Study on the Effect of Resistance and Training Methods on the Number of Calories Burned on a Stationary Bike

Shafna Kallil

August 21, 2020

1 Description

1.1 Introduction

Regular physical activity is advocated by health professionals around the world, for its health and psychological benefits. A healthy lifestyle is considered to be one that consists of a balanced diet and regular physical activity. Though since 1975 obesity rates have almost tripled, and as a result there is a higher prevalence of chronic disease and other serious conditions (World Health Organization). A primary reason for the increase in obesity rates is the adoption of a sedentary lifestyle (Zheng,et al., 2020).

The emergence of Covid-19 and the introduction of social distancing measures have increased the adoption of a sedentary lifestyle. As an individual who has personally become less active due to these safety measures, I wanted to get back into a healthy lifestyle.Personally, the easiest way to exercise safely at home was using a stationary bike. Through this experiment, I hope to learn which training style will result in the largest number of calories burned.

1.2 Method

I designed a 2^k factorial design with 3 replications, where k = 2. A 2^k factorial experiment was ideal since it would allow me to study the effect of each factor on the outcome as well as the interaction between factors and the resulting effect on the outcome. The experiment will compare 2 factors of 2 levels each. In total, 12 measurements would be taken. The order of the runs will be randomized using a R script prior to conducting the experiment. The measurements will be taken over a period of 4 days, 3 trials each day. The trials are to be conducted at 12 pm, 3 pm and 6 pm daily. The objective of this experiment is to determine the effects of training method and resistance level on the number of calories burned while riding a stationary bike.

FACTORS	-1	1
Training Method	Steady-State	HIIT (interval)
Resistance Level	Low	High

Figure 1: Factor Level Definition

Each trial of this experiment will last a duration of 10 minutes. In regard to training methods, Steady-State consists of cycling continuously at medium effort. While, the HIIT method is based on the 30-20-10 rule (Gliemann,et al., 2015), whereby the first 30 seconds will be medium effort, the next 20 will be high effort, and the last 10 is the fastest one is able to cycle. Since the 30-20-10 rule adds up to a minute, this method will be repeated until the 10 minutes are up. In regard to resistance level, the stationary bike used for this experiment has resistances ranging from $1 - 8$. This experiment will utilize level 1, which is low resistance and level 8 which is high resistance. To see whether resistance has an effect on the number of calories burned.

The conditions that will be tested are Steady-state/ Low resistance, Steady - State/ High Resistance, HIIT/Low Resistance, and HIIT/ High Resistance.

In order to have continuity and reduce external variables, the experiment will be conducted on the same stationary bike. Measurements will be taken on the calorie counter on the stationary bike. In addition, these 4 days I will consume a similar meal plan in order to reduce bias. Furthermore, there will be no music during the workout, since it may be a extraneous variable. Additionally, I am assuming that the calorie counter on the stationary bike is accurate. And that the timing of the workout and any deviations of performance due to the time of day is negligible. Since there is 3 hours in between each workout, to decrease fatigue.
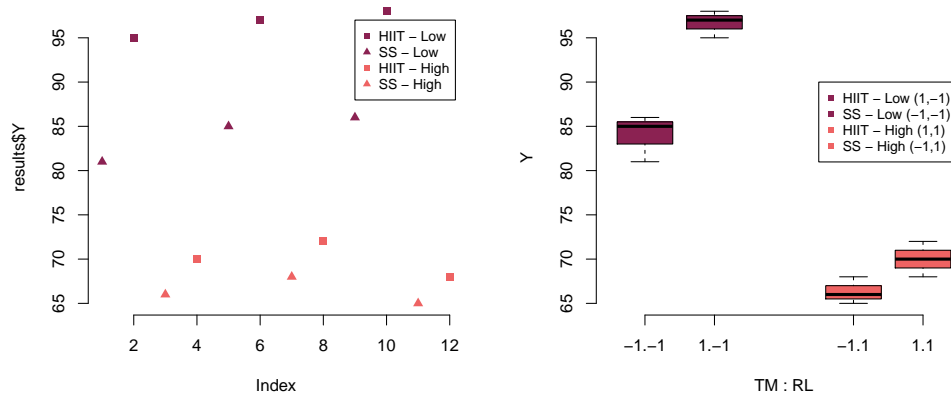
2 Analysis

2.1 Results

Table 1: Experimental Results

| TM	RL	run1	run2	run3	y1	y2	y3
-1	-1	1	5	11	81	85	86
1	-1	2	6	10	95	97	98
-1	1	3	7	8	66	68	65
1	1	4	9	12	70	72	68

2.2 Summary Plots

From plotting the points, it can be seen that there seems to be great variation between the different types of techniques used, thus indicating that there may exist a significant effect. But this needs to be further analyzed through a regression analysis.

