

Daily Stress and Objective Sleep Outcomes in a Real-World Sample of over 83,000 U.S. Adults



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Introduction

- Poor sleep quality (often defined as high WASO, low REM, etc.) is associated with adverse health outcomes
- Stress activates the HPA axis
 - Releases cortisol and adrenaline
 - Limits sleep quality
- Sleep deprivation:
 - Raises baseline cortisol levels
 - Increases amygdala sensitivity up to 60%
- Current literature reveals stress-sleep association
 - Gap persists: limited studies on real-world populations with objective sleep architecture

Methods

1

83,288
U.S. adults

- 47% female
- Mean age 51.6 ± 14.5 years

Overnight sleep recorded using the **Sleeptracker-AI Monitor**



Under-mattress piezo-electric sensors capture sleep stages, respiration, and movement continuously

2

Daily Survey

"Was your day stressful?"

Stress-free

Normal
(normal stressors occurred)

Stressful

3

Objective Sleep Architecture

TST
(Total Sleep Time)

REM
Sleep %

Deep
Sleep %

WASO
(Wake After Sleep Onset)

AI
(Arousal Index)

BAI
(Breathing Anomaly Index)

4

Statistical Approach

Mixed linear models

Participant as a random effect

Estimate % changes in sleep parameters

Results

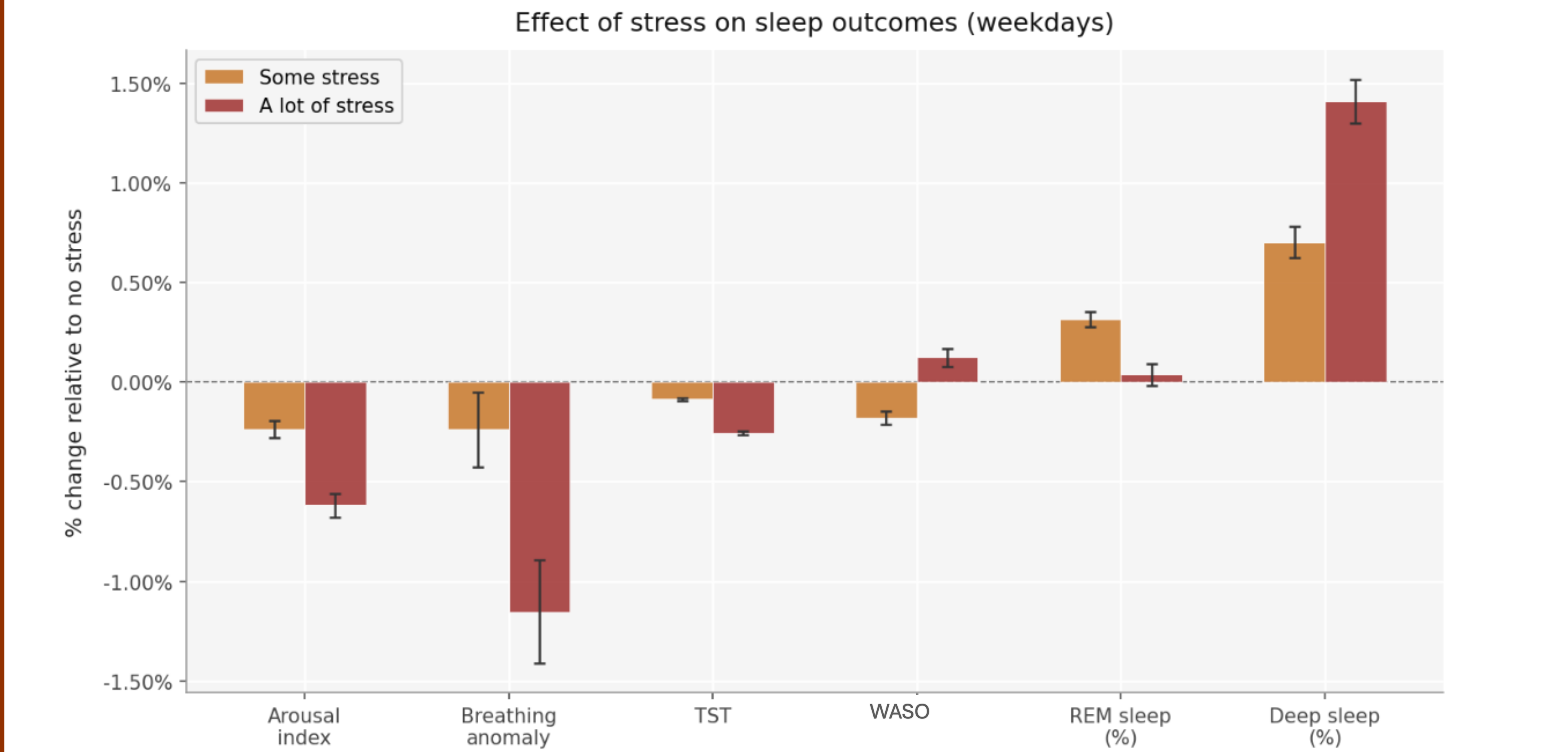


Figure 1. Mixed-effects regression estimates (% change relative to no stress) for six sleep outcomes comparing some stress and a lot of stress. Error bars = 95% CI. TST declined monotonically (-0.86%, -2.56%); WASO reversed direction at high stress (-1.41% to +0.92%); deep sleep increased consistently, peaking at +1.41% under high stress.

