An Overview of Epidemiologic Study Designs

Uma Visão Geral dos Desenhos de Estudos Epidemiológicos

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Abstract

This paper is the first one of a series on "study designs" in which a review of literature regarding epidemiologic study designs and their classification is presented. It is aimed at improving health professionals' understanding of the commonly used methods in epidemiologic research and their practical applications. There are several types of epidemiologic study designs, each with its own characteristics and particularities. The study design depends on the nature of the question and availability of resources.

Resumo

Este artigo é o primeiro de uma série sobre "desenhos de estudo" em que é apresentada uma revisão da literatura sobre os desenhos de estudos epidemiológicos e a sua classificação. Este artigo tem como objetivo melhorar a compreensão dos profissionais de saúde sobre os métodos mais usados em investigação epidemiológica e respetivas aplicações. Existem vários tipos de desenhos de estudos epidemiológicos, cada um com suas características e particularidades. O desenho do estudo depende da natureza da questão e da disponibilidade de recursos.

Keywords: Epidemiologic Studies; Research Design

Palavras-chave: Desenhos de Investigação; Estudos Epidemiológicos

Introduction

Epidemiology is the study of the distribution and determinants of disease frequency in human populations and the application of this study to control health problems.[1]

Epidemiologic studies are research investigations conducted to study the patterns, causes, and effects of health-related events in specific populations. These studies are crucial to understanding the distribution and determinants of diseases, identifying risk factors, and informing public health interventions. Epidemiologic studies provide valuable evidence to guide healthcare policies, disease prevention strategies, and the development of treatments.

Epidemiologic research comprehends several types of study designs, each one with its advantages and limitations. Each type of epidemiologic study design represents a different way of collecting information. The selection of one design over another

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is determined by the nature of question, the goal of research, the availability of resources, feasibility, concerns about validity and efficiency, and practical and ethical considerations. Multiple studies, including different study designs, are often conducted to build a comprehensive body of evidence in epidemiology.

For these reasons, it is important to understand the different types of study designs and their strengths and limitations.

Observational Versus Experimental Studies

In experimental studies or in intervention studies there is a deliberate intervention, planned by the researcher, to cause a certain effect while controlling other conditions.[2]

In a typical experiment involving human subjects, distinct groups are formed to receive different treatments or interventions. In a simple two-group experiment, one group is exposed to a specific treatment, while the other group serves as a control and does not receive the treatment. The aim is to compare the outcomes between the groups and assess the impact of the treatment or intervention. The treatment or intervention could take many forms, for example: administration of a drug or vaccine; performance of a diagnostic or therapeutic procedure; introduction of an educational tool, or others.[3] However, because experimental studies are often infeasible due to difficulties enrolling participants, high costs, hard ethical issues, most epidemiologic research is conducted using observational studies.[4]Observational studies involve the researcher documenting naturally occurring relationships between exposures and outcomes of interest; the researcher studies, observes and records the disease and its attributes and how it relates to other conditions/attributes without intervening. These studies do not involve any active intervention by the researcher on individuals. The exposures being studied have either occurred naturally or have been determined by external factors rather than by deliberate manipulation by the researcher.[5]

Descriptive Versus Analytical Studies

Descriptive studies aim to characterize the patterns and trends of a disease or health condition in a population. These studies focus on answering the "what, who, when, and where" questions regarding the disease. They help identify patterns, trends, and distribution of the disease in terms of person, place, and time. Descriptive studies involve collecting data on the affected population's demographic characteristics, such as age, gender, location, and the frequency of disease occurrence. However, they do not attempt to determine causal relationships or examine potential risk factors.

These studies provide a snapshot of the distribution of the disease and help identify populations at risk. Descriptive studies typically involve the following:

- Case reports and case series: these are individual or small group reports of specific cases or outbreaks, which provide initial information about the disease.

