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The Online R-FETPV 1st Module : Basic Epidemiology and Surveillance Data Analysis

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Department of Livestock Development

Food and Agriculture Organization of the United Nations

R-FETPV Regional Field Epidemiology Training Program for Veterinarian

Basic descriptive and analytic statistics for disease outbreak event CLIP#6

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Calculating the Odds Ratio (OR)

	Disease (Case)	No Disease (Control)
Exposed	A	B
Unexposed	C	D

$$\text{OR} = \frac{\text{Odds that a case was exposed } (A/C)}{\text{Odds that a control was exposed } (B/D)} \qquad \frac{AD}{BC}$$

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ANALYSIS AND INTERPRETATION OF RESULTS

The objective of quantitative epidemiologic research: quantify the association between disease and exposure. This entails different **measures of association**, expressing the **absolute or relative change in risk** due to exposure, which are to be selected according to the study type

Analysis of cross-sectional studies

In a cross-sectional study the following measures can be established

Prevalence of disease, Pr (D+)	pD = m1 / n	= (a + c) / (a + b + c + d)
Prevalence of exposure, Pr (E+)	pE = n1 / n	= (a + b) / (a + b + c + d)
Prevalence of disease given exposure, Pr(D+ | E+)	p1 = a / n1	= a / (a + b)
Prevalence of disease given no exposure, Pr(D+|E-)	p2 = c / n2	= c / (c + d)

Prevalence ratio PR = p1 / p2 = $\frac{a / (a + b)}{c / (c + d)}$

Prevalence difference PD = p1 - p2

Prevalence odds ratio POR = $\frac{p1 / (1-p1)}{p2 / (1-p2)}$ = $\frac{a\ d}{b\ c}$

(Freie Universitat, Berlin - http://www.arbo-zoo.net/_data/ArboConFlu_StudyDesign.pdf)

The three latter measures are of direct interest for the assessment of a risk factor and have the following interpretation (if the 2x2 table is as shown in the first section).

Exposure is	expected PR	expected PD	expected POR
… not associated with disease	1	0	1
… a risk factor	>1	>0	>1
… a protective factor	<1	<0	<1

(Freie Universitat, Berlin - http://www.arbo-zoo.net/_data/ArboConFlu_StudyDesign.pdf)

Hypothetical example

In a cross-sectional study it is investigated whether Holstein-Friesian (HF) breed is a risk (or protective) factor for subclinical mastitis (SCM) compared with Brown Swiss (BS). It is estimated that HF and BS cows are equally abundant in the study area. From the study population a random sample of 300 milking cows was obtained. The results are as below.

	SCM+	SCM-	Total
HF	27	95	122
BS	32	146	178
Total	59	241	300

(Freie Universitat, Berlin - http://www.arbo-zoo.net/_data/ArboConFlu_StudyDesign.pdf)

Discuss

- Why is this a cross-sectional study?
- Prevalence Ratio (PR) = ?
  - *Interpret…*
- Prevalence Difference (PD) = ?
  - *Interpret…*
- Prevalence Odds Ratio (POR) = ?
  - *Interpret…*

$$PR = \frac{27 / 122}{32 / 178} = 1.231 \quad > 1$$

SCM prevalence in HF is 1.231 times the prevalence in BS. This indicates that HF could be a risk factor for SCM compared with BS.

$$PD = 27/122 - 32/178 = 0.0415 \quad > 0$$

SCM prevalence in HF cows is 4.15 percent points higher than the prevalence in BS. This indicates that HF could be a risk factor for SCM compared with BS.

$$POR = \frac{(27)\ (146)}{(95)\ (32)} = 1.2967 \quad > 1$$

The odds of SCM in HF cows is 1.2967 times the odds in BS. This indicates that HF could be a risk factor for SCM compared with BS.

(Freie Universitat, Berlin - http://www.arbo-zoo.net/_data/ArboConFlu_StudyDesign.pdf)

CASE-CONTROL STUDY

Parameters to be estimated from case-control studies include

Prevalence of exposure, Pr (E+)

$$pE = n1 / n = (a + b) / (a + b + c + d)$$

Prevalence of exposure given disease, Pr(E+ | D+)

$$p1 = a / m1 = a / (a + c)$$

Prevalence of exposure given no disease, Pr(E+|D-)

$$p2 = b / m2 = b / (b + d)$$

Odds ratio for exposure,

$$ORE = \frac{p1 / (1 - p1)}{p2 / (1 - p2)} = \frac{a \; d}{b \; c} .$$

(Freie Universitat, Berlin - http://www.arbo-zoo.net/_data/ArboConFlu_StudyDesign.pdf)

ORE = the ratio of the odds of exposure in cases and controls.

