3. In search of a mosquito repellent that is safer than the ones that are currently on the market, scientists have developed a new compound that is rated as less toxic than the current compound, thus making a repellent that contains this new compound safer for human use. Scientists also believe that a repellent containing the new compound will be more effective than the ones that contain the current compound. To test the effectiveness of the new compound versus that of the current compound, scientists have randomly selected 100 people from a state.

Up to 100 bins, with an equal number of mosquitoes in each bin, are available for use in the study. After a compound is applied to a participant's forearm, the participant will insert his or her forearm into a bin for 1 minute, and the number of mosquito bites on the arm at the end of that time will be determined.

(a) Suppose this study is to be conducted using a completely randomized design. Describe a randomization process and identify an inference procedure for the study.

(b) Suppose this study is to be conducted using a matched-pairs design. Describe a randomization process and identify an inference procedure for the study.

(c) Which of the designs, the one in part (a) or the one in part (b), is better for testing the effectiveness of the new compound versus that of the current compound? Justify your answer.

(d) **If the scientist used the completely randomized design from part (a), describe an appropriate graphical display that could be used to compare the treatments.**

(e) **If the scientist used the matched-pairs design from part (b), write an appropriate the appropriate null and alternative hypotheses that would be used for this inference procedure. Define any parameter(s) used in your hypotheses, in context.**

(f) **Continuing with the matched-pairs design from part (b), the scientists found a p-value of 0.023. What is their decision and conclusion?**

(g) **Based on the p-value of 0.023 from part (f), can the scientists conclude that they have evidence that the new compound caused the mosquitoes to be repelled more effectively?**

Note: A complete answer key with rubric for parts a-c can be found here:

https://secure-media.collegeboard.org/apc/_ap05_sg_statisticsb__46664.pdf

(d) If the scientist used the completely randomized design from part (a), describe an appropriate graphical display that could be used to compare the treatments.

Possible answers: parallel boxplots, back-to-back stem and leaf plot, 2 histograms (with the same scale), parallel dotplots.

(e) If the scientist used the matched-pairs design from part (b), write an appropriate the appropriate null and alternative hypotheses that would be used for this inference procedure. Define any parameter(s) used in your hypotheses, in context.

Ho: $\mu = 0$; Ha: $\mu < 0$; μ = true mean difference in the # of mosquito bites, (new arm - old arm)

(f) Continuing with the matched-pairs design from part (b), the scientists found a p-value of 0.023. What is their decision and conclusion?

With a p-value of 0.023 < α (0.05), I reject Ho. I found statistically significant evidence that the mean difference is less than zero, that the average number of bites with the new repellent was less than the old repellent.

(g) Based on the p-value of 0.023 from part (f), can the scientists conclude that they have evidence that the new compound caused the mosquitoes to be repelled more effectively?

Yes, because this was an experiment with a control, the scientists can conclude that they have evidence that the new compound causes a difference.