Attributable Risk and Odds Ratio

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This article discusses the concept of ‘association’ in biostatistics. Measures of association assume a categorical or continuous level of data. The article also discusses in detail three kinds of risks and odds ratio. Attributable risk is also known as an excess risk which is calculated when individuals or subjects in research are assembled on exposure status. Population attributable risk is also discussed which indicates a reduction in an incidence which may be observed in case the whole population was completely unexposed.

Association

Association in statistics **refers to a wide variety of coefficients which are required to measure the statistical strength of different variables**. There are many statistical distinctions associated with the understanding of the association between statistical measures. The statistical measures are different from statistical significance. Measures of association assume a categorical or continuous level of data. The categorical data include nominal or cordial data level; whereas, the casual direction followed by the measure of association is based on symmetrical or asymmetrical direction.

When we say, “Smoking is associated with lung cancer”, what exactly do we mean by “associated”?

Attributable Risk

Attributable risk (AR), also known as risk difference, is the difference between the incidence rates in exposed and non-exposed groups. This is a kind of risk which **relates to a difference in the rate of a condition of an exposed population to an unexposed population**.

AR is calculated as the difference in cumulative incidences or incidence densities; thus, reflects the absolute risk of the exposure or the excess risk of the outcome (e.g. disease) in the exposed group compared with the non-exposed group. This risk is also known as **an excess risk which is calculated when individuals or subjects in research are assembled on exposure status**. The evaluators count the occurrence of disease. The level of exposure and frequency of disease is further divided into subgroups. One such subgroup is exposed and the other one is unexposed.

Exposure ↓ / Outcome →	Yes	No	Totals
Yes	a	b	
No	c	d	
Totals			N

Formula for Exposed group

Attributable risk = (Ie – Io) / Ie

In the above formula, Ie denotes to the incidence in exposed and Io denotes to the incidence in unexposed. In order to find out the percentage of attributable risk, the difference between Ie and Io is further divided by Ie.

$$AR = \frac{(I_E - I_O)}{I_E} = \frac{a}{a+b} - \frac{c}{c+d} \div \frac{a}{a+b} = \frac{RR-1}{RR}$$

“Attributable Risk” by Lecturio

Example
The population of 200 individuals is observed over a period of 10 years comprising of 100 smokers and 100 non-smokers. The observation is aimed at finding out the impact of smoking on lung cancer to find out who dies earlier from lung cancer in the following 10 years.

Smoker ↓ / Lung Cancer →	Yes	No	Totals
Yes	75	25	100
No	10	90	100
Totals	85	115	N

The statistics proved that 86.7% smokers were exposed to lung cancer.

$$AR = \frac{(I_E - I_O)}{I_E} = \frac{75 \div 100 - 10 \div 100}{75 \div 100} = \frac{65}{75} = 86.7\%$$

"Attributable Risk of Lung Cancer" by Lecturio

The study later revealed that, out of a total of 100 smokers, 76.5% would have been prevented in case they had quit smoking earlier.

$$PAR = \frac{(I_T - I_O)}{I_T} = \frac{85 \div 200 - 10 \div 100}{85 \div 200} = \frac{0.425 - 0.1}{0.425} = 0.765\%$$

"Attributable Risk – possible Prevention" by Lecturio

Population attributable risk (PAR)

This risk indicates **a reduction in an incidence which may be observed in case the whole population was completely unexposed**. The unexposed factor of the population is compared with an actual or exposed pattern in order to find out the population attributable risk. PAR estimates the proportion of disease in the study population that is attributable to the exposure; this makes it different from AR.

Example

To find out the expected percentage of people who will live more than 60 years of average life expectancy in case they quit smoking in their early 30's.

It is usually expressed as a fraction of all exposed data from a whole population. In order to calculate PAR, the incidence of exposure in the study population must be known or estimated. It is the percentage of elimination of a disease or incident in case exposure is eliminated. PAR is **calculated by eliminating incidence in the total population including both exposed and unexposed to the incidence in unexposed**.

