Chocolate and Cycling Assignemnt

Objective

You have been hired by the U.S. bicycle team to help them train for the Tour de France. The head trainer recently read an article, which presents the results of a study about the effects of the consumption of chocolate (dark chocolate and white chocolate) on a number of important outcome variables during cycling. These outcome variables included: oxygen consumption (ml/kg/min), heart rate (bpm), blood lactate (BLa), blood pressure (mmHg), and an all-out bicycle sprint performance (meters).

The experimental setup consisted of a randomized crossover design where the various outcome variables of n = 9 male participants was measured in two trials after participants consumed either dark chocolate (40 grams of Dove) or white chocolate (40 grams of Milkybar), each for two weeks. A crossover design is a repeated measurements design such that each subject receives the two different treatments (dark chocolate versus white chocolate) during the different two-week time periods, i.e., the patients cross over from one treatment to another during the course of the experiment. The order of which treatment was received in the first time period was randomized. Prior to receiving the first treatment, each participant underwent baseline measurements on the outcome variables.

The trainer was specifically interested in the results for the all-out sprint performance which measured the distance traveled (in meters) for a two-minute time trial. He would like to know how the regular consumption of chocolate affects the total distance covered during an all-out sprint and if the type of chocolate consumed matters.

Some of these results are presented in the table below.

Distance Covered (in meters = m) during Time Trial* Note: n = 9 for each condition

----------Baseline--------White Chocolate (WC)--------Dark Chocolate (DC)

Mean (m)----------1367----------1419----------1606

Std dev (m)---------171----------248----------158

p-value (compared to baseline)------0.319----------0.001

Dark Chocolate: 95% Confidence Interval for the population average change in total distance covered (dark chocolate over baseline) is 165 m to 314 m; (p-value 0.001).

Dark versus White Chocolate: 95% Confidence Interval for the population average change in total distance covered (dark chocolate over white chocolate) is 82 m to 292 m; (p-value = 0.003).

The trainer knows you have some statistics background and wants your help on understanding and interpreting these results. Based on the results from the article, write a memorandum to the trainer addressing his questions and explaining what these statistics results show.

Your memorandum should include a little discussion about the benefits of using a crossover design. Although this sample size is small, you can consider it a reasonable one for this type of

study, and can thus focus on interpreting the results. Be sure to comment about the two provided confidence intervals, including an interpretation of both confidence intervals, and an explanation of the meaning of the confidence level in context. Finally, include in your memorandum your recommendation for or against inclusion of chocolate (and if inclusion, which type of chocolate) in the athletes' diet.

Data is from: Patel, R. K.; Brouner, J.; Spendiff, O. Journal of the International Society of Sports Nutrition. 2015 12:47.

Background

The study about the effects of the consumption of chocolate (dark chocolate and white chocolate) on cyclists during cycling. Our parameter of interest is the all-out bicycle sprint performance (meters). The results we got from the study after conducting it on 9 male participants was measured in 2 trails, one after consumption of dark chocolate for a week and one after consumption of white chocolate for a week. So, we have a population paired data.

Defining our Hypothesis

We will first set our Hypotheses. We will set 2 sets of hypothesis, one for comparison between the baseline and any form of chocolate and then between dark and white chocolate.

First we will set it for baseline versus any form of chocolate. Null Hypothesis 1: The consumption of dark chocolate and white chocolate have no effect on the cyclists and they travel equal distances. => H0_1 = dark chocolate - white chocolate = 0

Alternate Hypothesis 1: There is significant difference between the consumption of dark and white chocolates, => Ha_1 = dark chocolate - white chocolate != 0

The next set of hypothesis will be set for comparison between dark and white chocolates. Null Hypothesis 2: There is no significant difference between consuming dark and white chocolates. =>H0_2 = mu1 - mu2 = 0 Alternate Hypothesis 2: There is significant difference between consuming dark and white chocolates. =>Ha_2 mu1 - mu2 != 0 These are both 2 sided hypotheses.

Examining our data and checking assumptions

With that set, we will check for our assumptions.

Since the order in which the participants consumed dark or white chocolate was selected at random, we will consider our data as a random sample and they are independent of one another. The second assumption we need to check is whether our data is normally distributed or not. We have been told to consider it normal and we can not apply CLT to avoid normality check, so we will consider our tiny sample of data to be normally distributed.

Analysis of results

We already have the results of the distance covered without having chocolates, after having white chocolates for a week and after consuming dark chocolate for a week. We have the mean, and standard deviation for all the three along with the corresponding p-value of white and dark chocolate compared with the baseline.

From the data, we get the following results:

- mu1 - mu_baseline = 1606 - 1367 = 239 meters
- 95% confidence interval of dark chocolate: (165 m, 314 m)
- p-value for the above = 0.001
- m2 - mu_baseline = 1419 - 1367 = 52 meters The difference in mean (mu1 - mu2) = 1606 - 1419 = 187 meters
  95% confidence interval for dark chocolate vs white chocolate: (82 m, 292 m)
  p-value for the above = 0.003
  where mu1 = mean distance dark chocolate, mu2 = mean distance white chocolate, mu_baseline = baseline mean distance.

We will consider our significance level to be 0.05.

Making a Decision

We see, from our analysis of the results that dark chocolate almost always performs better than white chocolate and the baseline results. This might be only for our sample and so, we will check our hypothesis and the confidence interval to see if our result is useful or not.

We will check for the first set of hypotheses, to see the difference in performance of cyclists before and after having chocolates, i.e. H0_1 and Ha_1.

From our sample we see that the difference between having either chocolate and the baseline performance is positive, implying that for this sample people performed better after having chocolates.

- We will first do the confidence interval check to see if our sample result is reasonable or not. At the 95% confidence interval, we get a range of reasonable values to be between 165 meters and 314 meters. Our value happens to be 239 meters which is inside the confidence interval. So, it is not a surprising value.
- For the hypothesis test, we see that we get a p-value of 0.001 which implies that if we consider our Null hypothesis to be true, the values we got is 0.1% possible. That means we have sufficient proof to reject our Null hypothesis which states that there is no significant difference between the performance of participants before and after taking any form of chocolate. This implies that there is a -significant difference between consuming and not consuming chocolates when it comes to cycling. Since the difference is positive, we can say that having chocolates has a positive effect on performance.

We will now check for the second set of Hypotheses, to see the effect of each type of chocolate on the performance of the cyclists, i.e. H0_2, Ha_2.

We see that the difference between consuming dark chocolate and white chocolate on the distance cycled is over 187 meters in favor of dark chocolate. So, from our sample we see that dark chocolate makes the cyclists perform better.

- To confirm this, we will check the confidence interval and see if the value we got was reasonable or not. We see that the confidence interval is (82 meters, 292 meters). 187 meters lies inside the confidence interval and so our result is reasonable. In addition, since both values in the confidence interval is positive, we can also conclude with 95% confidence that dark chocolate makes cyclists perform better than those who take white chocolate.
- For our Hypothesis test, we see that the p-value we get is 0.003 which is less than 0.05, our significance level. So, from this, we see that if our Null hypothesis was true, we would get the value of 187 meters only 0.003% of the time. This makes our null hypothesis look ridiculous. And since the value is way less than 0.05, we will reject the null hypothesis and conclude that there is significant difference between the effect of dark chocolate versus white chocolate on cyclists. In addition, we can say that dark chocolate performs much better than white chocolate.

Conclusion

From this, we can conclude that there is significant difference between the performance of cyclists when they took chocolates versus their performance when they did not take chocolates. Chocolates seem to have a positive effect on their performance. In addition, consuming dark chocolate gives a greater performance boost than consuming white chocolates.