Cohort study

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Introduction

Let me start with a small situation.

Suppose in a village of 2,000 people, some individuals smoke and some do not. After 10 years, we observe that lung cancer developed in 40 smokers and 5 non-smokers.

Now tell me — Can we say smoking increases the risk of lung cancer?

How do we measure that increase?

What type of study design would allow us to follow people over time to find this answer?

Exactly. To establish whether an exposure leads to a disease, we need to **start with exposure and move forward in time to see the outcome**.

That is the essence of a **Cohort Study**.

Re cap of Epidemiological studies

Main Type	Sub-Type
Observational Studies	**Descriptive Studies**
	Case Report, Case series, Cross-Sectional Study, Ecological study
	Analytical Studies
	Case-Control Study, **Cohort study** 
Experimental (Interventional) Studies	Randomized Controlled Trial (RCT)
	Field Trial
	Community Trial
Quasi-Experimental Studies	Non-Randomized Trial
	Before-After Study

Cohort study

“Cohort is defined as a group of people who share a common characteristic or experience within a defined time period. Ex: age, occupation, exposure to drug or vaccine, pregnancy, insured people”

Ex: Birth cohort, Marriage cohort

It is also known as prospective study, longitudinal study, Incidence study, Forward looking study.

Indications for cohort studies

- When there is a good evidence of an association between exposure and disease, supported by descriptive and case control studies
- When exposure is rare and incidence of disease high among exposed. Ex: Survivors of Man made disasters like atomic explosion in Hiroshima, Bhopal Gas tragedy, etc
- When loss to follow-up is low and ample funds available

Framework of a cohort study

- **Cause to effect approach**
- **There will be two groups Cohort (Exposed) group and Control (Non Exposed) group**
- Both groups must be free from disease
- Knowledge of disease should be equal in both groups
- Both groups should be comparable in all aspects
- **Diagnostic and eligibility criteria of disease must be defined before starting of study**
- Both groups will be followed under same identical collections over a period of time to determine the outcome of exposure in both groups.

Framework of Cohort study

Cohort	Disease developed		Total
	Yes	No	
Exposed group	a	b	a+b
Non Exposed group	c	d	c+d

Incidence among exposed = a/(a+b)
Incidence among non Exposed = c/(c+d)
If a/(a+b) is greater than c/(c+d),
it indicates the exposure is causing disease

Types of cohort studies

- **Prospective cohort study** – Current cohort study
- **Retrospective cohort study** – Historical cohort study – Joined in job 30 years back
- **Combination of retrospective cohort study** – will be started as retrospective cohort study and continued as prospective cohort study

Elements of a cohort study

1. Selection of study subjects
2. Obtaining data on exposures
3. Selection of comparison groups
4. Follow-up
5. Analysis

Selection of study subjects

1. Selection from General population – Residing in one area/ in one city
2. Selection from special groups –
    1. Select groups from one occupation – Doctors, lawyers
    2. Exposure group – Workers in Radiation releasing industry, Pesticide industry etc

Obtaining data on Exposure

1. Obtaining data directly from participants through personal interviews
2. Review of records – Dose of radiation, Duty shifts, Kind of surgery, Kind of treatment
3. Medical examination or special tests – Blood pressure, Serum cholesterol, ECG
4. Environmental surveys

Selection of Comparison groups

1. Internal comparison – Dose response- Within smokers – Classification based on Cigarettes per day – ½ pack , 1 pack, 2 packs, more than 2 packs
2. External comparison – Smokers and Non smokers
3. Comparison with general population – Lung cancer incidence in smokers and in general population

Follow up

1. Periodic medical examination of each member
2. Reviewing physician and hospital records
3. Routine surveillance of death records
4. Mailed questionnaires, telephonic calls, periodic home visits

- Loss to follow up should be minimized to less than 5 %
- That means at least 95% of people should be in follow up as possible

Analysis

- To Compare **incidence of outcome** between exposed and non-exposed groups
- To Measure **strength of association**
- To Estimate **risk attributable to exposure**

Key Measures

- Incidence
- Relative Risk (RR)
- Attributable Risk (AR)
- Population Attributable Risk (PAR)

2X2 table

	Disease Present	Disease Absent	Total
Exposed	a	b	a + b
Non-Exposed	c	d	c + d

Incidence calculation

Incidence in Exposed (Ie)

$$Ie = \frac{a}{a+b}$$

Incidence in Non-Exposed (Io)

$$Io = \frac{c}{c+d}$$

Relative risk (Risk Ratio)

$$\mathrm{RR} = \frac{Ie}{Io}$$

Interpretation:

RR = 1 → No association

RR > 1 → Exposure increases risk

RR < 1 → Exposure protective

Example: If RR = 4 → Exposed individuals have 4 times higher risk.

Attributable Risk (Risk Difference)

AR = $Ie - Io$

Meaning:

Excess risk due to exposure

Indicates **actual impact of exposure**

Example:
If AR = 0.10 → 10 extra cases per 100 exposed are due to exposure.

Population Attributable Risk (PAR)

PAR = $It - Io$

Where:

It = Incidence in total population (Exposed + Non Exposed population)

Io = Incidence in non-exposed

$$PAR\% = \frac{(It - Io)}{It} \times 100$$

Shows impact of exposure at **population level**.

Case control study vs Cohort Study

Basis of Comparison	Case-Control Study	Cohort Study
Direction of Study	Backward (Disease → Exposure)	Forward (Exposure → Disease)
Starting Point	Begins with disease status	Begins with exposure status
Grouping	Cases and Controls	Exposed and Non-exposed
Time Sequence	Retrospective	Prospective / Retrospective
Measure of Occurrence	Cannot directly calculate incidence	Incidence can be calculated
Measure of Association	Odds Ratio (OR)	Relative Risk (RR)
Best for Studying	Rare diseases	Rare exposures
Time Required	Short duration	Long duration (especially prospective)

Case control study vs Cohort Study

Basis of Comparison	Case-Control Study	Cohort Study
Cost	Less expensive	More expensive
Sample Size	Smaller sample sufficient	Usually requires larger sample
Loss to Follow-up	Not applicable	Major problem
Recall Bias	Common	Rare
Multiple Outcomes	Not suitable	Can study multiple outcomes
Multiple Exposures	Can study multiple exposures	Usually studies single exposure
Temporality (Exposure before Disease)	Difficult to establish clearly	Clearly established
Example	Smoking history in lung cancer patients	Smokers followed for lung cancer incidence

Summary

✓ Cohort study follows a **group sharing a common exposure** over time

✓ It follows a **cause → effect approach**

✓ Starts with **exposure status** and observes development of disease

✓ Can be **Prospective, Retrospective, or Combined**

* Suitable for studying **rare exposures**

Key Limitations: Time-consuming and costly, Loss to follow-up affects validity, Not ideal for rare diseases

Measures Used in Analysis: Incidence, Relative Risk (RR), Attributable Risk (AR), Population Attributable Risk (PAR)

Thank you