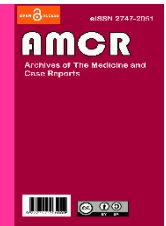




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## Cross-Sectional Study as Research Design in Medicine

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### ABSTRACT

A cross-sectional study is an observational study that analyzes data from a population at one point in time. These studies are often used to measure prevalence in medicine, analyze health studies, and describe health characteristics. Unlike other types of observations, in a cross-sectional study, each research subject was only observed once, the measurement of research variables was carried out at the time of the observation, and no follow-up was carried out on the measurements made. These studies are less expensive and easier to perform and help establish preliminary evidence in planning further studies in the future. This article reviews essential characteristics, describes strengths and weaknesses, discusses methodological issues, and provides design recommendations and statistical analysis for cross-sectional studies.

### 1. Introduction

In determining the research design, researchers should understand several essential things. Researchers must determine whether to intervene or will only make observations without intervention in the research to be carried out. Research that only makes observations without intervention is called an observational study. These observational studies are generally divided into three types: cross-sectional studies, case-control studies, and cohort studies.<sup>1</sup>

Observational research is the most frequently conducted research in the medical field. In this study, researchers only observed the phenomena studied systematically and then collected and compiled information, data, and sample materials such as biopsy tissue and blood for later data analysis. This study

aims to discuss a cross-sectional study which is part of an observational study.

#### Cross-sectional study

A cross-sectional study is a type of observational research design where the researcher observes and measures data variables at a certain time. Each research subject was only observed once, and the measurement of research variables was carried out at the time of the observation, and no follow-up was carried out on the measurements made. The purpose of this cross-sectional study is to obtain reliable data that can provide conclusions to prove the hypothesis through a study. This study can be descriptive or analytical, depending on the outcome assessment associated with exposure to risk factors or not.<sup>1-4</sup>



The characteristic of descriptive cross-sectional studies is the prevalence of one or more health outcomes in a population, so cross-sectional studies are often also referred to as prevalence studies because this study can determine the prevalence of disease in a population at one time.<sup>1,3</sup> In cross-sectional studies analytically, the researcher collects both risk factor data and outcome data at a particular time to compare the differences in outcomes between subjects exposed to risk factors and subjects not exposed to risk factors. Exposure to risk factors and outcomes are measured simultaneously; therefore, it is difficult to determine whether exposure to risk factors precedes or follows the results in this cross-sectional analysis study a disease that is chronic and is not suitable for assessing acute conditions.<sup>2,4</sup>

The advantage of conducting cross-sectional studies is that these studies tend to be faster and cheaper in

terms of financing. Research subjects also do not require intervention to get exposure or risk factors, so ethically, research is rarely found to be complicated. Meanwhile, the weakness of this cross-sectional study is that it cannot be used to assess the incidence or incidence of rare diseases and to assess causal factors, as well as the possibility of sample bias due to the need for a large enough sample.

In an analytical cross-sectional study, essential steps are needed to determine this design; the researcher must formulate research questions and appropriate hypotheses, identify independent and dependent variables, determine research subjects, take measurements, and conduct analysis.<sup>1</sup> Based on the formulation of research questions and hypotheses, the researcher can determine the variables to be assessed and determine the research sample.<sup>2</sup>

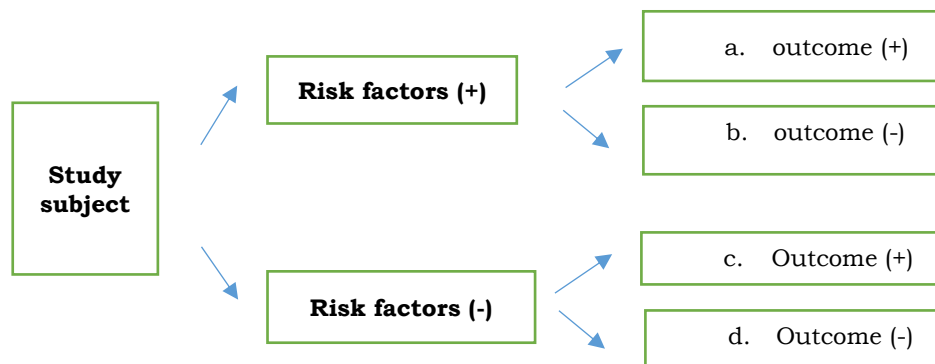


Figure 1. The flow of research is a cross-sectional study, assessing the role of risk factors and the occurrence of effects, both of which are examined simultaneously.

