Environmental Modifications to Reduce Blood Pressure among On-Duty Firefighters

Dillon J. Dzikowicz BS, RN

Doctoral Student at the University of Rochester School of Nursing
Advisor: Mary G. Carey, PhD, RN, FAHA, FAAN
Sigma Theta Tau
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Firefighters, Sleep, and Hypertension

- Nearly 60% of firefighters experience disturbed sleep in which 70% also had hypertension.

- Poor sleep quality and sleep disturbance are associated with hypertension.

- Determinants of disturbed sleep include loud noise, bright lights, and high temperature.

- Thus, work environment plays a crucial role in hypertension.
Physiological Framework

- Hypertension and sleep deprivation are both associated with increased sympathetic nervous system activity.

- Previous research has suggested firefighters have high sympathetic nervous system activity and low parasympathetic activity possibly due to sleep environment.
Challenges to Traditional Interventions

• Traditional interventions to improve cardiovascular health focus on individual behaviors such as exercise and weight/diet control but remain difficult to sustain

  • For example, Carey et al. (2011) demonstrated a partial reversal of Metabolic Syndrome after a 12-week diet & fitness program

  • However, the effects were not sustainable by firefighters themselves

• Non-traditional interventions such as improving sleep environment may more sustainable
The objective of this study was to develop an environmental sleep intervention to promote sleep and reduce the prevalence of hypertension among a sample of on-duty firefighters.
A 3-arm intervention was developed for this study:

1) Silence the bunkroom alarm
2) Reduce bunkroom lighting
3) Control the temperature
A quasi-experimental pre-post design was used to measure the effects of the intervention for 6 weeks.

- Noise (decibels), light (lux), and temperature (°F) were recorded to ensure intervention compliance.

- Heart rate and blood pressure were measured as cardiac outcomes.

- Sleep quality and quantity was measured using self-report daily diary (quality: 0, poor- 5, good), Pittsburgh Sleep Quality Index (PSQI), and sleep actigraphy to the non-dominant wrist to characterize sleep.
# Measures of Sleep from Actigraph

<table>
<thead>
<tr>
<th>Sleep Measure Evaluated</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Sleep Time</td>
<td>Time Asleep (only nighttime sleep)</td>
</tr>
<tr>
<td>Sleep Onset Latency</td>
<td>Minutes between Attempted Sleep and Actual Fall Asleep</td>
</tr>
<tr>
<td>Sleep Efficiency</td>
<td>Percent of Total Time in Bed Asleep</td>
</tr>
<tr>
<td>Wake After Sleep Onset</td>
<td>Minutes of Wakefulness Occurring After Defined Sleep Onset</td>
</tr>
</tbody>
</table>
Operational Definitions

- Hypertension was defined as >130/85 mmHg
- Elevated heart rate was defined as greater than 75 beats per minute (bpm)
- Disturbed sleep was defined as meeting 2 of the following 4 criteria:
  - Total sleep time <6 hours
  - Total sleep latency >30 minutes
  - Sleep efficiency <85%
  - Wake after sleep onset >30 minutes
Statistical Methods

- Descriptive statistics provided as means (±Standard Deviation) and percentages, as appropriate

- Pre- and post-assessment values were examined using paired T tests for continuous variables and Fisher exact tests in the case of categorical variables

- Histogram of cardiovascular parameters provided

- Statistical significance set at 0.05 for all analyses
Of the 14 on-duty professional firefighters who participated in both the pre- and post-test components of this study:

- Mean age = 42 years (+9.5)
- Firefighting experience = 13 years (+7.0)
- 93% (n=13) male
- 86% (n=12) white
- 86% (n=12) overweight or obese
- 57% (n=8) had a second job
- 14% (n=2) actively used tobacco products
## Bunkroom Environmental Changes with Intervention

