Mitigation of sleep deprivation through Omega-3 fatty acids: neurocognitive, inflammatory, EEG and EKG evidence

297.16/III49

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Introduction

Sleep deprivation is an acknowledged public health epidemic in our world-wide culture. The loss of sleep is associated with physical, physiological, cognitive and psychological consequences. Mitigating the consequences of sleep loss can be challenging. Napping is demonstrated the most effective method to combat the effects of sleep loss, however sleep supplements need be developed in order to alleviate the costs to the individual and society. Sleep deprivation may be mitigated to those found in cytokine induced sickness behavior. Based on these similarities it was hypothesized that the effects of sleep deprivation may be mitigated by inflammatory cytokines, and by reducing pro-inflammatory cytokines, we might reduce the effects of sleep loss.

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<thead>
<tr>
<th>Symptom</th>
<th>Sleep Loss</th>
<th>Cytokines</th>
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<tbody>
<tr>
<td>Fatigue</td>
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<tr>
<td>Sleep</td>
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<tr>
<td>Sleepiness</td>
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<td>Irritability</td>
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<td>Physiological</td>
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<td>Inflammatory</td>
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<td>Memory</td>
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<tr>
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<td>Physical</td>
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<td>CV Drive</td>
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Conclusion 1: Omega-3 treatment was associated with reduced mood decrements when sleep deprived. POMS Vigor and Fatigue were preserved at fully rest levels. In addition anxiety was reduced (based on IL-6 cytokine).

Conclusion 2: Performance and EEG ERPs indicate that Omega-3 treatment was associated with a preservation of function. Reaction time and accuracy were preserved, while ERP late positivity (associated with improved cognitive function) were elevated.

Conclusion 3: Omega-3 was associated with a) no change in IL-6, and b) reduced IL-1α IL-1 β. These data imply that overall reduced inflammatory cytokines associated with Omega-3 treatment may be the physiological mechanism of reduced symptoms of fatigue.

Methods

Participants.

N=30, Young Adults (< 28 yr, M=21.6 yr), Healthy (BMI < 25)

Equipment.

EEG: B-Alert, Portable, Wireless
- Fz, F3, Cz, C3, C4, POz, P3, P4

Protocol.

1) Confirm 24 hr of sleep deprivation prior to visit
   - Actigraph
   - Phone calls logged to office every 30 min
2) Take Biomarker samples
   - Blood spots (21 g UltraStick, Whatman filter 903, 5 spots for cytokines, 2 for Omega-3)
   - Salivae (Salivettes, 4 replicates, 1/15 min)
3) Administer self report mood/wellbeing scales
   - POMS + STAI + BDI + CESD + PSQI + MOS-36

4) Begin Neurocognitive tasks
   - 3CVT, 20 min, 70% Target/30% Non-Target/Interference Level
   - EO, 5 min passive vigilance, with visual stimuli
   - EC, 5 min passive vigilance, with auditory stimuli
   - SIR, 20 Target/learned images in field of 80 Non-Target
5) Repeat step 4 every 3 hr for hours 24-48 of sleep deprivation
6) Repeat Biomarker collection

Baseline

Session 1
- Placebo (4-6 wk)
- Self-Report Biomarkers
- Neurocognitive assessment

Session 2
- Placebo (4-6 wk)
- Self-Report Biomarkers
- Neurocognitive assessment

Figure 1. Profile of Mood States, Vigor and Fatigue scales. Omega-3 condition reported significantly greater fatigue and reduced vigor.

Figure 2. LF:HF ratio of heart rate variability provides a measure of SNS/PNS balance. 500 (A), stress/anxiety dominates placebo condition at 24 and 48 hr, while Omega-3 delayed this effect of sleep deprivation.

Results

Figure 3. Reaction time (A, C) and accuracy (B, D) are shown for 3CVT and SIR tasks. Omega-3 fatty acids preserved more accuracy and reaction time for the SIR, F(2, 88) = 10.98, p < .0001. Post hoc comparisons found that Omega-3 was associated with greater accuracy at both 24 and 48 hr during 3CVT, and both reaction time and accuracy at 48 hr only for SIR.

Figure 4. The ERP component associated with P300 late positivity was calculated (-135-495 µV). Average amplitude is shown for 3CVT, and the difference wave for SIR correct targets vs non-targets (memory component). For 3CVT (A), principal amplitude was significantly reduced at 24 hr while the difference is estimated by 48 hr. For SIR (B-D), the memory-related component associated with the targets was significantly greater than the placebo at both time points. These findings are consistent with the performance effects.

Figure 5. Omega-3 was associated with preservation of IL-6 basal levels (A), and suppression of IL-1α (B) and IL-6 (C), leading to an overall reduced inflammatory profile.

Acknowledgements. This work was funded through ONR contract # N00014-09-C-0583, through the HPT & E Research program awarded to RJJ.