Episode 73 – Interpreting Research November 25, 2022

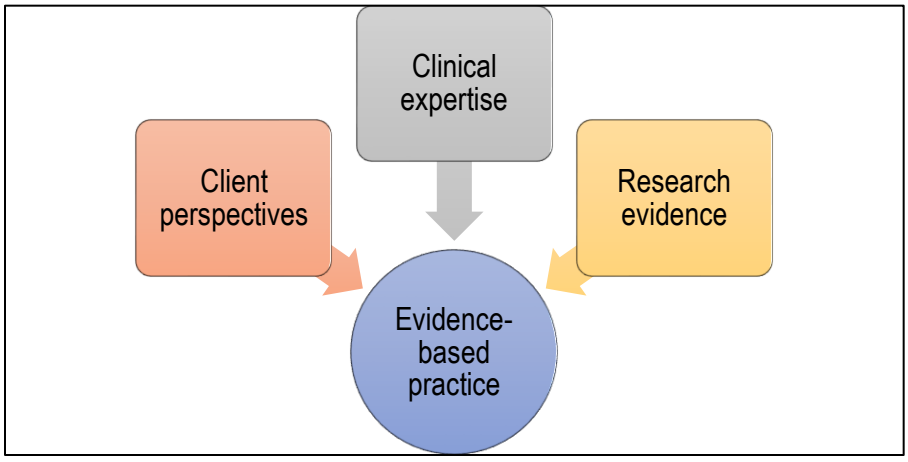
Introduction

Evidence-based practice (EBP) is the integration of:

- Clinical expertise: Practitioner's knowledge, judgment, and critical reasoning acquired through education, clinical skills, and professional experience.
- Research evidence: Best available information gathered from clinically relevant scientific literature conducted using sound methodology. Critical appraisal of the literature is a vital skill for evidence-informed (evidence-based) decision making.
- Client perspectives: Unique set of personal and cultural circumstances, values, priorities, needs, preferences, and expectations identified by the client and their caregivers/guardians. [1] [2]

When all three components of EBP are considered together, oral healthcare practitioners can make evidence-informed decisions, and provide high-quality services reflecting client interests, values, needs, and choices. [2] [3]

Evidence-based practice [2] [3]

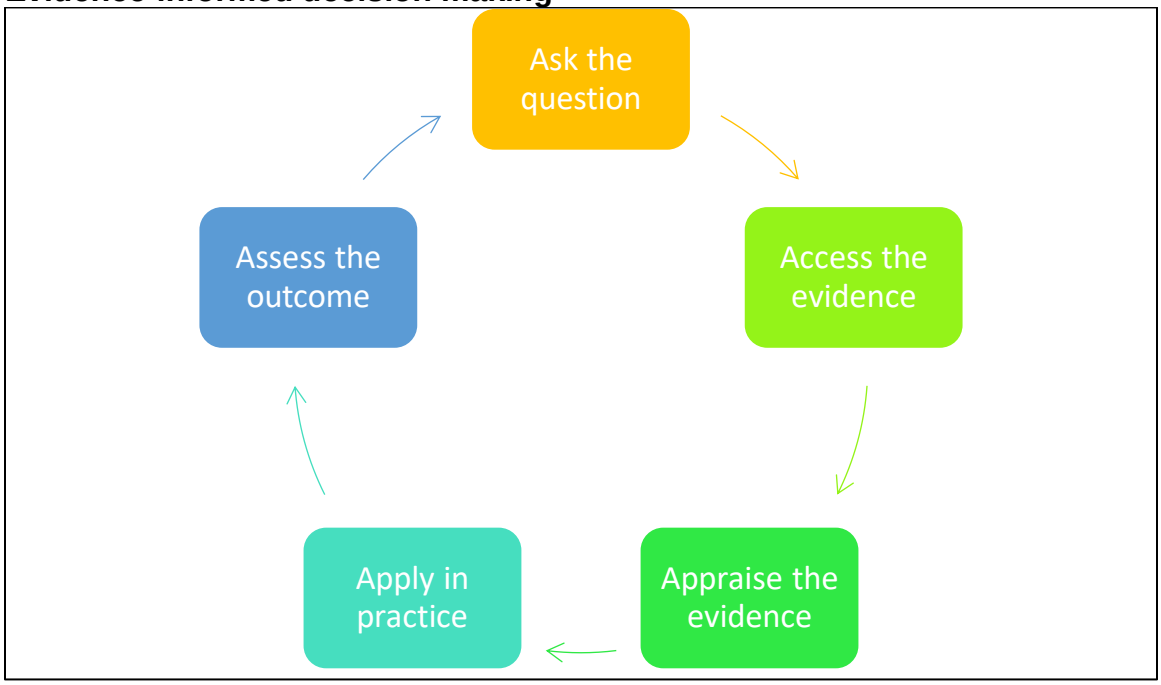


Evidence-informed decision making consists of the following steps:

1. Asking: Translating an issue or problem into a well-structured searchable clinical question (e.g., using the PICOS framework of Population / Patient / Problem [P], Intervention [I], Comparison [C], Outcome(s) [O], and type of Studies [S]).

2. Accessing: Systematically searching for best available evidence to answer the clinical question (e.g., peer-reviewed journals).[1]
3. Appraising: Critically appraising the evidence for its reliability, validity, usefulness (i.e., clinical applicability), strengths, and weaknesses.
4. Applying: Implementing the results of the evidence into clinical practice, while also taking into account one's own clinical expertise and client preferences.
5. Assessing: Evaluating the outcome. [2] [4] [5]

Evidence-informed decision making



PICOS framework [6]

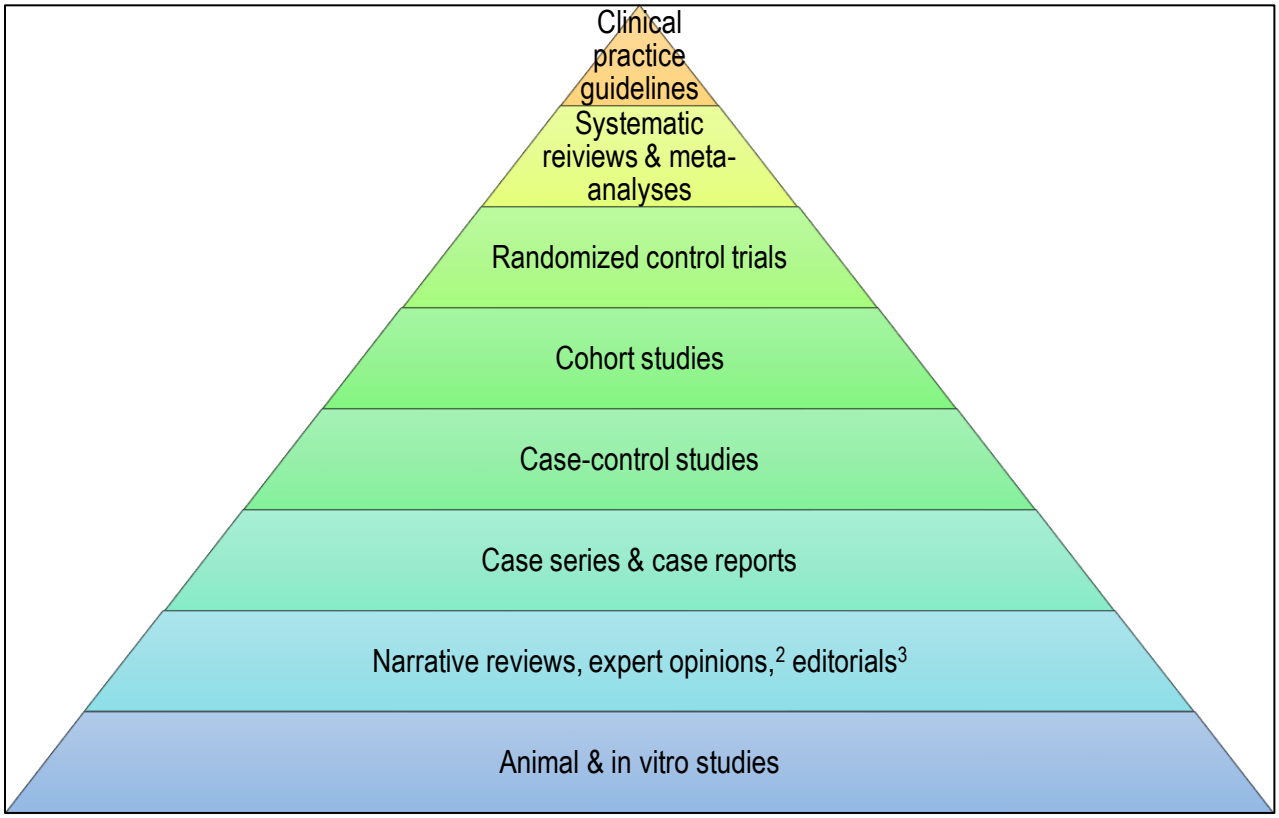
P	• **P**opulation/patient/problem being studied
I	• **I**ntervention, exposure, risk, or prognostic factor of interest
C	• **C**omparison or control group
O	• **O**utcome being evaluated to measure effectiveness of intervention
S	• **S**tudy type that would provide best answer to the clinical question

