A Comparison of Estimated Sleep-Wake Patterns Obtained from a Large U.S. Sample by Home-Based Under-Mattress Monitoring Devices Before and After the Start of the COVID-19 Pandemic

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Introduction

The COVID-19 pandemic has affected sleep in multiple ways. Technological advances in home sleep monitoring have provided the opportunity to analyze sleep-wake patterns on a scale much larger than previously imaginable. This study compares the estimated sleep-wake patterns in the time before and after the start of the pandemic in a large U.S. sample.

Methods

Sleep parameters [estimated total sleep time (TST), bedtime (BT), and morning rise time (RT)] were analyzed by a commercially-available home sleep monitoring device (Sleeptracker-AI Monitor, Fullpower Technologies, California, USA). The device passively monitors sleep using piezo-electric sensors that register the forces exerted through the mattress by features such as the individual's motion, respiration, heartbeats, and snoring vibrations. The de-identified data obtained from the devices were analyzed, following review and exemption of the study (#57681) from the Stanford University IRB. Data from the calendar years of 2019 and 2020, from 62,152 individuals with 20,255,441 recorded nights, were available. Individuals who had at least 300 nights of sleep each year were included in the analytic dataset, with Sunday nights through Thursday nights analyzed since sleep on weekend nights was expected to have more variability.

Population

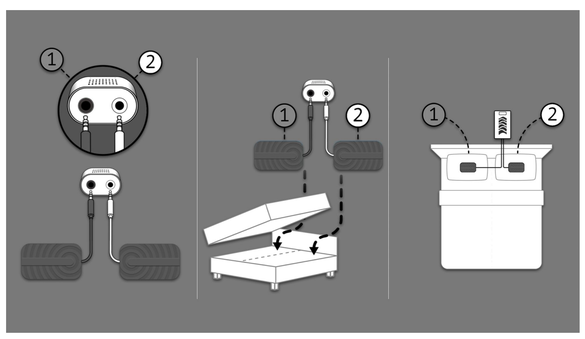
Available Data
2019 and 2020 calendar years
62,152 individuals with 20,255,441 recorded nights

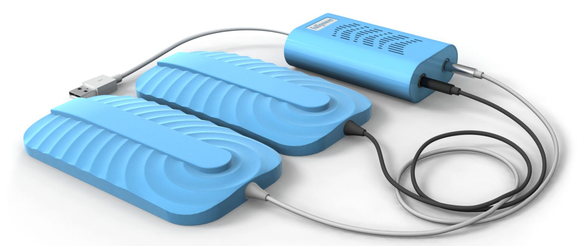
Criteria for Inclusion in Analytic Dataset
Individuals with at least 300 nights of sleep each year were included
Sunday nights through Thursday nights analyzed

Met Criteria for Data Analysis
8,580 individuals (4,459 men, 51 ± 13 years; 3,982 women, 50 ± 13 years) - 5,681,087 recorded nights

Deidentified data were analyzed, following review and exemption of the study (#57681) from the Stanford University IRB

