

# The Impact of Caffeine, Alcohol, and Herbal Teas on Physical Performance

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# 1 Abstract

More than 80% of the world's adolescent population is insufficiently active when it comes to physical performance, despite its significant benefit for body, heart, and mind. Physical performance and endurance are critical components of health and fitness. Through the development of supplements and testing of substances, studies have found that these can significantly influence fitness performance. This study investigates the effects of herbal tea, caffeine, and alcohol on the multistage shuttle run test, also known as the PACER test, a commonly used measure of cardiovascular endurance. I proposed that herbal tea, caffeine, and alcohol, commonly consumed beverages, could have distinct effects on the PACER test performance. This study employs a repeated measures design, allowing each participant to experience all four treatment conditions (herbal tea, caffeine, alcohol, and control). By identifying the specific effects of these substances on physical performance, this research contributes to a better understanding of how dietary choices can influence endurance.

# 2 Introduction

Physical performance and cardiovascular endurance are critical health concerns globally. In 2020, about 46.9% of adults of ages 18 and over met the Physical Activity Guidelines for aerobic activity, with only 24.2% meeting the guidelines for aerobic and muscle-strengthening activity. Among various factors that can influence physical performance, dietary substances like herbal tea, caffeine, and alcohol are widely consumed and have been reported to have varying effects on endurance. Previous studies suggest that caffeine, a central nervous system stimulant, can enhance alertness and performance, but it may cause anxiety. Partaking in high-intensity activities may impair endurance performance due to its heart rate-raising effects. Herbal teas are rich in antioxidants and other bioactive compounds, though scientific evidence on their effects on endurance is limited. Currently, some herbs are used to enhance muscle strength and body mass. Alcohol, known for its depressant effects on the central nervous system, is generally thought to impair physical performance, since it affects energy supply and impairs the metabolic process during exercise.

Thus, this study aims to investigate the potential effects of these three commonly consumed substances for the PACER test performance in particular as a way to measure their effectiveness in cardiovascular endurance. Given the widespread consumption of these substances and their potential impact on physical performance, specifically, I aimed to compare each of the effects by the islanders respective PACER test score. I explored if any substances enhance or impair their performances, with the hopes of providing any sort of insights for athletes, fitness enthusiasts, and the general public on the optimal choice of beverages before engaging in endurance activities.

## 3 Methods

### 3.1 Participants

The twenty-four participants aged 18-26 were recruited from the islands. They were chosen from the universities in *Colmar* and *Arcadia*, with the intention that they would have similar lifestyles. The similar age range was also used in order to reduce overall variability among the subjects. The participants were also all male to further avoid nuisance factors. Each participant completed the PACER test under four different treatment conditions: herbal tea, caffeine, alcohol, and control.

### 3.2 Design

Benchmark df = 1	between blocks = 23	within blocks = 3	Interaction df = 69	Errors df = 69
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A repeated measures design was used to control for within-subject variability. Each participant experienced all four treatments (herbal teas, caffeine, alcohol, control) at different times.

### 3.3 Instruments

The following treatments were used when measuring the overall PACER test score: Caffeine Tablet (100mg), Alcohol (Tequila 33ml), Herbal Tea (250ml), and the control trial with no substances.

### 3.4 Procedure

**Step 1:** Find subjects from the island universities that were willing to partake in the experiment.

**Step 2:** Measure the PACER test score of all the subjects through the control treatment in order to get a sense of their performances before measuring the impact of the substances.

**Step 3:** After waiting a day, the subjects then consumed 33 ml of tequila and were tested again. Afterwards, I applied the alcohol withdrawal treatment for 14 days to prevent any of the effects of alcohol to avoid carryover effects.

**Step 4:** The subjects drank 250 ml of herbal teas and then asked to run the PACER test again. Then I waited a day for the effects of the teas to wear off before running the test one more time under caffeine.

**Step 5:** Lastly, the subjects were tested after taking a 100mg tablet of caffeine. After all these trials, I used R to analyze the data and form a conclusion based on the results I found.