The sampling method is the process of selecting a particular subject from the study or a subset of the entire population that can represent the characteristics of that population. The sampling strategy is an essential component in cross-sectional studies due to the significant heterogeneity of the target population. There are two main categories for sampling methods: probability sampling methods, where the sample is selected using methods based on probability theory and non-probability sampling methods, where samples are selected based on subjective considerations. In general, the probability sampling method is preferred over the

non-probability one because the former is considered to be more accurate and thorough. However, there are circumstances in which it is impossible to conduct random sampling in applied clinical research, so non-probability sampling is an option.<sup>3</sup> When a researcher is going to make a comparison between two study prevalence rates, cross-sectional, the sample size formula used is the same as the formula used in the cohort study design.<sup>1,5</sup>

When planning a study with a cross-sectional design, a researcher must identify any bias. Bias is a systematic error in a study that can result in an



unexpected effect on the outcome. Bias can be grouped into two broad categories: selection bias and information bias.<sup>6-8</sup> Selection bias can occur when sample selection is strictly limited to specific groups, such as those with higher or lower disease susceptibility. This selection bias can also occur when groups with and without risk factors have different ways of predicting the effect. Nonresponse bias is a type of selection bias that is often found in cross-sectional studies using questionnaires due to differences in the characteristics of each sample group. In addition to nonresponse bias, Neyman bias, often referred to as prevalence-incidence bias, also often occurs in cross-sectional studies, which is caused by the selection of samples that are not representative of the population. Information bias occurs when the variable measured, aggregated, or interpreted is inaccurate. Because risk factors and outcomes are measured simultaneously, the subject's knowledge of risk factors and effects can affect the results, called recall bias.<sup>3</sup>

In addition to bias, there are also confounding factors in a cross-sectional study. The confounding factor should meet three conditions: the variable must be associated with the investigated exposure, the variable must be associated with the investigated outcome, and these variables are not in the causal path

between exposure and outcome. Confounding factors may result in a disruption of the relationship between exposure and outcome. Many statistical techniques can be applied to control for confounding factors. Among them are restrictions, stratification, and matching. For limitation, the researcher limited participation in this study to similar individuals associated with confounders. Stratification refers to studying the relationship between exposure and outcome in different strata of confounding variables. Matching is an adjustment of statistical techniques where two groups of subjects are made with the same value on the propensity score. Multivariate regression analysis is another way to control confounders by constructing a multivariate regression model for outcomes, exposures, and other confounding variables. Based on the regression equation, the effect of the variable of interest can be examined with the confounding variable that is considered statistically constant.<sup>3</sup>

After observing and assessing exposure to risk factors and outcomes, the data obtained must be analyzed. In this data analysis, the sample subjects were divided into four groups according to exposure to risk factors and their outcomes, as shown in the 2x2 contingency table below.

Table 1. Contingency table 2x2 cross-sectional.

Risk factors	Outcome		
	Yes	No	Total
Yes	A	B	a + b
No	C	D	c + d
Total	a + c	b + d	a + b + c + d

Information: a: subject with risk factor and positive outcome, b: subject with risk factor and negative outcome, c: subject without risk factor and positive outcome, d: subject without risk factor and negative outcome.<sup>1</sup>

The Chi-square method and Fisher's exact test can be used in cross-sectional analysis based on the difference between the expected and observed values in the study to determine statistical significance.<sup>2</sup> In a cross-sectional study, the estimated relative risk is

expressed by the prevalence ratio (RP), i.e., the ratio of between the number of subjects with disease (old and new) at one time with all existing subjects as in table 1 above with the following formulation;



$$RP = a / (a+b) : c / (c+d)$$

$a/(a+b)$  = proportion/prevalence of subject with risk factors and positive outcome;

$c/(c+d)$  = proportion/prevalence of subject without risk factors and positive outcome.

The desired confidence interval must always accompany the prevalence ratio. The confidence interval shows the range of prevalence ratios obtained in the reachable population when sampling is repeated in the same way. If the prevalence ratio is equal to one, the variable suspected as a risk factor does not affect the occurrence of the effector is neutral. If the prevalence ratio is more significant than one and the confidence interval range does not include the number one, the variable is a risk factor for the emergence of an effect. If the value of the prevalence ratio is less than one and the range of confidence intervals does not include the number one, it means that the variable is a protective factor, not a risk factor for the occurrence of effects. If the confidence interval value of the prevalence ratio includes the number one, then from the existing data, it cannot be concluded that the assessed risk factor is indeed a risk factor or protective factor.

The cross-sectional design can also be used for multivariate analysis, such as logistic regression, which simultaneously calculates the OR of several risk factors and their statistical significance and sorts by the effect of risk factors on the analyzed results. If the independent and dependent variables are quantitative (numeric) variables, then to analyze their relationship can be through a comparison of means or median using parametric statistical tests (Student's T, Fisher's Exact) or non-parametric (Mann-Whitney). Under these conditions, it is also possible to calculate correlation coefficients (Pearson or Spearman), linear regression models, and even to evaluate sensitivity, specificity, and predictive value (+ or -) using ROC Curves (receiver operating characteristics curves).<sup>2</sup>

## 2. Conclusion

Cross-sectional studies have great utility in descriptive and analytic studies.

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