Sleep Number Announces New Research on Sleep Stages, Influenza Prediction, and Sleep Disorders Using Its 360® Smart Bed at World Sleep 2022

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Results from Sleep Number's first study accepted for publication demonstrate potential for the 360 smart bed to detect sleep stages in real-time, which could help guide intervention for certain sleep disorders in the future.

Additional studies demonstrate the research capabilities of the 360 smart bed to predict and detect symptoms of influenza-like illnesses and to study sleep disorders, such as insomnia.

Sleep Number to host symposium on the optimization of sleep environments for improved sleep quality, led by world leaders in sleep research.

ROME--(BUSINESS WIRE)--Sleep Number Corporation (Nasdaq: SNBR), the sleep health, science, research and innovation leader, will announce new studies using its 360® smart bed at World Sleep 2022, the 16th international meeting of the World Sleep Society in Rome from March 11-16. Sleep Number will present results of its first study accepted for publication, which will appear in the journal Physiological Measurement, showing the potential of an algorithm to detect sleep stages in real-time using cardiac data gathered from its 360 smart bed. Additionally, Sleep Number will present results of a prediction model for influenza-like illnesses and a study to potentially detect sleep disorders like insomnia. These studies further demonstrate the potential research capabilities of the 360 smart bed to accurately assess and monitor sleep in a non-invasive, longitudinal way, while also delivering effortless, proven quality sleep. Sleep Number will also host a symposium with world-leading sleep experts to evaluate how factors like temperature, light, noise and sleeping position can be optimized to improve sleep quality.
Sleep Number Corporation, the sleep health, science, research and innovation leader, announced new studies using its 360® smart bed at World Sleep 2022, the 16th international meeting of the World Sleep Society in Rome from March 11-16. (Graphic: Business Wire)

“As evidenced by our new data presented at World Sleep 2022 and our first study accepted for publication, Sleep Number is redefining the standards for monitoring sleep for research and health through the 360 smart bed,” said Annie Bloomquist, Chief Innovation Officer, Sleep Number. “In collaborating with leading physicians, researchers and institutions, we know they need a trusted device that’s accurate and offers longitudinal data collection. They seek the ability to understand native, undisturbed, real-world sleep behaviors and their ensuing health implications to translate scientific understanding into improved sleep quality. Our 360 smart bed offers those capabilities. We are proud to advance the development of meaningful sleep health innovations and provide actionable, evidence-based solutions to achieving quality sleep to a global audience. This reflects Sleep Number’s commitment to improve society through higher quality sleep.”

Real-time implementation of sleep staging using interbeat intervals

- In this study, which was accepted for publication in the journal Physiological Measurement, Sleep Number demonstrated that nightly sleep stages could be accurately predicted using data from cardiac signals as compared to traditional brain wave signals. The results indicate that, in the future, the 360 smart bed may be able to detect the risk of sleep apnea.

In normal heart function, each value between two heart beats, known as heart interbeat intervals (IBIs) varies from beat to beat. This natural variation is known as HRV. IBIs can change rapidly during sleep, enabling the measurement of sleep stages in real-time through algorithms that utilize cardiac metrics. However, these traditional algorithms can range in accuracy and typically include numerous parameters or utilize entire sleep sessions for classification, making them not suitable for real-time interventions. In this study, Sleep Number developed a small deep neural network (DNN) algorithm to detect sleep stages using IBIs measured through ECG. ECG data from healthy sleepers and people with sleep apnea were used to train and validate the algorithm.

Results of the study showed the Sleep Number algorithm performed with high specificity and moderate sensitivity in detecting deep and REM sleep. The algorithm performed better overall in healthy sleepers compared to those with sleep apnea, likely due to differences in IBIs seen between the two groups. These results suggest this algorithm can be used to perform real-time sleep staging and potentially direct intervention strategies during REM or deep sleep.
Approximation of Influenza-like illness rates using sleep and cardiorespiratory data from a smart bed

- This study investigated whether Sleep Number’s COVID-19 prediction model could be applied to detect symptoms of other influenza-like illnesses (ILI) by comparing pre-pandemic smart bed sleeper data to U.S. Centers for Disease Control and Prevention (CDC) trend reports on ILI rates. The findings indicate that, in the future, the 360 smart bed may be able to predict and track the development of symptoms associated with a wide range of respiratory illnesses and notify sleepers prior to symptom onset.

Viral respiratory illnesses such as influenza can have an impact on sleep quality, duration and cardiorespiratory function. Previously, Sleep Number developed a symptom detection model to predict COVID-19 infection using real-world, unobtrusive sleep metrics gathered from its 360 smart bed users. Inputs to the detection model that were obtained using ballistocardiograph signals from the smart bed included sleep duration, sleep quality, restful sleep duration, time to fall asleep, respiration rate, heart rate and motion level.

