Epidemiological risk factors and the measures of association

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Risk factors

- *The factors that are influencing or are associated with the risk of causing adverse effects (e.g. Infection) in specific subpopulations, or that are protective («protective factors») like vaccination.*

- The identification of such risk factors may derive from different sources:

- **Epidemiological studies** (e.g. cross sectional, case-control, cohort studies)
- **Experts opinion** (when gaps in docuemnted knowledge exists)
- **Risk assessment** studies (to provide more precise estimation of the risk for each subpopulation)

Risk Based surveillance-categorization (adapted from RISKSUR Training Series, Module 2 Risk-based surveillance)
http://www.fp7-risksur.eu/progress/training-and-webinars

Identification of Risk Factors

Epidemiological studies are conducted to identify risk factors using the several measures (**strength of association**).

- these allow quantifying the consequences from exposure to a risk factor, and are used to predict, quantify the effect of prevention and to plan control programs

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Prevalence and risk factors of bovine tuberculosis in dairy cattle in Eritrea

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Table 3 Model 1 'Physiological status' and 'region' as potential risk factors for reactivity in the comparative tuberculin test on positive herds with ≥5 tested animals (4,776 observations within 344 positive herds) and animals tested, number and proportion of positive reactors in all positive farms (5269 observation). Estimated variance for herd: 1.118 on the logit scale

Physiological status and region	OR	95 % confidence interval		Number and % tested and % positive reactors in positive farms		
		Lower bound	Upper bound	Tested	% tested	% positive reactors
Calf (reference)	1.0			1613	30.6	14.6
Bull	5.2	3.3	8.3	147	2.8	30.6
Heifer empty	2.5	1.8	3.5	533	10.1	22.1
Heifer pregnant	5.8	4.2	8.1	460	8.7	34.4
Lactating empty	8.2	6.3	10.6	996	18.9	43.9
Lactating pregnant	10.8	8.4	13.9	1191	22.6	46.9
Dry pregnant	10.2	7.0	14.8	329	6.2	42.3
Anseba region (reference)	1.0			397	7.5	1.76
Debub region	8.5	1.9	37.1	1647	31.30	30.12
Maekel region	13.0	3.0	46.1	3225	61.21	36.84

Relative Measures of Association

These are ratio measures:

➢ **Risk Ratio (RR)**

➢ **Incidence Rate Ratio (IR)**

➢ **Odds Ratio (OR)**

Use depends on study design and appropriate measure of disease frequency

The 2x2 table

	Exposure + (risk factor present)	Exposure - (risk factor absent)	TOTAL
D+ (diseased animals)	a	c	a+c
D- (non-diseased animals)	b	d	b+d
TOTAL	a+b	c+d	

We'll come back to this time and time again…..

Relative Measures of Association

Range: 0 to infinity

If **RR (OR) (IR) = 1** : risk(odds) (rate) in exposed is equal to risk in non-exposed
> i.e. no association

If **RR (OR) (IR) > 1** : risk (odds) (rate) in exposed is greater than risk in non-exposed
> i.e. positive association, possibly causal

If **RR (OR) (IR) < 1** : risk (odds) (rate) in exposed is less than risk in non-exposed
> i.e. negative association, possibly protective

Risk Ratio (Relative Risk) (RR)

- A **risk ratio (RR)**, also called *relative risk*, compares the risk of a health event (disease, injury, risk factor, or death) among one group with the risk among another group. It does so by dividing the risk (incidence proportion, attack rate) in group 1 by the risk (incidence proportion, attack rate) in group 2.

$$RR = \frac{\text{Risk in the exposed group}}{\text{Risk in the unexposed group}}$$

$$RR = (a/a+b) \ / \ (c/c+d)$$

EXAMPLE: Calculating Risk Ratio

- In an outbreak of LSD in Bulgaria in 2016, LSD was diagnosed in 18 of 152 vaccinated cows compared with 3 of 7 unvaccinated cows.
  Calculate the risk ratio.

	Vaccinated	Unvaccinated	
LSD	18	3	21
Non-case	134	4	138
	152	7	159

EXAMPLE: Calculating Risk Ratios

Risk of LSD among vaccinated cows = 18 / 152 = 0.118 = 11.8%

Risk of LCD among unvaccinated cows = 3 / 7 = 0.429 = 42.9%

Risk ratio = 0.118 / 0.429 = 0.28

The risk ratio is less than 1.0, indicating a decreased risk or protective effect for the exposed (vaccinated) cows.

