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HIGH STRAIN EVENING EXERCISE DISRUPTS SLEEP: INSIGHTS FROM A REAL-WORLD EXAMINATION OF ~7-MILLION NIGHTS

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Introduction: Exercise is among the most effective daytime behaviors for promoting and maintaining sleep. However, late-night bouts of strenuous exercise that require high physiological demand (i.e., high strain) induce persistent increases in sympathetic arousal, which may disrupt sleep. We examined whether exercise strain moderates the relationship between evening exercise and objective sleep in free-living conditions.

Methods: A total of 19,977 individuals (26% female, M-age=37.9 years) wore a validated sleep and exercise biometric wearable device for 365 days between Sep 1, 2021 and Aug 31, 2022 (n=6,943,372 nights). Summated-heart-rate-zone-scores were used to categorize exercise strain into four groups: light, moderate, high, and all-out. Exercise timing was normalized to each individual's habitual bedtime to account for individual differences in sleep/wake timing. Generalized additive mixed model analyses were used to model the non-linear relationship between exercise timing and sleep at different levels of exercise strain.

Results: Later exercise timing was associated with delayed sleep onset, reduced sleep quantity and quality, and increased sympathetic activity compared to no-exercise rest days (ps<.001). Importantly, a dose-response relationship was observed such that higher levels of exercise strain predicted worse sleep (ps<.001). Regardless of strain, exercise bouts ending at least 4 hours before habitual bedtime were not associated with changes in sleep.

Discussion: Evening exercise—particularly involving high exercise strain—can disrupt subsequent sleep (both duration and quality). It is recommended individuals stop exercising at least 4 hours before their habitual bedtime. However, when evening exercise is unavoidable, individuals could select lighter strain exercises to mitigate sleep disruption.