ASTRONAUT SLEEP DURATION VARIES BY TIMING OF SCHEDULED SLEEP

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Introduction

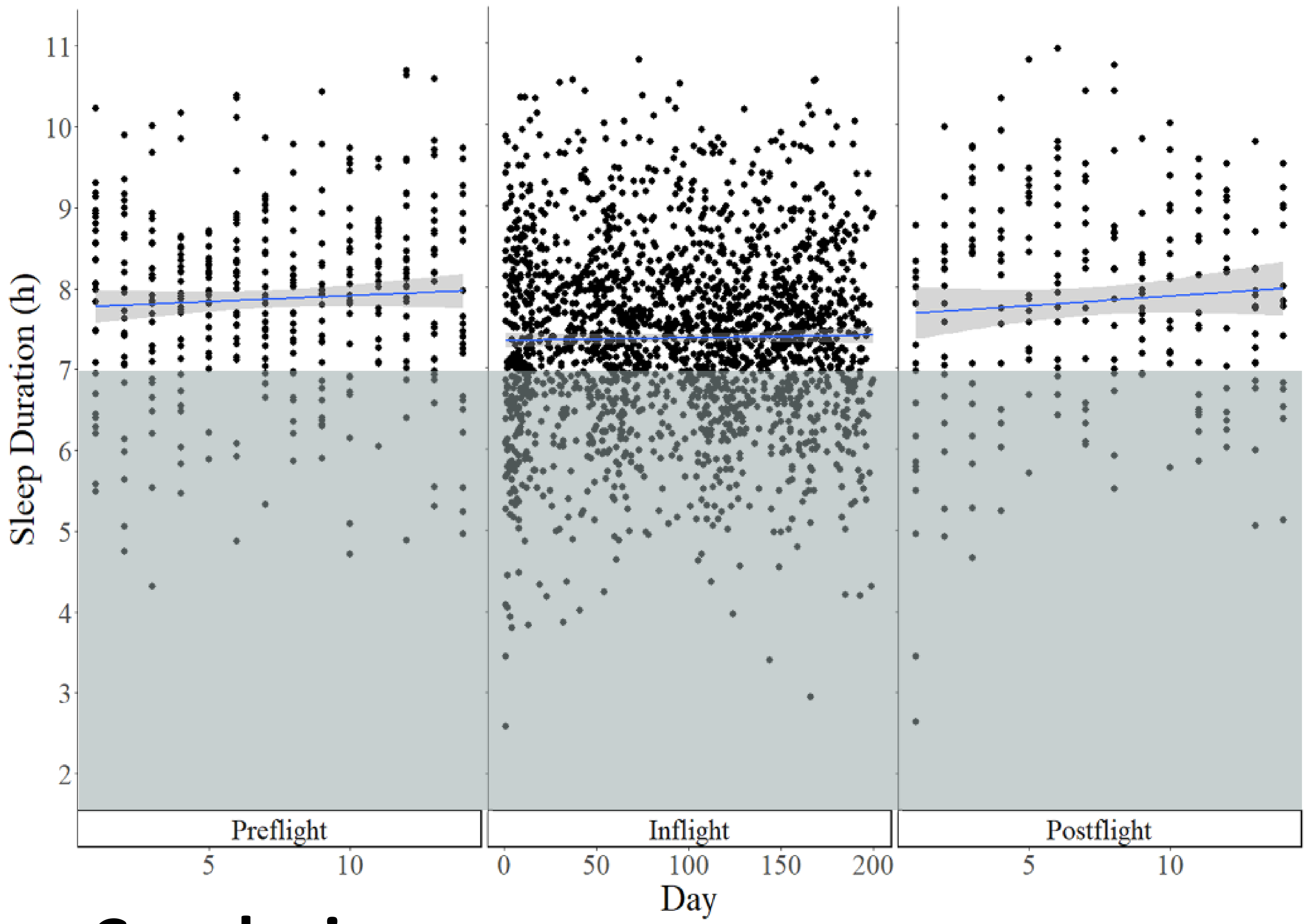
- Historically, humans average ~6h of sleep per night in space[1-7]
- This has led to reduced alertness and performance[4,7]
- Crew schedules have become more regular in recent missions aboard the ISS alongside improvements to crew facilities (e.g., the addition of sleep stations)
- We investigated whether improvements to schedules and facilities also ameliorated sleep outcomes

