Cross-sectional study

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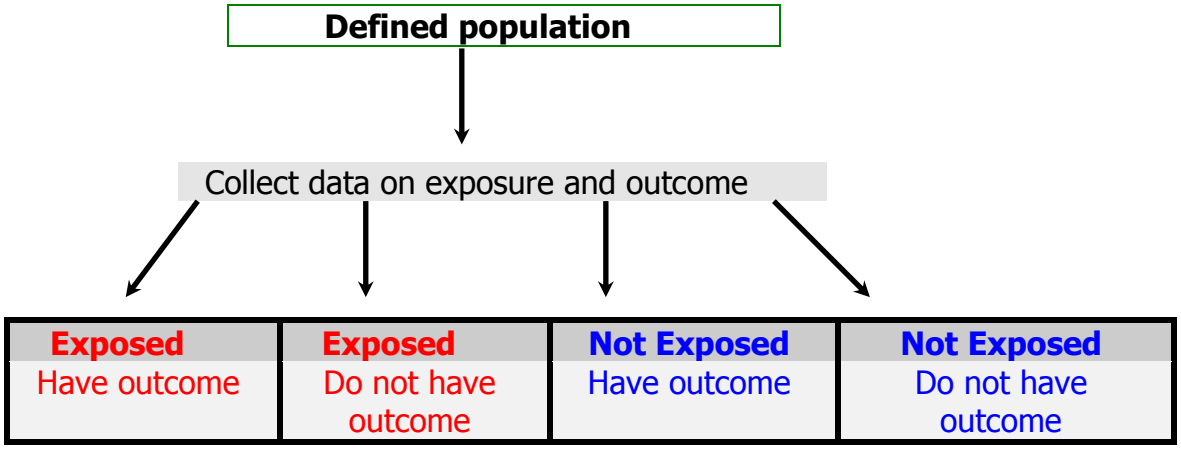
The cross-sectional study concept is like taking snapshot of the population at a specific time. Each person is determined whether he/she has an outcome and whether he/she has exposure. Both exposure and outcome are determined simultaneously. Thus, people with disease or study outcome are prevalence cases.



I would like to give example for better understanding.

The researchers created hypothesis that cat's hair cause asthma among population in the sub-district. They conducted the survey in the sub-district. They used simple random sampling to select 500 out of 3000 of the people. The participants had physical examinations and interviews. The researchers also checked whether the participants had cats in their house during a survey. There were 195 participants with asthma among 300 participants who raised cats (65%), while 80% of participants who did not raise cats (160 out of 200) had asthma. It seemed that cat's hair was not the cause of asthma among this population in the sub-district. The reason for this finding was that the participants who had asthma had been recommended to stop raising cats by their physicians prior to the period that the researchers conducted the survey. A conclusion might be misleading as a protective effect of cat hair.

Based on the example, characteristics of the cross-sectional study are as following:

- It can determine only prevalence case, except the study with laboratory technology that can determine incidence case.
- It study in one population.
- Participants are not selected based on exposure (did not select participants according to raising cat and compared prevalence of asthma between exposed and non-exposed groups) as done in cohort study

- Participants are not selected based on outcome (did not select participants according to having asthma and compared prevalence of raising cat between asthma and non-asthma groups) as done in case- control study
- It describes the association between exposure and outcome (non-causal relationship) not causal relationship. It has temporal ambiguity.

Analysis

1. Magnitude or outcome frequency
   - Prevalence of outcome
   - Prevalence of exposure

2. Association between exposure and outcome
   - Prevalence risk ratio (Risk ratio or relative risk from output of some programs- abbreviation RR)
   - Prevalent odds ratio
   - 95% confidence intervals

Interpretation

A statistically significant association between exposure and outcome does not guarantee causal relationship. The possible real event may be as following:

- The exposure does not associate/differ and researcher correctly conclude that it does not associate/differ.
- The exposure does not associate/differ, but researcher wrongly conclude that it associates/differs (Type I error).
- The exposure associates/differs, but researcher wrongly conclude that it does not associate/differ (Type II error).
- The exposure associates/differs and researcher correctly conclude that it affects/differs.

Probability of making a type I error is a probability of concluding the exposure associates/differs when in reality it does not differ.

Probability of making a type II error is a probability of concluding that the exposure does not associate/differ when in reality it does differ.

Power is a probability of detecting an association/difference between the exposure if the exposure does in fact associates/differs (1 - Probability of making a type II error).

Another name of the probability of type I error is called P-value. P-value less than 0.05 means the researcher concludes that exposure associates (or differs from non-exposure) based on the participants included in this study. It is possible that the association/difference could have occurred by chance alone. Thus, this association/difference found from this study does not reflect any true

association/difference between exposed and non-exposed groups, is only 0.05 (or 5%).

2.1 Compare prevalence of outcome in exposed group and those of non-exposed group

	Outcome	**No Outcome**	**Total**
Exposed	a	b	a +b
Non- Exposed	c	d	c + d

Prevalence of outcome in exposed group = a / a +b
Prevalence of outcome in non-exposed group = c / c + d

2.2 Compare prevalence of exposure in group with outcome and those of group without outcome.

	Outcome	**No Outcome**
Exposed	a	b
Non- Exposed	c	d
Total	a +c	b + d

Prevalence of exposure in group with outcome = a / a +c
Prevalence of exposure in group without outcome = b / b + d

Prevalent **risk ratio** is a comparison of these probabilities.