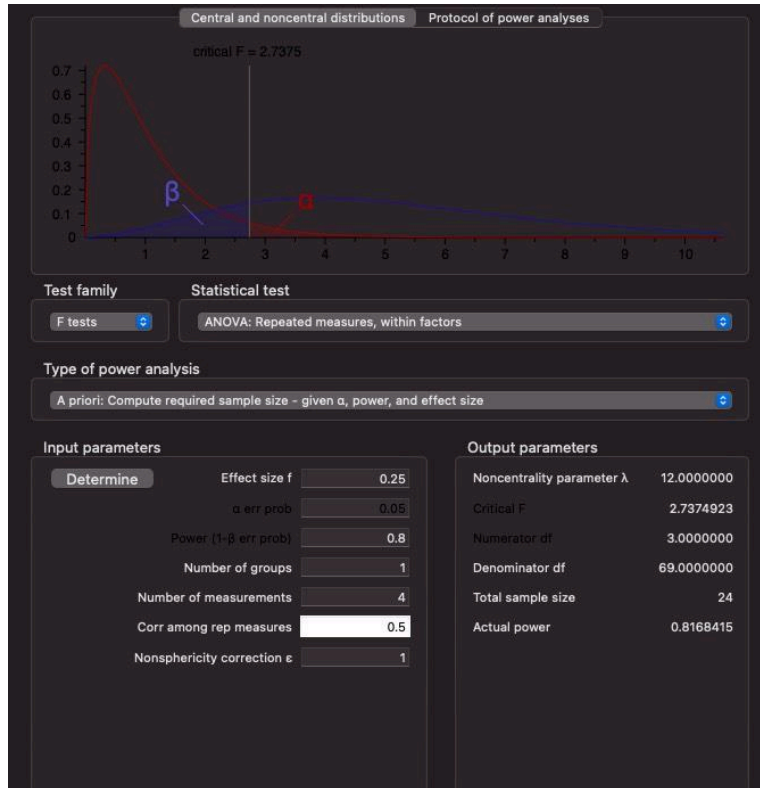
## **4 Data Analysis**

### **4.1 Type of Statistical Analysis**

Using R Studio, I ran a repeated measures ANOVA test in order to determine if there were statistically significant differences within the multiple conditions the subjects were tested under. was conducted to determine the overall effect of treatments on PACER test scores. By using repeated measures ANOVA, I accounted for individual differences for each participant in order to control variability and strengthen my statistical tests.

### **4.2 Sample Size Determination**

I used a power of 0.8 to measure if there is a true effect. The effect size was 0.25, which suggested that I expected there to be moderate differences between treatments. An alpha of 0.05 tells us there's a 5% chance of concluding there is an effect when there is none. There were 4 groups to represent the treatment conditions. In the end, using G\*Power helped me to determine a sample size of 24.



## 5 Results

### 5.1 ANOVA Analysis

Source	DFD	SS	MS	F	p-val
<b>Between Subjects</b>	23	105.7	4.596		
<b>Treatment</b>	3	18.011	6.004	44.01	5.23-16
<b>Residuals</b>	69	9.413	0.136		

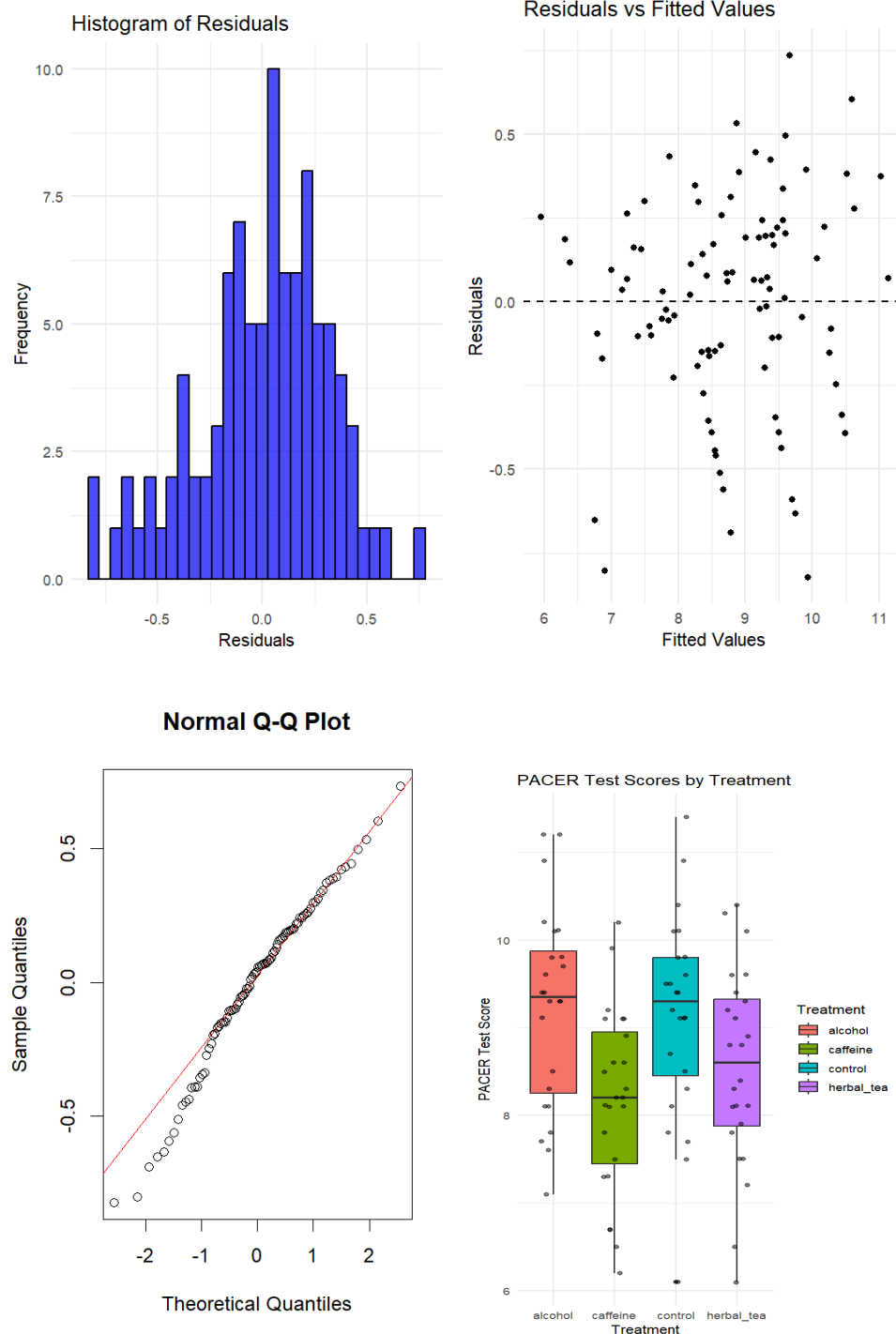
The ANOVA results indicate significant differences in PACER test scores across the four treatments ( $p < 0.001$ ). This suggests that the type of treatments influence the scores, and to support this, the low p-value indicates that we reject the null hypothesis that there is no difference in scores across the different treatments.