Methods

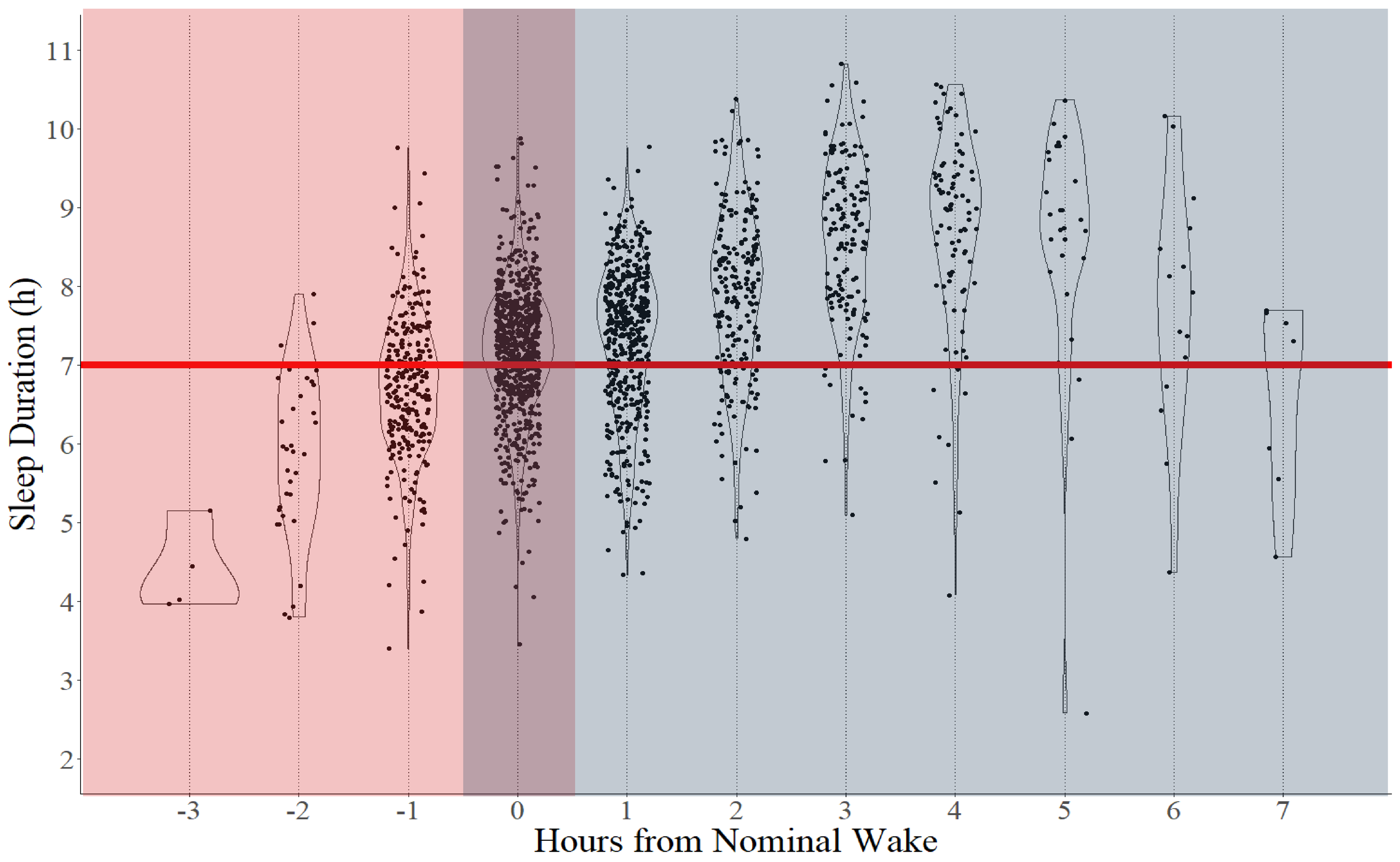
- N = 19 (7F) volunteer crewmembers (mean age 45 +/- 7 years) between Jan 2019 and Mar 2022
- **Baseline**: L-270 (14 days, 270 days prior to launch), L-180 (14 days, 180 days prior to launch)
- **Inflight**: 200 days inflight
- **Postflight**: R+0 (14 days, immediately after return)
- Sleep outcomes: sleep duration (h), sleep efficiency (%), number of awakenings (n), wake after sleep onset (min; WASO), and sleep latency (min)

