

Daily Diary and Ambulatory Monitoring of Sleep in Adults with Multiple Sclerosis: An Investigation into Causal Hypotheses of Overheating-Revoked Awakenings

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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

Results

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

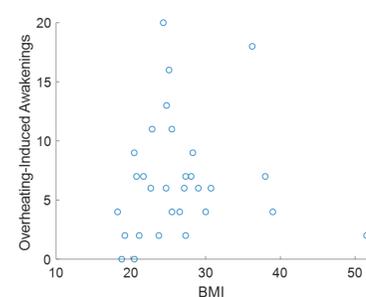
Age (years), M (SD)	45.5	(10.4)
Gender (Female), n (%)	28	(88)
Body Mass Index, M (SD)	27.0	(7.5)
Ethnicity (Caucasian), n (%)	23	(72)
Years since diagnosis, M (SD)	11	(8.0)
Years since symptom onset, M (SD)	15.8	(8.9)
Expanded Disability Status Scale, M (SD)	2.0	(2.3)
Sleep duration (minutes), M (SD)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

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

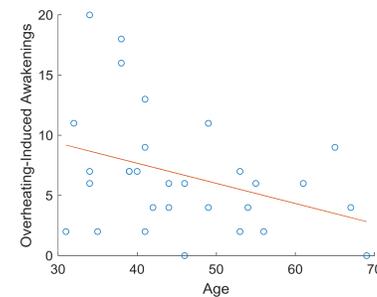
	Pre-sleep activity	Age	Bedroom temperature
ORAs	$r = 0.4761^*$	$r = -0.3560^*$	$r = -0.3541^*$

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

Figures 1 and 2. Relationships between biological factors (BMI, age) and ORAs

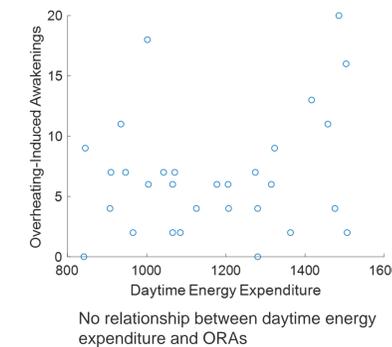


BMI shows no obvious relationship with ORAs

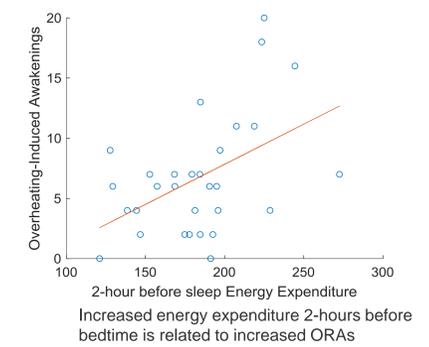


Increased age is related to reduced awakenings

Figures 3 and 4. Relationships between behavioral factors (daytime energy expenditure, energy expenditure 2-hours before sleep) and ORAs

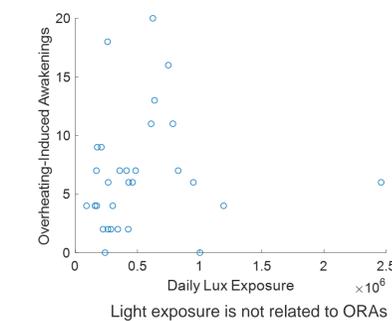


No relationship between daytime energy expenditure and ORAs

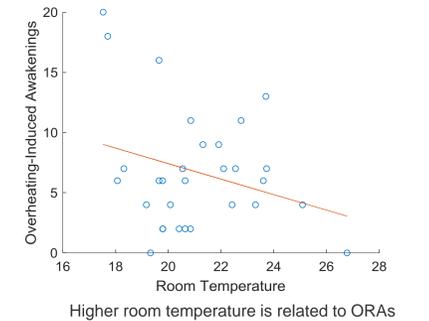


Increased energy expenditure 2-hours before bedtime is related to increased ORAs

Figures 5 and 6. Relationships between environmental factors (light exposure, bedroom temperature) and ORAs



Light exposure is not related to ORAs



Higher room temperature is related to ORAs

Conclusions and Limitations

- 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.