[1] Peer review is designed to assess the validity, quality, and often the originality of articles for publication. Its purpose is to maintain the integrity of science by filtering out invalid or poor-quality articles. [52]

Types of evidence

- Systematically searching for best available evidence to answer a clinical question is essential. One method to find the best available research evidence is the evidence hierarchy or evidence pyramid. [3]
- Evidence pyramid visually depicts the evidential strength of various study designs. Studies with the highest internal validity, characterized by a high degree of quantitative analysis, review, and stringent scientific methodology, are at the top of the pyramid. Observational research, expert opinions, in vitro studies, etc. reside lower in the pyramid. [1] [5] [7]

Evidence pyramid [1] [5] [7]



Quality of evidence increases from bottom to top of pyramid.

[2] Expert opinions are scientific views or comments by a group of designated experts based on a review of scientific evidence and/or expert opinion. [53]

[3] Editorials are statements of the opinions, beliefs, and policy of the editor or publisher of a journal, usually on current matters of health or scientific significance to the healthcare community or the public. Editorials published by editors of journals officially representing a society or organization (e.g., *Journal of Periodontology* is the official journal of the American Academy of Periodontology) are generally substantive. [8]

Types of study designs

Study design	Description
Clinical practice guideline	A statement produced by a panel of experts outlining current best practices to inform healthcare professionals and clients in making clinical decisions about screening, prevention, diagnosis, prognosis, or treatment of a specific health condition. The statement is produced after extensive review of the literature and is typically created by professional associations, government agencies, and/or public or private organizations. Practice guidelines should be reviewed frequently and updated as necessary for continued accuracy and relevancy. [8] [9] [10] For example, the American Heart Association guideline for the prevention of infective endocarditis (approved in 2007 & updated with a scientific statement in 2021) supports premedication for a relatively small subset of individuals.[4] This is based on a review of scientific evidence, which showed risk of adverse reactions to antibiotics generally outweigh benefits of prophylaxis for many individuals who would have been considered eligible for prophylaxis in previous guideline versions. Concern about drug-resistant bacteria development was a factor. [11] [12] [13]
Systematic review[5]	Summary of literature using explicit and reproducible methods to systematically search, critically appraise, and synthesize on a specific topic. The review synthesizes results of multiple related primary studies using strategies that reduce biases and random errors. Systematic reviews may or may not include a meta-analysis depending on whether the studies are similar enough so that combining their results is meaningful. Systematic reviews can also demonstrate where knowledge is lacking to guide future research. [6] [14] [15] [16]
Cochrane review	A systematic review of research in healthcare and health policy that is published in the *Cochrane Database of Systematic Reviews*. Cochrane reviews base their findings on results of studies that meet certain quality criteria, since the most reliable studies provide the best evidence for making healthcare decisions. Cochrane review authors apply methods which reduce the impact of bias across different parts of the review process. Cochrane reviews are considered the gold standard. [15]
Meta-analysis[5]	Statistical technique to combine results of multiple studies producing a single summary result based on the pooled data. Often used in systematic reviews. Not every systematic review contains a meta-analysis. Meta-analysis might not be appropriate if the designs of the studies are too different, if the outcomes measured are not sufficiently similar, or if there are concerns about the quality of the studies, for an average result across the studies to be meaningful. Results of a meta-analysis are frequently displayed in a graph called a forest plot. [6] [14] [15] [17]
Randomized controlled trial (RCT)	A prospective study in which similar participants are randomly assigned to an experimental group to receive an intervention (e.g., specific drug, treatment) or not (i.e., comparison or control group). Groups are followed to assess the effectiveness of the experimental intervention.

[4] Refer to Episode 23 for additional information on antibiotic prophylaxis.
[5] In Episode 70 on oral piercing, a systematic review and meta-analyses by Passos et al. (2022) was discussed. This systematic review included 54 studies, 15 of which achieved good methodological quality. The meta-analyses showed 33% of participants with piercings had gingival recession.

Study design	Description
	RCTs are the most robust and rigorous study design available since they are better at establishing a cause-and-effect relationship between the intervention and the outcome compared to other study types. Thus, results of RCTs are likely to be closer to the true effect than results of other study types. This method (rather than observational studies) is used to reduce bias. [1] [6] [16] [17]
Clinical trial	A clinical study that examines and assesses whether a new treatment is safe and effective. Clinical trials are often done in four phases. Some trials combine phases. Phase 1: A new treatment (e.g., drug, vaccine) is tested on a small group of participants (usually <50) for the first time to evaluate its safety, best dose, or schedule, and identify side effects. Phase 2: If phase 1 is successful, treatment is administered to a larger group of participants (usually ≥100) to determine effectiveness, safety, optimal dose, and monitor side effects on a wider range of participants. Typically includes participants who have the condition being targeted. Phase 3: If phase 2 results are encouraging, treatment is administered to larger groups of participants from different countries (usually ≥1,000) to confirm safety and effectiveness, monitor side effects, and compare with standard or equivalent treatments. Phase 4: Takes place after the treatment is approved and, on the market, to evaluate longer-term effects or compare effectiveness and safety with established treatments. Phase 4 typically involves several hundreds to several thousands of participants. [6] [16] [18] [19]
Crossover study	A clinical trial in which all participants receive the same two or more treatments but at different times. For example, one group is randomly assigned to receive drug A followed by drug B. The other group receives drug B followed by drug A. There is usually a rest period between treatments. [20]
Cohort study[6]	A longitudinal observational study with two or more groups (cohorts) of participants with similar characteristics. At least one group has been exposed to a risk factor, intervention, or treatment and one has not. The study follows their progress over time (prospective) and records results. [6] [16] [17]
Case-control study	An observational study to find out possible cause(s) of a disease or condition by comparing a group of participants who have the disease/condition (cases) with a group of participants without (controls) but who are otherwise similar in characteristics thought to be unrelated to causes of the disease/condition. Case-control studies are a type of retrospective, observational study, and typically generate odds ratios. [6] [16] [17]
Case series	A group or series of case reports involving participants who received similar treatment. Case series usually contain detailed information about each case, such

[6] Refer to Episodes 64 & 69 for discussion on the prospective cohort study "COVID-19 incidence and vaccination rates among Canadian dental hygienists." This study is published and the hyperlink to this study is posted with those Episodes.
Refer to Episode 68 for discussion on a prospective cohort study by Dr. Glogauer and colleagues on the effect of radiation therapy on oral innate immune response & oral microbiome.

