Australian and New Zealand College of Veterinary Scientists

Membership Examination

June 2013

Veterinary Epidemiology

Paper 1

Perusal time: **Fifteen (15)** minutes

Time allowed: **Two (2)** hours after perusal

Answer **ALL <u>EIGHT (8)</u>** questions

Answer **<u>EIGHT</u>** questions each worth 15 marks .....total 120 marks

Paper 1: Veterinary Epidemiology

Answer all eight (8) questions

1. Simulation models are commonly used in epidemiology. Various approaches can be used when constructing such models, and simulation models can be categorised based on the ways they are constructed. Discuss categorisation of simulation models based on the ways they are constructed. *(15 marks)*

2. Causal criteria should be used to supplement statistical associations to assess causation during epidemiological studies. Describe briefly why causal criteria are required. In your answer, provide **one (1)** causal criterion and explain how it is used to assess causality. *(15 marks)*

3. Explain what herd immunity means. Use the concept of herd immunity to explain why 100% vaccination coverage (i.e. every individual is fully immune) is not required for mass vaccination programs to prevent epidemics. *(15 marks)*

4. Define statistical power. List **three (3)** factors that affect statistical power, and describe how **each** can be manipulated to increase the power of an epidemiological study. *(15 marks)*

5. Discounting is used in some economic analyses. Define discounting and briefly describe why discounting is used in such analyses. *(15 marks)*

6. Disease can reduce productivity and profitability in livestock enterprises in many different ways. Using examples, describe at least **five (5)** different ways that the productivity and profitability of a livestock enterprise may be compromised by disease. *(15 marks)*

7. Define and explain the meaning of the term 'risk' as used in risk analysis, and contrast this with the meaning of the term 'risk' as used to describe disease frequency. *(15 marks)*

8. Briefly describe **two (2)** examples of how geographic information systems (GIS) have been or could be applied for epidemiological purposes. *(15 marks)*

End of paper

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Paper 2

Perusal time: **Fifteen (15)** minutes

Time allowed: **Two (2)** hours after perusal

Answer **ALL <u>THREE (3)</u>** questions

Question 2 a) requires completion of the contingency table located in the answer booklet you have been provided

Answer **<u>THREE</u>** questions each worth 40 marks.....total 120 marks

Paper 2: Veterinary Epidemiology

Answer all three (3) questions

When answering the following questions, display your workings as some marks will be awarded for correct steps, even if the final answer is not correct due to calculation errors.

1. **Identifying associations: Salmonellosis in feral pigs (*Sus scrofa*)**

   Feral pigs are an invasive animal in New Zealand and Australia, and can transmit infectious organisms including *Salmonella* spp. In an effort to understand the ecology of *Salmonella* spp. in this species, you conduct a cross sectional survey of feral pigs in Northern Australia. You determine the condition score of each sampled pig (fat or thin) and the *Salmonella* spp. carrier status (infected or uninfected) of each pig. Assume condition scores and *Salmonella* spp. carrier statuses were determined with no classification errors.

   Five hundred and forty three (543) pigs were sampled. Two hundred and eight pigs (208) were infected with *Salmonella* spp. One hundred (100) infected pigs were categorised as fat and one hundred and eight (108) infected pigs were categorised as thin. Two hundred and five (205) uninfected pigs were categorised as thin.

   a) Construct a two-way contingency table summarising these data with infection status and condition score as the dependent and independent variable respectively. *(6 marks)*

   b) Calculate an appropriate measure of disease frequency in this study population and calculate a 95% confidence interval for the measure of disease frequency. Interpret the confidence interval in words. *(9 marks)*

      You may find the following approximate formulae useful:

      $SE = \sqrt{p(1-p)/N}$ where p = a proportion and N=sample size

      95% $CI = \theta \pm Z_\alpha(SE)$ where θ = the observed proportion and $Z_\alpha = 1.96$

   c) Calculate an appropriate measure of association to assess whether the condition score of feral pigs is associated with infection with *Salmonella* spp. Interpret the measure of association. (Confidence intervals are not required.) *(11 marks)*

Question 1 continued over page

d) Suppose that pig gender is associated with condition score and is a determinant of infection status. Assuming condition score is not an effect modifier; explain briefly the effect that gender may have on the measure of association between condition score and infection status as calculated from the study data.

