

CASE CONTROL VS. CASE COHORT STUDIES

Cristina López Barroso

Introduction.

Epidemiological Context

Understanding the cause, development, and spread of diseases is essential for improving public health and medical practice, and for this purpose, it is essential to consider epidemiology. Epidemiology is the science that studies epidemics, i.e., the science that studies the phenomenon of the spread of diseases that affect societies expansively within a time frame. In other words, more specifically, epidemiology investigates the distribution of health problems among the population, the factors that can be triggering, and the state of the identified phenomenon, analyzing the existing causal relationships between these exposure factors (causes) and the studied population phenomenon (effect).

Importance of Epidemiological Research in Medicine.

Observational studies are an important tool in population analysis; it is a way to increase the comparability of exposure groups concerning the measured factors. Different tools or models can be found to develop population analysis. This work analyzes case-control studies and cohort studies.

1. **Case-Control Studies.** These studies are useful for investigating rare diseases or those with long incubation periods. They allow evaluating the association between specific exposures and diseases. They are more efficient and less costly compared to other designs.
2. **Cohort Studies.** They allow examining multiple health outcomes in relation to exposure over time. It helps identify risk factors, understand the natural history of a disease, and evaluate the effectiveness of interventions, providing information about the incidence, prevalence, and causality of diseases.

Combined Importance

The approaches (case-control studies and cohort studies) complement each other. Case-control studies are useful for quickly investigating risk relationships, while for long-term analysis of the relationship between exposures and outcomes, cohort studies are more commonly used.

Furthermore, the utilization and combination of both types of studies help strengthen the validity of results, aiding in the validation of findings.

Advancements and Challenges

Population studies are essential for identifying risk factors and understanding the epidemiology of diseases. However, ethical and logistical challenges persist, especially in data collection, bias management, and result interpretation. Case-control studies and cohort studies are fundamental methodologies in epidemiology; they allow understanding the relationship between exposure to the disease and the disease in specific populations.

Relevance of these studies in epidemiology

Both studies are crucial for identifying and understanding risk factors associated with specific diseases, establishing preventive intervention measures to reduce disease incidence, and evaluating the effectiveness of medical treatments/public health programs.

They provide valuable information that helps researchers, healthcare professionals, and policymakers better understand the causes and evolution of diseases, contributing to decision-making in the field of medicine and epidemiology.

Introduction to Case-Control Studies

Researchers select individuals with a specific disease (cases) that will be compared with healthy individuals, without the disease (controls), retrospectively evaluating exposure to different risk factors. The importance of this methodology lies in:

- Efficiency in time and resources. Recruiting existing cases in short times is useful for investigating rare or rapidly occurring diseases.
- Evaluation of rapid associations. Identifying risk factors is easy since the analysis of the relationship between exposure and disease is analyzed quickly.
- Cost-effectiveness. They are economical and quickly conducted compared to other study types, making it a useful tool in situations with limited resources.

Introduction to Cohort Studies

Researchers track a group of individuals exposed or not exposed to a specific exposure over time to evaluate the incidence of a disease. The importance of this methodology lies in:

- Causality assessment. It allows establishing temporal relationships between exposures and health outcomes.
- Multiple outcome analysis. Assessing multiple outcomes provides a comprehensive view of exposure effects.
- Identification of long-term risk factors. They are useful in identifying risk factors in chronic diseases and analyzing their long-term evolution.

Case-Control Studies

Case-control studies are a type of retrospective observational study used to investigate the association between a disease or condition of interest and risk factors or exposure. Researchers select a group of individuals with the disease or condition (cases) and a group of individuals without the disease (controls), comparing exposure to different factors between both groups.

The main characteristics are:

- Case Selection. It's based on the presence of the disease or condition of interest. They are obtained from medical records, hospitals, or other data sources.
- Control Selection. The selection is made so that these individuals can be comparable to the cases in terms of demographic characteristics and other relevant factors.
- Retrospective. Data on exposure to risk factors are collected retrospectively, after the disease or condition of interest has developed.
- Exposure Measurement. Information on exposure to risk factors is gathered using different methods, such as questionnaires, interviews, or medical records.
- Statistical Analysis. Statistical techniques are used to compare exposure to risk factors between cases and controls and evaluate the association between exposure and the disease or condition of interest.

