

**MODULE 4**

**A BRIEF OVERVIEW OF COMMON  
RESEARCH DESIGNS**

Department of Pediatrics & Preventive Dentistry

College of Dental Sciences & Research Centre,

Gujarat University, Ahmedabad



## IN THIS MODULE

- What is Epidemiology?
- Descriptive Studies
- Analytical Studies
- Qualitative vs Quantitative Research – Illustrative Guide

**How to cite this document:** A Brief Overview of Common Research Designs.

Department of Pediatrics & Preventive Dentistry, College of Dental Sciences & Research Centre; 2023.

## WHAT IS EPIDEMIOLOGY?

By definition, Epidemiology is the study (scientific, systematic, and data-driven) of the distribution (frequency, pattern) and determinants (causes, risk factors) of health-related states and events (not just diseases) in specified populations (neighbourhood, school, city, state, country, global). It is also the application of this study to the control of health problems.<sup>1</sup>

Epidemiology is the branch of science that deals with the incidence, distribution and control of disease in a population. However, in order to do so, researchers need to plan their studies by which they can define accurately which aspect of the disease are they focusing on. Depending on their research interest, epidemiological studies are broadly classified as Descriptive Studies and Analytical Studies.

## DESCRIPTIVE STUDIES

If the researcher simply wants to understand the “who” (population affected), “where” (geographical area in question) and “when” (time) in relation to “what” (the condition or disease), then the study is called a descriptive study. These types of studies focus on frequencies and distribution but cannot draw any concrete conclusions. They are good for generating a hypothesis and detailing a condition without any comparisons. These studies are called Descriptive studies. Examples of Descriptive Studies include: Surveys, Case reports, Case Series.

These studies are carried out in a small sample size and the findings obtained from these research designs cannot be generalized for the rest of the population. This is a primary reason why surveys, case reports and case series are rated lower in the evidence pyramid. However, an advantage of these studies is that it helps in understanding the basic premise of a given condition.

## ANALYTICAL STUDIES <sup>2</sup>

As the name suggests, study designs in this category are driven by analysis. They are further divided into two subgroups: Observational and Experimental.

### *Observational Study Designs*

Observational study designs are often referred to as the heart of epidemiological designs since they help in answering the etiology, diagnosis and prognosis of a condition. However, since it is difficult to control the bias in these research designs, they are not considered in the top echelons of the evidence pyramid. Unless and until the chosen study designs are critically appraised, observational study designs fail to deliver quality assessment of data. The common types of observational study designs are listed below.