Results

Sleep Duration (h) by Day and Flight Phase



Sleep Duration (h) by Sleep Offset Timing



Conclusion

- Humans can achieve sufficient sleep in space, especially when their schedules afford adequate sleep (namely, schedules that phase delay rather than advance)
- Future studies are needed to determine whether microgravity impacts sleep architecture and sleep quality
- Going forward, it is imperative that crewmembers are provided with stable schedules, with moderate workload, and environments that are conducive to sleep

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Introduction

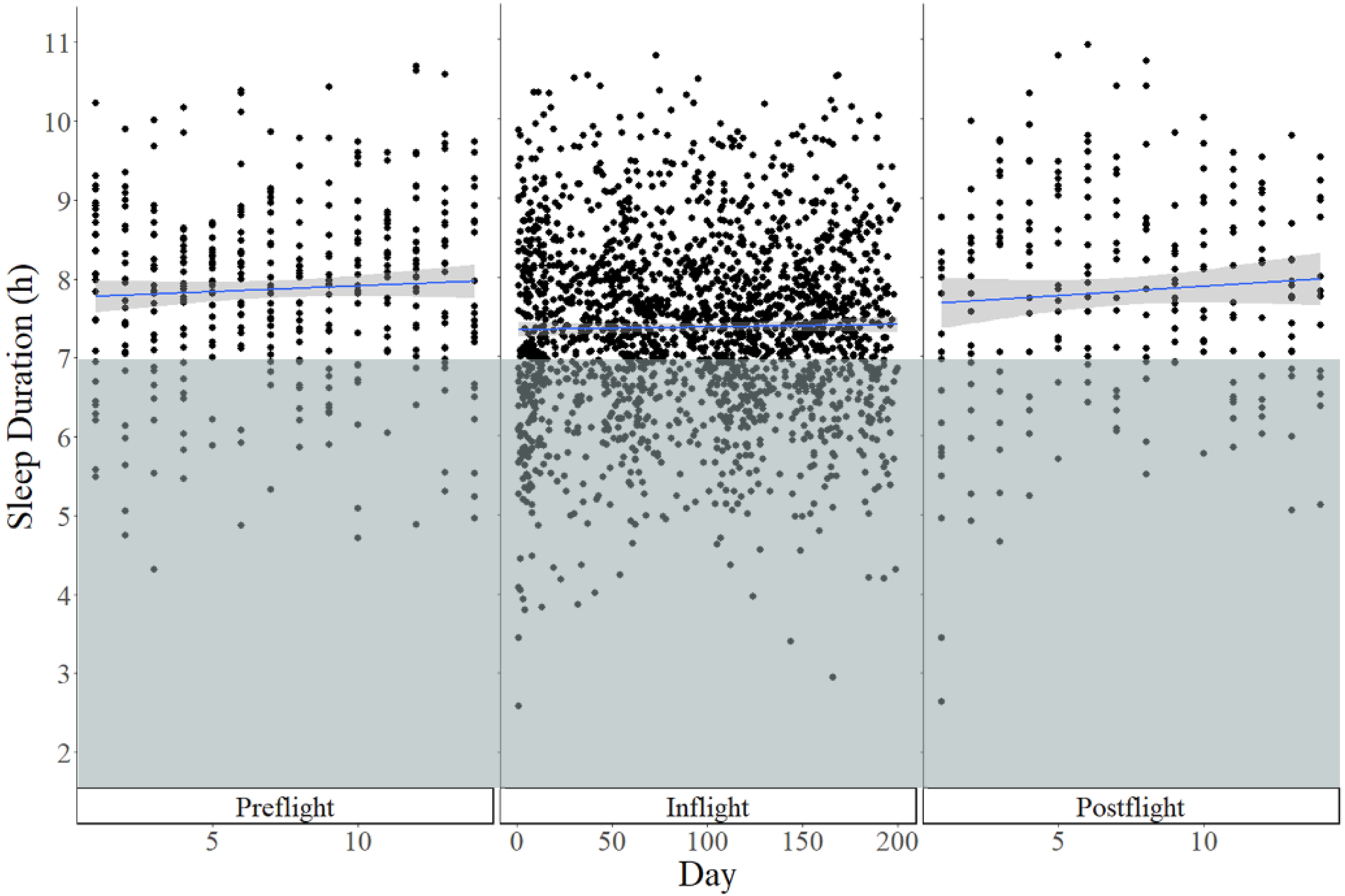
- Humans average approximately six hours of sleep per night in space, which has been associated with reduced alertness and performance[1-7]
- It is unclear whether this sleep loss is related to modifiable factors (irregular scheduling, poor sleep environment, excessive workload) or due to features of spaceflight that alter physiology (e.g., microgravity)
- Recent missions have afforded crewmembers better, more stable sleep and work schedules, and an improved sleep environment
- Despite these improvements, schedules vary enough to cause decrements in sleep duration
- We analyzed sleep outcomes depending on the distance from nominal sleep offset (6:00AM) to see the impact on scheduled sleep aboard the ISS