Device Setup





Timepoint Comparison: 2019 vs 2020

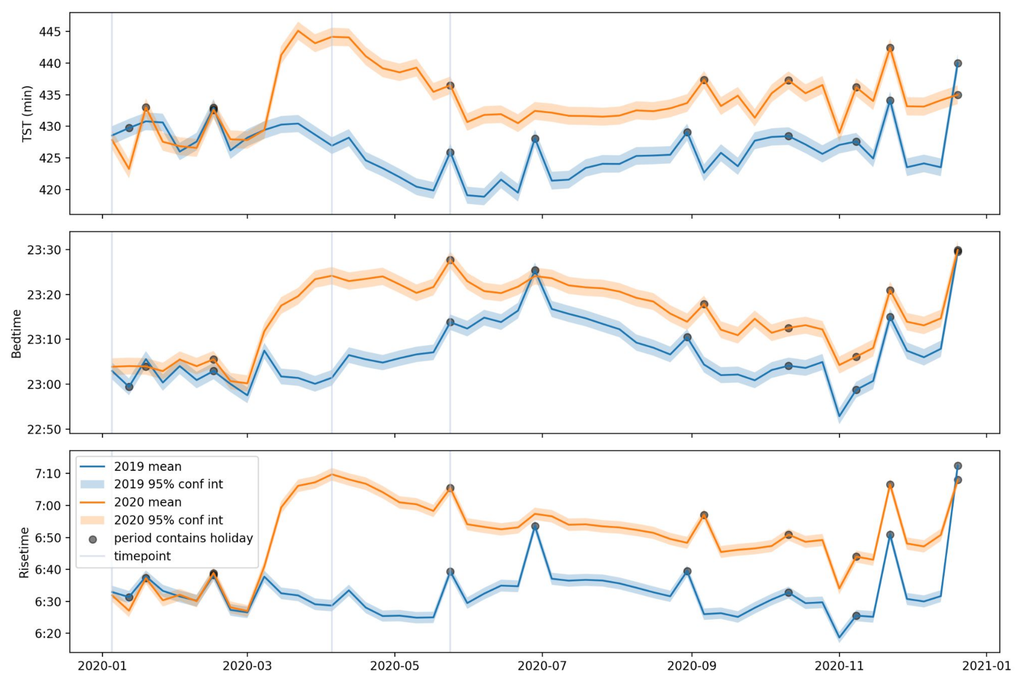
Change in Total Sleep Time, Bedtime, and Rise Time as compared to Pre-Pandemic Baseline

Timepoints	Total Sleep Time	Bedtime	Rise Time
(A) Pre-Pandemic Baseline	- 0.7 min	+ 0.9 min	- 1.0 min
1/6/2019 - 1/10/2019	428.6 ± 64.0 min	23:02.9 ± 82.9 min	6:32.9± 86.7 min
1/5/2020 - 1/9/2020	427.8 ± 65.3 min	23:03.9 ± 82.9 min	6:31.9 ± 86.1 min
(B) First Wave Zenith	+ 17.2 min*	+ 22.8 min*	+ 41.1 min*
4/7/2019 - 4/11/2019	426.9 ± 60.9 min	23:01.4 ± 79.9 min	6:28.7 ± 82.2 min
4/5/2020 - 4/9/2020	444.1 ± 65.9 min	23:24.2 ± 88.9 min	7:09.7 ± 90.4 min
(C) Nadir Between 1st and 2nd Waves	+ 10.6 min*	+ 13.9 min*	+ 26.1 min*
5/26/2019 - 05/30/2019	425.9 ± 61.3 min	23:13.8 ± 79.6 min	6:39.3 ± 79.8 min
5/24/2020 - 05/28/2020	436.5 ± 63.7 min	23:27.7 ± 85.9 min	7:05.4 ± 86.9 min