Study design	Description
	as demographic information (e.g., age, gender, ethnic origin) and information on diagnosis, treatment, treatment response, and follow-up after treatment. There is no comparison (control) group. [6] [21]
Case report (study)[7]	A detailed report of the diagnosis, treatment, treatment response, and follow-up after treatment of a single person (case). A single case can also be a group, town, population, event, etc. Case reports contain some demographic information about the person (e.g., age, gender, ethnic origin). A type of observational study. [16] [22]
Cross-sectional study (survey)	An observation of a group of participants or interventions, at one specific point in time. This type of study contrasts with a longitudinal study, which follows a set of participants over a period of time. [6] [16]
Longitudinal study	A study of a group of participants over a period of time. This contrasts with a cross-sectional study, which observes a group of participants at a point in time. [6] [16]
Observational study	A retrospective or prospective study in which the investigator observes the natural course of events with or without control groups (e.g., cohort studies, case-control studies). No attempt is made to affect the outcome (e.g., no treatment/intervention is given). There is a greater risk of bias in observational studies than in experimental studies. [6] [16] [23]
Pilot study	A small-scale 'test' of a particular approach or treatment. For example, a new survey could be piloted with a few people to determine any areas of concern before the full-scale study begins. [6]
Prospective study	A study in which the health or other characteristics of participants are monitored (or followed up) for a period of time, with events recorded as they happen. This contrasts with retrospective studies. [6] [16]
Retrospective study	A study that focuses on the past and present. The study examines past exposure to suspected risk factors for the disease or condition (e.g., looking for possible causes for a current disease by examining the study population's past habits). Unlike prospective studies, it does not cover events that occur after the study group is selected (i.e., does not follow the group forward in time). [6] [16]
Quantitative study	Research that gathers numerical data or data that can be converted into numbers, which can be ranked, measured, or categorized through statistical analysis. This type of research is useful for finding out how many, how much, how often, or to what extent. (e.g., census studies that count people, households, etc.). [6]
Qualitative study	Research that gathers and analyzes nonnumerical data, such as people's beliefs, experiences, attitudes, behaviour, and interactions (e.g., why people want to stop smoking, rather than how many have stopped). Enables investigators to better understand complex concepts, social interactions, or cultural phenomena. [6]
Mixed methods study	Research that gathers and analyzes both quantitative and qualitative data within the same study. [24]
Quasi-experimental study	A research design differing from experimental studies in that participants are not randomly assigned to groups, but the investigator still controls the intervention(s) (e.g., test or treatment) received by at least one of the groups. This means conclusions cannot be drawn about cause and effect. This design is frequently used when it is not feasible or ethical to conduct a randomized controlled trial. [17]

[7] Refer to the additional resources in the Keynotes from Episode 30 on pemphigus for examples of case reports.

Study design	Description
Umbrella review	A review of existing systematic reviews. It compiles all the evidence from existing reviews on a topic to give a high-level overview. Also called overviews of reviews, reviews of reviews, summary of systematic reviews, or synthesis of reviews. [25]
Literature review	A comprehensive summary of previous research on a topic. Literature reviews survey scholarly articles, books, and other sources relevant to a particular area of research. [26]
Scoping review	An exploratory research project that systematically maps the literature on a topic by identifying key concepts, theories, and sources of evidence that inform practice in the field. Also known as a mapping review. [27]
Rapid review	A form of evidence synthesis in which parts of the systematic review are simplified or taken out to provide information to reach conclusions in a timely manner. [16]
Narrative review	Evidence overview or expert commentary on a given topic. Unlike systematic reviews, narrative reviews are not designed to be reproducible as their methodology (e.g., search strategy, inclusion criteria) is usually not described making them vulnerable to bias. [17]
Single-centre study	A study conducted at a single site (e.g., hospital, clinic) and in accordance with a single protocol or set of parameters. [16]
Multicentre study	A study in which participants selected to take part come from different locations or populations (e.g., different hospitals or countries). [6]
Experimental study	A study in which participants are sorted into two or more groups. At least one group is the control group. All groups are then followed up under carefully controlled conditions to investigate whether or not a test or treatment affects the course or outcome of a condition or disease. Controlled clinical trials and randomized controlled trials are examples of experimental studies. [6]
Single-blind study	A study in which participants do not know which study group they are in (e.g., experimental/intervention or placebo/control group). [6]
Double-blind study	A study in which participants and investigators/clinicians do not know which study group participants are in (e.g., experimental/intervention or placebo/control group). [6]
Triple-blind study	A study in which participants, clinicians, and outcome assessors (i.e., those conducting the statistical analysis, such as statisticians) do not know which study group participants are in. [6]
Quadruple-blind study	A study in which all participants, clinicians, investigators, and outcomes assessors are unaware which study group participants are in. [28]
Primary research	A study in which data is gathered directly from participants or a population (e.g., experimental and observational studies, clinical trials, and surveys). [4]
Secondary research	A study in which data already collected through primary research is analyzed (e.g., systematic reviews, meta-analysis, evidence-based practice guidelines, and consensus reports). [4]
Animal study[8]	A laboratory experiment using animals to study the development and progression of diseases. Animal studies also test how safe and effective new treatments are before they are tested in humans. [29]

[8] Refer to Episode 6 for discussion on the animal study on how periodontal inflammation primes the systemic innate immune response.

Study design	Description
In vitro study[9]	Research performed in the laboratory (outside the body) as compared to in vivo (in the body). [30]

Determining study design
Different types of research studies are better suited to answer different categories of clinical questions. However, it is not always possible to find a systematic review or meta-analysis to answer a question. In this situation, it is necessary to work down the evidence pyramid to the next highest level of evidence.

Clinical questions can be divided into seven types: therapy, diagnosis, prognosis, harm or etiology, prevention, cost, and quality of life. The type of study design depends on the type of question. [4]

Study design according to question type [4] [31]

Type of question	Question	Study design
Therapy	Which treatment does more harm than good?	RCT → cohort study → case control → case series
Diagnosis	Which diagnostic test should be used?	Prospective, blind comparison to a gold standard (i.e., a controlled trial that looks at participants with varying degrees of an illness and administers both diagnostic tests [the test under investigation and the "gold standard" test] to all participants in the study group)
Prognosis	What is the client's likely clinical course over time?	Cohort study → case control → case series
Etiology / harm	What are the causes of this disease or condition?	RCT → cohort study→ case control → case series
Prevention	How to reduce the chance of a disease by identifying and modifying risk factors?	RCT → cohort study → case control → case series
Cost	Is one intervention more cost-effective than another?	Economic analysis
Quality of life	What will be the client's quality of life following an intervention?	Qualitative study

Example using the PICOS framework:
P: Who is the population/patient/problem?
--- *Children on bottle feeding*
I: What is the intervention/exposure/risk/prognostic factor of interest?
--- *Bottle feeding at night*
C: Is there a comparison or control group?
--- *No bottle feeding at night, water consumption only*

[9] Refer to Episode 72 for discussion on the *in vitro* study on how metronidazole enhances oral innate immunity.

O: What is the outcome(s) of interest?
--- *Incidence of caries*

From this example, the PICO clinical question is: *Does bottle feeding at night cause caries in children?* The best type of study to find the answer to this clinical question would be found in randomized control trials, followed by cohort studies, case-control, and case series studies. [32]

Searching for research evidence

Source	Example*	Hyperlink
Online databases	Cochrane Library	https://www.cochranelibrary.com/
	Cochrane Oral Health	https://oralhealth.cochrane.org/oral-health-evidence
	Health Evidence	https://www.healthevidence.org/
	National Collaborating Centre	https://www.nccmt.ca/
	National Library of Medicine	https://www.nlm.nih.gov/
	PubMed	https://pubmed.ncbi.nlm.nih.gov/
Evidence-based journals	*Journal of Evidence-Based Dental Practice*	https://www.sciencedirect.com/journal/journal-of-evidence-based-dental-practice
	Evidence-Based Dentistry	https://www.nature.com/ebd/
Professional journals	*British Dental Journal*	https://www.nature.com/bdj/
	Canadian Journal of Dental Hygiene	https://www.cjdh.ca/
	Caries Research	https://www.karger.com/journal/home/224219
	Community Dentistry and Oral Epidemiology	https://onlinelibrary.wiley.com/journal/16000528
	International Journal of Dental Hygiene	https://onlinelibrary.wiley.com/journal/16015037
	Journal of the American Dental Association	https://jada.ada.org/
	Journal of the Canadian Dental Association	https://jcda.ca/
	Journal of Dental Hygiene	https://jdh.adha.org/
	Journal of Periodontology	https://aap.onlinelibrary.wiley.com/journal/19433670
	Journal of Public Health Dentistry	https://onlinelibrary.wiley.com/journal/17527325
Internet search engines	Google scholar	https://scholar.google.com/

*Nonexhaustive list.

Conducting research

There are several steps for conducting research, which can vary depending on the type of study design. Understanding the process of conducting research is important to help identify quality research studies.

Main steps to conducting research [1] [17] [33] [34] [35]

1
- Develop a clear & focused research question, which identifies study variables & their relationship.
- PICOS statement is often used to generate a quantitative clinical question & to guide a review of the literature. The focus of the study is answering the research question.

2
- Review relevant literature to learn about the topic & to examine previous studies to determine their design, results, any issues, & identify any gaps.
- Literature review guides the research by helping to establish focus & limitations, determine methodology, & to clarify purpose or applications.