The risk ratio of 0.28 indicates that vaccinated cows were only approximately one-fourth as likely (28%, actually) to develop LSD as were unvaccinated cows.

Incidence Rate Ratio (IR)

- A **incidence rate ratio** compares the incidence rates, person-time rates, or mortality rates of two groups.

$$IR = \frac{\text{Incidence rate in the exposed group}}{\text{Incidence rate in the unexposed group}}$$

EXAMPLE: Calculating IR

A cohort study to look at the association between pre-dipping (exposure) and mastitis (disease)

	Pre-dipping	No pre-dipping	
No. Cases mastitis	8	18	26
No. Cow-months (i.e. time at risk)	236	250	236

EXAMPLE: Calculating IR

IR = (a/b) / (c/d)

  = (8/236) / (18/250)

  = 0.03 / 0.07

  = 0.4

i.e. the rate of mastitis in pre-dipped cows is 0.4 times the rate of mastitis in not pre-dipped cows

Odds ratio (OR)

- An **odds ratio (OR)** is another a measure of association used in comparative studies, particularly case-control studies, that quantifies the association between an exposure and a health outcome.

$$OR = \frac{\text{Odds of disease in the exposed group}}{\text{Odds of disease in the unexposed group}}$$

$$OR = \frac{(a)}{b} \quad \frac{(c)}{d} = ad/bc$$

EXAMPLE: Calculating Odds Ratio

A case-control study to look at the association between physiological status and reacting to tuberculin testing in cows

	Lactating pregnant	Dry pregnant	
Reacting +	60	157	217
Reacting -	41	359	400
	101	516	617

EXAMPLE: Calculating Odds Ratios

OR = AD / BC

= (60*359) / (41*157)

= 21540 / 6437

= 3.3

i.e. the odds of positive reactors to tuberculin testing in lactating pregnant are 3.3 times the odds of positive reactors to tuberculin testing in dry pregnant

Prevalence and Risk Factors of Mastitis in Lactating Dairy Cows in Southern Ethiopia

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Table 2. Prevalence of mastitis in milking cows in Southern Ethiopian as influenced by breed, stage of lactation, age, and parity.

Risk Factors	No. Examined	CM	SCM	Total	χ^2	OR (95% CI)
Breed					47.5*	
Local zebu	446	21 (4.7)	117 (26.2)	138 (30.9)		1.2 (1.0-1.5)
Zebu × Holstein-Fresian	259	35 (13.5)	38 (14.7)	73 (28.2)		1.0
Holstein-Fresian	186	49 (26.3)	56 (30.1)	105 (56.5)		3.3 (2.5-4.4)
Jersey	83	11 (13.3)	13 (15.7)	24 (28.9)		1.0
Lactation Stage					28.0*	
Early	214	64 (29.9)	34 (15.9)	98 (45.8)		2.4 (1.8-3.2)
Mid	403	31 (7.7)	73 (18.1)	104 (25.8)		1.0
Late	357	20 (5.6)	118 (33.1)	138 (38.7)		1.8 (1.5-2.2)
Age					30.3*	
Young adults	326	53 (16.3)	24 (7.4)	77 (23.6)		1.0
Adults	399	48 (12.1)	104 (26.1)	152 (38.1)		2.0 (1.6-2.4)
Old	249	15 (6.0)	96 (38.6)	111 (44.6)		2.6 (2.0-3.4)
Parity					124.9*	
Few	328	25 (7.6)	12 (3.7)	37 (11.3)		1.0
Moderate	331	31 (9.4)	74 (22.4)	105 (31.7)		3.6 (2.9-4.6)
Many	315	60 (19.0)	138 (43.8)	198 (62.9)		12.8 (10.7-16.9)

CM = clinical mastitis, SCM = subclinical mastitis, OR = odds ratio.
Numbers in parenthesis indicate percentage.
*$P < 0.001$ (highly significant).

Further remarks on measures of association

	Cross-sectional	Cohort	Case-control
RR	X	X	
IR		X	
OR	X	X	X

Thanks