Methods used in case-control studies:

In case-control studies, there are many methods used for the selection of cases and controls, as well as for data collection and analysis. Some of the methods used:

- Incident case sampling: New cases occurring during a specified period are selected.
- Prevalent case sampling: Existing cases at a given time are selected.
- Population-based control sampling: Controls are selected from the same population from which the cases were obtained.
- Hospital control sampling: Controls are selected among individuals who go to the same hospital or health center as the cases, but without the disease or condition of interest.
- Matched control sampling: Controls are selected so that they are similar to cases in terms of demographic characteristics and other relevant factors.

It has already been mentioned that case-control studies are used in the health field for researching rare diseases and identifying risk factors, but they are also applied in estimating odds ratios (the odds ratio measures the strength of the association between exposure and disease, in case-control studies, the odds ratio is used as a measure of association between exposure and the disease or condition of interest) and outbreak investigations to determine the source of infection.

Cohort Studies

Cohort studies are a type of observational study in research used to examine the relationship between a risk factor or exposure and the development of a disease or outcome of interest over time. These studies follow a group of individuals over time and collect information about their exposure to a specific risk factor and their outcome of interest.

The main characteristics of this type of study are:

- Population selection: An initially disease-free population is selected.
- Exposure measurement: Information about participants' exposure to the risk factor or variable of interest is collected.
- Long-term follow-up: Participants are followed over time to evaluate if they develop the disease or outcome of interest.
- Group comparison: Exposed and unexposed groups are compared to determine the association between exposure and the outcome.
- Outcome measurement: Results of interest are recorded and analyzed over time.
- Statistical analysis: Statistical techniques are used to assess the association between exposure and the outcome.

Methods used in cohort studies:

- Interviews and questionnaires: Interviews or questionnaires are conducted with participants to collect information about exposure and other relevant factors.
- Medical examinations: Periodic medical exams may be performed to evaluate the presence of the disease or outcome of interest.
- Medical records: Medical records can be used to obtain information about exposure and outcomes.
- Statistical analysis: Statistical techniques are used to analyze collected data and assess the association between exposure and the outcome.

Case-control studies are used in the health field for long-term monitoring, measuring multiple factors, and estimating relative risks.

Case-control studies vs. cohort studies.

	Case-Control Studies	Cohort Studies
Design	Participants are selected based on their disease status (cases) and compared with a control group without the disease. Retrospective information on exposure is collected.	Participants are selected based on their exposure to the risk factor and followed over time to assess if they develop the disease. Prospective information on exposure is collected.
Application	Useful when the disease is rare or has a long incubation period.	They are suitable for evaluating multiple outcomes and providing estimates of relative risk.
Advantages	They are faster, cheaper, and require fewer participants than cohort studies. Useful for investigating rare diseases or those with a long incubation period.	They allow evaluating multiple outcomes and providing direct estimates of incidence and relative risk. Useful for investigating common diseases and assessing the temporal relationship between exposure and outcome.
Limitations	May be subject to selection biases and retrospective information biases. Do not provide direct estimates of disease incidence.	They are expensive, require a long follow-up period, and may be subject to follow-up losses and prospective information biases.
Example	May be more suitable in situations where the disease is rare or has a long incubation period. For example, in studying a disease like lung cancer, which may take years to develop after tobacco exposure.	They may be more suitable when evaluating the temporal relationship between exposure and outcome, or when investigating multiple outcomes. For example, in studying the relationship between exposure to a medication and the development of different long-term side effects.

Applications in Medical Research

Case-control and cohort studies are two types of studies used in medical research to better understand the epidemiology of specific diseases.

