whereas Actiware performed better in scoring nighttime than daytime sleep.
Conclusion: For both algorithms, the performance was similar in detecting daytime and nighttime sleep. Compared to Actiware, the Cole-Webster algorithm was generally better at detecting wake (i.e., high specificity) but worse at detecting sleep epochs (i.e., low sensitivity) and yielded worse overall performance (i.e., low F1). Future studies should test/validate other Actigraphy-based algorithms' performance in scoring daytime sleep.
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0100

DAYTIME SLEEP-TRACKING PERFORMANCE OF FOUR WEARABLE DEVICES DURING UNRESTRICTED HOME SLEEP

Evan Chinoy[1], Joseph Cuellar[1], Jason Jameson[1], Rachel Markwald[2]
Naval Health Research Center; Leidos Inc. [1] Naval Health Research Center [2]

Introduction: Many previous studies, from our group and others, have tested the sleep-tracking performance of commercial wearable devices and generally found that many can track sleep-wake patterns on most nights in laboratory or home settings with equal or better performance as actigraphy. However, nearly all previous studies tested devices under fixed time in bed (TIB) and only during nighttime sleep. Despite the relevance for night shift workers, device algorithms are programmed/optimized for tracking nighttime sleep, and daytime sleep-tracking performance largely remains unexplored. We therefore tested the sleep-tracking performance of devices during unrestricted home daytime sleep.
Methods: Participants were 16 healthy young adults (6 men, 10 women; 26.6±4.6 years, mean±SD) with habitual daytime sleep schedules (i.e., slept between 06:00 and 22:00 for ≥1 hour at least twice weekly). Participants slept at home for 1 week under unrestricted conditions (i.e., self-selecting TIB) using a set of four commercial wearable sleep-tracking devices and completed sleep diaries. Wearables included the Fatigue Science Readiband, Fitbit Inspire HR, Oura Ring, and Polar Vantage V Titan. TIB biases and missed daytime sleep episodes were assessed against sleep diaries.
Results: In total, 86 episodes met criteria for "daytime sleep," ranging from 2-10 episodes per participant. Percentage of daytime sleep episodes with TIB biases ≤15 and ≤60 minutes, and percentage of missed episodes in total and for short TIB (i.e., <4 hours), respectively, were as follows: Readiband (33.8%, 90.8%, 11.0%, 85.7%), Inspire HR (60.4%, 87.7%, 2.4%, 6.3%), Ring (39.5%, 90.7%, 35.8%, 85.7%), and Vantage V Titan (49.0%, 92.2%, 38.6%, 100%).
Conclusion: The commercial wearable devices generally had similar performance for tracking daytime sleep episode TIB. Like our previous findings when the devices were tested during nighttime sleep, TIB biases were also low for most daytime sleep episodes. However, the devices missed detecting several daytime episodes, which occurred more often when TIB was <4 hours. Preliminary findings suggest that daytime sleep TIB tracking is largely achievable with different commercial wearable devices; however, device sleep algorithms are not as reliable as when tracking nighttime sleep. Daytime sleep-tracking performance should be explored further.
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0101

PERFORMANCE OF A MULTISENSOR RING TO EVALUATE SLEEP AT-HOME RELATIVE TO PSG AND ACTIGRAPHY: IMPORTANCE OF GENERALIZED VERSUS PERSONALIZED SCORING

Stephen Hutchison[1], Michael Grandner[1], Zohar Bromberg[2], Zoe Morrell[2], Arnulf Graf[2], Dustin Freckleton[2]
University of Arizona [1] Happy Health [2]

Introduction: Multisensor sleep wearable devices have demonstrated utility for research and relative accuracy for discerning sleep-wake patterns at home and in the laboratory. Additional sensors and more complex scoring algorithms may improve the ability of wearables to assess sleep health.
Methods: Thirty-six healthy adults completed assessment while wearing the experimental device (Happy Ring), as well as Philips Actiwatch, Fitbit, Oura, and Whoop devices. Evaluations at home were conducted using the Dreem headband as an at-home polysomnography reference. The experimental Happy Ring device includes accelerometry, photoplethysmography, electrodermal activity, and skin temperature. Epoch-by-epoch analyses compared the Happy Ring to home polysomnography, as well as other sleep-tracking wearable devices. Scoring was accomplished using two machine-learning-derived algorithms: a "generalized" algorithm, similar to that used in other devices, which was static and applied to all users, and a "personalized" algorithm where parameters are personalized, dynamic, and change based on data collected across different parts of the night of sleep.
Results: Compared to home polysomnography, the Happy generalized algorithm demonstrated good sensitivity (94%) and specificity (67%), and the Happy personalized algorithm also performed well (93% and 75%, respectively). Other devices demonstrated good sensitivity, ranging from 91% (Whoop) to 96% (Oura). However, specificity was more variable, ranging from 41% (Actiwatch) to 60% (Fitbit). Overall accuracy using the Happy Ring was 91% for generalized and 92% for personalized algorithms, compared to 92% for Oura, 89% for Whoop, 89% for Fitbit, and 89% for Actiwatch. Regarding sleep stages, accuracy for the Happy Ring was 66%, 83%, and 78% for light, deep, and REM sleep, respectively, for the generalized algorithm. For the personalized algorithm accuracy was 78%, 92%, and 95%, for light, deep and REM sleep, respectively. Post-hoc analyses showed that the Happy personalized algorithm demonstrated better specificity than all other modalities ($p<0.001$). Kappa scores were 0.42 for generalized and 0.60 for personalized, compared to 0.45 for Oura, 0.47 for Whoop, and 0.48 for Fitbit.
Conclusion: The multisensory Happy ring demonstrated good sensitivity and specificity for the detection of sleep at home. The personalized approach outperformed all others, representing a potential innovation for improving detection accuracy.
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