

1. A biologist is interested in studying the effect of growth-enhancing nutrients and different salinity (salt) levels in water on the growth of shrimps. The biologist has ordered a large shipment of young tiger shrimps from a supply house for use in the study. The experiment is to be conducted in a laboratory where 10 tiger shrimps are placed randomly into each of 12 similar tanks in a controlled environment. The biologist is planning to use 3 different growth-enhancing nutrients (A, B, and C) and two different salinity levels (low and high).

a) List the treatments that the biologist plans to use in this experiment.

b) Using the treatments listed in part (a), describe a completely randomized design that will allow the biologist to compare the shrimps' growth after 3 weeks.

c) Give one statistical advantage to having only tiger shrimps in the experiment. Explain why this is an advantage.

d) Give one statistical disadvantage to having only tiger shrimps in the experiment. Explain why this is a disadvantage.

2. When a tractor pulls a plow through an agricultural field, the energy needed to pull that plow is called the draft. The draft is affected by environmental conditions such as soil type, terrain, and moisture. A study was conducted to determine whether a newly developed hitch would be able to reduce draft compared to the standard hitch. (A hitch is used to connect the plow to the tractor.) Two large plots of land were used in this study. It was randomly determined which plot was to be plowed using the hitch. As the tractor plowed that plot, a measurement device on the tractor automatically recorded the draft at 25 randomly selected points in the plot.

After the plot was plowed, the hitch was changed from the standard one to the new one, a process that takes a substantial amount of time. Then the second plot was plowed using the new hitch. Twenty-five measurements of draft were also recorded at randomly selected points in this plot.

a) What was the response variable in this study?

Identify the treatments.

What were the experimental units?

b) Given that the goal of the study is to determine whether a newly developed hitch reduces draft compared to the standard hitch, was randomization used properly in this study? Justify your answer.

c) Given that the goal of the study is to determine whether a newly developed hitch reduces draft compared to the standard hitch, was replication used properly in this study? Justify your answer.

d) Plot of land is a confounding variable in this experiment. Explain why?

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.

b) Suppose this study is to be conducted using a matched-pairs design. Describe a randomization process.

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?

4. A study was conducted to determine if taking vitamin C reduces the occurrence of the flu. The study was conducted using 808 student volunteers who did not take a flu shot. The subjects were randomly assigned to one of two groups: a treatment group who received 1,000 milligrams of vitamin C daily or a control group who received a placebo flavored to taste like the vitamin C treatment. All participants were monitored to ensure that they adhered to their assigned treatment on a daily basis throughout the period of the study. At the end of the flu season, each subject's medical record was reviewed by a physician to determine whether he or she had contracted the flu during the period of the study.

- a) Is this study an experiment or an observational study? Explain your answer.
- b) What does a double-blind experiment mean? Could this study be done as a double-blind experiment?
- c) What is a block design? What is the purpose of a block design? Could this study be done using a block design? Explain.

5. In response to nutrition concerns raised last year about food served in school cafeterias, the Smallville School District entered into a one-year contract with the Healthy Alternative Meals (HAM) company. Under this contract, the company plans and prepares meals for 2,500 elementary, middle, and high school students, with a focus on good nutrition. The school administration would like to survey the students in the district to estimate the proportion of students who are satisfied with the food under this contract.

Two sampling plans for selecting the students to be surveyed are under consideration by the administration. One plan is to take a simple random sample of students in the district and then survey those students. The other plan is to take a stratified random sample of students in the district and then survey those students.

- a) Describe a simple random sampling procedure that the administrators could use to select 200 students from the 2,500 students in the district.
- b) If a stratified random sampling procedure is used, give one example of an effective variable on which to stratify in this survey. Explain your reasoning.
- c) Describe one statistical advantage of using a stratified random sample over a simple random sample in the context of this study.