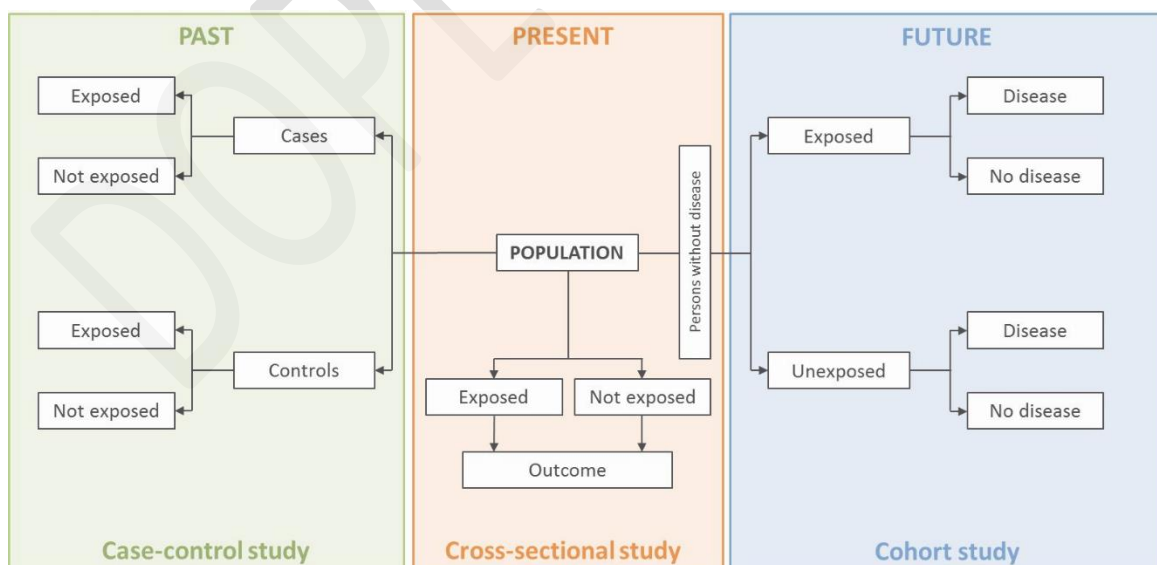


Figure 1 Source: stats4drs.com

## **Cohort study**

Cohort studies are employed to understand whether a causative factor is responsible for an eventual condition that is observed prospectively. These are longitudinal studies that can take weeks, months or even years to finish. They are easy to conduct but can have high drop-out rates.

### *Example*

Population: Pregnant Mothers

Cohorts or Groups: Mothers who took xylitol during third trimester and mother who did not take xylitol during third trimester

Effect to be observed: Incidence of Maternally Derived Streptococcus Mutans Disease (MDSMD) in off-springs in both groups.

An exceptional variation in this study design is when a cohort study has only one group. This is called an *inception cohort*.

## **Case-Control Study**

In this study design there are two groups. One group is called the “Case” group where people with a particular condition are added. The other is called a “Control” group where people without any condition are compared. A disadvantage of this study is that it is vulnerable to recall bias, meaning, the participants fail to give an accurate history thereby contributing to misleading derivations.

### *Example*

Case group: Teenagers with ectopic eruption of mandibular first premolars

Subgroups within the case group: Teenagers with a history of receiving space maintainers and teenagers without a history of receiving space maintainers

Control group: Teenagers without ectopic eruption of mandibular first premolars

Subgroups within the case group: Teenagers with a history of receiving space maintainers and teenagers without a history of receiving space maintainers

## **Cross-Sectional Study**

Cross-sectional studies can help in establishing a possible (not definite) causative relation between an effect and a condition. A cross-section of a population can be surveyed or interviewed in order to understand the impact of a causal factor on a condition. For example, a cross-section of mothers of children with cleft palate can be interviewed about their drug history during pregnancy.

## **EXPERIMENTAL STUDY DESIGNS**

Study designs of this group comprise the highest level in the evidence pyramid. The four commonly used experimental study designs are discussed below.

### **Large Randomized Control Trials**

This research design is the gold standard of experimental research design where participants are screened, randomly assigned, blinded to the intervention and researcher and are evaluated by different researchers before and after the intervention.

#### *Example*

Group I (control): Conventional Syringe used for palatal nerve block in children

Group II (experimental): Insulin Syringe used for palatal nerve block in children

To analyze: Pain perception and anxiety level in both groups using standardized scales

Elimination of bias: Pre-intervention and post-intervention evaluation done by independent researchers blinded to participants' group allocation.

### **Small Randomized Control Trials with Uncertain Results**

The study design employed here is a RCT design. However, the total sample size is very less and thus results cannot be generalized based on trends even if statistical significance is inferred.

### **Split-Mouth Designs**

This is one of the most commonly used designs in dentistry where the same participant is given two different interventions by two different researchers. The pre-intervention and post-intervention evaluations are made by two different researchers.

