**Independent Contractor to the U.S. Bicycle Team**

**Should we include chocolate in our cyclists’ diet?**

**Observed Study from the Journal of Sports Nutrition**

In preparation for the Tour de France, we have observed a study, conducted by Patel, R. K.; Brouner, J.; Spendiff within the Journal of the International Society of Sports Nutrition. This study observed the effects of the consumption of chocolate (dark chocolate and white chocolate). It compared nine cyclist’s performance after eating chocolate to see if this increased a cyclist’s performance, and from this study we should determine if our cyclists should do the same.

At first, the study measured both the effects of dark chocolate versus white chocolate – this lasted for about two weeks, and recorded oxygen consumption, heart rate, blood lactate, blood pressure, and all-out bicycle sprint performance. The next trial was performed using a crossover design. A crossover design is a repeated measurement design such that each cyclist receives the two different types of chocolate at random during a two-week period.

Looking at the results, it is apparent that the cyclists who ate dark chocolate had an on average larger distance covered in meters compared to cyclists who ate white chocolate. The average distance covered for dark chocolate was 1606 compared to 1419 for white chocolate. Additionally, there was a smaller difference in the average distance covered for the cyclists who ate dark chocolate compared to the cyclists who ate white chocolate.

There were two independent statistical tests conducted at the 95% confidence interval. A 95% confidence interval is a range of values where we can be 95% certain that it contains the true mean of the population. Dark chocolate, for the average change in total distance covered compared to the baseline was 165m to 314m (with a p-value of 0.001), while dark chocolate versus white chocolate had a confidence interval of 82m to 292m (with a p-value of 0.003) (Patel, R. K.; Brouner, J.; Spendiff within the Journal of the International Society of Sports Nutrition).

**Our Internal Company Study**

From the results of this study, it is imperative that we conduct a similar study for our biking company for preparation of our cyclists. We can see that there are benefits of a cross-over study, and we should do the same.

From the observed confidence interval, we can see that there is a statistically significant average change in the total distance covered for cyclists who ate dark chocolate over white chocolate. To observe this, we can create several histogram graphs to visualize the distance covered for both types of chocolate. Additionally, from our study, we would measure several variables similar to the study above – oxygen consumption, heart rate, blood pressure and bicycle sprint performance.

Finally, we would propose a hypothesis test to determine whether our cyclists should include dark over white chocolate in our diet. From the study above, it is apparent that dark chocolate increases cyclists sprint performance – and from our study we would be able to determine if this study and or hypothesis is upheld.

Someone else:

I'm writing to inform you the analysis required about the incorporation of chocolates in the diet of athletes, more precisely to know how the regular consumption of chocolates affects the total distance covered during an all-out sprint and if the type of chocolate consumed matters.

With this objective, we have analyzed the article realized by [1] and suggested by you. The authors explain that the experimental setup carried out consisted of a randomized crossover design.  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. The order of which treatment was received in the first time was randomized. Prior to receiving the first treatment, each participant underwent baseline measurements on the outcome variables.

A crossover study has two advantages [2]. First, the influence of confunding covariates is reduced because each crossover patient serves as their own control. Second,optimal crossover designs are statistically efficient, and so require fewer subjects than do non-crossover designs (even other repeated measures designs).

Then in the following section, we analyzed and give an interpretation about the result obtained in the article.

***Table 1: 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*** |

**R1: 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)”.*

**R2: 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)."*

**Table [1]** show us the results for the experiments. We can see a comparison of values were obtained in the experiments. First, when the person do not consume chocolate (baseline) and then when they consume chocolate (dark or white). According the values for mean and standard deviation (std), we can say that the effects of consumption of chocolate are positive because when the participants consumed chocolate (either type of chocolate) achieve better result in average than when did not consume chocolate, regarding to the all-out bicycle sprint performance.

To statistically validate this difference, that said, the difference obtained were not only for a chance, the researcher carried out other statistical test like as confidence interval (CI) and hypothesis testing (p-value).(see **R1** and **R2**)

Firstly, we analyses the WC’ effects, interpreting the p-value, which indicate something like, “the probability of seeing some value assuming some circumstance”. For instance here, the value that we are seeing is the difference in the sample 1419-1367 = 52 (that said if you consume WC you achieve 52 meter more). In the other hand, the assumption here is, there is not difference between baseline and WC in the population. That said the difference is 0 (if you consume or not WC there is not difference), under this assumption the probability to get 52 meters is near 32 %, that is a high probability. Therefore the difference (52 meters) obtained in the experiments is not sufficient statistical evidence to say that the WC has positive effect.

Regarding to DC’ effects, we can see that the difference in the sample is 1606-1419 = 187 meters, doing the same analyses, under the assumption that in the population there is not difference between baseline and DC, we get a probability 0.1 % to achieve a difference of 187 meters, it’s almost  0 probability. Therefore, we have strong evidence against the assumption, and conclude that the DC has positive effect. In addition this study show us possible values for this differences through the construction of confidence interval (CI), we can see this values are between (165 meters, 314 meters) with 95% the confidence level. This CI does not include 0 value indicating the positive effect produced by the DC and the 95% confidence level refers that 95% of intervals formed this way expected to cover the true population difference.

To sum-up, in the following work we have analyzed, the study accomplished by [1], firstly we discuss the advantages of using a crossover design and we have concluded that his main advantage is the reduction of the influence of confounding variables.

Then we have analyzed results were obtained, based on this result we recommend the inclusion of dark chocolate (DW) in the athletes’ diet because the study show us statistically strong evidence in favor of this type of chocolate.

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| --- | --- | --- | --- |
|  | 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 |

 R1: 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)”.

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Bibliography

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

[2] <https://en.wikipedia.org/wiki/Crossover_study>