0200

DOES SLEEP PREDICT ANTIBODY RESPONSE AND MAINTENANCE TO THE COVID-19 VACCINE?

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Introduction: There is growing evidence that insufficient sleep can negatively impact the immune system, including vaccination response. Prior laboratory studies have shown that acute sleep restriction can result in impaired antibody resposne to the hepatitis A and influenza vaccine. Similarly, prospective studies have shown that short sleep duration, measured by self-report and wrist actigraphy, is associated with muted antibody responses. These prior findings have critical implications for the COVID-19 pandemic and the efficacy and durability of the COVID-19 vaccines currently available. Whether sleep accounts for variability in response to the COVID-19 vaccination series has not been investigated.
Methods: We recruited 530 healthy participants (mean age= 52.4, SD=12.1, range: 18-88 years; 64.1% female) who were naive to the COVID-19 vaccination series. Participants completed self-report questionaires (e.g., Pittsburgh Sleep Quality Index) and morning sleep diaries for 7-consecutive days surrounding COVID-19 vaccine administrations. Additionally, 198 participants wore a sleep tracking device (Oura ring) continuously for ~2 months beginning prior to vaccination, which provides behavioral sleep data on days prior to and following the COVID-19 vaccination series. Blood samples were collected prior to vaccination, +1 month after their final vaccine shot (peak response), and +6 months after their final vaccine shot (maintenance); neutralization assays using pseudotype virus will be carried out to quantify antibody titers.
Results: Data collection concludes December 2021, with antibody assays to be completed February 2022. Initial baseline data indicates that most participants reported poor overall global sleep quality (PSQI mean=6.3, SD=3.6; 52% PSQI>5). Linear mixed models will be conducted to test associations between habitual sleep duration (averaged over the measurement time points), sleep efficiency, and subjective sleep quality with antibody responses over time. Additionally, we will report on the relevance of sleep timing (midpoint) and vaccination timing (receiving the vaccine in the morning vs afternoon vs evening), and the role of self-reported sleep disorders (e.g., obstructive sleep apnea) and shift worker status. Covariates in these analyses will include age, gender, race, body mass index, prior COVID infection, and vaccine type (Moderna, Pfizer, Johnson and Johnson).
Conclusion: These analyses will provide new knowledge about the role of sleep in mounting and maintaining antibody response to the COVID-19 vaccination series. These findings may provide novel insights into when and for whom improvements in sleep may result in better vaccine efficacy.
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0201

SLEEP DURATION AND TIMING IS PROSPECTIVELY LINKED WITH INCREASES IN INSULIN RESISTANCE OVER LATE ADOLESCENCE

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Introduction: During puberty, adolescents experience a period of transient insulin resistance (IR) that normalizes upon full maturation. Yet, IR continues to rise for some adolescents, increasing metabolic disease and type 2 diabetes risk in adulthood. Whether short sleep duration and/or later sleep timing are risk factors for persistently increasing IR in late adolescence has not been explored.
Methods: The study population includes 362 adolescents from Mexico City enrolled in a longitudinal birth cohort (ELEMENT study). Beginning in 2015, when participants were between the ages of 9 and 17, there were 2 clinic visits that occurred approximately 2 years apart. During the visit, a fasting blood sample and anthropometric measurements were taken. Insulin resistance was assessed with glucose and insulin via HOMA-IR. Four groups were defined using puberty-specific cutpoints for IR: normal HOMA-IR over the follow-up period (reference), transition from normal to IR, transition from IR to normal, and IR at both time points. Baseline sleep assessments (sleep duration, timing, and variability of both duration and timing) were measured with 7-day actigraphy. Multinomial logistic regression models were used to evaluate associations between sleep duration and timing with HOMA-IR categories, adjusting for age, sex, and baseline pubertal status
Results: Seventeen percent of the sample developed insulin resistance over the follow-up period. Adolescents ≥1 hour below the sleep duration recommendations-for-age were over twice as likely to be in the group that developed IR compared to the normal group (95% CI 1.1, .9; P for trend=0.03). Similarly, adolescents who had a sleep midpoint later than 4:36 AM were 2.77 times as likely to be in the increasing HOMA-IR category (95% CI 1.0, 7.5; P for trend=0.05). Interestingly, there was no evidence that changes in adiposity over follow-up mediated associations between sleep and insulin resistance.
Conclusion: Insufficient sleep duration and late sleep timing were independently associated with development of IR over a 2-year period in peri-puberty. Adequate sleep during the pubertal period may promote metabolic health into young adulthood, independent of any changes in adiposity.
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PREDICTING SLEEP INERTIA IN A BIOMATHEMATICAL MODEL OF FATIGUE AND PERFORMANCE: A NOVEL APPROACH

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Introduction: Biomathematical models of fatigue typically include sleep inertia as an additive process during wakefulness. However, there is predictive information to be gained from tracking the

propensity for sleep inertia through sleep periods. We propose a novel approach involving a neurobiological sleep inertia process with relatively fast dynamics (in the order of several minutes) interacting with the much slower dynamics of the established processes of sleep/wake regulation. This sleep inertia process is captured by the addition of two ordinary differential equations (ODEs) in the model framework of McCauley and colleagues (2009, 2013, 2021) – one for wakefulness to track impairment from sleep inertia, and one for sleep to track the propensity for sleep inertia upon awakening. A single time constant is introduced to control the dynamic behavior of these ODEs to capture the dynamics of sleep inertia.

