Elaborate Causal Theory.

Causal Identification | Causal Explanation

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Gather data to Confront Theory.

RCT. Cohort. Case-Control Cross-Sectional

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Compare Theory with data.

Stratification Modeling.

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Acknowledge Uncertainty.

Causal Effect of A

is the difference between

A Fact. The disease experience of the exposed individual

and

$\boxed{\text{A Counterfactual}}$. The disease experience of the exposed individual had s/he not been exposed.

unobservable

A proxy of the counterfactual: Frequency of disease in unexposed.

What makes a good proxy? Exposed and Unexposed are alike in all causes of disease except for the exposure.

Full comparability.

Basic Quantifications in Epi

Measures of Disease Frequency. → # of New cases during a period of interest.

Risk. (aka incidence)

Rate

Odds → $\frac{\text{Risk}}{(1-\text{Risk})}$ → Risk.

Prevalence. → The # of existing cases at a point in time or during a period of interest.

Metrics of Comparison

Ratio

Difference.

INUS: Insufficient But Necessary Component of Unnecessary but sufficient cause

* in case-control study. odds ratio$_{exposure}$ = odds ratio$_{disease}$

But one cannot calculate disease odds, since case-control studies are conditionning on disease. We cannot estimate the disease odds in exposed and the disease odds in unexposed.

Specific type of incidence.

when ID is better than CI?
different periods of time

Cumulative incidence
an estimate of risk.

the proportion of a fixed population that becomes diseased during a stated period of time.
-the probability of risk of developing a disease over the stated period of time

$$\frac{\text{\# of New Disease events during a specific time period}}{\text{population at risk at the beginning of the time period}}$$

Assumption: All non cases are followed for the entire duration of the follow-up period. (few pp withdraw from study or dying from competing risks or other causes of death).

Incidence density rate

The Average incidence rate for a population at risk during a period of time ($t_0 \to t$).

$$\frac{\text{\# of New Disease Events}}{\text{Total person-time at risk.}}$$

Average rate per unit of time.

prevalence

point prevalence
The prevalence at a specific point in time.

Period prevalence.
the prevalence over a specified period of time.

prevalence = Incidence rate × Average Duration $P = IDR \cdot time = ID$

Risk → Risk Difference.

→ Excess rate: $IR - 1 = \frac{I_1}{I_0} - 1$

Absolute risk

The probability that an individual will develop a disease or other health condition during a stated period of time, conditioned on that individual's not dying from any other disease during the period.

→ cumulative incidence - (with no attrition due to other causes) (Risk)

→ Incidence density rate. Generally provide more accurate estimates of absolute risk than measures that use the population at risk as the denominator! (Rate).

$Risk(t_0, t) = 1 - \exp(-ID(t - t_0))$

relative risk.

$\frac{\text{risk in } E}{\text{risk in } E^-}$.

→ $\frac{IDR_{smokers}}{IDR_{non\text{-}smokers}}$

→ $\frac{O}{\bar{E}}$.

→ proportionate Mortality Ratio (PMR) or PIR: the ratio of two proportions.

Attributable Risk

→ AR. = $Rate_E - Rate_{\bar{E}}$

eg. 63/100,000 - 7/100,000 = 56/100,000

56 lung C per year per 100,000 smokers were attributable to smoking

→ AR% = $\frac{Rate_E - Rate_{\bar{E}}}{Rate_E}$ $= 1 - \frac{1}{RR}$

(etiologic fraction).

eg. $\frac{63 - 7}{63} = 89\%$.

89% of Lung cancer among smokers were attributable.

→ PAR: Amount or proportion of disease in a population that can be attributed to the Exposure

PAR = Rate population - Rate ($\bar{E}$)

$PAR = \frac{p(r-1)}{p(r-1)+1}$ $r = \frac{\lambda_1}{\lambda_0}$

→ PAR%

$PAR = \frac{Rate_{population} - Rate(\bar{E})}{Rate_{population}}$

to their smoking

if smoking was eliminated, 89% of the lung cancers that occurred among the smokers would have been eliminated.

Eg. 17 lung cancers per year per 100,000 persons in this entire population were attributable to smoking

AR and AR% measure the potential benefit to be expected among exposed persons if they could eliminate their exposure.

Health Education Program.

PR and PR% measure the potential benefit to be expected in the entire population if the exposure of interest could be eliminated.

Preventable Risk.

$$PR = \frac{Rate(E) - Rate(\bar{E})}{Rate(\bar{E})}$$

PR

the proportion of events in the non-exposed population that could have been prevented if they had been exposed to the protective factor.

treatment.

In clinical trial: Absolute Risk Reduction (ARR).

Relative Risk Reduction (RRR).

Number Needed to treat

NNT: the # of individuals that would need to be treated to prevent a single case

NNT = 1/AR

... smokers would

NNT = 1/PR

? interpretation.

NNT = 1/ARR.

need to be non-smoker to prevent one lung cancer per year

# of exposed persons or # of general persons...

Hazard Rate

Definition

probability of disease in the very short time period, given the free of disease at the beginning of the time period

(a probability)

formula.

$$HR = P[D=1 \text{ in } (t, t+dt) \mid D=0 \text{ at } t]$$

(with $dt \Rightarrow 0$)