The sleep data of 4,187 sleepers from January 2017 to December 2019 were included in the study. Data from January 2017 to June 2018 were fitted to weekly ILI rates reported by the CDC to train the prediction model, and correlation coefficients between predicted and reported ILI rates between July 2018 and December 2019 were calculated. The study showed a correlation of 0.91 between ILI symptoms predicted with the Sleep Number model and CDC-reported rates. Coefficients close to 1.0 indicate a positive correlation. In addition, when analyzing the 2018-2019 influenza season specifically, the correlation of predicted and reported ILI rates was 0.87.

The sleep metrics measured by the 360 smart bed are a unique source of real-world longitudinal data collected in an unobtrusive manner. These results demonstrate the potential for the Sleep Number model to predict and track the development of symptoms associated with a wide range of respiratory illnesses, including influenza and COVID-19.

EEG spectral properties and associated ECG-based heart rate variability in people with insomnia versus healthy sleepers

- Sleep Number found that important sleep characteristics of insomnia that are traditionally measured by brain wave activity via an electroencephalogram (EEG), can be captured utilizing cardiac signals measured by the 360 smart bed. The results suggest that, in the future, the 360 smart bed may be able to detect a risk of insomnia by using cardiac data, without a sleeper having to participate in a formal sleep lab study.

Sleep disorders such as insomnia may disrupt normal central and autonomic nervous system function, meaning they can affect the way the brain operates and the unconscious regulation of essential bodily functions including breathing, heart rate, blood pressure and others. These disruptions can be measured by coupling EEG readings,
which analyze brain waves, and electrocardiogram (ECG) readings, which analyze cardiac activity, with heart rate variability (HRV). This study was conducted to compare the sleep architecture (rapid eye movement [REM] sleep and non-REM sleep), central and autonomic nervous system functions and EEG/ECG coupling of healthy sleepers versus people with insomnia using polysomnography.

The study showed that people with insomnia exhibited certain brain waves during non-REM sleep, which is likely a sign of restlessness and could negatively impact sleep quality. In addition, the study found these brain waves, measured by EEG, could be predicted through HRV changes measured by ECG.

**Symposium: Can the sleeping environment be optimized to improve sleep quality?**

Environmental factors play a significant role in achieving quality sleep. On Monday, March 14, Sleep Number’s symposium will evaluate temperature sensing; the impact of light exposure on sleep and circadian rhythms as well as the impact of ambient noise on sleep quality; and the benefits of optimizing sleeping position in people with sleep disorders that impact breathing.

The symposium panel includes several world leaders in sleep research:

- **Eve Van Cauter, Ph.D.:** Frederick H. Rawson Professor and Director of the Sleep, Metabolism and Health Center at the University of Chicago; Sleep Number Scientific Advisory Board member
- **Virend Somers, M.D., Ph.D.:** Professor of Medicine at Mayo Clinic College of Medicine and Science; Director of the Cardiovascular Facility and the Sleep Facility Center for Clinical and Translational Science at Mayo Clinic; Sleep Number Scientific Advisory Board member
- **Eus van Someren, Ph.D.:** Professor at Vrije Universiteit Amsterdam and Head of the Department of Sleep and Cognition at the Netherlands Institute for Neuroscience
- **Christian Cajochen, Ph.D.:** Professor and Head of the Centre for Chronobiology at the University of Basel

To view our studies and learn more about our innovations in sleep health, science and research, visit: [www.sleepnumber.com/science](http://www.sleepnumber.com/science).

**About Sleep Number**

Individuality is the foundation of Sleep Number. Our purpose driven company is comprised of over 5,000 passionate team members who are dedicated to our mission of improving lives by individualizing sleep experiences. We have improved nearly 14 million lives and are positively impacting society’s wellbeing through higher quality sleep.

Our award-winning 360® smart beds are informed by science. They learn from over one billion sleep sessions of
highly-accurate, real world sleep data – the cumulation of almost 14 billion hours’ worth - to automatically adjust to each sleeper and provide effortless comfort and proven quality sleep. Our 360 smart beds deliver individualized sleep health reports and insights, including a daily SleepIQ® score, and are helping to advance meaningful sleep health solutions by applying sleep science and research.

For life-changing sleep, visit SleepNumber.com or one of our 650 Sleep Number® stores. More information is available on our newsroom and investor relations sites.

Forward-looking Statements

Statements used in this news release relating to future plans, events or performance such as plans to expand our capabilities to predict and detect symptoms of influenza-like illnesses and to study sleep disorders, such as insomnia, and analyze real-time sleep staging to potentially detect and guide intervention for sleep disorders are forward-looking statements subject to certain risks and uncertainties. Additional information concerning these and other risks and uncertainties is contained in the company’s filings with the Securities and Exchange Commission (SEC), including the Annual Report on Form 10-K, and other periodic reports filed with the SEC. The company has no obligation to publicly update or revise any of the forward-looking statements in this news release.

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