- Cross-sectional studies: in cross-sectional studies, data is collected at a single point in time to estimate the prevalence of a disease or health condition in a population. These studies are useful in order to identify the burden of disease and the potential risk factors (please note that cross-sectional surveys may be analytical studies as well).

Analytical studies focus on investigating the causes and risk factors associated with a particular disease. These studies aim to determine the relationship between exposures or interventions and the development of disease outcomes. Analytical studies involve comparing groups with and without the disease to assess the association between potential risk factors and the disease's occurrence. Analytical studies can be observational (if the exposure is naturally determined) or interventional (if the researcher actively administers the intervention).

Time Measurement

Regarding the type of measurement, we can distinguish studies between those that use cross-sectional measurements (for example: moments of time, cross-sectional studies) and those that make longitudinal measurements, data are collected in two or more distinct time periods (for example: cohort and case-control studies).

Prospective Versus Retrospective Study Designs

In prospective studies, the researcher starts by determining the exposure to a risk factor and then assesses whether the outcome (disease) occurs at a future time point, participants are followed up over a period of time to determine the occurrence of outcomes.

In retrospective studies, the researcher begins by determining whether the outcome (disease) is present and then traces the presence of prior exposure to a risk factor, data are collected either from records or by asking participants to recall exposures. There is no follow up of participants. Traditionally, prospective studies were associated with cohort studies[6] and retrospective studies with case-control studies. However, this association no longer makes any sense[3] since the terms prospective and retrospective should be used to refer to the time of occurrence of the outcome (disease) versus the measurement of exposure (cause) in the study. In this way, both case-control and cohort studies can be prospective or retrospective.[7]By definition, an experimental study has to be a prospective study since the

researcher determines the exposure for each study participant and then follows them to observe outcomes.[5]

Level of Observation: Individual Versus Population Group

Observational studies can be categorized into two types, based on the level of observation: studies that utilize individuals as observation measures, and those that observe groups of individuals. Within the former category, we find cross-sectional studies, case-control studies, and cohort studies. On the other hand, ecological studies fall under the latter category.[3]

A classical ecological study examines the rates of disease in relation to a factor described on a population level. This population-level factor can take the form of an aggregate measure that summarizes characteristics of the individuals within the population. For instance, it could be the proportion of individuals aged 65 years and above, or an environmental measure that describes the geographical location where the population lives or works, for example, or the level of air pollution in that area.[3,4]Ecological studies are widely used and quick to perform since, in most cases, the data are available in pre-existing databases such as vital statistics, population-based records, censuses, among others. As they do not require primary data collection, they are also inexpensive.[2]

Table 1 has the summary of the principal observational epidemiologic studies.

Table 1. Summary of the principal observational epidemiologic studies.

Level of observation	Type of observation	Study	Definition
Individual	Longitudinal	Cohort study	When a group of individuals, who share a common characteristic or exposure, is followed over a defined period to determine the occurrence of the outcome of interest.
		Case-control study	A study that compares two groups of people: those with the disease or condition under study (cases) and a very similar group of people who do not have the disease or condition (controls).
	Cross sectional	Cross sectional study	Measures the prevalence of health outcomes or determinants of health, or both, in a population at a point in time or over a short period.
Population group	Cross sectional or longitudinal	Ecological study	Examines the relationship between exposure variables and health outcomes at population level.

Conclusion

The various epidemiologic study designs have inherent strengths and limitations that health professionals must know to better choose the one that responds to its objective.

Different authors have put forward a useful three-point algorithm which can help determine the design of a research study from its methods section[8]:

1. Does the study describe the characteristics of a sample, or does it attempt to analyze (or draw inferences about) the relationship between two variables? – If no, then it is a descriptive study, and if yes, it is analytical.

2. If analytical, did the investigator determine the exposure? – If no, it is an observational study, and if yes, it is an experimental study.

3. If observational, when was the outcome determined? – at the start of the study (case–control study), at the end of a period of follow-up (cohort study), or simultaneously (cross sectional).

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