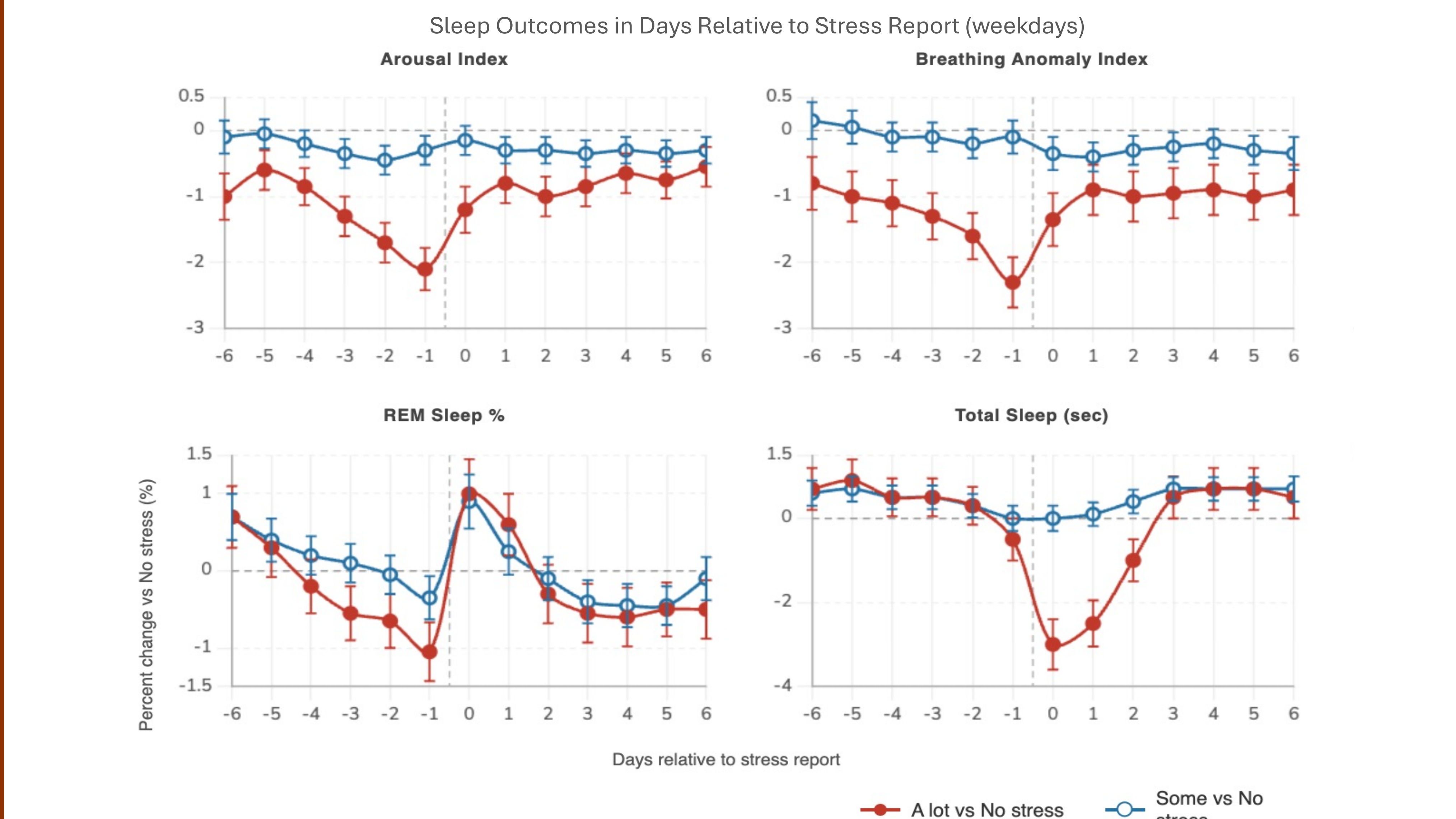


Figure 2. Longitudinal line graphs measuring sleep outcomes aligned to days surrounding a weekday stress report. Error bars = 95% CI. Across panels, higher stress is associated with a clear dip around the stress day (day 0) in arousal and breathing anomaly indices, and a marked reduction in total sleep time, with partial recovery in subsequent days.

Results

1 MAIN FINDING

Stress altered all 6 sleep architecture metrics. Effects were not uniformly dose-dependent.

N1 Light Sleep

N2 Light Sleep

N3 Deep Sleep (Slow-Wave)

REM Rapid Eye Movement

WASO Wake After Sleep Onset

TST Total Sleep Time

2 KEY QUANTITATIVE FINDINGS

HIGH STRESS

Sleep Quantity ↓ -2.56%

HIGH STRESS

Sleep Continuity Worse WASO +0.92%

MODERATE STRESS

Unexpected Benefit WASO -1.41% ↓, REM +0.31% ↑

DEEP SLEEP RESPONSE

Deep Sleep ↑ with Stress +1.41% at High Stress

3 CENTRAL TAKEAWAY

LOW STRESS

MODERATE STRESS

HIGH STRESS

Moderate ("Normal") Stress

↓ WASO

↑ REM

Potential adaptive / hormetic response

High Stress

↑ WASO

↓ Sleep Quantity

! The REM and WASO pattern reversed once stress became high.

Key Takeaway

- Moderate or "normal" stress **reduced** WASO and **increased** REM
- High stress **increased** WASO and **reduced** REM
- Stress continues to affect the sleep profile beyond day of stress occurrence

Conclusion

- These non-linear, outcome-specific patterns demonstrate that stress does not uniformly "worsen" sleep:
 - Effects depend on both stress severity and the sleep metric examined
- Findings highlight the value of large-scale continuous wearable monitoring for detecting real-world stress-sleep dynamics
 - At home- accessibility improves sample diversity and generalizability
- Future work should examine:
 - Divergent sleep architecture signatures between chronic and acute stress
 - Stressor-type dependent sleep outcomes



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