Naval Submarine Medical Research Laboratory

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# Personal Light Treatment Devices as a Viable Countermeasure for Submariner Fatigue

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Navy submariners experience circadian misalignment and fatigue that can lead to decreases in performance and negative health outcomes. This study investigates whether individualized lighting exposures, through the use of personal light treatment devices (PLTDs), can maintain circadian entrainment, improve sleep, and sustain performance in the crew of an active duty U.S. submarine. 42 active duty submariners were randomly assigned to a PLTD group or a control group. Participants in the PLTD group were provided with blue-light exposure glasses and blue-blocking glasses; participants in the control group did not use PLTDs. Over the 14-day experimental period, Sailors wearing PLTDs received a greater amount of sleep and more efficient sleep; Sailors wearing PLTDs also reported lower levels of sleepiness and presented with higher scores of projected performance effectiveness. Compliance with PLTD use was high, and Sailors did not report any major disruption to operational duties. These data provide preliminary evidence that PLTDs are a viable and effective countermeasure for fatigue onboard U.S. Navy submarines.

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## Abstract

Navy submariners stand rotating schedules of shift work (8-hour watches) that are discordant with the natural sleep/wake cycle, and they operate in an environment that lacks circadian-aligned lighting sources. As a result, Sailors experience circadian misalignment and fatigue that can lead to decreases in performance and negative health outcomes. This study investigates whether individualized lighting exposures, through the use of personal light treatment devices (PLTDs), can maintain circadian entrainment, improve sleep, and sustain performance in the crew of an active duty U.S. submarine. Forty-two active duty submariners were randomly assigned to a PLTD group or a control group. Participants in the PLTD group were provided with blue-light exposure glasses that provided light with a peak wavelength of 470 nm (worn for approximately 40 minutes upon waking) and with blue-blocking glasses that attenuated light exposure in the wavelength range of 400-510 nm (worn for approximately two hours before going to sleep); participants in the control group did not use PLTDs. Circadian phase (salivary dim light melatonin onset; DLMO), objective sleep (actigraphy), cognitive performance (Automated Neuropsychological Assessment Metrics; ANAM), and self-report mood and sleep measures were assessed before and after PLTD use. Over the 14-day experimental period, Sailors wearing PLTDs received a greater amount of sleep and more efficient sleep than Sailors in the control group; Sailors wearing PLTDs also reported lower levels of sleepiness and presented with higher scores of projected performance effectiveness, albeit no significant improvement in the ANAM was detected. Compliance with PLTD use was high, and Sailors did not report any major disruptions to operational duties. These data provide preliminary evidence that PLTDs are a viable and effective countermeasure for fatigue onboard U.S. Navy submarines. Considerations for PLTD use in the fleet are discussed.