(2 marks)

e) Briefly explain how a multivariable analyses could be used to prevent the potential problem identified in part 1 d) (above). *(2 marks)*

f) Examine the following table and formula. These present details of a multivariable analysis for the data above.

Table 1: Results from a regression model.

Variable	Estimate (β)	Probability	Odds ratio (e^{β})	95% confidence interval (odds ratio)
Intercept	-0.39	<0.01	0.67	0.51-0.90
Gender	-0.26	0.13	0.77	0.54-1.08
Condition score	0.34	0.06	1.40	0.99-1.97

These results can also be described using this formula:

$$\log\left(\frac{P}{1-P}\right) = -0.39 - 0.26Gender + 0.34Condition\ score$$

where P is the predicted probability that the animal is a *Salmonella* spp. carrier.

i. State the type of multivariable model that has been used. *(3 marks)*

ii. Identify the outcome variable. *(1 mark)*

iii. Identify the explanatory variables. *(2 marks)*

iv. Describe whether the analysis identified any risk factors for the outcome that are significant at the 0.05 level. Justify your answer.

(4 marks)

Continued over page

2. **Application of diagnostic tests**

Assume you are analysing data from equine influenza (EI) epidemic that occurred in Australia in 2007. You want to examine diagnostic aspects of the antibody enzyme-linked immunosorbent assay (ELISA) used during the outbreak.

Assume you have a data set of ELISA test results. These comprise test results from a total of 1798 horses (each horse was tested only once). Four hundred and seventy five (475) of these horses tested positive to an EI polymerase chain reaction test (PCR) some weeks before the blood was collected for ELISA testing. It can be assumed that all of these animals were truly infected. Of these 475 infected horses, 4 horses tested negative with the ELISA. A further 1323 horses from areas remote from infected areas were tested and it can be assumed that these animals had never been infected with EI. Of these 1323 animals, 43 tested positive with the ELISA.

a) Complete the following contingency table in the answer booklet you have been provided. *(6 marks)*

	Disease* (+)	Disease (-)	**Totals**
ELISA +			
ELISA -	Complete table in Answer Booklet		
Totals			

*Disease means EI PCR positive

b) Calculate the sensitivity and specificity of this ELISA. *(6 marks)*

c) Calculate the apparent and true prevalence of the disease (ie of being EI PCR positive). *(8 marks)*

d) One horse is randomly selected from these 1798 study horses.

i. Assume that horse's test was positive. What is the probability that the horse had been truly infected during the epidemic? That is, calculate the positive predictive value (PPV). *(3 marks)*

ii. Assume the test was negative. What is the probability that the horse was truly uninfected during the epidemic? That is, calculate the negative predictive value (NPV). *(3 marks)*

iii. State briefly what would happen the PPV and the NPV of this test if the prevalence of EI in this 1798 horse study population had been lower. *(2 marks)*

Question 2 continued over page

e) Suppose you are using the ELISA to test a herd of horses, to assess the EI status of the herd i.e. to assess whether EI has infected horses in the herd.

i. Define briefly herd level sensitivity, and list **four (4)** factors that influence herd level sensitivity. *(7 marks)*

ii. Define herd level specificity and list **two (2)** factors that influence herd level specificity. *(5 marks)*

3. **Study design**

You are an epidemiologist who has been consulted to design an epidemiological study for a client. The client has developed a vaccine against Hendra virus infection for use in horses. The client wishes to demonstrate its efficacy so that registration can be sought in Australia.

Select an appropriate study type, one that will meet the client's needs, and briefly justify your selection against other common study types used by epidemiologists. Describe your proposed study design by outlining the essential design features of the proposed study. In your design, include strategies to minimise bias, including to minimise confounding. *(40 marks)*

End of paper