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre-Intervention</th>
<th>Post-Intervention</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise (decibels)</td>
<td>76 ±9.8</td>
<td>69 ±6.3</td>
<td>0.207</td>
</tr>
<tr>
<td>Light (lux)</td>
<td>0.75 ±1.8</td>
<td>0.19 ±0.8</td>
<td>0.031</td>
</tr>
<tr>
<td>Temperature (°F)</td>
<td></td>
<td>Regulated Between 65-68°F</td>
<td></td>
</tr>
</tbody>
</table>
### Objective Results

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre-Intervention</th>
<th>Post-Intervention</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Disturbance</td>
<td>60%</td>
<td>41%</td>
<td>0.178</td>
</tr>
<tr>
<td>Hypertension</td>
<td>46%</td>
<td>21%</td>
<td>0.020</td>
</tr>
<tr>
<td>Elevated Resting Heart Rate</td>
<td>58%</td>
<td>42%</td>
<td>0.200</td>
</tr>
</tbody>
</table>

Antidotal Evidence on Sustainability & Agreeableness:
"Buzzer off is great. Hard to wake up for call with red light. Would like it colder but Captain likes it warmer"

"I overslept in the bunkroom by over 2 hours. I even slept through my alarm"
## Sleep Changes with Intervention

<table>
<thead>
<tr>
<th>Sleep Measures</th>
<th>Pre-Intervention</th>
<th>Post-Intervention</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Sleep Time</td>
<td>6.53 ±0.5</td>
<td>6.55 ±1.1</td>
<td>0.953</td>
</tr>
<tr>
<td>Sleep Onset Latency</td>
<td>40.5 ±32.3</td>
<td>38.7 ±24.2</td>
<td>0.828</td>
</tr>
<tr>
<td>Sleep Efficiency</td>
<td>79.1 ±6.5</td>
<td>77.62 ±6.7</td>
<td>0.405</td>
</tr>
<tr>
<td>Wake After Sleep Onset</td>
<td>36.7 ±12.2</td>
<td>44.9 ±18.3</td>
<td>0.162</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>2.8 ±0.4</td>
<td>4.1 ±0.3</td>
<td>0.007</td>
</tr>
<tr>
<td>PSQI</td>
<td>6.7 ±2.9</td>
<td>7.3 ±3.9</td>
<td>0.474</td>
</tr>
<tr>
<td>Time to Fall Asleep</td>
<td>18.2 ±14.9</td>
<td>13.3 ±8.2</td>
<td>0.091</td>
</tr>
<tr>
<td>Time Out of Bed</td>
<td>22.94 ±39.6</td>
<td>7.37 ±20.1</td>
<td>0.010</td>
</tr>
</tbody>
</table>
Cardiovascular Changes

![Graph showing cardiovascular changes before and after intervention]

- Pre-Intervention: Systolic BP = 123.04, Diastolic BP = 83.5
- Post-Intervention: Systolic BP = 120.71, Diastolic BP = 80.07
Discussion

• This pilot study demonstrated:
  • A sleep intervention within the bunkroom of a firehouse for 6-weeks demonstrated improved in sleep quality, increased sleep quantity, and reduction in the prevalence of hypertension among on-duty firefighters
  • A longer study period may have demonstrated greater effect sizes
The results of this pilot study suggest reduction in sympathetic nervous system activity with improved sleep quality and quantity.

This is most evident by the decrease in maximum heart rate during sleep.

With greater intervention exposure, we suspect more drastic changes in blood pressure and heart rate.
Future Plans

• The results of this pilot study demonstrate have influenced a proposed R01 through the National Institute of Nursing Research

• The intervention proposed may need to be re-addressed
  • “Certainly darker. Nice that bright lights don't come on, but miss that natural sun to help wake up to”

• Future deployment of this improved intervention in firehouses to determine the true effect size is expected but has the potential for national scale
Conclusions

• Our pilot study results suggest changing the bunkroom environment of a firehouse may improve sleep quality and increase quantity while reducing the prevalence of hypertension.

• Nursing interventions which reduce sympathetic nervous system activity may help reduce blood pressure among on-duty firefighters but other occupations and patients could be targeted as well.


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