ORE measures whether or not exposure is more common in the diseased group than in the non-diseased group.
ORE is algebraically identical with the odds ratio for disease (ORD).

For low prevalences (< 0,1) the ORE obtained form of a case-control study is a good estimator of the relative risk of disease.

The interpretation of the value of ORE (and ORD) is the same as that of the prevalence odds ratio.

(Freie Universitat, Berlin - http://www.arbo-zoo.net/_data/ArboConFlu_StudyDesign.pdf)

Hypothetical Example

A veterinarian collected blood samples from 23 cows he visited 0-7 days after abortion (AB). Additionally, on each farm, a blood sample was taken from a cow that gave birth to a healthy calf. The 46 sera were submitted to a laboratory for testing *Neospora caninum* antibodies (NCA). Here are the results:

	AB+	AB-	Total
NCA+	15	7	22
NCA-	8	16	24
Total	23	23	46

(Freie Universitat, Berlin - http://www.arbo-zoo.net/_data/ArboConFlu_StudyDesign.pdf)

Discuss

- Why is this a case-control study?
- ORE= ?
  - *Interpret…*
- ORD= ?
  - *Interpret…*
- 95% CI (OR) Cornfield's method = 1.27-14.45.
  - *Interpret…*

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RESULTS

$$ORE = ORD = \frac{(15)\ (16)}{(7)\ (8)} = \underline{\mathbf{4.286}} \quad \underline{\mathbf{>1}}$$

The odds of abortion in *Neospora caninum* exposed (according to antibody level) cows is 4.3 times the odds in unexposed cows. This indicates that exposure to *Neospora caninum* could be a risk factor for abortion.

Inferences from the results

95% CI (OR) Cornfield's method = **1.27-14.45.**

The expected value under the null hypothesis (OR= 1) is **not included in the interval**. Thus, we conclude that **there is a statistically significant evidence for an association** between exposure to *Neospora caninum* and abortion in the cattle population covered by the vet.

(Freie Universitat, Berlin - http://www.arbo-zoo.net/_data/ArboConFlu_StudyDesign.pdf)

Relative Risk Calculation

Predictor	Outcome: Yes	Outcome: No
Yes	A	B
No	C	D

$$RR = \frac{(A/(A+B))}{(C/(C+D))}$$

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COHORT STUDIES

We have two options: (A) If the follow-up time is equal for all animals under study, we use the count data.
(B) If the follow-up time is variable we have to consider incidence rates or densities.

A: Count data

Parameters to be estimated include:

Cumulative incidence in the exposed cohort,

$$p1 = a / n1 = a / (a + b)$$

Cumulative incidence in the unexposed cohort,

$$p2 = c / n2 = c / (c + d)$$

Relative risk (cumulative incidence ratio, risk ratio),

$$RR = p1 / p2 = \frac{a / (a + b)}{c / (c + d)}$$

The numerical value of RR is interpreted in a similar way as OR.

(Freie Universitat, Berlin - http://www.arbo-zoo.net/_data/ArboConFlu_StudyDesign.pdf)

Hypothetical example

1000 dogs selected for a prospective study on the impact of high doses of **vitamin E and cancer.** The owners of 500 dogs received a food additive based on high dosed vitamin E for daily administration (**VE**). The owners of the other 500 dogs, matched for breed, sex, and age received a food additive containing no active compound (placebo).

In phase 1 of the experiment, the dogs were followed up over a period of 2 years. Each case of death in the cohorts was subjected to PM inspection where the presence or absence of any form of cancer was recorded (**CAN**). The number of diagnosed cancer is as follows:

	CAN+	CAN-	Total
VE+	4	496	500
VE-	8	492	500
Total	12	982	1000

(Freie Universitat, Berlin - http://www.arbo-zoo.net/_data/ArboConFlu_StudyDesign.pdf)

Discuss

- Why is this a cohort study?
- (Relative Risk) RR= ?
  - *Interpret…*
- 95% CI (RR) Cornfield's method = 0.151-1.649
  - *Interpret…*

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Results

p1 = 4/500 = 0.008
p2 = 8/500 = 0.016
RR = 0.5 <1

According to phase 1 of the study the observed risk of developing cancer under the VE treatment is 50% compared to a placebo treatment. This indicates that the VE treatment could be a protective factor.

Inferences form the results

95% CI (RR) Cornfield's method = **0.151-1.649**

The expected value under the null hypothesis (RR= 1) is **included in the interval**. Thus, we conclude that there is **no statistically significant evidence for an association** between VE treatment and development of cancer from this study.

(Freie Universitat, Berlin - http://www.arbo-zoo.net/_data/ArboConFlu_StudyDesign.pdf)