Methods

- N = 19 (7F) Crewmembers (mean age 45 +/- 7 years), volunteered from NASA Standard Measures protocol between Jan 2019 and Mar 2022
- Nominal Sleep Schedule: 9:30 PM – 6:00 AM
- **Preflight**: L-270 (14 days, 270 days prior to launch) and L-180 (2 weeks, 180 days prior to launch)
- **Inflight**: Average 206 days in space (+/- 49 days); only 3 crewmembers exceeded 200 days inflight, so we set a cutoff for analyses of 200 days inflight; With this cutoff, the crew average 186 (+/- 16 days) inflight
- **Postflight**: R+0 (14 days, immediately after return)
- Sleep outcomes: sleep duration (h), sleep efficiency (%), number of awakenings (n), wake after sleep onset (min; WASO), and sleep latency (min)

Photo Credit: NASA

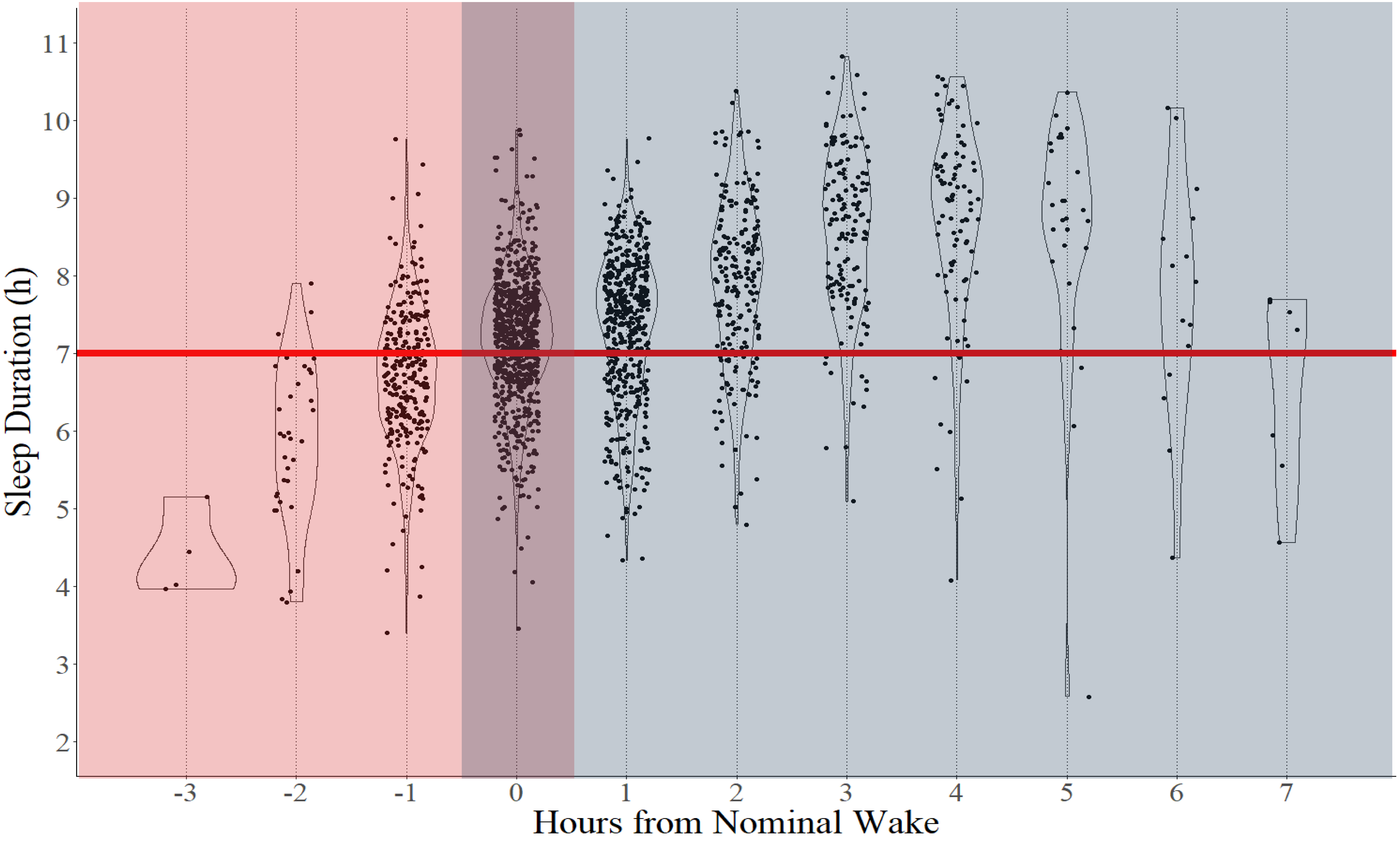
Results



Average Sleep Duration (*SD*)

- Preflight: 7.26 (*0.44*)
- Inflight: 7.88 (*0.51*)
- Postflight: 7.84 (*0.79*)

Results



- For every hour after the nominal sleep period a crewmember woke up, their total sleep increased by 25 min (up to 5 hours)

Results

Hours from Nominal Wake	N	Mean Sleep Duration (*SD*)	Sleep Efficiency (*SD*)	WASO (*SD*)	Sleep Latency (*SD*)
-3	4	4.46 (*0.50*)	84.33 (*1.88*)	14.33 (*13.30*)	19.67 (*12.28*)
-2	35	5.57 (*0.75*)	88.63 (*4.67*)	19.81 (*9.55*)	5.40 (*5.93*)
