The relationship between adolescent obesity and sleep

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Background and Terminology

Circadian Rhythm

The phisological and behavioral changes that occur on a 24-hour cyles following light changes in light

DLMO and DLMOff

Dim-light melatonin onset and dim-light melatonin offset. Indicate when the body is ready to sleep and ready to wake.

Melatonin

A hormone central to the circadian clock, which is can be measured relatively non-invasively with saliva.

Biological Night

The period of time between DLMO and DLMOff, when melatonin levels are high

Research topic and motivations

Rationale

- Obesity is a widespread condition in the US
- Lack of research taking the whole biological night into account
- Research on adolescent sleep needs to be reevaluated in the context of the “digital age”

Question

What is the relationship between adolescent obesity and the circadian rhythm?

The Data

Courtesy of Dr. Stacey Simon

CIRC study

- Adolescents age 14-19 enrolled in normal school
- All obese participants, BMI > 90th percentile
- Actigraphy data collected for 1 week, melatonin data collected Wed, Thu, or Fri

SUNRISE study

- Adolescents age 15-19 enrolled in normal school
- Range of BMIs: healthy to overweight but no obesity
- Actigraphy data collected for 1 week, melatonin data collected Thu
- Lack of sleep inclusion criteria, TS and SE examined in all participants

Preliminary Results

With equalized sleep-wake parameters, the obese group had differences in melatonin onset and offset

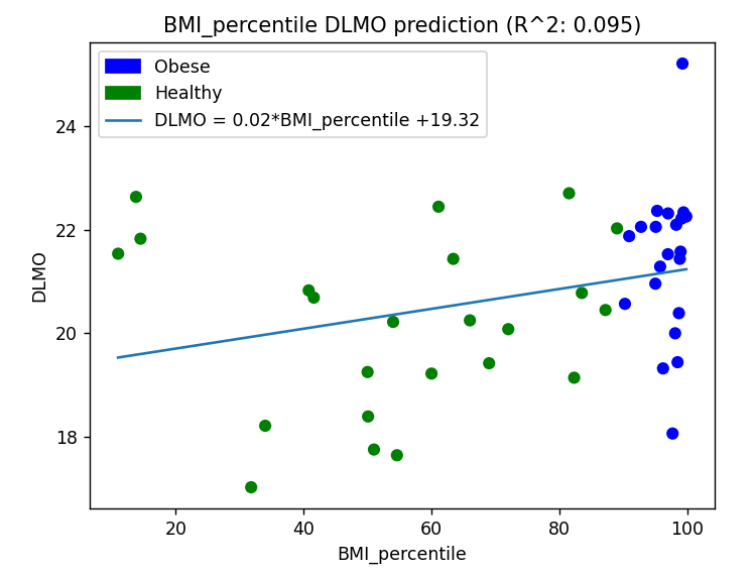
- Dim light melatonin onset (DLMO) in obese group was later by ~43.8 min ($p = 0.0176$)
- Dim light melatonin offset (DLMOff) in obese group was earlier by ~48.6 min ($p = 0.0348$)

	Healthy	Obese
Avg. bedtime	23:06	23:21
Avg. DLMO	20:10	20:54
Avg. wake time	7:05	7:02
Avg. DLMOff	8:26	9:14

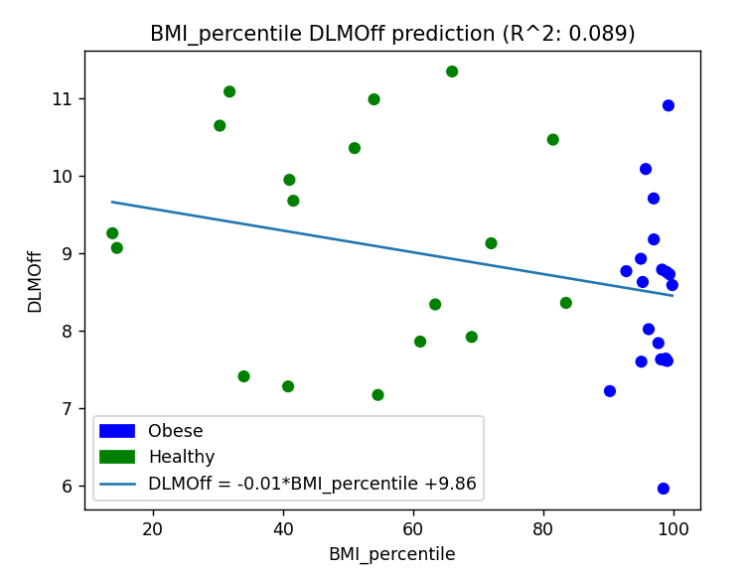
The obese group had a shorter biological night by ~1.5 hours on average!

Results Continued

DLMO Regression



DLMOff Regression



Moving towards modeling rhythms

Molecular & macro models

- Novel models in computational neuroscience incorporate both molecular mechanisms and macro phenomena
- These techniques can give us a better picture of the nature of differences between groups

Confounding Factors and Limitations

Undiagnosed sleep disorders

Both studies screened for sleep disorders, but participants could still have these disorders

Time of year

Our circadian clock changes with the changing light cycles throughout the year

Light exposure

Small variations in light exposure could have significant effects on melatonin timing

Healthy group representation

The healthy group has “manufactured” levels of healthy sleep and may not represent the broader population

Seasonality?

It has been hypothesized that insulin resistance is linked to the biological state of preparing for winter (Scott & Grant, 2006)

Many tissues in the body have their own peripheral circadian rhythms, including adipocytes (fat storage)

This is could be linked to the shorter biological night experienced by obese participants

Future Work

Using physiologically-based math models to predict melatonin dynamics

Using math models

Correct for light exposure and investigate light sensitivity

Light data

References and Acknowledgements

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