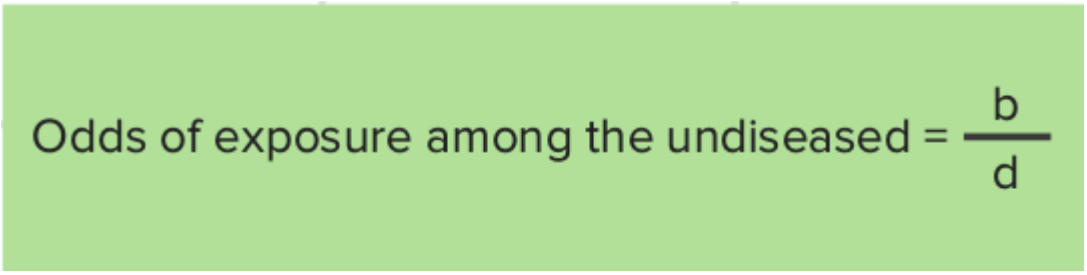
Odds Ratio (OR)

Odds Ratio (OR) measures the association between an outcome and treatment or exposure. It is a comparison of an outcome given two different groups i.e. exposure and the absence of exposure.

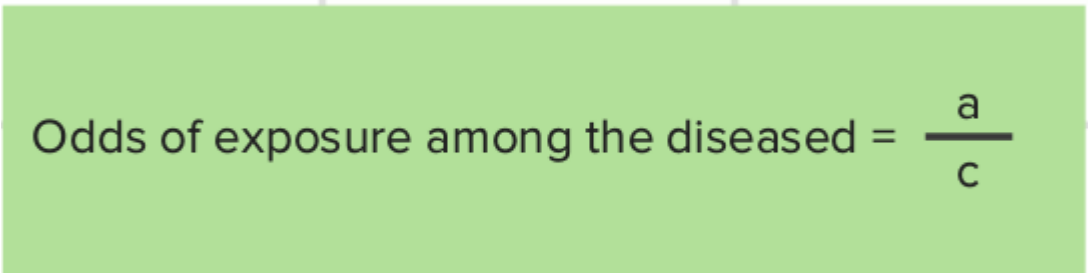
In case the **incidence rate cannot be computed accurately, the odd ratio can be used to find out the desired results**. Several case studies which involve case-control cannot measure incidence accurately; for that purpose, relative risk is required to be measured for an accurate evaluation of results. Relative risk can be used for the measurement of the odd ratio in case the disease is rare to occur in a patient. It refers to how strong the association of a disease in a patient is linked with the association of a causation factor in the same patient.

Odds ratio value of 1 depicts no effect on the odds from the exposure to the outcome, values less than 1 depicts that lower odds of the outcome are attributed by the exposure and values greater than 1 depicts higher odds of the outcome are attributed by the exposure.

Exposure ↓ / Outcome →	Yes	No	Totals
Yes	a	b	
No	c	d	
Totals			N



"Odds Ratio – undiseased" by Lecturio



"Odds Ratio – diseased" by Lecturio

Example

This ratio is used to calculate the association of property A in a patient, i.e., high blood pressure to the property B, i.e., high level of alcoholic consumption. These two properties are interlinked.

Relative Risk (RR)

Relative Risk (RR) is used in studies involving a comparison of likelihood, or chance, of an event occurring between two groups. It is considered a descriptive statistic, not an inferential statistic since it does not determine statistical significance. It refers to the **probability of occurrence of an event, i.e., the development of a disease in an exposed group to the probability of occurrence of another event in an unexposed group**. Relative risk has two important features, i.e.

1. Comparison between two exposures, and
2. Proper denominator representing the exposure.

Relative Risk is quite similar to Odds Ratio, although RR is calculated by the use of percentages, whereas Odds Ratio is calculated by using the ratio of odds.

The formula used to calculate relative risk is given as follows:

RR = Prevent when exposed / Prevent when not exposed

Example

If the probability of the development of lung cancer in smokers is 20%, it may be 2% in the case of non-smokers.

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Example

If the probability of the development of lung cancer in smokers is 20%, it may be 2% in the case of non-smokers. This situation can be expressed as follows:

Smoker ↓ / Lung cancer →	Yes	No	Totals
Yes	20	80	100
No	1	99	100
			N

Putting the values in formula below:

Relative Risk

$$= \frac{a}{a+b} \div \frac{c}{c+d}$$

"Relative Risk among the unexposed" by Lecturio

That is:

RR = (20/ (20 + 80)) / (1 / (1 + 99))

RR = 20

Relative Risk values are greater than or equal to zero. A value of 1 indicates a neutral result; the chance of an event occurring for one group is the same for an event occurring for the other group.

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Notes