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 were 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. 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.

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 165.01 m to 312.76 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 82.11 m to 291.21 m; (*p*-value = 0.003).

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

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 the following three questions:

1. Did the total distance covered after consumption of white chocolate increase as compared to baseline, on average? If so, by how much? And was the increase statistically significant? Use the corresponding averages in the table as well as the reported *p*-value of 0.319 to explain your answer.
2. Did the total distance covered after consumption of dark chocolate increase as compared to baseline, on average? If so, by how much? And was the increase statistically significant? Use the corresponding averages in the table as well as the reported *p*-value of 0.001 to explain your answer.
3. Based on these results, in terms of increasing total distance covered, what is your recommendation (for or against) regarding the inclusion of chocolate in the athletes' diet? And if for inclusion, which type of chocolate? Use your answers to questions 1 and 2, as well as the provided 95% confidence interval for comparing dark chocolate to white chocolate to explain your answer.