3
- Determine hypothesis.
- Establish variables, along with the research context.
- Define units of measurements, including allowable margin of errors.

4
- Define research design, which will depend on type of study being conducted.
- Establish methodology, e.g., population & sample size with inclusion/exclusion criteria; type of data to be collected & collection methods; measures to avoid bias; analysis methods.

5
- Collect data. Depending the research plan, data collection may include surveys, observations, interviews, tests, experiments, etc.
- After gathering data, analysis of the data follows.

6
- Data analysis is done quantitatively &/or qualitatively depending on the type of study.
- There are many ways to analyze the data. Appropriate methods must be chosen to come up with a valid answer. Analysis outcomes determine if the hypothesis was supported or rejected.

7
- Draw conclusions & prepare a paper to present the study & its findings. If findings are to be disseminated to a wider audience, the paper is converted into an article for publication.
- A final paper will typically include an introduction, literature review, methods, analysis, discussion on the findings, conclusions, & recommendations for further research.

Take home messages

- Understanding and critically appraising research literature is important for evidence-informed decision making and evidence-based practice.

- Healthcare, including oral healthcare, has evolved over the years and will continue to evolve through soundly conducted research.
- Oral health professionals need to stay well informed by consulting reliable sources of information.

Glossary of common research and statistical terms

Absolute risk is the likelihood of an event or outcome occurring (e.g., an adverse reaction to a drug being tested) among the group being studied. Studies comparing two or more groups of participants may report results in terms of the absolute risk reduction. [6]

Absolute risk difference is the absolute difference in the risk of an outcome, such as infection or death between two groups. For example, if an intervention reduces the absolute risk of death from 25% to 10%, the absolute risk difference is 15%. Absolute risk difference is synonymous with risk difference and absolute risk reduction/increase. However, it is different from relative risk and relative risk reduction. [16]

Adverse effect is an unintended effect that is harmful or otherwise unwanted, and suspected to be related to, or caused by, a drug, treatment, or intervention. [6]

Adverse event is any undesirable event experienced by an individual while they are receiving a drug, treatment, or intervention, regardless of whether or not the event is suspected to be related to or caused by the drug, treatment, or intervention. [6]

Adverse reaction is an unintended harmful or unwanted reaction experienced by an individual after receiving a drug, treatment, or intervention, and which is suspected to be related to, or caused by the drug, treatment, or intervention. [6]

Bias is the systematic (as opposed to random) deviation of the results of a study from the 'true' results caused by the way the study was designed, conducted, analyzed, or reported. [1] [6]

Bias exists in all research and vary in their magnitude. Biases can result in both an over and/or underestimation of the effect of an intervention. There are many types of biases. Bias is impossible to totally eradicate; however, investigators should report on potential sources of bias and demonstrate how they have tried to minimize its effect.

Common types of bias in research [1] [6] [17] [36] [37] [38] [39] [40]

Type of bias	Description
Attrition bias	Withdrawal of participants from a study leading to incomplete outcome data. Loss of participants may change the characteristics of the groups.
Confirmation bias	The search for and use of data to support ideas, beliefs, or hypotheses.
Detection bias	How outcomes are assessed.
Information bias	Can be caused by questionnaires that have difficult or biased questions, observer, or interviewer errors (e.g., lack of blinding), response errors (e.g., if participants know the treatment they are having), or measurement error (e.g., a faulty machine). Can affect all types of research studies.

Type of bias	Description
Interviewer bias	Relates to aspects of the interviewer, such as the way they ask questions and respond to, record, and interpret answers.
Performance bias	Differences between the intervention and control groups in the treatment or observation received.
Publication bias	Occurs when investigators only publish study results that show a treatment works well and do not publish results that show it did not have an effect. If this happens, analysis of the published results does not give an accurate idea of how well the treatment worked. This type of bias can be assessed by a funnel plot.
Question-order bias	The order in which questions appear in a questionnaire can affect participant responses.
Recall bias	A systematic error that occurs when participants do not remember previous events or experiences accurately or omit details. Recall bias is a problem in studies that use self-reporting (e.g., case-control studies and retrospective cohort studies).
Reporting bias	Only a portion of all the relevant data is made available.
Sampling bias	Participant sample size is too small to represent the population of interest.
Selection bias	Failure to randomize participants into study cohorts. This results in differences in participant characteristics between cohorts before the study begins.

Blinding, also referred to as masking or concealment, is a process by which those involved in the study are kept unaware of which participants are in the intervention group and the control group so they cannot influence results. This can be done on different levels and can include the participants, investigators, clinicians (often healthcare practitioners providing the treatment), and outcomes assessors (e.g., statisticians analyzing the outcome data). The best way to do this is by sorting participants into study groups randomly. The purpose of blinding is to protect against bias.

Types of blinding include:
- Single blinding where participants are unaware of the group they are in.
- Double blinding where participants and clinicians/investigators are unaware.
- Triple blinding where participants, investigators, and outcome assessors are unaware.
- Quadruple blinding where all participants, clinicians, investigators, and outcomes assessors are unaware.

Blinding investigators & clinicians helps to ensure the intervention and control group participants are treated as similarly as possible, which is crucial because differences in care may affect the results as opposed to the actual intervention. [1] [6] [28]

Clinical significance is a measurement of how effective a treatment or intervention is when applied to real-world scenarios. Assessing clinical significance considers factors such as the size of a treatment effect, the severity of the condition being treated, the side effects of the treatment, and the cost. [17]

Confidence interval (CI) is a way of expressing how certain investigators are about the findings from a study, using statistics. The confidence interval gives a range of results that is likely to include the 'true' value for the population. A wide confidence interval

indicates a lack of certainty about the true effect of the test or treatment, often because a small group of participants was studied.

A narrow confidence interval indicates a more precise estimate (e.g., if a large number of participants was studied). Confidence interval is usually stated as '95% CI', which means the range of values has a 95 in a 100 chance of including the 'true' value. In other words, 95% of the time the true value for the population lies within the given range of values. A confidence interval of 90% or 99% may also be used.

For example, a study may state "based on our sample findings, we are 95% certain the 'true' population blood pressure is not higher than 150 and not lower than 110". In such a case, the 95% confidence interval would be 110 to 150. This would be written as (95% CI, 110 to 150) or (95% CI, 110-150). [6] [16] [17]

Cohort is a group that is part of a clinical trial or study. [41]

Confounder is a factor extraneous to the main question in a study, but acts to affect the outcome, and thus distorts the true relationship between study variables. For example, a study of heart disease may look at a group of participants who exercise regularly and a group who do not exercise. If the ages of the participants in the two groups are different, then any difference in heart disease rates between the two groups could be because of age rather than exercise. Thus, age is a confounding factor.

Confounding factors make it more difficult to determine whether the intervention has an effect. Although it is difficult to make two groups (cohorts) identical in all respects, besides the intervention introduced, investigators should clearly establish efforts taken to improve the comparability and reduce the risk of confounding factors influencing the results.

Methods to reduce confounding factors include randomization strategies, blinding, and statistical methods. Statistical methods, such as multivariate analysis (e.g., multiple linear regression or logistic regression), allows investigators to detect any effect of the confounding variables on the outcome. [1] [2] [6]

Confounding occurs when the effect of an intervention on an outcome is distorted because of an association between the population, intervention, or outcome and another factor (i.e., confounding factor) that can influence the outcome independently of the intervention under investigation. [6]

Control group is a group of participants in a study who do not receive the intervention or test being studied. Instead, they may receive the standard intervention or a placebo intervention. The results for the control group are compared with those in the intervention group. The aim is to check for any differences. Ideally, the participants in the control group should be as similar as possible to those in the intervention group, to make it easier to detect any effects due to the intervention. [6]

Cost-benefit analysis is one of the tools used to carry out an economic evaluation. The costs and benefits are measured using the same monetary units (e.g., CAD) to see whether the benefits exceed the costs. [6]

Cost-effectiveness analysis is an analysis assessing the cost of achieving a benefit by different means. The benefits are expressed in non-monetary terms related to health (e.g., symptom-free days, heart attacks avoided, deaths avoided, or life years gained as a result of the intervention). Options are often compared on the cost incurred to achieve one outcome (e.g., cost per death avoided). [16]

Data pooling is the process of combining sources of data on different participants. It is often used to increase sample size especially when studying rare diseases. [6]

Effect size is a generic term for the estimate of the true value of the effect (i.e., the amount of change) from a given intervention or treatment compared to not receiving the intervention/treatment or receiving another intervention/treatment. Effect size may be expressed as a relative risk, odds ratio, relative risk reduction, etc. [17]

Effectiveness measures the ability of an intervention or treatment to do what it was intended to do in the real world (i.e., produce a specific desired result or effect that can be quantitatively measured). [17]

Efficacy is how beneficial a test, treatment, or intervention is under ideal and controlled conditions (e.g., in a lab or clinical trial), compared with doing nothing or opting for another type of care.

