MEASURES OF DISEASE AND RISK

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OUTLINE

- Numerators and denominators
- Risk and rates
- Incidence and prevalence
- Risk difference
- Relative risk measures
- Standardised mortality ratios
- Population attributable risk

EXAMPLE

- Among new diagnoses of HIV infection in 2007, 4,260 were acquired through heterosexual contact

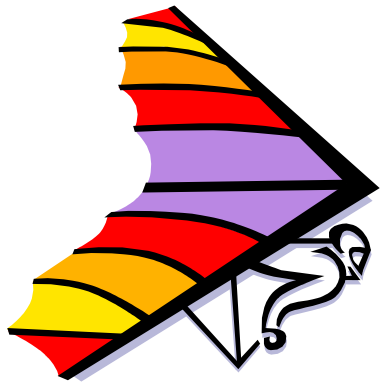
and

- 3,160 through sex between men

- What does this tell us about sexual transmission of HIV?

EXAMPLE

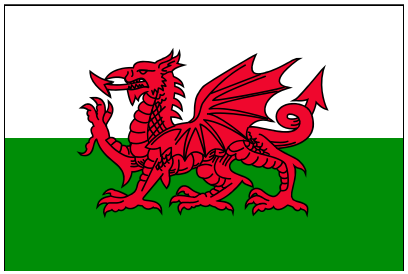
- A report of survey on hang gliding accidents noted that 73% of accidents occurred between 11 a.m. and 3 p.m.
- It concluded that hang gliding should be restricted during these hours
- Do you agree?



EXAMPLE

- There are nearly twice as many deaths from heart disease each year in Scotland as there are in Wales

- Do you think that different lifestyles might explain this finding?



DENOMINATORS AND TIME PERIODS

- We need to relate the numbers with the disease to the size of the population at risk
- Also need to consider appropriate time periods
- We need risks or rates to make comparisons, not just the numbers

EXAMPLES

- Compare proportions of heterosexuals and homosexuals acquiring HIV infection in a specific time period
- Consider the number of hang gliding accidents per hour of the day as a proportion of the number of people hang gliding at that time.
- Number of deaths from heart disease in a year divided by the number in the population in Scotland compared to that in Wales

PREVALENCE RATE

- Number of cases of a disease at a point in time divided by the number of people in the population
- HIV +ve people at the end of 2009 = 86,500
- UK population = 61.8 million
- Prevalence = 0.00140
- More usually expressed as 140 per 100,000

http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1287145264558
http://www.statistics.gov.uk/cci/nugget.asp?id=6

Source: HPA & ONS

INCIDENCE RATE

- Number of new cases of a disease in a specified time period divided by the number in the population at risk
- Number of new cases in 2009 was 6,630
- Population at risk is 61.8 million
- Incidence rate = 0.0001073
- Or 10.73 per 100,000 per year

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RELATIONSHIP BETWEEN INCIDENCE AND PREVALENCE

- Prevalence = incidence x duration
- For HIV

140 = 10.73 x duration

$\Rightarrow$ duration = 13 years

As therapy for those with HIV improves, ‘duration’ increases, so prevalence rises even if incidence stays the same or reduces slightly

PREVALENCE

- Useful for chronic and intermittent diseases/conditions, and also exposures
- eg asthma
  backpain
  diabetes
  obesity
  smoking

INCIDENCE

- Useful for assessing risk of acquiring disease.
- A mortality rate is an ‘incidence’ measure. The incidence of ‘death’.
- Cancer incidence widely recorded
- Incidence of acute infectious diseases.

ADDITIONAL INFORMATION

- Often we need rates that are specifically for subsets of the population such as:
  - Men and women
  - Different age groups
  - Smokers and non-smokers
  - Different social classes
- Rates for the whole population are sometimes called ‘crude’ rates.