## 5.2 Post-hoc Analysis

<b>Treatment</b>	<b>emmean</b>	<b>SE</b>	<b>df</b>	<b>lower.CL</b>	<b>upper.CL</b>
<b>Alcohol</b>	9.23	0.228	23	8.76	9.71
<b>Caffeine</b>	8.18	0.228	23	7.70	8.65
<b>Control</b>	9.13	0.228	23	8.66	9.60
<b>Herbal Tea</b>	8.54	0.228	23	8.07	9.02

Post-hoc analysis revealed significant differences between alcohol and caffeine, alcohol and herbal tea, caffeine and control, caffeine and herbal tea, and control and herbal tea. Caffeine surprisingly showed the most negative impact on the PACER performance, significantly reducing scores. Alcohol did not significantly differ from the control group, suggesting a neutral effect, outperforming the other substance treatments. Herbal tea had an intermediate effect only performing better than caffeine.

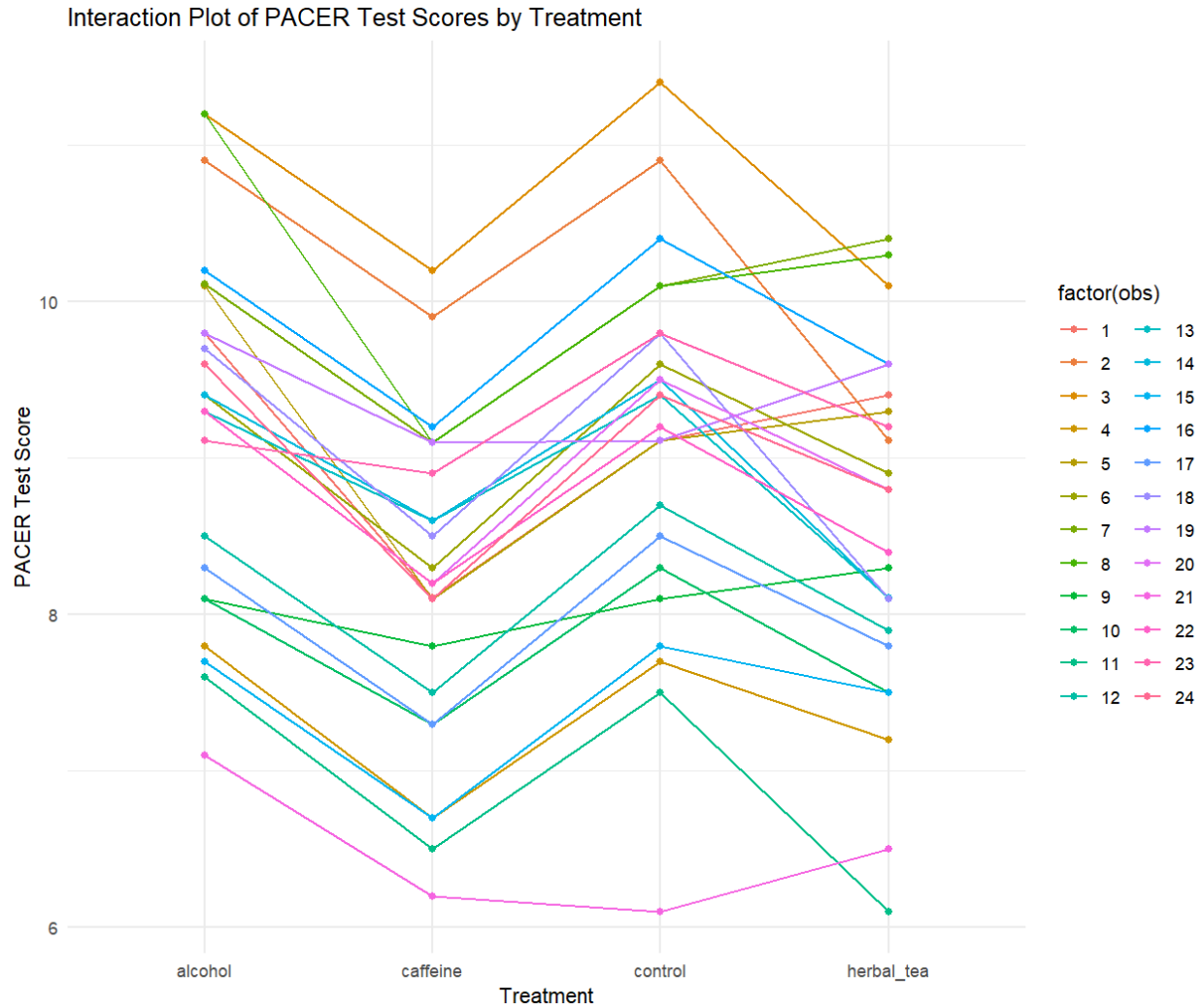
## 5.3 Residual Diagnostics



Our **residual plots** show that they are approximately normally distributed, indicating that the normality assumption is likely to be satisfied. The consistent spread of residuals suggests that the variance of the residuals are constant across different levels of fitted values.



## 5.4 Interaction Plots



The **interaction plot** of PACER test scores further supports that the control and alcohol groups had similar effects, with caffeine being the lowest scores and herbal teas having intermediate impact.

## 6 Discussion

This study aimed to investigate the effects of different substances—herbal tea, caffeine, alcohol, and control (no treatment), on the PACER test performance. A repeated measures design was employed in order to control for individual variability through testing each participant under each group.

The study involved only 24 participants. The repeated measures ANOVA indicated a highly significant effect of treatment on PACER test performance ( $F(3, 69) = 44.01, p < 0.001$ ), suggesting that the type of beverage consumed before the test had a statistically significant impact on performance. The post-hoc tests also revealed specific differences between treatments, particularly highlighting the negative impact of caffeine compared to other treatments. The analysis surprisingly showed that caffeine significantly reduced overall PACER test scores. Herbal teas showed to have had a mixed effect, generally better than caffeine but not as good as alcohol or control. This indicates a mild positive or neutral impact on performance. Alcohol surprisingly did not significantly