Successful Cases or Significant Discoveries Obtained from Each Study Type

Case-Control Studies: Case-control studies focus on the detailed analysis of an individual or a small group presenting a specific disease or condition. These studies allow in-depth examination of risk factors, symptoms,

treatment, and patient outcomes. Some successful cases or significant discoveries obtained through case-control studies include:

- Identification of new diseases or syndromes
- Study of rare diseases
- Identification of risk factors

Cohort Studies: Cohort studies are based on following a group of individuals over time to assess the relationship between risk factors and disease development. Some successful cases or significant discoveries obtained through cohort studies include:

- Identification of modifiable risk factors
- Evaluation of intervention effectiveness
- Study of long-term diseases

Importance of Combining Both Approaches

The combination of case-control studies and cohort studies in an epidemiological study can provide a more comprehensive and robust understanding of the relationship between exposure and an outcome of interest. By using both approaches, different types of information that complement and strengthen findings can be obtained.

Some reasons why combining both approaches is important include:

1. **Validation of Results:** Case-control studies and cohort studies can provide additional evidence and validate results obtained in each approach. If both types of studies find a similar association between exposure and outcome, this strengthens the evidence of a causal relationship.
2. **Consideration of Time:** Cohort studies allow for evaluating exposure before the outcome occurs, aiding in establishing a clear temporal sequence. On the other hand, case-control studies can provide information about past exposures and their relationship with the outcome. Combining both approaches allows for considering both previous and future exposure.
3. **Study of Rare Diseases:** Case-control studies are especially useful for investigating rare diseases as they allow for efficiently selecting cases with the disease of interest. By combining these studies with cohort studies, more comprehensive data about the relationship between exposure and disease can be obtained.
4. **Consideration of Multiple Confounding Factors:** By combining both approaches, multiple confounding factors can be considered and controlled more effectively. Cohort studies allow for adjusting for known confounding factors, while case-control studies can provide additional information about unknown confounding factors.

In summary, combining case-control studies and cohort studies in an epidemiological study is important because it allows for result validation, time consideration, studying rare diseases, and considering multiple confounding factors. By using both approaches, a more comprehensive and solid understanding of the relationship between exposure and an outcome of interest is achieved.

Example in Cardiovascular Disease

Cardiovascular diseases (CVDs) are conditions affecting the cardiovascular system, being one of the leading causes of death globally. Studying cardiovascular diseases is crucial due to their high incidence and severe consequences for public health. These diseases represent a significant burden on healthcare systems worldwide.

Understanding the incidence of cardiovascular diseases involves analyzing risk factors such as hypertension, smoking, obesity, diabetes, etc. These factors are key to understanding prevention, early diagnosis, and treatment of CVDs. Studying these diseases encompasses multidisciplinary fields including clinical medicine, biomedical research, public health, and epidemiology. Continuous research is fundamental for developing effective prevention, treatment, and management strategies for cardiovascular diseases, aiming to reduce their global impact and improve the cardiovascular health of the population.

In the context of this work, having delved into the characteristics of each and their clinical application, I can explain an example applied to the study of risk prediction measures for case-cohort and case-control designs in relation to cardiovascular diseases.

An example of studying risk prediction measures for cardiovascular diseases using a case-cohort design would be as follows:

Imagine we want to investigate the relationship between tobacco consumption and the risk of developing cardiovascular diseases. For this, we select a sample of individuals who have developed cardiovascular diseases (cases) and another sample of individuals without cardiovascular diseases (controls).

In this case-cohort design, we start by selecting a group of individuals without cardiovascular diseases and follow them over time to observe if they develop the disease. During this follow-up, we record both tobacco exposure and other cardiovascular risk factors such as blood pressure, body mass index, and family history of cardiovascular diseases.

In this study, we can calculate risk prediction measures such as relative risk (RR) and attributable risk (AR) to assess the association between tobacco consumption and the risk of developing cardiovascular diseases.

- Relative risk (RR) allows us to compare the risk of developing cardiovascular diseases between individuals exposed to tobacco and those not exposed. An RR greater than 1 indicates a higher risk in the exposed group, while an RR less than 1 indicates a lower risk in the exposed group.
- Attributable risk (AR) provides an estimate of the proportion of cases of cardiovascular diseases that can be attributed to tobacco consumption. The higher the AR, the greater the contribution of tobacco to the development of cardiovascular diseases in the population.