COMPARISON OF RATES/RISK IN DIFFERENT POPULATIONS

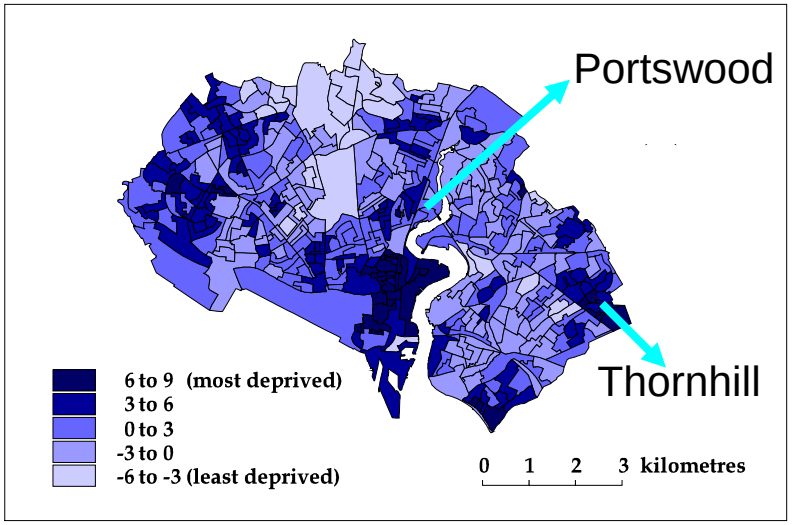
- Differences between rates
- Ratios of them

SMOKING

- In two areas of Southampton the prevalence of smoking in young women is:

Thornhill: 48%

Portswood: 24%



- The difference in the prevalence of smoking at the two ages is 24%
- The ratio of the prevalences is 2.0

OBESITY

- In two areas of Southampton the prevalence of obesity in young women is:

  Thornhill: 28%

  Portswood: 14%

- The difference in the prevalence of obesity at the two ages is 14%
- The ratio of the prevalences is 2.0

RISK DIFFERENCE

- The absolute difference between two risks or rates.
- Sometimes called excess risk or attributable risk
- Useful for health planning and public health interventions.
- A risk difference of 0 implies no difference between the risks or rates

RELATIVE RISK

$$\frac{\text{Risk in exposed group}}{\text{Risk in unexposed group}}$$

RELATIVE RISK

- The ratio of two risks
- Widely used in epidemiology when searching for associations between exposures and risk.
- e.g. Relative risk of lung cancer in smokers compared to non-smokers is approximately 10.

INTERPRETATION OF RELATIVE MEASURES

- A relative risk of 1 implies no difference between the exposed and unexposed groups
- A relative risk >1 implies that the risk is higher in the exposed group than in the unexposed group
- A relative risk < 1 implies the converse

Smoking and obesity – Portswood and Thornhill

	Smoking	Obesity
Portswood prevalence rate	14%	24%
Thornhill prevalence rate	28%	48%
Rate difference (Thornhill – Portswood)	14%	24%
Prevalence ratio (Thornhill / Portswood)	**2.0**	**2.0**
Prevalence ratio (Portswood / Thornhill)	**0.5**	**0.5**

VARIETIES OF RELATIVE MEASURES

- Relative risk (RR)
- Risk ratio (RR)
- Hazard ratio (HR)
- Odds ratio (OR)
- Incidence rate ratio (IRR)
- Prevalence (rate) ratio (PR)
- Standardised mortality ratio (SMR)
- Standardised incidence ratio (SIR)

RELATIVE RISK

- Relative risk (RR)
- RR = ratio of incidence of disease in exposed individuals to the incidence of disease in non-exposed individuals (from a cohort/prospective study)
  - If RR > 1, there is a positive association
  - If RR < 1, there is a negative association

ODDS RATIOS

- Interpretation is the same as relative risk
- Any statistic with ‘relative’ or ‘ratio’ in its name can be interpreted in the same way
  - 1.2 indicating 20% increase in risk
  - 0.8 indicating 20% reduction in risk
  - 5 indicating a five-fold increase in risk
  - 1 indicates no difference in risk
    ie no association between exposure and outcome

  - between two comparison groups, or associated with a unit change in the ‘exposure’ variable

