

PHP 2510 (Fall, 2009)

First Midterm Exam

October 22

Name: _____

Name: _____

There are three questions on this exam. Show your reasoning for each answer, and circle your final answer to avoid any ambiguities.

1. Consider a family with a mother, father, and two children. Let event

$A_1 = \{\text{mother has influenza}\},$

$A_2 = \{\text{father has influenza}\},$

$A_3 = \{\text{first child has influenza}\},$

$A_4 = \{\text{second child has influenza}\},$

$B = \{\text{at least one child has influenza}\},$

$C = \{\text{at least one parent has influenza}\},$

$D = \{\text{at least one person has influenza}\}.$

Answer the following questions:

(a) What does $A_1 \cap A_2$ mean?

(b) Are A_3 and A_4 mutually exclusive? (Just answer yes or no).

(c) Express D in terms of B and C .

Suppose an influenza epidemic strikes the US. In 10% of such families the mother has influenza; in 10% of such families the father has influenza; and in 2% both the mother and father have influenza.

(d) Are events A_1 and A_2 independent? Justify your answer.

(e) What is the probability that the father has influenza given that the mother has influenza?

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2. A study followed 60 male patients with small cell lung carcinoma (SCLC) for 5 years, and found that only 2 patients survived. Suppose that the nationwide average 5-yr survival rate of patients was 8%. Answer the following question.
- (a) What is the expected number of alive patients in the study if the nationwide survival rate holds true for the study population?
 - (b) Compute $\binom{60}{2}$.
 - (c) What is the exact probability of having 2 alive patients if the survival rate is 8%?
 - (d) Is there evidence of an excessive mortality in the study? That is, what is the exact probability of seeing two or less alive patients if the nationwide rate holds true?
 - (e) Answer (d) using Poisson approximation.

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3. Suppose that the triceps skin-fold thickness of men with chronic airflow limitation (CAL) can be regarded as being normally distributed with a mean of 0.95 with a standard deviation of 0.4.

- (a) What is the variance of triceps skin-fold thickness of men with CAL?
- (b) For a randomly selected man with CAL, what is the probability that his triceps skin-fold thickness is greater than 1.35 (average triceps skin-fold thickness of normal men)?

Define X_1 and X_2 to be the triceps skin-fold thickness of two randomly-selected men with CAL. Suppose they are independent.

- (c) Find the expected value and the variance of $\frac{X_1+X_2}{2}$.
- (d) Find the expected value and the variance of $X_1 - X_2$.

Define T_i as being whether the triceps skin-fold thickness of a randomly-selected man with CAL is greater than 1.35, i.e. $T_i = 1$ if $X_i > 1.35$, for $i = 1, 2$.

- (d) Find the expected value and the variance of $\frac{T_1+T_2}{2}$.

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