* $p < 0.05$ by paired t-test

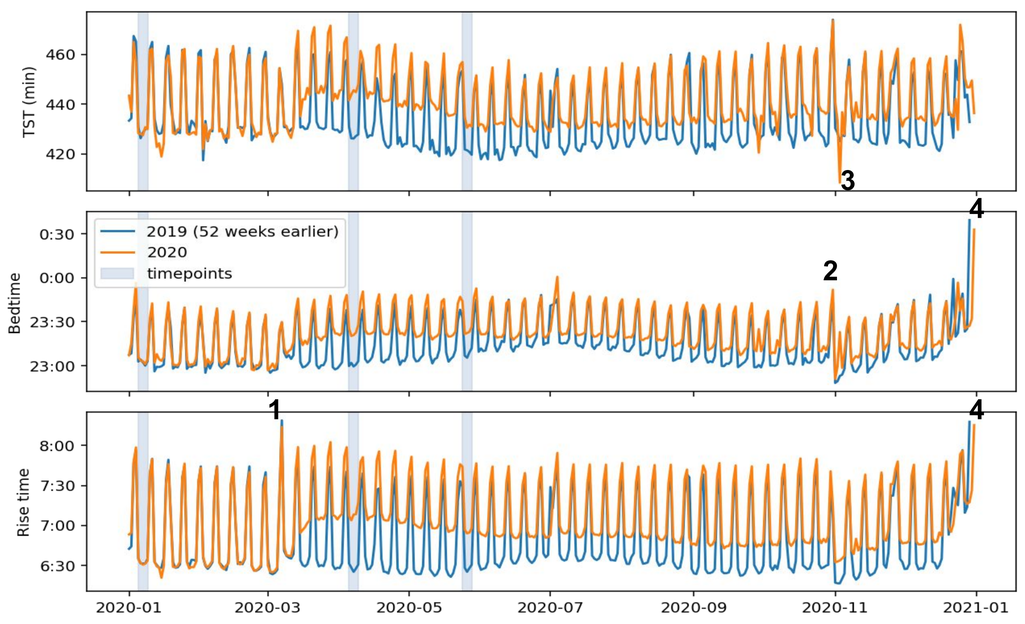
Sleep Comparison: 2019 vs 2020 by Week

Mean TST, Bedtime, and Rise Time by Week (Sun-Thurs) across 8580 individuals



Sleep Comparison: 2019 vs 2020 by Day

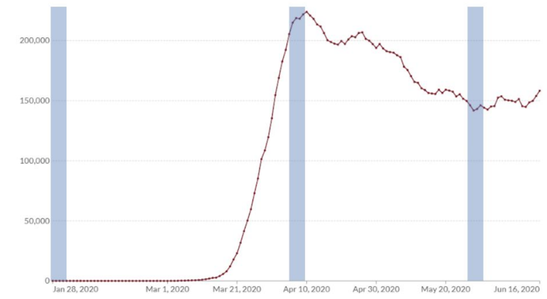
Mean TST, Bedtime, and Rise Time by Date across 8580 individuals



Notable Anomalies:
1: Spring Time Change
2: Fall Time Change
3: 2020 Election Night
4: New Year's Eve

Timepoint Selection

NEW REPORTED COVID-19 CASES IN 2020



(A) 1/5/2020 - 1/9/2020
Pre-pandemic baseline: first full week of 2020

(B) 4/5/2020 - 4/9/2020
First wave zenith: 218,581 new U.S. weekly cases

(C) 5/24/2020 - 05/28/2020
Nadir between 1st and 2nd waves: 147,228 new U.S. weekly cases

- Each timepoint comprised a week of nights ending on weekdays (Sunday night through Thursday night)
- Each given week in 2020 was compared with a week 52 weeks (364 days) earlier in 2019.

Results

A total of 8,580 individuals (4,459 men, 51 ± 13 years; 3,982 women, 50 ± 13 years) with 5,681,087 recorded nights met the inclusion criteria for data analysis.

In preparation for time-series analysis, we analyzed key timepoints. Each timepoint comprised a week of nights ending on weekdays (Sunday night through Thursday night), with a given week in 2020 compared with a week 52 weeks (364 days) earlier in 2019. The weeks selected were:

(A) 1/5/2020-1/9/2020 (pre-pandemic baseline, first full week of 2020);
(B) 4/5/2020-4/9/2020 (first wave zenith: 218,581 new U.S. weekly cases), and
(C) 5/24/2020-05/28/2020 (nadir between first and second waves: 147,228 new U.S. weekly cases).

The differences between 2019 and 2020 in estimated mean TST, BT, and RT for each of the timepoints, in minutes, were: (A) TST -0.7, BT +0.9, RT -1.0; (B) TST +17.2*, BT +22.8*, RT +41.1*; (C) TST +10.6*, BT +13.9*, RT +26.1*; a (+) indicates an increase and (-) a decrease in the sleep parameter from 2019 to 2020, and (*) signifies $p < 0.05$ by paired t-test. Weekend data followed similar but less pronounced trends compared to the weekday data, with an average difference of +9.0*, +13.4*, and +22.1* in estimated TST, BT, and RT, respectively, for the weekend preceding timepoint (B).

Conclusion

An estimated increase in TST and delayed BT/RT was associated with the pandemic's first wave zenith vs. the prior year for the same individuals. At the nadir between waves 1 and 2, differences between the individuals' sleep parameters were still greater compared to pre-pandemic levels.

The causes of these changes are likely multifactorial, including possible factors such as the coronavirus's clinical/subclinical effects and comorbidities, social isolation, stress, and variability in work-from-home schedules. Home sleep monitoring enables analysis of longitudinal trends, and further work will focus on studying the evolution of sleep architecture/patterns over the pandemic's course.

Oral Presentation at
WORLD SLEEP March 11-16 2022 Rome, Italy