Similarly, the boxplot also highlights that there is a difference between the factors, since different combinations resulted in a different number of calories burned. It can be seen that at a low resistance, I managed to burn more calories in comparision to a high resistance. Similarly, HIIT also had a higher outcome in comparision to steady state, but the variation was smaller than that of resistance level.

2.3 Interaction Plot
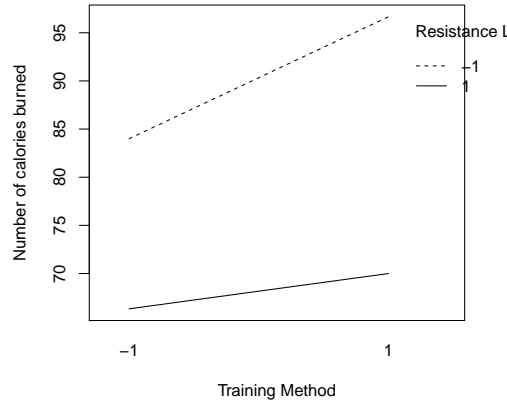
From the plot above, it can be seen that the factors training method and resistance level showcase a significant intereaction effect, as the lines are not parallel. It also indicates that a better outcome occurs when at low resistance or using HIIT. This will need to be further analyzed, in order to determine significance through regression analysis.

2.4 Linear Regression

2.4.1 Regression Analysis

```
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)     79.25       0.57  138.72         0
## TM               4.08       0.57    7.15         0
## RL             -11.08       0.57  -19.40         0
## TM:RL           -2.25       0.57   -3.94         0
```

From the regression analysis, it can be seen that training method, resistance level, and the interaction of the 2 are all statistically significant since the probability value is 0.

2.4.2 Main Effects and Interaction Effect

	Estimate	2.5 %	97.5 %
TM	8.17	5.53	10.80
RL	-22.17	-24.80	-19.53
TM:RL	-4.50	-7.13	-1.87

The main effect of Training Method is 8.17. This indicates that on average, when completing HIIT I lose 8.17 more calories than with steady state. The main effect of Resistance Level is -22.17. This indicates that on average, when completing on a High resistance level I lose 22.17 less calories than on a low resistance setting. The interaction effect is -4.50. As the interaction between Training Method and Resistance level is negative, this indicates that the impact of training method is smaller when using a high resistance level in comparison to a low resistance level.

After analyzing the confidence intervals, we can also see that the main effects and interaction effect is significant, since 0 is not present within the interval.

3   Conclusions and Discussions

3.1   Conclusion

From the analysis above, we can conclude that :

The factor Training method has a significant positive effect on the number of calories burned. Thus, HIIT yields a higher outcome in comparison to steady-state.

The factor Resistance Level has a significant negative effect on the number of calories burned. Thus, at a higher resistance level I burn fewer calories in comparison to training at a lower resistance level.

The interaction of the 2 factors had a significant negative effect on the number of calories burned. This showcased that the impact training method had on the number of calories burned was smaller when using a high resistance level in comparison to a low resistance level.

In conclusion, after running this experiment I have found that as a novice bike rider the best training style which would result in the highest number of calories burned would be completing HIIT at a low resistance level. Though completing any training method at low resistance yielded a better outcome than training at a high resistance.

3.2   Discussion

Since this experiment was conducted based on an effort scale : medium, high, extreme, there exists a source of error. While conducting the experiment, I noticed when at a low resistance I was going at 20km/h, 25km/h and 30km/h,respectively. While at a higher resistance, I was biking at 15km/h, 20km/h and 25km/h, respectively. The lower speeds I travelled at could have a significant effect on the number of calories burned, since speed is a potential confounding variable. And it may be a potential explanation to why there was a large variation in the outcome between the two resistance levels.

Additionally, I noticed that the distance I travelled was also higher for the low resistance trials. And that the highest amount of calories burned always positively correlated with distance. Which brings me to infer that one of the variables of the calorie counter on the stationary bike is the distance travelled. Thus, due to these extraneous variables the results I have found from conducting a 2^2 factorial design, may not be completely accurate.

Thus, there are 2 ways I could potentially improve on this experiment if it were to be replicated again.

1. Bike at similar speeds for both resistance levels. Experiment will no longer be based on an effort scale.

2. Take into account the extraneous variables as covariates, when conducting the data analysis.

4   References

Obesity and overweight. (n.d.). Retrieved from | https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

ZHENG, C., HUANG, W. Y., SHERIDAN, S., SIT, C. H., CHEN, X., & WONG, S. H. (2020, January 01). COVID-19 pandemic brings a sedentary | lifestyle: A cross-sectional and longitudinal study. Retrieved from https://doi.org/10.1101/2020.05.22.20110825

Gliemann, L., Gunnarsson, T. P., Hellsten, Y., & Bangsbo, J. (2015). 10-20-30 training increases performance and lowers blood pressure and VEGF in | runners. Scandinavian journal of medicine & science in sports, 25(5), e479–e489. https://doi.org/10.1111/sms.12356