#### *Example*

Group I: Composite build-up done in MIH affected teeth in upper left back tooth region with 37% phosphoric acid as the etchant

Group II: Composite build-up done in MIH affected teeth in upper right back tooth region with 5% sodium hypochlorite as the etchant

Evaluations: Two different evaluators evaluate the restorations clinically by Ryge's criteria

### **Nonrandomized Trials with Contemporary Controls (Quasi-Experimental Designs)**

These trials lack randomization and hence lack a true comparator group. They are uncontrolled trials whose results are not recommended for guiding clinical practice. In this study design, there will be two groups, one receiving the intervention and one not receiving the intervention. However, participants are not blinded and randomization does not occur, making it a weak study design.

### **Nonrandomized Trials with Historical Controls**

This study design has an experimental group consisting of participants who are not blinded to the intervention. The observations of the intervention in this group are compared with a control group from a previous study.

### **High-quality Systematic Reviews with Meta-Analysis**

This research design is the apex of evidence pyramid as it takes into account all previous studies done on a specific topic. The best appraised studies are then chosen and sent for a statistical analysis called meta-analysis (can be qualitative or quantitative). Fig 2 and Fig 3 show how systematic reviews differ from other types of reviews.<sup>3</sup>

Label	Description	Methods used (SALSA)			
		Search	Appraisal	Synthesis	Analysis
Critical review	Aims to demonstrate writer has extensively researched literature and critically evaluated its quality. Goes beyond mere description to include degree of analysis and conceptual innovation. Typically results in hypothesis or model	Seeks to identify most significant items in the field	No formal quality assessment. Attempts to evaluate according to contribution	Typically narrative, perhaps conceptual or chronological	Significant component: seeks to identify conceptual contribution to embody existing or derive new theory
Literature review	Generic term: published materials that provide examination of recent or current literature. Can cover wide range of subjects at various levels of completeness and comprehensiveness. May include research findings	May or may not include comprehensive searching	May or may not include quality assessment	Typically narrative	Analysis may be chronological, conceptual, thematic, etc.
Mapping review/ systematic map	Map out and categorize existing literature from which to commission further reviews and/or primary research by identifying gaps in research literature	Completeness of searching determined by time/scope constraints	No formal quality assessment	May be graphical and tabular	Characterizes quantity and quality of literature, perhaps by study design and other key features. May identify need for primary or secondary research
Meta-analysis	Technique that statistically combines the results of quantitative studies to provide a more precise effect of the results	Aims for exhaustive, comprehensive searching. May use funnel plot to assess completeness	Quality assessment may determine inclusion/exclusion and/or sensitivity analyses	Graphical and tabular with narrative commentary	Numerical analysis of measures of effect assuming absence of heterogeneity
Mixed studies review/mixed methods review	Refers to any combination of methods where one significant component is a literature review (usually systematic). Within a review context it refers to a combination of review approaches for example combining quantitative with qualitative research or outcome with process studies	Requires either very sensitive search to retrieve all studies or separately conceived quantitative and qualitative strategies	Requires either a generic appraisal instrument or separate appraisal processes with corresponding checklists	Typically both components will be presented as narrative and in tables. May also employ graphical means of integrating quantitative and qualitative studies	Analysis may characterise both literatures and look for correlations between characteristics or use gap analysis to identify aspects absent in one literature but missing in the other
Overview	Generic term: summary of the [medical] literature that attempts to survey the literature and describe its characteristics	May or may not include comprehensive searching (depends whether systematic overview or not)	May or may not include quality assessment (depends whether systematic overview or not)	Synthesis depends on whether systematic or not. Typically narrative but may include tabular features	Analysis may be chronological, conceptual, thematic, etc.
Qualitative systematic review/qualitative evidence synthesis	Method for integrating or comparing the findings from qualitative studies. It looks for 'themes' or 'constructs' that lie in or across individual qualitative studies	May employ selective or purposive sampling	Quality assessment typically used to mediate messages not for inclusion/exclusion	Qualitative, narrative synthesis	Thematic analysis, may include conceptual models

Figure 2 Health Information and Libraries Journal (2009)

