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OPERATIONALIZING SLEEP FOR THE MILITARY: ADVANCING AN INFRASTRUCTURE FOR FATIGUE RISK MANAGEMENT WITH WEARABLE TECHNOLOGY

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Introduction: A recent investigation on fatigue within United States (US) Naval Surface Force by the Government Accountability Office recommended that the US Navy incorporate methods to empirically monitor and manage fatigue-related threats. In response, a feasibility effort was undertaken to assess two commercial wearable devices previously evaluated against polysomnography by our group for potential use within a novel fatigue monitoring system onboard US warships.

Methods: 501 Sailors from three warships (415 men, 85 women, 1 response missing; 29.1±7.4 years, mean±SD) were included in analyses. During multi-day missions at sea, participants were instructed to continuously wear a wrist-worn Fatigue Science Readiband and an Oura Ring. Participants met with the research team daily to sync wearable devices and complete self-ratings of sleep and fatigue on a tablet. While returning to port, participants completed a user experience questionnaire that included 5-point scales for device comfort and interference with daily activities (larger values indicate greater comfort or interference).

Results: There were no overall differences in total sleep time (TST) and sleep efficiency (SE) between devices (TST: Ring=352.23±87.1, Readiband=353.89±97.79; p=0.45, d=-0.01; SE: Ring=84.59±7.08, Readiband=84.20±10.24; p=0.06, d=0.04). There were 9 days for TST and 4 days for SE (of 66 total days) that resulted in effect sizes >0.50 between devices (for >0.20: TST, 39/66; SE, 29/66). Preliminary analyses between TST and self-reported exhaustion and inability to function suggest predictive relationships with the wearables (Ring: r=-0.20; Readiband: r=-0.21), with no relationship with SE across devices (both r<0.01). Average comfort ratings for Ring (3.74) exceeded Readiband (3.59), but this difference was small (p=0.04, d=0.12). Interference with daily activities was also similar between devices (Ring=2.10, Readiband=2.20; p=0.14, d=0.08).

Conclusion: Both commercial wearables performed similarly for their TST and SE assessments, and TST was associated with self-rated fatigue within this operational environment. While the ring form factor was selected more for comfort than the wrist form factor, the difference was small. Collectively, findings indicate that both devices show promise for operational use within fatigue monitoring systems. Further testing is being conducted to better understand the strengths and limitations of wearable devices for monitoring sleep in warship environments.

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DAILY SELF-REPORTED SLEEP DURATION PATTERNS AMONG MALE AND FEMALE COLLEGIATE ATHLETES

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Introduction: Student-athletes' time demands include scholastic, athletic, and social events that may influence sleep duration; and the association between sleep duration, athletic performance, and injury risk are inconclusive. Further, limited research investigates long-term habitual sleep patterns in collegiate student-athletes. We aimed to describe the feasibility of monitoring long-term self-reported sleep duration, within-person sleep duration patterns, and test sex differences across a semester in a collegiate student-athlete cohort.

Methods: We monitored daily self-reported sleep in a prospective cohort study using ecologic momentary assessment. Each day, a smartphone application prompted student-athletes to record total sleep hours obtained in the previous 24 hours(h). We provide descriptive statistics for response frequency, and within-person sleep, percentage of days below recommended (7-9) hours, and coefficient of variation (CV) [(standard deviation/mean)*100]. We tested sex differences using chi-squared tests, and within-person median hours of sleep on weekdays verses weekends with paired t tests (p<.05).

Results: Sixty-three student-athletes (male: 57.1%) on eight teams responded. Out of a possible 54 responses, response frequency was <25% for 27.0% of student-athletes, 25-50% for 19.1% of student-athletes, 50-75% for 20.6% of student-athletes, and ≥75% for 33.3% of student-athletes. Among those responding ≥50% of days (n=34), median self-reported sleep ranged 6.5-9h per 24h and the percent of days below recommended hours of sleep ranged from 0-53.6%. The CV ranged from 6.2-31.8% overall, and from 7.0-24.1% among athletes with response rate ≥50%. There was a significant association between sex and quartile of response rate ($\chi 23$=15.91, p<.001); the highest percent of males (41.7%) had <25% response rate, whereas 55.6% of females had ≥75% response rate. There was no association between sex and reported sleep above or below recommended hours ($\chi 22$=2.25, p=0.32). There was no difference between median within-person weekday and weekend hours of sleep (t51=0.75, p=0.46).

Conclusion: Student-athletes generally self-reported obtaining the recommended total sleep; however, participation was variable as response frequency was ≥75% for one-third of student-athletes and females responded more often than males. This suggests future studies should validate the reliability of self-report with objective data in this population to obtain complete data to appropriately assess associations between habitual sleep patterns and injury risk, performance, and recovery outcomes.

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FROM SHORE TO SHIPBOARD: SEVERITY OF SLEEP DISTURBANCE AND SLEEP-RELATED IMPAIRMENT OF SAILORS ABOARD US NAVY WARSHIPS

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Introduction: Sleep quality is known to be negatively impacted during military operations at sea. Yet, there are limited naval studies that explore measures of sleep disturbances and sleep-related impairment, especially in relation to different warship classes. This analysis compares sleep disturbances and sleep-related impairment across two warship classes during similar at-sea periods.