Using these calculations, we can obtain results that help us understand the relationship between tobacco consumption and the risk of cardiovascular diseases in the case-cohort design. These results can be useful for informing health policies and promoting interventions aimed at reducing tobacco consumption and preventing cardiovascular diseases.

The clinical application of these designs allows for identifying cardiovascular risk factors and evaluating their impact on the development of cardiovascular diseases. These studies provide scientific evidence for clinical decision-making and the implementation of preventive and therapeutic interventions. For example, if a case-cohort or case-control study finds a significant association between tobacco consumption and the risk of cardiovascular diseases, this supports the importance of promoting smoking cessation as a preventive measure.

Conclusion

In summary, case-cohort and case-control designs are valuable tools in clinical and epidemiological research to study the relationship between risk factors and cardiovascular diseases. These designs allow for calculating risk prediction measures and provide scientific evidence for the prevention and treatment of cardiovascular diseases.

Bibliography

- Equipo Editorial. (2019, 8 agosto). *Epidemiología (Qué es, concepto, definición y objetivos)*. Significados. <https://www.significados.com/epidemiologia/>
- Ferré, M. B., Novell, M. I., & Moreso, J. L. P. (2009). Estudios de cohorte. *Fisioterapia*, 31(5), 218-223. <https://doi.org/10.1016/j.ft.2009.03.001>
- Ganna, A., Reilly, M., Fairé, U. D., Pedersen, N., Magnusson, P. K. E., & Ingelsson, E. (2012). Risk prediction measures for Case-Cohort and nested Case-Control designs: an application to cardiovascular disease. *American Journal of Epidemiology*, 175(7), 715-724. <https://doi.org/10.1093/aje/kwr374>
- H, J. H. D. (2013). Tipos de diseños de los estudios clínicos y epidemiológicos (Types of clinical and epidemiologic study designs). *Avances en Biomedicina*. [https://www.researchgate.net/profile/Jose_Donis/publication/259874219_Avances_en_Biomedicina_Publicacin_Oficial_del_Instituto_de_Inmunologia_Clnica_Mrida-Venezuela_Volumen_2\(2\)_May-Ago_2013_p_XX-XX_Copyright__ULA_2013_Depsito_Legal_PPI201102ME3935_Tipos_de_diseos_de_los_estudios_clnicos_y_epidemiolgicos_\(Types_of_clinical_and_epidemiologic_study_designs\)/links/0c96052e5d480a25a2000000.pdf](https://www.researchgate.net/profile/Jose_Donis/publication/259874219_Avances_en_Biomedicina_Publicacin_Oficial_del_Instituto_de_Inmunologia_Clnica_Mrida-Venezuela_Volumen_2(2)_May-Ago_2013_p_XX-XX_Copyright__ULA_2013_Depsito_Legal_PPI201102ME3935_Tipos_de_diseos_de_los_estudios_clnicos_y_epidemiolgicos_(Types_of_clinical_and_epidemiologic_study_designs)/links/0c96052e5d480a25a2000000.pdf)
- Månsson, R., Joffe, M. M., Sun, W., & Hennessy, S. (2007). On the estimation and use of propensity scores in Case-Control and Case-Cohort studies. *American Journal of Epidemiology*, 166(3), 332-339. <https://doi.org/10.1093/aje/kwm069>
- Manterola, C., Quiroz, G., Salazar, P., & García, N. (2019). Metodología de los tipos y diseños de estudio más frecuentemente utilizados en investigación clínica. *Revista Médica Clínica Las Condes*, 30(1), 36-49. <https://doi.org/10.1016/j.rmclc.2018.11.005>
- Onland-Moret, N. C., Van Der A, D. L., Van Der Schouw, Y. T., Buschers, W., Elias, S. G., Van Gils, C. H., Koerselman, J., Roest, M., Grobbee, D. E., & Peeters, P. H. (2007). Analysis of case-cohort data: A comparison of different methods. *Journal of Clinical Epidemiology*, 60(4), 350-355. <https://doi.org/10.1016/j.jclinepi.2006.06.022>