Label	Description	Methods used (SALSA)			
		Search	Appraisal	Synthesis	Analysis
Rapid review	Assessment of what is already known about a policy or practice issue, by using systematic review methods to search and critically appraise existing research	Completeness of searching determined by time constraints	Time-limited formal quality assessment	Typically narrative and tabular	Quantities of literature and overall quality/direction of effect of literature
Scoping review	Preliminary assessment of potential size and scope of available research literature. Aims to identify nature and extent of research evidence (usually including ongoing research)	Completeness of searching determined by time/scope constraints. May include research in progress	No formal quality assessment	Typically tabular with some narrative commentary	Characterizes quantity and quality of literature, perhaps by study design and other key features. Attempts to specify a viable review
State-of-the-art review	Tend to address more current matters in contrast to other combined retrospective and current approaches. May offer new perspectives on issue or point out area for further research	Aims for comprehensive searching of current literature	No formal quality assessment	Typically narrative, may have tabular accompaniment	Current state of knowledge and priorities for future investigation and research
Systematic review	Seeks to systematically search for, appraise and synthesis research evidence, often adhering to guidelines on the conduct of a review	Aims for exhaustive, comprehensive searching	Quality assessment may determine inclusion/exclusion	Typically narrative with tabular accompaniment	What is known; recommendations for practice. What remains unknown; uncertainty around findings, recommendations for future research
Systematic search and review	Combines strengths of critical review with a comprehensive search process. Typically addresses broad questions to produce 'best evidence synthesis'	Aims for exhaustive, comprehensive searching	May or may not include quality assessment	Minimal narrative, tabular summary of studies	What is known; recommendations for practice. Limitations
Systematized review	Attempt to include elements of systematic review process while stopping short of systematic review. Typically conducted as postgraduate student assignment	May or may not include comprehensive searching	May or may not include quality assessment	Typically narrative with tabular accompaniment	What is known; uncertainty around findings; limitations of methodology
Umbrella review	Specifically refers to review compiling evidence from multiple reviews into one accessible and usable document. Focuses on broad condition or problem for which there are competing interventions and highlights reviews that address these interventions and their results	Identification of component reviews, but no search for primary studies	Quality assessment of studies within component reviews and/or of reviews themselves	Graphical and tabular with narrative commentary	What is known; recommendations for practice. What remains unknown; recommendations for future research

Figure 3 Health Information and Libraries Journal (2009)