For example, a vaccine with 80% efficacy means participants in the clinical trial who received the vaccine had an 80% lower risk of developing disease than the group who received the placebo. This is calculated by comparing the number of cases of disease in the vaccinated group versus the placebo group. An efficacy of 80% does not mean that 20% of the vaccinated group will become ill. [16] [42]

Empirical evidence is evidence based on experience, observation, or an experiment rather than on reasoning alone. [16]

Event rate is the proportion of participants in a group who have a specific experience (e.g., their symptoms become less severe). This could also be described as a result or event. For example, if 27 out of 100 individuals have the experience, the event rate is 0.27 or 27%. The terms 'control event rate' and 'experimental event rate' may be used to describe control and experimental groups, respectively. [16]

External control is a control group that comes from a different dataset or study than the group that received the intervention or treatment. [6]

Forest plot is a type of graph used to display the results of a meta-analysis. [6]

Funnel plot is a visual way of showing how the results of several studies of the same treatment vary. Usually, the effect of treatment in each study is plotted on a graph against the number of participants involved. Ideally, the points fall into an inverted funnel shape. If they do not, publication bias or other problems likely exist. [6]

Hazard ratio (HR) is the hazard, risk, or chance of an event occurring in the treatment group of a study as a ratio of the chance of an event occurring in the control group over time. [6]

In other words, it is the calculated likelihood a particular intervention will make a study outcome more or less likely to occur. A hazard ratio of 1.0 indicates the variable has no impact on the outcome (zero risk reduction, compared to the control treatment). A hazard ratio of less than 1.0 indicates the variable decreases the likelihood of the outcome. A ratio greater than 1.0 indicates the variable increases the likelihood of the outcome.

For example, a ratio of 2.0 suggests the variable doubles the likelihood of the outcome. A ratio of 0.5 suggests it halves the risk of the outcome. A hazard ratio of 0.70 means the study treatment/intervention provides 30% risk reduction compared to the control treatment. This would be written as (HR = 0.70).

For example, if the hazard ratio for death for a treatment is 0.5, then treated participants are likely to die at half the rate of untreated participants. A hazard ratio of 2.0 means treatment will cause the participant to progress more quickly, and a treated participant who has not yet progressed by a certain time has twice the chance of having progressed at the next point in time compared with someone in the control group. [17] [43]

Heterogeneity is a term used in meta-analyses and systematic reviews to describe when the results of a test or treatment (or estimates of its effect) differ significantly in different studies. Such differences may occur as a result of differences in the populations studied, the outcome measures used, or because of different definitions of the variables involved. Heterogeneity is the opposite of homogeneity. [6]

Homogeneity is a term used in meta-analyses and systematic reviews to indicate the results of studies are similar. It is the opposite of heterogeneity. Study results are also regarded as homogeneous if any differences could have occurred by chance. [6]

Hypothesis is a tentative proposal made to explain certain observations or facts that requires further investigation to be verified. [44]

Incidence is the number of new cases of a disease occurring in the total population during a certain period. It is different from prevalence. For example, the number of new cases of diabetes in a country over one year would describe the incidence. [16] [17]

Incidence rate refers to the number of new cases of a condition in a particular group or population. For example, if there are 1000 people and 14 of them develop a condition, the incidence rate is 14 per 1000 or 1.4%. [17]

Incidence Rate Ratio (IRR) is the ratio of two incidence rates. The incidence rate among the exposed (e.g., to a risk factor, treatment, or intervention) proportion of a particular population, divided by the incidence rate in the control portion of this population, gives a relative measure of the effect of a given exposure.

IRR less than 1.0 indicates the incident rate is lower in an exposed group compared to the control group. IRR equal to 1.0 indicates the incident rate is equal among those in an exposed group and those in the control group. IRR greater than 1.0 indicates the incident rate is greater in an exposed group compared to the control group. [17] [45]

Intention-to-treat (ITT) analysis is an assessment of participants in a randomized controlled trial, based on the group they were initially and randomly allocated to. This is regardless of whether or not they dropped out, fully adhered to the treatment, or switched to an alternative treatment. ITT analyses are often used to assess clinical effectiveness because they mirror real-world practice, when not everyone adheres to the treatment, and the treatment individuals receive may be changed according to how they respond to it. Studies of drug treatments often use a modified ITT analysis, which includes only the participants who have taken at least one dose of a study drug. ITT analysis helps prevent bias caused by the loss of participants, and the resulting imbalance between comparison groups. [6] [17]

Interrupted time series is a method of statistical analysis that involves tracking a long period of time before and after a specific identified point, in order to determine the impact and effect of that point. [16]

Intervention is the aspect of interest in experimental and observational studies. Interventions can be therapeutic (e.g., a drug, surgical procedure), preventative (e.g., vaccination), or diagnostic (e.g., measurement of blood pressure), targeted at participants, groups, organizations, communities, or health systems. [6]

Journal impact factor (IF) is commonly used to evaluate the relative importance of a journal within its field and to measure the frequency with which the “average article” in a journal has been cited in a particular year or time period. Journals which publish more review articles will get highest IFs. The calculation is based on a two-year period and involves dividing the number of times articles were cited by the number of articles that are citable.

For example, to calculate the 2022 IF of a journal:

$$\frac{\text{Number of times articles published in 2020 \& 2021 were cited by indexed journals in 2022}}{\text{Total number of "citable items" published in 2020 \& 2021}} = \text{2022 IF}$$

Journal Citation Reports, published by Clarivate Analytics, provides the ranking for journals in the areas of science, technology, and social sciences.

IF is a useful tool for the evaluation of journals. However, it must be used carefully since IF is a quantitative assessment of citations and does not accurately reflect the quality of individual articles published in a journal nor the quality of the journal's peer review process. Also, journals with more issues and articles can have higher IFs which could be misleading as it does not really reflect the quality of articles.
Review articles (which tend to receive more citations), editorials, letters, and news items are not counted in article total but if cited are counted as citations for the journal. This leaves room for manipulation of the ratio used to calculate IFs leading to inflated impact factors in some cases.

Clinical journals usually have low citation counts putting such journals at a disadvantage with research journals in the field that have higher citation counts. [46] [47] [48] [49] [50]

Life years gained are the average years of life gained per individual as a result of an intervention. [6]

Mean is a value calculated by adding each value in a set of numbers and dividing by the total number of observations. The mean is commonly called the 'average.' For example, given the set of numbers 1, 3, 6, 8, 9 the mean = 5.4 [(1+3+6+8+9)/5]. [17]

Mean difference (or 'difference in means') is a statistic measuring the absolute difference between the mean value in two groups in a clinical trial. It estimates the amount by which the experimental intervention changes the outcome on average, compared with the control. It can be used as a summary statistic in meta-analysis when continuous outcomes (e.g., height) are measured on the same scale in all included studies. [17]

Median is the middle value found when the values are ranked in sequential order. This divides the set of values into an equal quantity below and above the median value. For example, the median of 4, 1, 7, 3, 9 is 4 because when the values are put in order (1, 3, **4**, 7, 9), the number 4 is in the middle. [17]

Morbidity rate is the number of cases of an illness, injury, or condition within a given time (usually a year). It can also refer to the percentage of individuals with a particular illness, injury, or condition within a defined population. [16]

Mortality rate is the proportion of a population that dies within a particular period of time. The rate is often given as a certain number per 1,000 individuals. [16]

Moving average is a statistical way of smoothing data by taking an average over a period of time (e.g., 7 days). This is synonymous with rolling average and running average. [16]

Multivariable analysis is an analysis of one dependent variable measuring an outcome and multiple independent variables meant to predict the outcome. [16]

Negative predictive value is the proportion of individuals with a negative test result who do not have the disease or characteristic. It is different from specificity. [6]

