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Circadian Rhythm Effects of Social Jetlag and Exercise on Stress Levels and Weight Change of Fischer Rats

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Purpose

Circadian rhythms are the internally driven 24-hour cycles of biological processes regulating sleep schedules, physiological activity, digestion, and hormone levels in living organisms.[1] Changes in environmental cues, such as light, alter circadian rhythms. The superchiasmatic nucleus (SCN), a region of the mammalian brain, receives retinal information and sets the internal clock.[2] Altering the light/dark cycle makes the SCN reschedule behavioral activity patterns, yet this requires a few days. Social jetlag, such as changing sleep schedules on the weekend, does not allow the biological clock sufficient time to adapt.[3] Abruptly disturbing sleep cycles leads to deviations from normal weight changes and increases the secretion of cortisol, a stress hormone.[4] However, exercise helps regulate circadian rhythms by inducing the secretion of melatonin and promoting natural activity patterns.[5] Therefore, in our model of Fischer rats, we hypothesized exercise may mitigate the negative health implications of social jetlag.

Materials and Methods

- 16 Fisher rats around 4 months of age were used in the experiment.
- The animals were housed individually and acclimated for a week.
- The rats followed a 7 day cycle starting on Wednesday.
- After a week, the rats were divided into 2 equal groups based on weight and activity.
- For 2 weeks, the rats maintained either a normal L/D cycle or a shifting LD cycle.
- Wheel running data was collected to follow the internal circadian clock.
- At the start of week 3, wheels were removed from half of the rats in each group.
- This created 4 different subject groups: Group 1 was a control with non-fluctuating LD cycles and unlimited wheel access.
- Group 2 had non-fluctuating LD cycles with no wheel access for the last 6 weeks.
- Groups 3 and 4 had fluctuating LD cycles, with Group 3 having unlimited wheel access throughout the experiment, and Group 4 not having a wheel for the last 6 weeks.
- All animals had access to food and water for 24 hours.

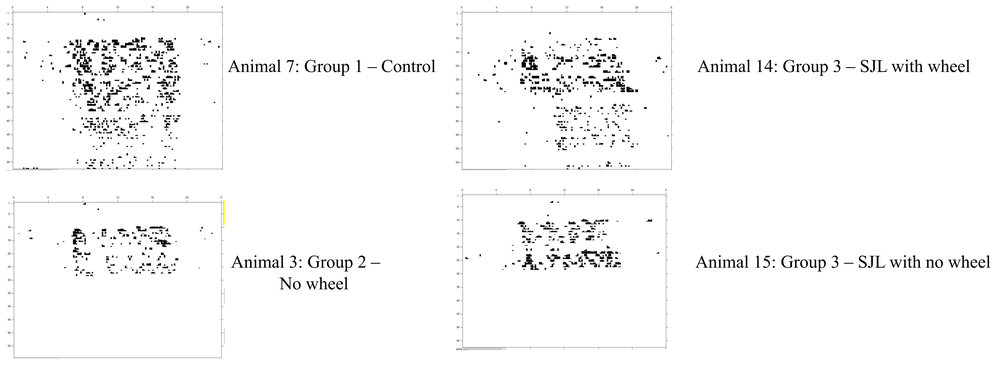
Alternating of Day and Night Cycles

- Animals were acclimated to a standard LD cycle.
- Rats subjected to social jetlag had a shifted LD cycle schedule.
- LD cycle of lights off from 7:00 am to 7:00 pm for 5 days.
- LD cycle of lights off from 12:00 pm to 12:00 am for 3 days.
- Animals had lights off from 7:00 am to 12:00 am on Sundays to begin social jetlag.
- Animals returned to the regular LD cycle by having lights turn on at 7:00 pm on Tuesday.
- All four groups of rats began the same LD cycles on Tuesday nights.

Monitoring Wheel Running, Weight Measuring & Collection of Urine

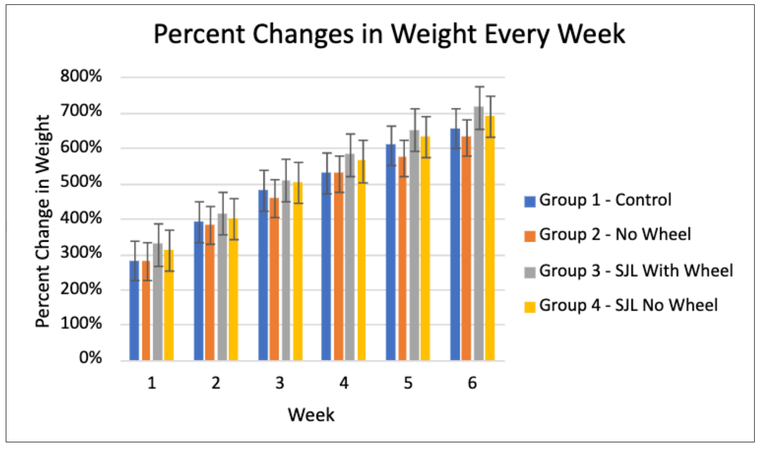
- Animal activity was measured from a running wheel connected to a data monitor
- Wheel available during entrainment period and during social jet lag period
- Onset of wheel running a reliable measure of internal clock
- Corticosterone levels recorded based on 24-hour cycle with 3-hour acclimation
- Rats placed in metabolic chamber with gel hydration packets for urine sample collection
- Weight change of animals was measured every Thursday at 12:00 pm.

Figure 1



Weight Changes

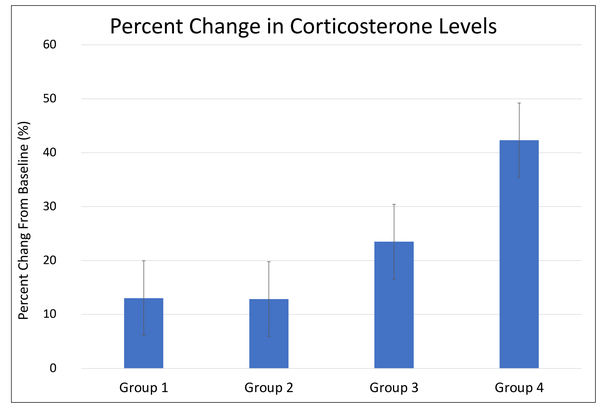
Table 1



Corticosterone Data

The evaluation of the relative change in corticosterone levels was done using Corticosterone Enzyme Immunoassay Kit from Arbor Assays.[6] Baseline and final collections of urine were diluted and ran in the assay (Figure 2).

Figure 2



Significance

- Groups 1 and 3 included data from an identical study that did not include the removing of the wheel. The percent changes were averaged together in Figure 2.
- As predicted, Group 4 had the largest increase in stress levels compared to Group 1, however, despite the trend, the P value was 0.153 and is not statistically significant.
- Although Group 3 did show a trend of increased corticosterone levels, because of variability within the group, there was no statistical significance with Group 1 since the P value was 0.363.
- Exercise seems to decrease the impact of social jetlag on corticosterone as the animals with a wheel did not have as elevated levels as those without a wheel, but the sample size has too much variance to support the hypothesis.

References

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