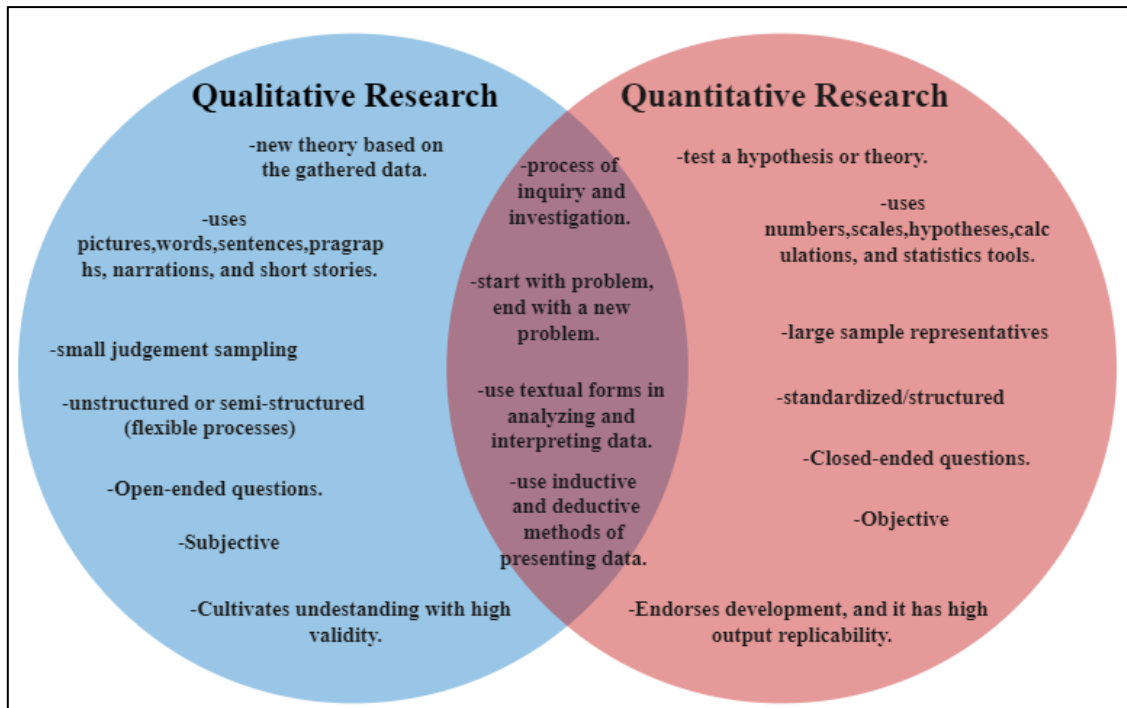


Figure 4 Source: EDrawMax

Fig. 1 Quantitative study design stages

- Clarify aims (based on the research question) and formulate objectives
- State hypothesis (null hypothesis for comparative studies)
- Decide type of study eg cross-sectional survey, randomised controlled trial
- Give details of study intervention eg treatment, investigation, interview
- What are the dependent/independent/confounding variables?
- What is the study population from which samples will be drawn eg patients from your practice or other dental practices?
- Decide sampling methods and inclusion/exclusion criteria
- Decide sample size and justify it with a power calculation
- In a comparative study, how many groups will be studied, is a control group required and how will you allocate participants to each group?
- How will participants be recruited to the study?
- Will the participants/investigators be 'blind'?
- Choose appropriate instruments to measure outcomes
- Decide end-points for clinical trials
- Plan procedures eg order, site, timing, frequency, information given, equipment used, storage of samples etc.
- Consider how to reduce bias
- Consider how to reduce hazards and risks and deal with potential problems
- Plan method of data entry and the data analysis package to be used
- Plan analysis of the data, statistical tests to be used, level of significance etc

Figure 5 Source: British Dental Journal (2004)



<i>Point of comparison</i>	<i>Qualitative research</i>	<i>Quantitative research</i>
Focus of research	Quality (nature, essence)	Quantity (how many, how much)
Philosophical roots	Phenomenology, symbolic, interaction	Empiricism, logical positivism
Associated phrases	Fieldwork, ethnographic, naturalistic, grounded, subjective	Experimental, empirical, statistical
Goal of investigation	Understanding, description, discovery, hypothesis generating	Prediction, control, confirmation, hypothesis testing
Design characteristics	Flexible, evolving, emergent	Pre-determined structure
Setting	Natural, familiar	Unfamiliar, artificial
Sample	Small, non random, theoretical	Large, random, representative
Data collection	Researcher as primary instrument, interviews, observations	Inanimate instruments (scales, tests, surveys, questionnaires, computers)
Mode of analysis	Inductive (by researcher)	Deductive (by statistical methods)
Findings	Comprehensive, holistic, expansive	Precise, narrow, reductionistic

Adapted from Merriam, 1989; Yin, 1995.

## REFERENCES

1. Principles of Epidemiology in Public Health Practice: An introduction to applied epidemiology and biostatistics. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (CDC), Office of Workforce and Career Development; 2012.
2. Sutherland SE. Evidence-based dentistry: Part IV. Research design and levels of evidence. J Can Dent Assoc. 2001;67(7):375-378.
3. Grant MJ, Booth A. A typology of reviews: An analysis of 14 review types and associated methodologies. Health Info Libr J. 2009;26(2):91-108. doi:10.1111/j.1471-1842.2009.00848.x