Number Needed to Harm (NNH) is the number of participants who must receive a treatment or intervention to cause one adverse event. For example, if a stroke prevention intervention is given to 100 participants and 4 of them experience joint pain (i.e., an adverse event), the number needed to harm is 25 (i.e., 100 ÷ 4 = 25). The closer the NNH is to 1.0, the more likely someone on the treatment will experience an adverse event, so ideally this number should be as large as possible. [6] [17]

Numbers Needed to Treat (NNT) is the average number of participants who need to receive the treatment or other intervention for one of them to get the positive outcome in the time specified. The closer the NNT is to 1.0, the more effective the treatment. For example, if the NNT for drug A compared with drug B for pain relief after a tooth extraction is 4, on average, for every four participants who get drug A instead of drug B, one participant will have pain relief after tooth extraction who would not have done if all four had got drug B. The other three participants out of the four will have or not have pain relief, just as if they had taken drug B. [16]

Null hypothesis is the statistical hypothesis that one variable (e.g., the treatment or intervention) has no association with another variable or set of variables (e.g., an outcome such as death), or that two or more population distributions do not differ from one another. For example, a particular vaccine may be used to prevent influenza. A possible null hypothesis may be "this vaccine has no effect on the incidence of influenza." [17]

Odds Ratio (OR) compares the odds (probability) of something happening (e.g., developing a disease or a treatment working) in one group with the odds of it happening in a different group. OR is a measure of effect size. OR is calculated by dividing the odds of an event occurring in the intervention group by the odds of that event occurring in the control group.

In technical terms, OR is the incidence rate of a particular clinical outcome among participants exposed to a clinical protocol (i.e., experimental group) divided by the incidence rate of that outcome among participants who are not exposed to the protocol (i.e., control group).

An odds ratio of 1.0, shows the odds of the event happening is the same for both the control and experimental groups. An odds ratio of greater than 1.0 means the event is more likely to occur in the experimental group. An odds ratio of less than 1.0 means the event is more likely in the control group. [13] [16] [17]

Person-years is the quantification of the amount of follow-up that accumulated in a group of participants or in a study, which takes into account both the number of

participants in the study and the amount of time spent each participant spent in the study. For example, 1,000 individual years of data will be used in an analysis that tracked 1,000 participants for one year. [16]

PICOS (population, intervention, comparison, outcome, study) framework is a structured approach for developing clinical questions. It divides the question into five components: the population (population, patient, problem being studied); the intervention (intervention, exposure, risk, or prognostic factor of interest); the comparators (comparison or control group); the outcomes (measures effectiveness of the intervention), and the type of study type that would provide the best answer to the clinical question. [6]

Placebo is a fake or dummy treatment given to participants in the control group of a clinical trial. It is indistinguishable from the actual treatment, which is given to participants in the experimental group. The aim is to determine what effect the experimental treatment has had, over and above any placebo effect caused because someone has had (or thinks they have had) care or attention. [6]

Point estimate is the statistical best guess or estimate of the effect of an intervention or treatment (e.g., the true value of interest). [17]

Population is a group of participants with a common link (e.g., same medical condition, living in the same area, or same characteristics). The population for a clinical trial is all the individuals the test or treatment is designed to help. The group of participants taking part in a clinical trial need to be typical of the whole population of interest. [6]

Positive predictive value is the proportion of individuals with a positive test result who actually have the disease or characteristic. It is different from sensitivity. [6]

Power is the ability of a test to reject the null hypothesis when a specific alternative hypothesis is true. In clinical trials, power is the probability that a trial will detect, as statistically significant, an intervention effect. If a clinical trial reports a power of 0.80 (or 80%), and assuming the prespecified treatment effect truly existed, then if the trial was repeated 100 times, one would find a statistically significant treatment effect in 80 of them. Ideally, investigators want a test to have high power, close to maximum of one (or 100%). In general, studies with more participants have greater power. [17]

Prevalence is the proportion of a population having a particular condition or characteristic at a given time. For example, the percentage of individuals in a city with a particular disease or who smoke. Prevalence is different from incidence. [17]

Primary data are data generated (e.g., via experiments, surveys, interviews), collected, and used for a specific research purpose. [6]

***P*-value**, sometimes called the probability of chance, is a statistical measure that indicates whether or not an effect is statistically significant. For example, if a study comparing two treatments found that one seems to be more effective than the other, the

P-value is the probability of obtaining these results by chance. Accordingly, if the *P*-value is below 0.05 (that is, there is less than a 5% probability the results occurred by chance), it is considered there probably is a real difference between treatments. If the *P*-value is 0.001 or less (less than a 0.1% probability the results occurred by chance), the result is seen as highly significant.

Statistical significance is usually set at $p<0.05$, although $p<0.01$ or $p<0.001$ may be used in instances where the outcome is serious (e.g., death).

However, a statistically significant difference is not necessarily clinically significant. For example, drug A might relieve pain statistically significantly more than drug B. But, if the difference in average time taken is only a few minutes, it may not be clinically significant.

Whereas, the *P*-value shows there is likely to be a difference between treatments, the confidence interval describes how big the difference in effect might be. [6] [17]

Quality-adjusted life year is a measure of the state of health of an individual or group in which the benefits, in terms of length of life, are adjusted to reflect the quality of life. One quality-adjusted life year (QALY) is equal to one year of life in perfect health. QALYs are calculated by estimating the years of life remaining for an individual following a particular treatment or intervention and weighting each year with a quality-of-life score (on a 0 to 1 scale). It is often measured in terms of the individual's ability to carry out the activities of daily life, and freedom from pain and mental disorders. [6]

Quantitative data is numerical data or data that can be converted into numbers, which can be ranked, measured, or categorized through statistical analysis. [6] [17]

Qualitative data is nonnumerical data, such as an individual's beliefs, experiences, attitudes, behaviours, interactions, etc. [6] [17]

Randomization, also known as random sampling or random allocation, is a method that uses chance to allocate participants to intervention and control groups in a study. For example, it could involve using a random numbers table or a computer-generated random sequence. It means each participant (or each group in the case of cluster randomization) has the same chance of having each intervention.

Randomization reduces bias and generally produces participant groups more representative of the wider intended population and yields results that are more generalizable. It also ensures participants in both groups have similar characteristics so any difference in outcome can be attributed only to the treatment and not the way the participants were allocated to groups. The more dissimilar the groups, the more likely external or confounding factors are responsible for any differences in outcomes between the intervention and control groups. Randomization methods should be clearly outlined in the methods section of the study. [1] [6] [17]

Rate ratio is a form of a relative risk. It is a way to express the probability of an event occurring in the study group during a specific time compared with the probability of the same event occurring in the control group during the same time. If both groups face the same level of risk, the rate ratio is 1.0. If the first group had a rate ratio of 2.0, participants in that group would be twice as likely to have the event happen. A rate ratio of less than 1.0 means the outcome is less likely in the first group. [16]

Regression analysis is statistical method used to estimate or predict the influence of one or more independent variable (e.g., sex, age, education level) on a dependent variable (e.g., prevalence of a disease). Logistic regression and meta-regression are types of regression analysis. [17]

Relative risk (RR) is an estimate of the ratio of the probability of an outcome in one group compared to the probability of an outcome in another group. In other words, the probability of an event occurring in the study group compared with the probability of the same event occurring in the control group, described as a ratio.

RR of 1.0 indicates there is no difference between the two compared groups (i.e., both groups face the same level of risk). RR less than 1.0 means the intervention decreases the risk of the outcome occurring (i.e., the outcome is more likely in the control group). RR greater than 1.0 means the intervention increases the likelihood of the outcome occurring (i.e., the outcome is more likely to occur in the experimental group).

