to the commercially available data from the companion smartphone apps, exactly as a consumer would see.

*devices listed alphabetically

Stone, J. D., Rientz, L. E., Foresey, J., Ramadan, J., Markwald, R. R., Finomore Jr., V. S., Galster, S. M., Ruzal, A., & Hagen, J. A. (2020). Evaluations of Commercial Sleep Technologies for Objective Monitoring During Routine Sleeping Conditions. *Nature and Science of Sleep*, 12, 821-942. doi:10.2147/NS.S270705

Evaluations of commercial sleep technologies for objective monitoring during routine sleeping conditions. Credit: WVU Rockefeller Neuroscience Institute

Wearable sleep tracking devices—from Fitbit to Apple Watch to never-heard-of brands stashed away in the electronics clearance bin—have infiltrated the market at a rapid pace in recent years.

And like any [consumer products](#), not all sleep trackers are created equal,

according to West Virginia University neuroscientists.

Prompted by a lack of independent, third-party evaluations of these devices, a research team led by Joshua Hagen, director of the Human Performance Innovation Center at the WVU Rockefeller Neuroscience Institute, tested the efficacy of eight commercial sleep trackers.

Fitbit and Oura came out on top in measuring total sleep time, total wake time and sleep efficiency, the results indicate. All other devices, however, either overestimated or underestimated at least one of those sleep metrics, and none of the eight could quantify sleep stages (REM, non-REM) with effective accuracy to be useful when compared to an electroencephalogram, or EEG, which records electrical activity in the brain.

The study is published in the *Nature and Science of Sleep*.

"The biggest takeaway is that not all consumer devices are created equal, and for the end user to take care in selecting the technology to suit their application based on the data," Hagen said. "Some devices are currently performing well for total sleep time and sleep efficiency, but the community at large seems to still struggle with sleep staging (deep, REM, light). This is not surprising, since typically brain waves are needed to properly measure this. However, when thinking about what you generally have control over with your sleep—time to bed, time in bed, choices before bed that impact sleep efficiency—these can be accurately measured in some devices."

Researchers observed five healthy adults—two males, ages 26 and 41, and three females, ages 22, 23 and 27—who participated by wearing the sleep trackers for a combined total of 98 nights.

The commercial sleep technologies displayed lower error and bias values

when quantifying sleep/wake states as compared to sleep staging durations. Still, these findings revealed that there is a remarkably high degree of variability in the accuracy of commercial sleep technologies, the researchers stated.

"While technology, both hardware and software, continually advances, it is critical to evaluate the accuracy of these devices in an ongoing fashion," Hagen said. "Updates to hardware, firmware and algorithms happen continuously, and we must understand how this affects accuracy."

Research in this area will evolve with the technology, added Hagen, who himself utilizes four to five sleep devices to keep monitoring his ZZZs.

"I'm a big believer in living the research," he said. "I need to understand what the consumer sees in the smartphone apps, what the usability of the devices is, etc. Without that objective sleep data, you can only rely on how you feel when you wake up—and while that is important, that doesn't tell the whole story. If your alarm goes off and you happen to be in a deep sleep stage, you will wake up very groggy, and could feel as though that sleep was not restorative, when in fact it could have been. It's just not subjectively noticeable right at that moment."

At the end of the day, however, it's up to the user's needs as to which product may be most suited for that person, Hagen added.

"After accuracy, it comes down to logistics. Do you prefer a watch with a display? A ring? A mattress sensor? What is the price of each? Which smartphone app is most appealing? But again, that is if all accuracies are close to equal. If the price is right and the form factor is ideal, but the data [accuracy](#) is extremely poor, then those factors don't matter."

The Human Performance Innovation Center works with members of the

US military along with collegiate and [professional athletes](#) to better understand and optimize [human performance](#), resiliency, and recovery, applying these findings to solutions for the general and clinical populations.

More information: Jason D Stone et al.

Evaluations of Commercial Sleep Technologies for Objective Monitoring During Routine Sleeping Conditions

, *Nature and Science of Sleep* (2020). [DOI: 10.2147/NSS.S270705](https://doi.org/10.2147/NSS.S270705)

Provided by West Virginia University

Citation: You snooze, you lose—with some sleep trackers (2021, February 17) retrieved 12 May 2024 from <https://medicalxpress.com/news/2021-02-snooze-losewith-trackers.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.