-1	261	6.59 (*0.61*)	88.23 (*4.65*)	28.25 (*13.31*)	8.98 (*7.63*)
0	742	7.07 (*0.48*)	88.63 (*3.17*)	30.83 (*10.99*)	9.06 (*6.37*)
1	462	7.33 (*0.55*)	88.93 (*2.33*)	32.14 (*10.20*)	7.12 (*7.39*)
2	206	7.78 (*0.73*)	88.75 (*4.56*)	31.90 (*14.15*)	10.02 (*8.32*)
3	142	8.33 (*0.88*)	89.57 (*4.23*)	36.21 (*19.32*)	6.33 (*6.12*)
4	86	8.42 (*1.04*)	88.13 (*4.55*)	34.73 (*14.59*)	11.78 (*13.34*)
5	28	8.41 (*1.26*)	90.02 (*2.80*)	32.72 (*7.10*)	6.99 (*6.73*)
6	15	7.47 (*1.20*)	85.69 (*7.76*)	29.89 (*14.58*)	8.17 (*9.02*)
7	7	6.62 (*1.11*)	93.11 (*3.55*)	11.17 (*8.43*)	2.67 (*5.96*)

Conclusion

- Humans are capable of achieving sufficient sleep in space
- Overall sleep quality improves under schedules that afford adequate sleep, such as schedules that start later (phase delay) rather than earlier (phase advance)
- Future studies are needed to determine whether microgravity impacts sleep architecture and sleep quality
- Future studies are also needed to better understand how sleep is related to performance and sleepiness, and to the impacts of medication use inflight
- Going forward, it is imperative that crewmembers are provided with stable schedules, with moderate workload, and environments that are conducive to sleep

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