For example, if the first group had a relative risk of 2.0, participants in that group would be twice as likely to have the event happen. [6] [13] [16] [17]

Relative risk reduction (RRR) is reported as a percentage and represents the extent to which a treatment or intervention reduces an individual's risk of experiencing a given outcome. It is calculated by subtracting the relative risk (RR) from 1.0 (i.e., the risk of the outcome), (RRR = 1.0 - RR) with accompanying confidence intervals. RRR of 100% means the treatment was a complete success. RRR of 0% means the treatment had no effect. [17]

Relative treatment effect is the effect of a treatment relative to another treatment or control, for example measured by relative risk (RR). [6]

Reliability is the ability to get the same or similar result each time a study is repeated with a different population or group. [6]

Risk ratio is a ratio of the risk of an outcome in one group compared to the risk of an outcome in another group. It is an estimate of the relative risk. [16]

Sample refers to participants in a study recruited from part of the study's target population. If they are recruited in an unbiased way, the results from the sample can be generalized to the target population as a whole. [6]

Sample size should ideally be large enough to represent the population being studied. Sample size directly affects the power of the study. Larger studies provide more precision, meaning the results may be more reliable and usable. Trials with small samples are more likely to miss clinically significant results, if they exist. The concept of 'power' is the ability of a study to identify a difference between the two groups when a difference actually exists. The study should provide a power calculation that establishes a sample size estimation required, and if not, the sample size may be too small, making the study underpowered. [1]

Sampling is the way participants are selected for inclusion in a study. [6]

Secondary data are data collected routinely (e.g., population census, hospital data) or collected for research then reused in other studies. [6]

Sensitivity is how well a test detects what it is testing for. It is the proportion of individuals with the disease or condition that are correctly identified by the study test. For example, a test with a sensitivity of 96% will, on average, correctly identify 96 individuals in every 100 who truly have the condition, but incorrectly identify four individuals in every 100 as not having the condition when they truly have it. This is different from positive predictive value. [16]

Specificity is how well a test correctly identifies individuals who do not have what the test is testing for. It is the proportion of individuals without the disease or condition that are correctly identified by the study test. For example, a test with a specificity of 96% will, on average, correctly identify 96 individuals in every 100 who truly do not have the condition, but incorrectly identify four participants in every 100 as having the condition when they truly do not have it. [16]

Standard deviation (SD) is a measure of how far individual data points are from the mean value for a set of data points. In other words, measures the spread of data across a sample, so a large SD suggests data are spread out over a wide range of values.

In any normal distribution, approximately:

- 68% of the values fall between -1 and +1 SD (i.e., one standard deviation above and below the mean);
- 95% between -2 and +2 SD (i.e., two standard deviations above and below the mean);
- 99% between -3 and +3 SD (i.e., three standard deviations above and below the mean).

For example, if the mean (average) height of females in a given population is reported as 165cm ± 2cm, the SD is 2cm and the range of height within 1 SD of the mean is 163cm to 167cm. [17]

Standard error of mean (SEM) is the precision of the estimate of a sample mean. SEM is a measure of the variability or spread of the means from repeated samples (of a given size) drawn from the population. In other words, SEM measures the range of sample

means. Mathematically, SEM is the standard deviation (SD) divided by the square root of the sample size, so it is always smaller than the SD. SEM cannot be used in place of SD. [17]

Standardized mean difference (SMD) appears in meta-analyses of continuous data (e.g., weight) when studies use different scales of measurement for the same outcome (e.g., weight in kilograms vs. weight in pounds). It is necessary to standardize individual study results on a uniform scale so they can be combined. SMDs do not have units. Hedges' (adjusted) g is the preferred SMD for Cochrane reviews. To calculate, SMD is the difference in mean outcome between groups divided by the standard deviation of outcome among participants. [17]
For example, consider a trial evaluating an intervention to increase birth weight. The mean birth weights in intervention and control groups were 2700g and 2600g, respectively, with an average SD of 500g. SMD = (2700 - 2600)/500 = 0.2.

Statistical association is the statistical relationship between two or more events, characteristics, or other variables. The relationship may or may not be causal. [6]

Statistical power is the ability of a study to demonstrate an association or causal relationship between two variables (if an association exists) means that the study is statistically significant. The statistical power of a study is primarily related to the number of participants included. If too few participants are included, any differences in the outcomes will not be statistically significant. [6]

Statistical significance helps quantify whether a result is likely due to random chance or due to a true effect. An effect size is statistically significant when any differences in outcome(s) between treatment and control groups are likely real, and not due to chance. *P*-values and confidence intervals (CI) are the most commonly used measures of statistical significance. [6] [17]

Systematic error refers to the various errors or biases inherent in a study. [6]

Test accuracy is any measure relating to the correctness of a test, such as sensitivity, specificity, predictive values, and the proportion of results that are correct. [6]

Treatment allocation is the process by which participants in a study are allocated to a treatment group. [6]

Triangulation is the use of two or more different research methods in combination; principally used as a check of validity. The more the different methods produce similar results, the more valid the findings. [6]

Validity is whether a test or study actually measures what it aims to measure. Internal validity shows whether a study or test is appropriate for the question. For example, whether a study of exercise among gym members measures the amount of exercise individuals do at the gym, not simply whether individuals join. External validity is the degree to which the results of a study hold true in non-study situations. It may also be

referred to as the generalizability of study results to non-study populations. For example, the external validity of a study that took place in Spain may be questioned if the results were to be applied to individuals in Australia. [6]

Variable refers to a person, place, thing, or phenomenon that is being measured. In an experiment, the independent variable is the variable that is varied or manipulated by the investigator. The dependent variable is the response that is measured.

For example, in a study of how different doses of a drug affect the severity of symptoms, an investigator could compare the frequency and intensity of symptoms when different doses are administered. Here the independent variable is the dose and the dependent variable is the frequency and intensity of symptoms. [51]

References

[1] A. Alkadhimi, S. Reeves and A. DiBiase, "How to appraise the literature: basic principles for the busy clinician - part 1: randomised controlled trials," *BDJ,* vol. 232, pp. 475-481, 8 April 2022.

[2] American Speech-Language-Hearing Association, "Evidence-Based Practice (EBP)," 2022. [Online]. Available: https://www.asha.org/research/ebp/. [Accessed 7 November 2022].

[3] Gerstein Science Information Centre, "Evidence-Based Practice," University of Toronto, 23 August 2022. [Online]. Available: https://guides.library.utoronto.ca/evidencebasedmedicine. [Accessed 7 November 2022].

[4] Durr-e-Sadaf, "How to apply evidence-based principles in clinical dentistry," *Journal of Multidisciplinary Healthcare,* vol. 12, pp. 131-136, 11 February 2019.

[5] Ascension Wisconsin, "Evidence-Based Practice: Introduction to EBP in 6 Steps," 2 November 2022. [Online]. Available: https://ascension-wi.libguides.com/ebp/6Steps. [Accessed 9 November 2022].

[6] National Institute for Health and Care Excellence, "Glossary," 2022. [Online]. Available: https://www.nice.org.uk/Glossary. [Accessed 14 November 2022].

[7] D. Bowen and J. Forrest, "Translating research for evidence based practice," *Access,* pp. 10-14, January 2017.

[8] National Library of Medicine, "Publication Characteristics (Publication Types) with Scope Notes," 12 May 2022. [Online]. Available: https://www.nlm.nih.gov/mesh/pubtypes.html. [Accessed 15 February 2022].

[9] Himmelfarb Health Sciences Library , "Practice Guideline," George Washington University, 2019. [Online]. Available: https://himmelfarb.gwu.edu/tutorials/studydesign101/practiceguidelines.cfm. [Accessed 15 February 2022].

[10] National Cancer Institute , "Clinical practice guidelines," [Online]. Available: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/clinical-practice-guidelines. [Accessed 15 February 2022].

[11] W. Wilson, K. Taubert, M. Gewitz, et al., "Prevention of infective endocarditis: Guidelines from the American Heart Association," *JADA,* vol. 139, no. Supplement 1, pp. S11-S24, 1 January 2008.

[12] W. Wilson, M. Gewitz, P. Lockhart, et al., "Prevention of viridans group streptococcal infective endocarditis: A scientific statement From the American Heart Association," *Circulation,* vol. 143, p. e963–e978, 15 April 2021.

[13] American Dental Association, "Antibiotic Prophylaxis Prior to Dental Procedures," 5 January 2022. [Online]. Available: https://www.ada.org/resources/research/science-and-research-institute/oral-health-topics/antibiotic-prophylaxis. [Accessed 15 November 2022].

[14] S. Gopalakrishnan and P. Ganeshkumar, "Systematic reviews and meta-analysis: Understanding the best Eevidence in primary healthcare," *Journal of Family Medicine and Primary Care,* vol. 2, no. 1, pp. 9-14, January-March 2013.

[15] Cochrane Library, "What is a systematic review?," 2022. [Online]. Available: https://www.cochranelibrary.com/about/about-cochrane-reviews. [Accessed 15 November 2022].

