TO: James Moore, Tour de France Trainer

FROM: Hare Tortoise, Data Scientist

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SUBJECT: Power of Chocolate for Cycling

The world’s first cycling race (road racing) as a sport began in France on May 31st, 18681. Since then, this sport has grown its popularity around the world, including in the United States, to this day despite of some disruptions along the way. Knowing to train athletes professionally for the Tour de France is the goal and to understand the study results (the effecs of chocolate consumption) pertaining to all-out sprint performance is the pursuit, I have addressed the two key points of interest as well as accompied by the recommendations in the following:

**Crossover Design Benefits:**

According to the “Study Type Determination” by Suchmacher and Geller2, there are two advantages of using the crossover method:

1. It corroborates the findings of the first phase of the study by reproducing them in the second phase, reinforcing the conclusion of the study.
2. It affords the comparison between groups in a self-paired manner; that is, group A and B can be compared against themselves at the end of the study and this allows for greater biological homogeneity.

Moreover, based on “ANTIEPILEPTIC DRUGS | Clinical Drug Development in Epilepsy” by Sills and Brodie3, another two benefits of the crossover deisgn are that each respondent acts as his or her own control, and that a small number of people are required in comparison to parallel-group studies.

**Study Result4:**

**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).

**Study Result Interpretations:**

There is a positive impact in Dark Chocolate consumption on mean level, whether it is compared to Baseline (239), or White Chocolate (187). However, in order to know whether the positive impact is statistically significant or not, we would need to reply on Hypothesis Testing.

The two results to interpret are: Dark Chocolate vs Baseline and Dark vs White Chocolate, where both evaluations are pertaining to average change in total distance covered (m).

For Dark Chocolate vs Baseline scenario, the hypothesis testing setup would be the following:

* Null Hypothesis: There is no difference between Dark Chocolate and Baseline on average (Dark Chocolate mean – Baseline mean = 0)
* Alternate Hypothesis: There is a positive impact on Dark Chocolate consumption compared to Baseline on average (Dark Chocolate mean – Baseline mean > 0)

With the desired 95% confidence interval, we obtain the significance level benchmark as 5% or 0.05. Given p-value of 0.001, the probability of obtaining the statistics, assuming there is no difference between the Dark Chocolate and Baseline in the collected data (assuming the null hypothesis is correct), which is substantially lower than the benchmark, and thus we reject the null hypothesis, accepting the alternative that is true in that there is a difference between the Dark Chocolate and placebo. In other words, having Dark Chocolate make a difference compared to not having it.

In addition, the range of the confidence internval is 165m to 314m, which does not cover zero and therefore supporting the finding that there is a statistical difference in consuming Dark Chocolate at 95% C.I.

For Dark vs White Chocolate scenario, the hypothesis testing setup would be the following:

* Null Hypothesis: There is no difference between Dark and White Chocolate on average (Dark Chocolate mean – White Chocolate mean = 0)
* Alternate Hypothesis: There is a positive impact on Dark Chocolate consumption, compared to White Chocolate on average (Dark Chocolate mean – White Chocolate mean > 0)

With the desired 95% confidence interval, we obtain the significance level benchmark as 5% or 0.05. Given p-value of 0.003, the probability of obtaining the statistics, assuming there is no difference between Dark and White Chocolate in the collected data (assuming the null hypothesis is correct), which is substantially lower than the benchmark, and thus we reject the null hypothesis, accepting the alternative that is true in that there is a difference between Dark and White Chocolate. In other words, having Dark Chocolate make a difference compared to having White Chocolate.

In addition, the range of the confidence internval is 82m to 292m, which does not cover zero and therefore supporting the finding that there is a statistical difference in consuming Dark Chocolate versus White Chocolate at 95% C.I..

**Recommendation**

From the sampling standpoint, 9 respondents are considered very small. Yet, with the crossover design, it is acceptable and reasonable – while using larger sample sizes is always encouraged as to project and represent the population.

In terms of the study result, it indicates Dark Chocolate consumption does make a positive impact on average in total distance covered, whether in respect to Baseline or to White Choclate and therefore, I would encourage to add Dark Chocolate to athletes’ diet with anticipation that there is to have some improvement on their cycling performance,

**Source:**

1. **Samuel Abt, “cycling.”**

*Britannica Academic,* [*https://academic.eb.com/levels/collegiate/article/cycling/28375*](https://academic.eb.com/levels/collegiate/article/cycling/28375)

1. **G.J. Sills, M.J. Brodie,"ANTIEPILEPTIC DRUGS | Clinical Drug Development in Epilepsy"**

*Encyclopedia of Basic Epilepsy Research, 2009*

1. **Mendel Suchmacher, Mauro Geller,"Study Type Determination"**

*Practical Biostatistics, 2012*

1. **Patel, Brouner, Spendiff**

*Journal of the International Society of Sports Nutrition*. **2015** 12:47.

This is a homework assignment. The names mentioned in headers are fictional.