INTERPRETATION OF ORS

OR for obesity in females (relative to males) is 1.52

- Females have 1.52 times the risk of becoming obese in early adulthood compared to males (or a 52% increased risk)

OR for obesity in relation to birth weight is 2.44 per kg

- For every 1kg increase in birth weight the risk of obesity in young adulthood increases 2.44 times (or by 144%)
- (note that for a 2kg increase in birth weight the risk increases by 2.44 x 2.44 times = 5.95)

ODDS RATIO AS AN APPROXIMATION TO THE RELATIVE RISK

- The odds ratio **ad/bc** in a case-control study provides an approximation to the relative risk.

- This is the ratio of the odds of exposure in the cases

  a/c

- to the odds of exposure in the controls

  b/d

	Cases	Controls
Exposed	a	b
Unexposed	c	d

ODDS RATIO AS AN APPROXIMATION TO THE RELATIVE RISK

	Lung Cancer	No Lung Cancer	Total
Smokers	1350	1296	2646
Non Smokers	7	61	68
Total	1357	1357	2714

$$OR = \frac{\text{Odds } (p_1)}{\text{Odds } (p_0)} = \frac{p_1/(1-p_1)}{p_0/1-p_0)} = \frac{0.51/(1-0.51)}{0.10/(1-0.10)} = \frac{1.04}{0.11} = 9.45$$

