

# Caffeine and Exercise Affect Sleep Duration, Quality and Perceived Tiredness

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## Introduction

### Background:

Caffeine is the most widely consumed psychoactive substance in the world [4]. Sleep, exercise, caffeine, and mood are interrelated with alterations in one leading to significant health consequences [1]. While caffeine is well known for its stimulant abilities, it also impacts regular sleep patterns [2]. Caffeine impairs the quality and duration of sleep [3]. Caffeine delays sleep onset, decreases total sleep time and decreases perceived sleep quality [3,2]. Exercise has been linked to improved sleep quality and duration [5]. Exercise can be used effectively to promote longer and higher quality sleep [5].

### Objectives:

The purpose of this study is to evaluate the effect of caffeine and/or exercise on sleep quality, duration, and perceived feelings of tiredness. We predict subjects will sleep longest and report the best sleep quality on days where they exercised and abstained from caffeine. Further, we predict subjects will report lower feelings of perceived tiredness when administered caffeine.

## Materials and Methods

### Subjects:

18-50 year old adults (N=61), BMI ≤ 35

	Sedentary		Exercise	
	Placebo (N=14)	Caffeine (N=18)	Placebo (N=14)	Caffeine (N=15)
	Mean ± SEM			
Age	25.6 ± 2.4	29.2 ± 2.4	28.9 ± 2.5	27.6 ± 1.7
BMI	25.6 ± 1.1	26.5 ± 1.8	26.9 ± 1.4	25.6 ± 1.4
Daily Caffeine Intake (mg/day)	122.45 ± 35.1	162.6 ± 52.4	107.7 ± 34.9	91.1 ± 30.5

### Design:

This study was a 2x2 design with participants randomized to exercise or sedentary activity and to consume caffeine or placebo prior to exercise or rest for 4 days week over a two week period. Participants were required to abstain from all caffeine sources 24 hours prior to each conditioning/treatment session where they drank 350-mL of Gatorade with a relative (3 mg/kg body weight) dose of placebo or caffeine.

### Analytic Plan

Data were analyzed using a mixed analysis of variance with treatment (placebo or caffeine) and condition (exercise or sedentary) as between subjects factors, time as the repeated measure, and usual caffeine intake and BMI as the covariates. Data were considered significant if  $p < 0.05$ . SYSTAT 11.0 was used for all analyses.

## Results: Sleep Duration

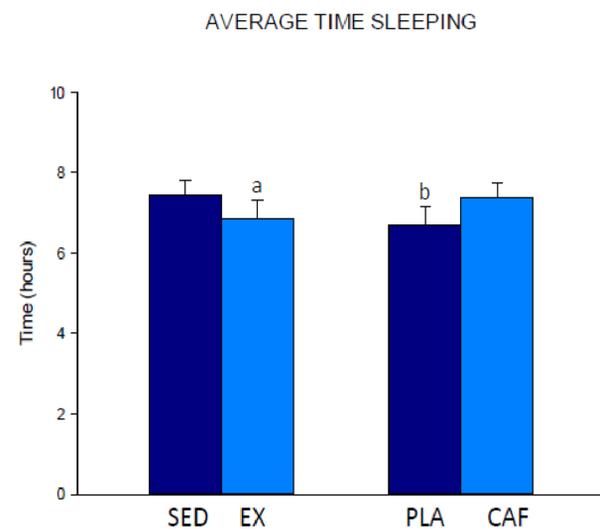


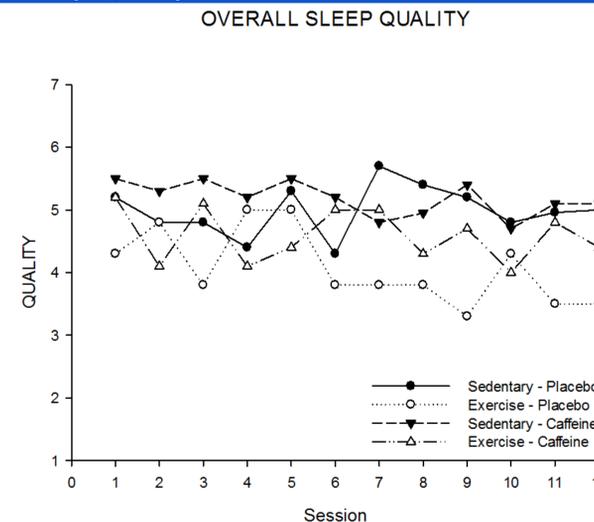
Figure 1:

There was an independent main effect of condition (sedentary/exercise) on hours slept. **a)** On average, subjects who exercised in the lab self-reported less time (hours) sleeping [ $F(1, 18) = 4.5, p = 0.049$ ] compared to sedentary. There was a trend for an independent effect of treatment (placebo/caffeine) on hours slept ( $p = 0.08$ ). **b)** On average, subjects who received placebo self-reported less time (hours) sleeping compared those who received caffeine. There were no interactions by usual caffeine intake.

## Results: Sleep Quality

Figure 2:

There was a significant time x treatment x condition interaction on overall sleep quality [ $F(11, 198) = 1.92; p = 0.038$ ]. Sleep quality decreased over time in subjects who exercised (o, Δ) compared to condition controls (sedentary). In addition, subjects who exercised and received placebo (o) had the lowest overall average sleep quality.



## Results: Perceived Tiredness

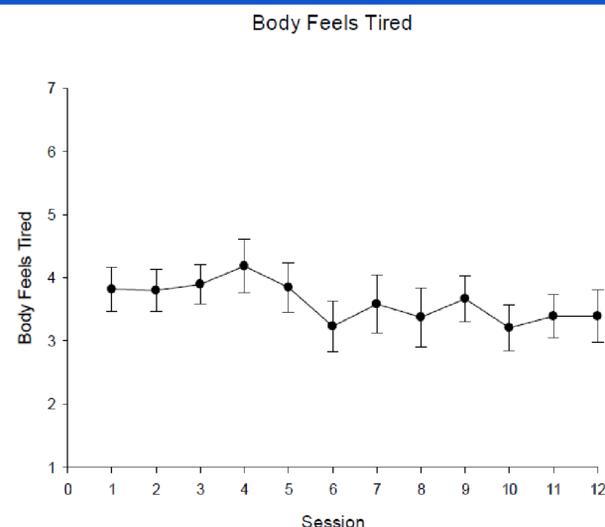


Figure 3:

There was a main effect of time for 'Body Feels Tired' [ $F(11, 154) = 2.1; p = 0.026$ ]. Over time, all subjects reported their body felt less tired. There were no treatment (placebo/caffeine) or condition (sedentary/exercise) interactions.

## Summary

Independent effects of exercise or caffeine on time slept

- Participants who exercised reported sleeping less than those who were sedentary
- Those who received caffeine reported longer sleep duration than those who were not administered caffeine

Combined effect of exercise and caffeine over time on sleep quality

- Highest sleep quality ratings associated with caffeine and without exercise
- Poorest sleep quality ratings associated with caffeine and exercise

Perceived tiredness

- Over time, all participants reported a decrease in "body felt tired"

## Conclusions and Future Directions

- Exercise and caffeine did not have the hypothesized results on sleep quality and duration. Withdrawal reversal is the primary action mechanism of caffeine. Reversing this negative state through caffeine administration improved sleep quality and duration.
- Unaccustomed exercise in inactive individuals may have caused physical discomfort that disrupted sleep quality and duration. Participants may have been exercising at a higher intensity when caffeine was administered.
- Future studies should examine the possibility of competing mechanisms of caffeine and exercise on sleep patterns and quality.

## References

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