derived EMA self-reports. Sleep estimates from the different modalities were compared for agreement (bivariate correlation) and discrepancies (t-test). Additionally, clustering analysis of high-discrepancy nights (>1h discrepancy between modalities) was performed to identify pattens of sleep behaviors that could lead to specific discrepancies.
Results: Adherence throughout the 8-week monitoring period (total 11,088 nights) was = high for the Oura ring; 9826 nights [80%]), Tappigraphy; 9740 nights [88%)), and EMA; 9166 nights [83%]). Sleep estimates across the three modalities showed high agreement (r=0.79-.91), with some discrepancies: Relative to self-report data, Oura wake time tended to be a later (Mean diff=9mins, t=18.58, p<.001), while tappigraphy estimates of bedtime tended to be early (Mean diff=15mins, t=26.48, p<.001). On 23% of nights (1755 nights), however, large discrepancies were detected (>1h). K-means clustering identified three distinct patterns of discrepancy, which were dominantly expressed in different individuals. Group comparison revealed that these individuals differed in demographic variables (age, student/work status), sleep variables (sleep timing, duration, subjective sleepiness), and phone usage characteristics (overall and pre-bedtime phone usage).
Conclusion: These data show that the combined use of three streams of data concerning sleep is complementary. Moreover, discrepancy patterns provide specific insights into sleep and peri-sleep behaviors facilitating digital phenotyping.
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EVALUATION OF MULTIPLE WEARABLE SLEEP-TRACKING DEVICES TESTED UNDER AD LIB HOME SLEEP CONDITIONS

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Introduction: Consumer wearable sleep-tracking devices are increasingly popular and have performed well versus gold standard sleep measurement techniques (polysomnography and actigraphy) in recent validation studies. However, most validation studies were conducted in laboratories under controlled conditions. We therefore aimed to test the validation performance of multiple consumer wearable sleep-tracking devices under real-world ad lib sleep conditions at home.
Methods: We tested 21 healthy young adults (12 women, 9 men; 29.0±5.0 years, mean±SD) for 7 nights each. Participants slept at home under ad lib sleep conditions, using a set of consumer wearable sleep-tracking devices and completed daily sleep diaries. Consumer wearables included the Fatigue Science Readiband, Fitbit Inspire HR, Oura Ring, and Polar Vantage V Titan. Participants also wore the Philips Respironics Actiwatch 2, a research-grade actigraphy watch, for comparison. To assess validity of sleep/wake measures, all devices were compared with the previously-validated Dreem 2 electroencephalography-based headband device. Analyses included agreement of epoch-by-epoch sensitivity (for sleep) and specificity (for wake), and sleep summary comparisons of time-in-bed (TIB) and total sleep time (TST).
Results: Sensitivity and specificity, respectively, were as follows: Actiwatch 2 (0.95, 0.36), Readiband (0.93, 0.43), Inspire HR (0.93, 0.45), Ring (0.94, 0.41), and Vantage V Titan (0.96, 0.33). Device average biases, in minutes±SD, for TIB and TST, respectively, were as follows: Actiwatch 2 (N/A, +0.7±42.4), Readiband (+18.2±34.9, +0.4±49.5), Inspire HR (+7.8±35.0, -5.9±44.4), Ring (+9.2±28.0, +4.4±44.5), and Vantage V Titan (+0.2±50.0, -3.2±46.1).
Conclusion: The consumer wearable devices had comparable sleep-tracking performance during real-world ad lib home sleep. Similar to prior studies, the devices all had high sensitivity and low-to-medium specificity, indicating a greater ability to accurately detect sleep than wake. Notably, specificity for most consumer wearables was higher than a research-grade actigraph, indicating potentially greater ability than actigraphy to detect wake. Sleep summary outcomes were similar among the wearables, which accurately tracked TIB and TST on most nights. However, on some nights there was still considerable bias and variability. Overall, preliminary findings indicate that consumer wearables are promising for tracking sleep and wake in real-world home conditions.
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THE ACTIGPATCH: VALIDATION OF A NOVEL ADHESIVE MONITOR AGAINST PSG AND WRIST-ACTIGRAPHY.

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Introduction: Wrist actigraphy is a gold-standard method for estimating sleep patterns in the field. Actigraphy adherence is limited when participants remove the device for daily activities (e.g., showers, exercise). Here we evaluate the validity of a novel water-resistant wearable, the "Actigpatch," compared to polysomnography and traditional actigraphy.
Methods: Seven adults (4F; aged 22-54 years [m: 31.1±13.1]) slept in the laboratory for a total of 33 nights. Participants wore a Micro Motionlogger actigraphy (Ambulatory Monitoring Inc., Ardley, NY) on the non-dominant wrist and the Actigpatch—a 0.5in2 circuit board enclosed in a water-resistant adhesive (Circadian Positioning Systems, Newport, RI)—on the triceps. Both devices recorded tri-axial accelerometry, with sleep-wake estimates produced in 1-minute epochs (Sadeh algorithm). Simultaneous PSG data were reduced to 1-minute resolution favoring wake, keeping with recent recommendations. We computed epoch-by-epoch confusion matrices and derived 2 validation parameters: sensitivity (e.g., ability to detect sleep) and specificity (e.g., ability to detect wake). Finally, we compared total sleep time estimates (TST) to evaluate the bias of each device. Nested mixed models (nights within individuals) compared device performance.
Results: The Actigpatch demonstrated high sensitivity (.95; 95%CI: [.92 .98]) and specificity (.89; [.86, .91]) against polysomnography. Similar sensitivity (.96; [.94, .99]) and specificity (.84; [.78 .91]) were found comparing the Actigpatch to the Motionlogger. Comparing the devices' validity with PSG, sensitivity was not statistically different between the Actigpatch and Motionlogger (b=.0041, t=0.56; p=.58); however, the Motionlogger demonstrated higher specificity (.95; [.92, .97]) compared to the Actigpatch (b=0.065, t=4.69; p<.001). To that end, TST estimates were longer (p=.016) for the Actigpatch (449min; [428, 471] relative to the Motionlogger (438min; [416, 459]).
Conclusion: These data indicate that the adhesive "Actigpatch" is as sensitive to detect polysomnographic-confirmed sleep as a common research-grade actigraph. The Actigpatch may be less capable of detecting wake episodes. Unlike traditional actigraphs, the Actigpatch can be worn continuously for 3 weeks without risk of water or impact damage. Participants are not responsible for remembering to wear the device. Field studies, or studies in populations struggling with adherence (e.g., children) may benefit from wearable monitors such as the Actigpatch.
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