Methods: 432 sailors (77.6% male; 27.4±7.1 years) participated in a training evolution aboard either a destroyer (DDG; n=194) or an amphibious class ship (LHD; n=238). Participants completed a 7-day recall questionnaire assessing their sleep and health behavior prior to getting underway (baseline) and 1–2 days prior to completing a 2-week underway (underway). Primary outcomes included the PROMIS Sleep-Related Impairment scale (P-SRI) and the PROMIS Sleep Disturbance scale (P-SD). While underway, participants self-reported their diet quality, daily caffeine and nicotine intake, overall health, and daily time spent exercising; these factors were included as covariates in all analyses. Linear mixed effects models were used to explore the within-subject effect of baseline vs. underway sleep and a between-subjects effect by ship class (i.e., DDG or LHD). Independent t tests and chi-square tests were used to compare ship groups at baseline.
Results: Participants within ship class had a similar age, time in military service, and sex (p≥.06). Across both ship classes, there were increases in severity of sleep-related daytime impairment and sleep disturbances between baseline and underway (P-SRI: B=5.2±0.6; P-SD: B=3.4±0.5; p<.001). Additionally, DDG participants had a significantly greater increase in sleep-related impairment between baseline and underway compared with their LHD-class counterparts (Group*Time interaction effect: B=4.3±0.9, p<.001; LHD: 54.5±0.6 [baseline] vs. 54.5±0.5 [underway], DDG: 54.9±0.6 [baseline] vs. 60.2±0.6 [underway]).
Conclusion: These results suggest sleep-related impairment and sleep disturbances are greater while underway compared with an in-port environment. Although preliminary, these results suggest that differential impacts on sleep-related impairment may occur across ship classes, even when undergoing similar underway events. Further research is needed to understand how insufficient sleep and its consequences change in shipboard environments and how these effects may vary between ship classes so as to better inform targeted naval-focused sleep health improvement strategies.
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0143

FIREFIGHTERS' SLEEPINESS AND TOTAL SLEEP TIME VARIES THROUGHOUT THEIR SHIFT SCHEDULE.

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Introduction: Most career firefighters in the US are allowed to rest and sleep, yet at the same time must be ready to respond to emergencies. We recently found that inter-daily rhythms in firefighter total sleep time (TST) and that the rhythms are related to their shift schedule. Considering the relationship between sleep duration and health outcomes, the purpose of this research is to assess the daily relationship between preceding TST and sleepiness throughout two popular fire department shift schedules.
Methods: Firefighters participated in a pre-experimental, longitudinal sleep study that assessed sleep over 18 days on the 24-hours on and 48-hours off (24/48) (n=22) and again 18 days, six-months after firefighters transitioned to the 48-hours on and 96-hours off (48/96) shift schedules (n=20). Daily TST was assessed using actigraphy and the Emergency Services Sleep Diary and daily sleepiness was assessed using the Epworth Sleepiness Scale (ESS), completed every afternoon at 1:00 PM.
Results: The results of the one-way repeated measures ANOVA for each schedule indicated a statistically significant difference in ESS scores among days within the 24/48 ($F(2,42) = 8.56$, $p<0.01$) and 48/49 shift schedule ($F(5,95) = 7.40$, $p<0.05$). Using pre-shift as baseline, differences of preceding TST and afternoon sleepiness were related in the 24/48 ($r(64)= -.62$, $p \leq .001$) and 48/96 ($r(118)= -.54$, $p \leq .001$) shift schedule. The greatest mean levels of sleepiness occurred on days in which firefighters commuted to and from the fire station. During non-workdays, mean afternoon sleepiness decreased as firefighters returned to baseline TST.
Conclusion: Firefighters experienced an inverse relationship between preceding TST and afternoon sleepiness. The least TST occurred on commute days; firefighters begin shift with insufficient sleep and drove home with insufficient sleep. Subsequently, firefighters experienced greatest levels of sleepiness during those afternoons. The findings of daily variation in TST and sleepiness highlight the importance for firefighters to prioritize sleep so that they begin shift well rested and commute home well rested. In addition, the implication of the results questions whether other acute health outcomes also vary within fire department shift schedules.
Support (If Any):

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IDENTIFICATION OF SLEEP FACTORS RELATED TO BLOOD PRESSURE IN EMERGENCY MEDICINE HEALTHCARE WORKERS

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Introduction: Emergency Department (ED) healthcare workers (HCWs) may be at elevated risk for the development of cardiovascular disease (CVD), due in part to sleep and/or circadian disturbances. This study aimed to evaluate the relationship of sleep factors with blood pressure, a primary marker of CVD risk, in ED HCWs.
Methods: Participants were HCWs (physicians, nurses, advanced practice providers, technicians, etc.) from 4 EDs in New York City who completed study procedures between November 2020-October 2021. Participants completed a 2-week data burst, which included sleep/activity (Fitbit Inspire) and home blood pressure monitoring (Omron 5 Series BP7250; preceding and following their main daily sleep episode). Linear regression models, adjusted for age, gender, and race/ethnicity, were conducted predicting blood pressure from sleep factors.
Results: The sample included n=74 ED HCWs (mean [SD] age=38.4 [8.7] years). Most were female (62.2%) and non-Hispanic/Latino White (55.6%). Mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) were 116.1 (12.5) mmHg and 75.1 (7.6) mmHg, respectively. Actigraphy-derived sleep factor means for the data burst period were: a) Total sleep time (TST): 6.8 (1.0) hours; b) Sleep efficiency (SE): 94.5 (2.2)%; c) Percentage of main sleep episodes throughout the burst with TST <6 hours: 25.9 (20.8)%; d) Sleep start time: 24:06 (01:24); and e) Within-subject inter-daily bedtime variability (i.e., SD of sleep start times): 2.4 (1.8) hours. Higher TST was associated with lower SBP (B [SE] =-0.50 [0.30] mmHg/10 min, p=.04) and DBP (B [SE] =-0.50 [0.20] mmHg/10 min, p=.01). Greater SE was associated with lower SBP (B [SE] =-1.23