For comparing probability or risk of having outcome in exposed group and those of non-exposed group, RR is calculated as following:

When
Prevalence of outcome in exposed group (probability or risk)

$$= \frac{\text{Number of persons who exposed and had outcome}}{\text{Number of persons who exposed}}$$

= a / (a+ b)

Prevalence of outcome in non-exposed group (probability or risk)

$$= \frac{\text{Number of persons who do not expose but had outcome}}{\text{Number of persons who do not expose}}$$

= c / (c+ d)

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

RR = 1

The risk of having outcome in exposed group equals to the risk of having outcome in non-exposed group. In another word, there is no association between exposure and outcome.

RR > 1

The risk of having outcome in exposed group is more than the risk of having outcome in non-exposed group. In another word, there is positive association between exposure and outcome.

RR < 1

The risk of having outcome in exposed group is less than the risk of having outcome in non-exposed group. In another word, there is negative association between exposure and outcome.

2.2 Compare prevalence of exposure in group with outcome and those of group without outcome

The concept is the same. The calculation is done in comparing the prevalence of exposure between two groups.

Caution for interpretation of OR

When the probability of the outcome in the unexposed group is large such as more than 10%, the OR differs from RR. In case that the OR is larger than 2.5 or less than 0.5, OR should be adjusted when incidence of the outcome is more than 10% (Schwartz et al).

$RR = OR / [(1-P_u) + (P_u)(OR)]$

Where P_u is the probability of the outcome in the unexposed group.

For detail of OR, please read case control study.

<u>Example</u>

A cut-off level of Waist-to-height ratio (WHtR) for cardiovascular risk factors was controversial for its appropriateness in Asians. The study aimed to determine the appropriate WHtR cut-off level for Thai Adults. One hundred twenty seven out of 387 health personnel of at least 35 years of age from X institute participated in the study. Participants completed self-administered questionnaires, and had physical examination and blood drawn for lipid profile.

In univariate analysis, WHtR at least 0.5 was statistically significantly associated with high blood pressure (RR; 95% CI = 1.7; 1.0 - 2.7), high cholesterol (1.6; 1.0 - 2.6), high low-density-lipoprotein (LDL) (3.5; 1.2 - 9.7), high triglyceride ≥ 150 mg/dl (2.7;1.5 - 4.9), high triglyceride ≥ 200 mg/dl (4.1;1.2 - 13.4), and high total cholesterol to HDL ratio (THR > 5.0) (6.5; 1.6, 27.2) (Table 2). Low high-density-lipoprotein (< 40 in male and < 50 mg/dl in female) was marginally association with p-value of 0.057 (2.6; 0.9 - 7.7).

Here is example of high LDL.

WHtR	LDL High	LDL Normal	Total
At least	17	53	70
	(24.3%)	(75.7%)	(55.1%)
Below	4	53	57
	(7.0%)	(93.0%)	(44.9%)
Total	21	106	127
	(16.5%)	(83.5%)	(100.0%)

Single Table Analysis

RISK RATIO (RR) (Outcome: HLDL=; Exposure: WHtR = 1.00) 3.46
95% confidence limits for RR 1.23 < RR < 9.71

	Chi-Squares	P-values
Uncorrected:	6.79	0.00917708 <---
Mantel-Haenszel:	6.73	0.00945612 <---
Yates corrected:	5.59	0.01801708 <---

I would like to explain easily using the rule of three in arithmetic as following:

Among 70 participants with WHtR ≥ cut-off level, they have high LDL 17 persons
If there are 100 participants with WHtR ≥ cut-off level,
the probability or risk of having high LDL is (17 / 70)* 100 persons

Among 57 participants with WHtR < cut-off level, they have high LDL 4 persons
If there are 100 teachers with BMI < cut-off level,
the probability or risk of having high LDL is (4 / 57)* 100 persons

Compare the prevalence of high LDL among WHtR ≥ cut-off level group and those of WHtR < cut-off level group

RISK RATIO = ((17 / 70)* 100) ÷ ((4 / 57)* 100)
= 3.46
(95% confidence limits of RR =1.23 to 9.71)

High WHtR is statistically significantly associated with high LDL (P-values = 0.009). In another words, If we conduct the same study over and over again (numerous times),

the risk of having high LDL of WHtR ≥ cut-off level was 3.46 times greater than those of WHtR < cut-off level and the RR value in the population was any value between 1.23 to 9.71 times. The probability of the association found from this study does not reflect any true association of high WHtR, is less than 0.01 (or 1%).

Advantage

- It is feasible in practice.
- It is less time consuming.
- It can be used for creating new hypothesis.
- It is appropriate for determine disease burden and health need. Thus, it is suitable for health planning task.
- The trend of outcome over time can be assessed using serial cross-sectional studies in stable and closed population.
- It can be used for determining key indicators of health service quality overtime.

Disadvantage

- It has limitation due to temporal ambiguity.
- It is more likely to have recall bias.
- Sometimes, it is hard to distinguish between risk factors and prognostic factors.
- It is not feasible in practice for rare disease or a disease with high fatality rate in a short time.

Other names found in various text books

- Prevalence study
- Survey

Cross-sectional study aritcles

The articles can be download from www.oknation.net/blog/lakthai

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