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SLEEP ENHANCEMENT TECHNOLOGY IN 2021: AN UPDATED SURVEY OF APPS

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Introduction: Commercially available smartphone apps that claim to improve sleep quantity and/or quality represent an ever-evolving and fast-growing market. Although a large body of work has validated the performance of sleep tracking technologies, there is little information regarding potential sleep enhancement technologies. Our study systematically surveyed currently available commercial sleep enhancement smartphone apps to provide details to inform both providers and patients alike, in addition to the healthy consumer market.

Methods: We systematically searched the Google Play Store (Android) on 30 JUN 2021 and the App Store (Apple) on 30 JUN 2021 and 26 JUL 2021 in the US using the keyword "sleep." The Android search was conducted via the Google Play Store website. The Apple search was conducted via third-party websites linked to the App Store due to restrictions on searching the App Store online. This survey was conducted using Google Chrome web browsers and is inclusive of all smartphone applications found.

Results: We identified 550 apps: 59.5% on Android (N=327) and 40.5% on Apple (N=223). Ninety-four percent of apps offered a free version. The majority of sleep apps were intended for use during wake (72.7% exclusively during wake; 25.1% during both wake and sleep), with only 2.2% intended to be used during sleep alone. Most apps purport to enhance rather than measure sleep (87.8% versus 0.5%). The vast majority of apps claim to enhance sleep via reductions in sleep latency (92.9%). Reduced sleep latency is primarily achieved using auditory stimuli (74.5%).

Conclusion: Most current sleep apps are designed to be used while awake, prior to sleep, and focus on the enhancement of sleep, rather than measurement, by targeting sleep latency. Given the evidence that supports sleep latency as an important target for sleep promoting interventions and the multitude of available sleep enhancement apps across both Android and Apple platforms, sleep apps could be considered a possible strategy for patients and consumers to improve their sleep, although validation of these apps is required.

Support (If Any): Department of Defense Military Operational Medicine Research Program (MOMRP)

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SLEEP APNEA DIAGNOSIS USING TRACHEAL SIGNALS AND OXIMETRY

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Introduction: Diagnosing sleep apnea requires detection of apneas and hypopneas during sleep either via in-laboratory overnight polysomnography (PSG) or portable in-home sleep apnea testing (HSAT). While PSG is the optimal method, it is expensive, inconvenient and often inaccessible for patients. Although HSATs are more convenient and less expensive than PSG, they are not as accurate and have relatively high failure rates because of the nature of the sensors used to measure respiratory variables. We have developed a HSAT, the Patch, that is unique in that it is very simple and reliable because it measures respiratory variables using tracheal motion and sound combined with oximetry to detect respiratory events. In this study we tested the ability of the Patch to detect respiratory events versus simultaneous PSG.

Methods: Participants were adults with a suspected sleep disorder referred to the sleep laboratory at Toronto Rehabilitation Institute for PSG. Simultaneous to the PSG, the Patch, consisting of a module containing a microphone and a 3-D accelerometer that was affixed to participants' suprasternal notch, and a finger oximeter. After filtering the tracheal signals, the envelope of the tracheal motions in the cranial and postero-anterior directions and tracheal sound envelope were extracted. Along with tracheal features, the amplitude and slopes of oxygen desaturations were also extracted and, were fed into a supervised deep neural network model to detect apneas and hypopneas. The total number of detected events was divided by total estimated sleep time to estimate the apnea-hypopnea index (AHI). The performance of the model in diagnosing sleep apnea was evaluated by sensitivity (AHI≥15) and specificity (AHI<15). The relationship between the estimated AHI and PSG-based AHI was quantified using Pearson correlation.

Results: Ninety-nine participants (42 females, age: 48±16 years, body mass index: 29.2±5.2 kg/m2, and AHI: 15.8±19.4 events/hour) completed the study. We found that the Patch had 88.6% sensitivity and 89.1% specificity for diagnosing sleep apnea. Strong agreement was observed between the estimated and reference AHI values ($r = 0.92$, $p < 0.001$).

Conclusion: The Patch is a novel, robust and convenient portable device that provides an accurate means of detecting and quantifying sleep apnea. It has the potential to provide reliable home-based sleep apnea monitoring.

Support (If Any): Funded by Bresotec Inc.

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REM-LIKE NEURAL ACTIVITY IS SUPERIOR TO NREM PARAMETERS FOR PREDICTING NON-SLEEP RESTRICTED VIGILANCE

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Introduction: Currently unknown is whether REM-like neural activity reverses, incurs, or is neutral with respect to its effect on sleep pressure independent from NREM recovery. We investigated the relationship between a novel scalp-EEG measure of REM-like neural activity and next-day performance on the Psychomotor Vigilance Task (PVT) – a sensitive measure of sleep debt. Our EEG measure reflects the oscillatory-theta activity (OTA) that is the hallmark of REM sleep in animal studies. This method preserves amplitude information, isolates OTA from aperiodic theta-band power, and accounts for REM-like activity thought to occur outside of conventionally scored-REM epochs. We compared the PVT-association of OTA, traditionally measured EEG REM-theta, and traditional sleep parameters. To assess REM-like independent effects, we controlled for traditional parameters using a multivariate model.

Methods: Our method uses Irregular-Resampling Auto-Spectral Analysis to remove the aperiodic spectrum, followed by low-band