

## 2007 AP® STATISTICS FREE-RESPONSE QUESTIONS

2. As dogs age, diminished joint and hip health may lead to joint pain and thus reduce a dog's activity level. Such a reduction in activity can lead to other health concerns such as weight gain and lethargy due to lack of exercise. A study is to be conducted to see which of two dietary supplements, glucosamine or chondroitin, is more effective in promoting joint and hip health and reducing the onset of canine osteoarthritis. Researchers will randomly select a total of 300 dogs from ten different large veterinary practices around the country. All of the dogs are more than 6 years old, and their owners have given consent to participate in the study. Changes in joint and hip health will be evaluated after 6 months of treatment.
- (a) What would be an advantage to adding a control group in the design of this study?
  - (b) Assuming a control group is added to the other two groups in the study, explain how you would assign the 300 dogs to these three groups for a completely randomized design.
  - (c) Rather than using a completely randomized design, one group of researchers proposes blocking on clinics, and another group of researchers proposes blocking on breed of dog. How would you decide which one of these two variables to use as a blocking variable?
3. Big Town Fisheries recently stocked a new lake in a city park with 2,000 fish of various sizes. The distribution of the lengths of these fish is approximately normal.
- (a) Big Town Fisheries claims that the mean length of the fish is 8 inches. If the claim is true, which of the following would be more likely?
    - A random sample of 15 fish having a mean length that is greater than 10 inches
    - or
    - A random sample of 50 fish having a mean length that is greater than 10 inchesJustify your answer.
  - (b) Suppose the standard deviation of the sampling distribution of the sample mean for random samples of size 50 is 0.3 inch. If the mean length of the fish is 8 inches, use the normal distribution to compute the probability that a random sample of 50 fish will have a mean length less than 7.5 inches.
  - (c) Suppose the distribution of fish lengths in this lake was nonnormal but had the same mean and standard deviation. Would it still be appropriate to use the normal distribution to compute the probability in part (b) ? Justify your answer.

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### Question 2

#### Intent of Question

The three primary goals of this question are to assess a student's ability to: (1) clearly explain the importance of a control group in the context of an experiment; (2) describe the randomization process required for three groups; and (3) reduce variability by grouping experimental units as homogeneously as possible.

#### Solution

##### **Part (a):**

A control group gives the researchers a comparison group to be used to evaluate the effectiveness of the treatments. The control group allows the impact of the normal aging process on joint and hip health to be measured with appropriate response variables. The effects of glucosamine and chondroitin can be assessed by comparing the responses for these two treatment groups with those for the control group.

##### **Part (b):**

Each dog will be assigned a unique random number, 001–300, using a random number generator on a calculator, statistical software, or a random number table. The numbers will be sorted from smallest to largest. The dogs assigned the first 100 numbers in the ordered list will receive glucosamine. The dogs with the next 100 numbers in the ordered list will be assigned to the control group. Finally, the dogs with the numbers 201–300 will receive chondroitin.

##### **Part (c):**

The key question is which variable has the strongest association with joint and hip health. The goal of blocking is to create groups of homogeneous experimental units. It is reasonable to assume that most clinics will see all kinds and breeds of dogs so there is no reason to suspect that joint and hip health will be strongly associated with a clinic. On the other hand, different breeds of dogs tend to come in different sizes. The size of a dog is associated with joint and hip health, so it would be better to form homogeneous groups of dogs by blocking on breed.

#### Scoring

Parts (a), (b), and (c) are scored as essentially correct (E), partially correct (P), or incorrect (I).

**Part (a)** is scored as essentially correct (E) if an advantage of using a comparison group is described in the context of this study.

Part (a) is scored as partially correct (P) if an advantage of using a control group is described but not in the context of this study.

Part (a) is scored as incorrect (I) if the student says that control groups should always be used but gives no further explanation *OR* an incorrect explanation.

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## Question 2 (continued)

Note: Since “treatment” and “control” are standard terms in design, a comparison of specific aspects of the study is needed to establish context.

**Part (b)** is scored as essentially correct (E) if randomization is used correctly, and the method of randomization can be implemented after reading the student response (so that two knowledgeable statistics users would use the same method to assign dogs to treatment groups).

Part (b) is scored as partially correct (P) if randomization or chance is used, but the method could not be implemented after reading the student response.

Part (b) is scored as incorrect (I) if randomization or chance is not used in a planned way *OR* the solution does not yield a completely randomized design.

**Part (c)** is scored as essentially correct (E) if:

the student argues that the variable with the stronger relationship to joint and hip health should be used as the blocking variable;

*OR*

the student states that the variable with the larger anticipated variability in the response measure should be used as the blocking variable so that units within blocks are as homogeneous as possible. A rationale is required, but a variable does not have to be selected.

Part (c) is scored as partially correct (P) if:

the student indicates that the purpose of blocking is to create groups of homogeneous experimental units but makes an error in the application to this experiment;

*OR*

the student does not acknowledge that there may be more variability associated in the response variable with one of the variables (breed or clinic) than the other;

*OR*

the student does not recognize that both variables are associated with variation in the response variable.

Part (c) is scored as incorrect (I) if the student does not exhibit an understanding of the purpose of blocking.

### **4 Complete Response**

All three parts essentially correct

### **3 Substantial Response**

Two parts essentially correct and one part partially correct

### **2 Developing Response**

Two parts essentially correct and no parts partially correct

*OR*

One part essentially correct and two parts partially correct

*OR*

Three parts partially correct