Longitudinal and Cross-sectional Associations between the Dietary Inflammatory Index and Objectively and Subjectively Measured Sleep among Police Officers

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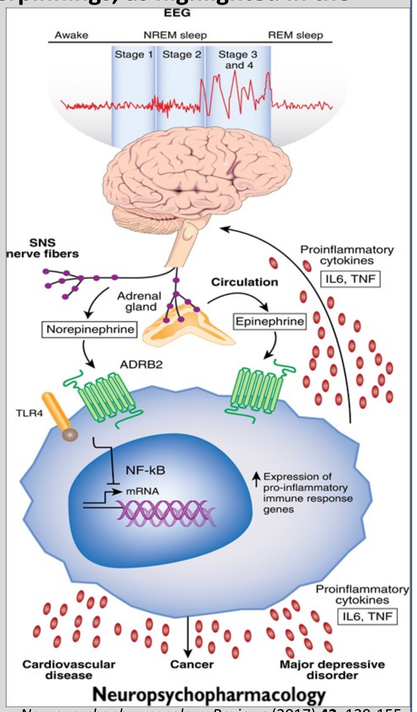
Background and Hypotheses

Sleep is a physiological necessity. In terms of abnormal sleep among Americans:

- 30% of adults receive <7 hours of sleep per night [1]
- 33% of adults experience transient insomnia[2]
- 30-50% of men and 11-23% of women have moderate obstructive sleep apnea[3]

Some biological processes associated with sleep have inflammatory underpinnings, as highlighted in the figure.



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Diet is associated with sleep.

- High-fat diets negatively impact sleep structure[4]
- High-carbohydrate diets may improve sleep structure[4]
- Intake of vitamins such as B12 may help in melatonin synthesis which may improve sleep

We also know that diet is one of the strongest moderators of systemic inflammation,[6] as evidenced by work involving the Dietary Inflammatory Index (DII®).[7]

Shift-workers suffer from increased sleep disturbances and a worse diet quality compared to their day-working counterparts.[8,9]

Hypotheses:

Using data from the Buffalo Cardio-Metabolic Occupational Police Stress Cohort (BCOPS), we hypothesized those with more pro-inflammatory dietary changes over time would have adverse changes in sleep. Shiftwork was examined as an effect modifier.

Methods

Study Population and Sample Size: Police officers enrolled in the BCOPS study with data collection points between 2004-2009 (n=464), 2010-2014 (n=281), and 2016 (n=191).

Outcome (Sleep) Assessment: Objectively measured sleep using the Micro Motion Logger Sleep Watch™. Sleep metrics included time-in-bed (TIB), sleep duration, sleep efficiency, wake-after-sleep-onset (WASO), and sleep latency.

Subjective sleep was measured using the Pittsburgh Sleep Quality Index (PSQI).

Exposure (Diet) Assessment and the DII: Diet was obtained using a food frequency questionnaire (FFQ). The energy-density DII (E-DII™) quantifies the degree of inflammatory potential of one's diet with more negative scores being more anti-inflammatory and more positive scores being more pro-inflammatory.

Statistical analyses: Included repeated-measures linear regression to assess cross-sectional effects. A linear mixed-effects model estimated differential impacts of baseline (i.e., cross-sectional) and change from baseline (i.e., longitudinal) DII on sleep.

Results

Baseline Population Characteristics: Most were male (74%), European-American (77%), had less than a college degree (67%), were never or former smokers (74%), had an average age of 41.5±6.7 years, and an average body mass index of 29.3±4.8 kg/m^2.

Those with more pro-inflammatory diets, compared to more anti-inflammatory diets, were more likely:

- To be males (p<0.01)
- To be current smokers (0.05)
- Have a larger waist circumference (p<0.01

Repeated Measures Cross-sectional Results:

Table: Cross-sectional Associations between the E-DII and Sleep Quantity and Quality

Sleep Metric	DII Continuous Beta (SE)	P-value
Time-in-Bed (hrs)	0.007 (0.020)	0.72
Night Sleep Duration (hrs)	-0.028 (0.023)	0.21
Sleep Efficiency (%)	-0.277 (0.176)	0.12
WASO (min)	1.284 (0.555)	0.02
Sleep Latency (min)	-0.054 (0.089)	0.55
PSQI Global Sleep Score	-0.141 (0.055)	0.01

The DII and sleep measures were allowed to vary with time. Only adjustments for WASO and PSQI are being displayed for poster presentation. **Adjustments**: WASO – tobacco use, BMI, systolic blood pressure, years of employment as a police officer, waist circumference, average number of alcoholic drinks per week, and average day shift hour per week; Global PSQI Score - years of employment as a police officer, CESD, Impact of Events Scale, and Beck Anxiety Inventory.

Table: Longitudinal Changes and Baseline Effects of the Dietary Inflammatory Index on Various Sleep Parameters (only presenting WASO and PSQI as results for other sleep metrics were null)

Sleep Metric	β_{Change} (SE)	p-value β_{Change}	β_{Base} (SE)	p-value β_{Base}
WASO (min)	1.36 (0.74)	0.07	1.14 (0.66)	0.08
PSQI Global Sleep Score	-0.22 (0.07)	<0.01	-0.08 (0.07)	0.22

P-value β_{Change} represents the p-value for the longitudinal change in DII score beta coefficient. P-value β_{Base} represents the p-value for the baseline DII beta coefficient. The change in DII was defined the baseline DII minus the value at later time points. **Adjustments**: WASO – tobacco use, BMI, systolic blood pressure, years of employment as a police officer, waist circumference, average number of alcoholic drinks per week, number of career cumulative shift changes, and average day shift hour per week; Global PSQI Score - years of employment as a police officer, Center for Epidemiologic Studies Depression Scale, Impact of Events Scale, and Beck Anxiety Inventory.

Stratified results by shiftwork status for WASO

- Among day workers, β_{Change} was 3.33 (SE=1.24) minutes (p=0.01)
- Among evening workers, β_{Change} was 1.06 (SE=1.11) minutes (p=0.34)
- Among night workers, β_{Change} was -0.99 (SE=1.70) minutes (p=0.56)

Conclusions

Improvements in dietary inflammatory potential over time, could increase sleep efficiency by decreasing the amount of time spent awake after initially falling asleep (i.e., WASO).

If day workers improved their DII score by 5 points, this would equate to about a 17-minute decrease in WASO per night which equates to about **119 minutes of sleep gained per week**.

Such results were not observed among evening or night shift-workers. It could be that other factors strongly associated with night shiftwork are stronger drivers of sleep quality among this group compared to their day-working counterparts.

Subjective sleep quality results trended in the opposite direction (i.e., a more pro-inflammatory diet was associated with better subjective sleep quality). This may be due to reporting biases, and this may highlight the need for future research to focus on objective measures of sleep among shift-working populations.

Future Studies: Because this is an observational study, it is intriguing to hypothesize that even stronger associations would be observed by conducting clinical trials of an anti-inflammatory diet intervention on objective markers of sleep. Additionally, this work raises the questions of if such associations apply to other shift-working populations such as nurses.

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