Introduction

• Adults with Multiple Sclerosis (MS) have a variety of neurological symptoms including heat intolerance due to thermoregulatory dysfunction
• Our research shows that this dysfunction leads to overheating-revoked awakenings (ORAs) defined as nocturnal awakenings accompanied by a 1-degree increase in wrist skin temperature (WT)
• This study examined the relationship between ORAs and six factors known to influence sleep, including:
  • Two biological (body mass index [BMI], age),
  • Two behavioral (daily energy expenditure, pre-sleep activity 2-hours before sleep)
  • Two environmental (daytime light exposure, bedroom temperature) among adults with MS

Methods

Design
• Observational, prospective design

Inclusion criteria
• Adults age 20-70 years with physician-diagnosed MS
• Community-dwelling and English literate

Exclusion criteria
• Medical conditions likely to interfere with assessment of outcomes (e.g. Parkinson’s disease)

Data collection
• Actigraphy (GeneActiv Sleep), Sleep Diary, and bedroom temperature (iButton) for 7 consecutive days
• Sleep/wake, light exposure, WT, and energy expenditure were derived from Actigraphy data

Statistical Analysis
• ORAs were marked within about 5000 hours of actigraph and skin temperature data using MATLAB 2014a
• Pearson’s product-moment correlation examined the relationships between ORAs and factors known to influence sleep

Table 1. Demographic characteristics of participants (N=30)

<table>
<thead>
<tr>
<th>Age (years), M (SD)</th>
<th>Gender (Female), n (%)</th>
<th>Body Mass Index, M (SD)</th>
<th>Ethnicity (Caucasian), n (%)</th>
<th>Years since diagnosis, M (SD)</th>
<th>Years since symptom onset, M (SD)</th>
<th>Expanded Disability Status Scale, M (SD)</th>
<th>Sleep duration (minutes), M (SD)</th>
<th>Number of awake periods, M (SD)</th>
<th>Sleep efficiency, M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>45.5 (10.4)</td>
<td>28 (88)</td>
<td>27.0 (7.5)</td>
<td>23 (72)</td>
<td>11 (8.0)</td>
<td>15.8 (8.9)</td>
<td>2.0 (2.3)</td>
<td>289.8 (87.5)</td>
<td>11.2 (2.6)</td>
<td>57.9 (15.8)</td>
</tr>
</tbody>
</table>

Table 2. Pearson’s correlations between ORAs and factors influencing sleep (N=30)

<table>
<thead>
<tr>
<th>ORAs</th>
<th>Pre-sleep activity</th>
<th>Age</th>
<th>Bedroom temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 0.4761*</td>
<td>r = -0.3560*</td>
<td>r = -0.3541*</td>
<td></td>
</tr>
</tbody>
</table>

Note: *p < .05; Other factors showed either a weak or almost no correlation with ORAs.

Results

• These findings provide evidence that sleep among adults with MS is interrupted by small increases in WT related to level of energy expenditure 2-hours before bed and bedroom temperature.
• Limitations include cross-sectional design, which eliminates the possibility to observe changes over time. Additionally, the sample was small and homogenous.

Implications for Practice and Research
• Clinicians should provide information on factors known to lead to overheating prior and during nighttime.
• Future research efforts should investigate personalized intervention approaches to reduce ORAs.