Methods: 398 healthy young adults (ages 21–49 years) each participated in one of eight multi-day laboratory studies of total sleep deprivation, sustained sleep restriction, or simulated shift work. At 2–4 hour intervals while awake, participants performed a Psychomotor Vigilance Test (PVT), for which number of lapses (RT>500ms) was assessed, and rated their sleepiness on the Karolinska Sleepiness Scale (KSS). Sleep periods were recorded polysomnographically. Data were divided into a calibration set (five studies) used to estimate a single new model parameter capturing sleep inertia, and a validation set (three studies) used to independently verify model validity.

Results: Based on the calibration data set, the sleep inertia time constant estimate was 0.71h±0.01. Based on the validation data set, goodness-of-fit root-mean-square-error was 2.28 for PVT and 0.733 for KSS, indicating high predictive accuracy. A dynamic buildup and then decline of predicted propensity for sleep inertia during sleep emerged, peaking 2–3h into the sleep period.

Conclusion: The model expansion with a one-parameter sleep inertia process captured the transient effect of sleep inertia accurately across a range of sleep deprivation, sleep restriction, and simulated shift work scenarios. The emerging dynamic of sleep inertia propensity during sleep is consistent with findings on the magnitude of sleep inertia as a function of sleep duration and stage of awakening.

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0203

RISE AND SHINE! THE EFFICACY OF A MULTIMODAL ENVIRONMENTAL ALARM SYSTEM ON MITIGATING THE EFFECTS OF SLEEP INERTIA

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Introduction: Sleep inertia is a temporary period of reduced alertness and impaired physical and cognitive performance that immediately follows waking. Sleep inertia can have devastating consequences necessitating an intervention to successfully mitigate symptoms. Previous work has demonstrated modest benefits for individual environmental interventions which manipulate either lighting, sound, or temperature. The current study sought to expand on previous work and measure the impact of a multimodal intervention that collectively manipulated light, sound, and ambient temperature on vigilance, mood, and sleepiness.

Methods: 37 adults (M=27.13 years, 19 F) who self-reported taking longer than 30 minutes to wake up for 60% of their work week slept in the lab for four nights. They were woken up each morning with either a traditional alarm sound or the multimodal intervention (two control nights and two intervention nights, counterbalanced across participants). Feelings of sleep inertia were measured each morning through completion of the Psychomotor Vigilance Test and ratings of sleepiness and mood at five different time-points (5, 15, 30, 60, and 90 min after wake).

Results: While there was little impact of the intervention on all outcome measures, there were differential impacts depending on a person's chronotype and the length of the lighting exposure during the intervention condition. Moderate evening-types who received a shorter lighting exposure (£15 min) demonstrated more vigilance lapses ($p = 0.04$) relative to the control condition whereas intermediate-types demonstrated better response speed ($p < 0.005$) and fewer lapses ($p = 0.002$). Conversely, moderate evening-types who experienced a longer light exposure (>15 min) during the intervention exhibited fewer false alarms over time ($p = 0.03$). Participants who received a longer light exposure also reported marginally lower negative affect the longer they were awake ($p = 0.06$).

Conclusion: Collectively, the results suggest that the length of the environmental intervention may play a role in mitigating feelings of sleep inertia, particularly for groups who may exhibit stronger feelings of sleep inertia including evening-types. Results may help inform the efficacy of "smart alarms" that activate based on entering light sleep. Future studies should measure this impact using additional measures of cognitive performance.

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0204

SLEEP IRREGULARITY IS ASSOCIATED WITH INCREASED RISK OF HYPERTENSION: DATA FROM OVER TWO MILLION NIGHTS.

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Introduction: Sleep irregularity has been associated with worse cardio-metabolic health compared to regular sleep, but prior studies have been limited in sample size and have assessed sleep irregularity by actigraphy or questionnaires over a relatively short duration (~ 14 days). The current study investigated associations between sleep regularity and hypertension in a large, global sample over multiple months.

Methods: Data from 12,300 participants (aged 18-90 years) who used an under-mattress sleep device and a portable blood pressure monitor between July 2020 and March 2021 were included in this study. Sleep duration regularity was assessed as the standard deviation via device-assessed total sleep time. Sleep timing regularity was assessed as the standard deviation in sleep onset time and in sleep midpoint. Logistic regressions controlling for age, sex, BMI, and mean total sleep time were conducted to investigate potential associations between sleep regularity and hypertension.

Results: Participants were typically middle-aged (Mean ± SD; 50 ± 12 years) and predominantly male (12% females). Each participant had ~180 nights of recordings and ~70 blood pressure entries. There were 2,499 cases of hypertension defined as SBP>140 and/or DBP >90mmHg (20% of the sample). Across total sleep time quartiles, high sleep duration irregularity was consistently associated with a 9 to 15% increase in hypertension risk. A 38-minute increase in sleep midpoint irregularity was associated with an 11% (1.11 [1.03, 1.20]) increase in hypertension