differ from the control condition. This was interesting given the common perception that alcohol impairs physical performance. The results suggest that moderate alcohol consumption might not have a substantial short-term impact on endurance activities. The interaction plot showed individual variability in response to the treatments. The boxplots further supported the distribution of PACER test scores for each treatment, with clear indications that caffeine generally lowered scores, while alcohol and control conditions maintained higher performance levels.

I acknowledge that there were some limitations to my experiment. Each subject only received each treatment once. Distributing multiple doses might reveal different effects or more accurate dose-response relationships. Another limitation is that the study measured the immediate effects of beverage consumption on PACER test performance rather than long term impact. The participants were also aware of the treatment they were receiving, which could introduce possible bias. Blinding participants to the treatment conditions might alter the mindsets or any sort of mental state going into the trial. Factors like the time of day, participants' hydration levels and individual fitness levels were not controlled or standardized, which could affect performance outcomes or be potential nuisance factors. Time in between treatments and the PACER test could have also had some sort of effect based on the amount of rest the subjects had. Larger samples could possibly provide a different outcome to the results of the experiment with more diversity. Research should investigate the effects of varying doses of each treatment and their long-term impacts on endurance and physical performance. This would help in understanding the dose-response relationship and potential cumulative effects. These findings can inform guidelines on beverage consumption related to physical performance, particularly for activities requiring endurance.

Overall, the study provides valuable insights into how different beverages affect PACER test performance. Caffeine consistently impairs performance, while other substances such as alcohol and herbal tea have neutral to mildly positive effects. Despite the possible limitations of the study, it sets the stage for further research into the complex interactions between diet, hydration, and physical performance.

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