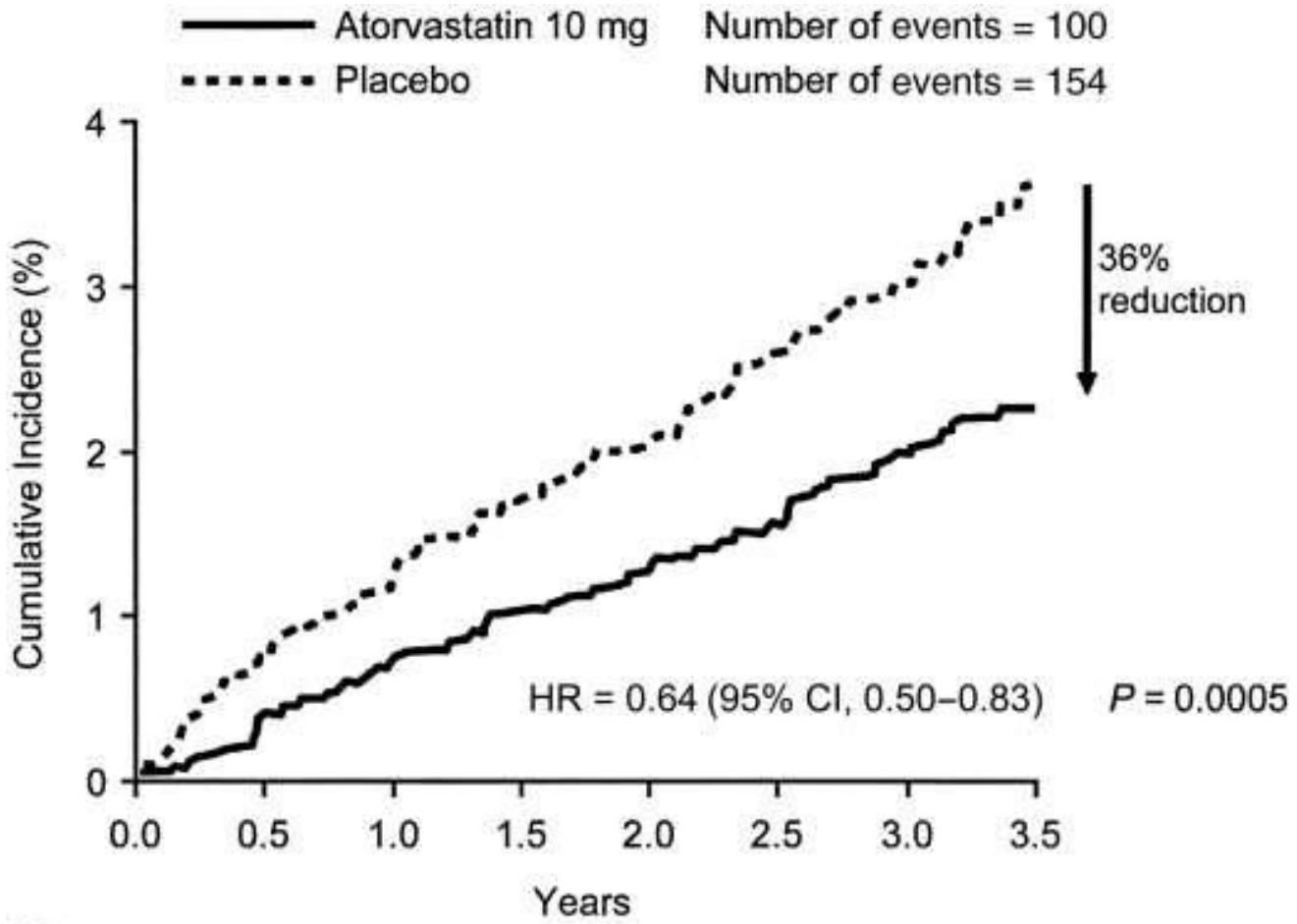
$p_1 = 1350/2646 = 0.51$

$p_0 = 7/68 = 0.10$

HAZARD RATIO

- Distinction between hazard/rate ratio and odds ratio:
  - Hazard ratio: ratio of incidence rates
  - Odds ratio: ratio of proportions
- Interpretation:
  - HR = 1 (event rates are the same in both arms)
  - HR = 2 (at any time twice as many patients in the treatment group are having an event proportionally to the comparator group)
  - HR = 0.5 (at an time half as many patients in the treatment group are having an event proportionally to the comparator group)

HAZARD RATIO



Number at risk

Placebo	5,137	5,085	5,042	5,007	4,964	4,603	3,259	1,801
Atorvastatin	5,168	5,134	5,103	5,063	5,035	4,679	3,263	1,801

SMRS AND SIRS

- Calculated by taking the number of deaths (new cases) in the exposed population over a period of time and comparing this with the number expected in the same time period.

- The expected number is derived from national rates applied to the number in the population at risk.

EXPECTED NUMBERS

- If heart disease death rate in the national population is 3 per 1000 per year (i.e 0.003) then in a town of 10,000 people we would expect 30 of them to die of heart disease in one year

- (10,000 x 0.003 = 30)

MORTALITY RATIO

If actually 45 people in the town died of heart disease in one year then the mortality ratio would be

45/30 = 1.5

indicating more deaths than expected, ie an excess

STANDARDISED MORTALITY RATIO

- A simple mortality ratio doesn't take account of different age distributions in the town compared with the national population

- For example, in Eastbourne the proportion of the population who are elderly is greater than elsewhere, so we would expect proportionally more heart disease deaths in Eastbourne

- A standardised mortality ratio is adjusted (standardised) for age and sometimes also for other factors.

POPULATION ATTRIBUTABLE RISK

- From knowledge of

  the risks in the exposed and unexposed groups (or the relative risk)

  and

  the prevalence of the exposure in the general population

- We can obtain the population attributable risk which is the proportion of the disease in the population that can be attributed to the exposure.

POPULATION ATTRIBUTABLE RISK

- Note that these calculations are approximate
- Exposures do not operate independently so PARs for a number of exposures might add up to more than 100%
- Use as a guide only
- Useful for prioritising public health measures

EXAMPLES

- Smoking and lung cancer

  Prevalence ≈ 30% RR ≈ 10 PAR 73%

- Gastric cancer and Chilli pepper

  Prevalence ≈ 81% RR ≈ 5.6 PAR 79%

- Hip OA and Heberden's nodes in the elderly

  Prevalence ≈ 40% RR ≈ 1.5 PAR 17%

PAR = (Prevalence*(RR-1)) / (1 + prevalence*(RR-1)

SUMMARY

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Incidence of hip fractures (100,000) by region, 80 years+