[16] Ontario COVID-19 Science Table, "Glossary," [Online]. Available: https://covid19-sciencetable.ca/glossary/. [Accessed 15 November 2022].

[17] Health Evidence, "Glossary," McMaster University, 2022. [Online]. Available: https://www.healthevidence.org/glossary.aspx. [Accessed 15 November 2022].

[18] National Institutes of Health, "Glossary of Common Terms," 10 February 2016. [Online]. Available: https://www.nih.gov/health-information/nih-clinical-research-trials-you/glossary-common-terms. [Accessed 16 November 2022].

[19] Government of Canada, "Clinical trials and drug safety," 22 May 2020. [Online]. Available: https://www.canada.ca/en/health-canada/services/clinical-trials.html. [Accessed 16 November 2022].

[20] National Cancer Institute, "Crossover study," [Online]. Available: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/crossover-study. [Accessed 16 November 2022].

[21] National Cancer Institute, "Case series," [Online]. Available: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/case-series. [Accessed 16 November 2022].

[22] National Cancer Institute, "Case report," [Online]. Available: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/case-report. [Accessed 16 November 2022].

[23] National Cancer Institute, "Observational study," [Online]. Available: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/observational-study. [Accessed 16 November 2022].

[24] A. Shorten and J. Smith, "Mixed methods research: expanding the evidence base," *Evidence-Based Nursing,* vol. 20, no. 3, pp. 74-75, July 2017.

[25] University of Manitoba, "Understanding Review Types: Umbrella Reviews," 20 January 2022. [Online]. Available: https://libguides.lib.umanitoba.ca/reviewtypes/umbrella. [Accessed 16 November 2022].

[26] Bloomsburg University, "Literature Review," 25 August 2022. [Online]. Available: https://guides.library.bloomu.edu/litreview. [Accessed 16 November 2022].

[27] University of Manitoba, "Understanding Review Types: Scoping Reviews," 20 January 2022. [Online]. Available: https://libguides.lib.umanitoba.ca/reviewtypes/scoping. [Accessed 16 November 2022].

[28] S. Ashraf, S. Ashraf, M. Ashraf, et al., "A quadruple blinded placebo controlled randomised trial to evaluate the effectiveness of an Iodine complex for patients with mild to moderate COVID-19 in Pakistan (I-COVID-PK): A structured summary of a study protocol for a randomised controlled trial," *BMC,* vol. 22, article 127, pp. 1-3, 10 February 2021.

[29] National Cancer Institute, "Animal study," [Online]. Available: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/animal-study. [Accessed 16 November 2022].

[30] National Cancer Institute, "In vitro," [Online]. Available: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/in-vitro. [Accessed 16 November 2022].

[31] John Moritz Library, "Evidence-Based Practice: Levels of Evidence," Nebraska Methodist College, 27 September 2022. [Online]. Available: https://libguides.methodistcollege.edu/ebp/ebplevels. [Accessed 17 November 2022].

[32] B. Pai, G. Rajesh and R. Shenoy, "Research design hierarchy: Strength of evidence in evidence-based dentistry," *Journal of Interdisciplinary Dentistry,* vol. 2, no. 3, pp. 158-163, 2012.

[33] Offord Centre for Child Studies, "The Research Process," 2022. [Online]. Available: https://offordcentre.com/research/participate-in-studies/the-research-process/. [Accessed 17 November 2022].

[34] I. Bouchrika, "What Is Empirical Research? Definition, Types & Samples," Research.com, 14 October 2022. [Online]. Available: https://research.com/research/what-is-empirical-research. [Accessed 17 November 2022].

[35] K. Sudheesh, D. Duggappa and S. Nethra, "How to write a research proposal?," *Indian Journal of Anaesthesia,* vol. 60, no. 9, pp. 631-634, September 2016.

[36] C. Pannucci and E. Wilkins, "Identifying and avoiding bias in research," *Plastic and Reconstructive Surgery,* vol. 126, no. 2, pp. 619-625, Augus 2010.

[37] Centre for Evidence-Based Medicine, "Confirmation bias," 2022. [Online]. Available: https://catalogofbias.org/biases/confirmation-bias/. [Accessed 18 November 2022].

[38] J. Waterfield, "Interviewer Bias," SAGE research methods, [Online]. Available: https://methods.sagepub.com/reference/the-sage-encyclopedia-of-educational-research-measurement-and-evaluation/i11424.xml. [Accessed 17 November 2022].

[39] Centre for Evidence-Based Medicine , "Performance bias," 2022. [Online]. Available: https://catalogofbias.org/biases/performance-bias/. [Accessed 17 November 2022].

[40] Centre for Evidence-Based Medicine, "Recall bias," 2022. [Online]. Available: https://catalogofbias.org/biases/recall-bias/. [Accessed 17 November 2022].

[41] National Cancer Institute, "Cohort," [Online]. Available: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/cohort. [Accessed 18 November 2022].

[42] World Health Organization, "Vaccine efficacy, effectiveness and protection," 14 July 2021. [Online]. Available: https://www.who.int/news-room/feature-stories/detail/vaccine-efficacy-effectiveness-and-protection. [Accessed 17 November 2022].

[43] Medical Dictionary, "Hazard ratio," 2022. [Online]. Available: https://medical-dictionary.thefreedictionary.com/hazard+ratio. [Accessed 18 November 2022].

[44] National Cancer Institute, "Hypothesis," [Online]. Available: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/hypothesis. [Accessed 18 November 2022].

[45] Statology, "What is Incidence Rate Ratio?," 2022. [Online]. Available: https://www.statology.org/incidence-rate-ratio/. [Accessed 18 November 2022].

[46] University Library, "Measuring Your Impact: Impact Factor, Citation Analysis, and other Metrics: Journal Impact Factor (IF)," University of Illinois , 3 October 2022. [Online]. Available: https://researchguides.uic.edu/if/impact. [Accessed 19 November 2022].

[47] M. Sharma, A. Sarin, P. Gupta, et al., "Journal Impact Factor: Its Use, Significance and Limitations," *World Journal of Nuclear Medicine,* vol. 13, no. 2, p. 146, May-August 2014.

[48] Clarivate, "Journal Citation Reports," 2022. [Online]. Available: https://clarivate.com/webofsciencegroup/solutions/journal-citation-reports/. [Accessed 19 November 2022].

[49] S. Hancocks, "Impact factors – time to move on?," *BDJ,* vol. 198, no. 7, p. 383, 9 April 2005.

[50] Wooster Campus Research Library, "Scholarly Impact and Citation Analysis," Ohio State University, 17 February 2022. [Online]. Available: https://osu.libguides.com/c.php?g=110226&p=714742. [Accessed 19 November 2022].

[51] Rutgers University Libraries, "Systematic Reviews in the Health Sciences," 18 November 2022. [Online]. Available: https://libguides.rutgers.edu/c.php?g=337288&p=2273206. [Accessed 19 November 2022].

[52] Wiley Author Services, "What is peer review?," John Wiley & Sons, Inc. , 2022. [Online]. Available: https://authorservices.wiley.com/Reviewers/journal-reviewers/what-is-peer-review/index.html. [Accessed 15 November 2022].

[53] European Centre for Disease Prevention and Control, "Expert opinions," 2022. [Online]. Available: https://www.ecdc.europa.eu/en/all-topics-z/scientific-advice/expert-opinions. [Accessed 15 November 2022].

Additional Resources

Understanding Research Evidence
A series of 11 short videos that explain some important terms encountered in research.

- What's the Risk? Understanding Absolute and Relative Risk Reduction
- Relative Risk: It's easy to calculate and interpret
- Effectiveness of Interventions - Understanding the Number Needed to Treat
- Types of Reviews What kind of review do we need?
- How to Calculate an Odds Ratio
- Understanding a Confidence Interval
- Forest Plots: Understanding a Meta-Analysis in 5 Minutes or Less
- The Importance of Clinical Significance
- Evidence-Informed Decision Making: A guiding framework for public health
- 6S Pyramid: a tool that helps you find evidence quickly and efficiently
- Making Sense of a Standardized Mean Difference

https://www.nccmt.ca/training/videos#ure1

McMaster Health Evidence
Search healthevidence.org for access to over 8,300 quality-rated systematic reviews evaluating the effectiveness and cost-effectiveness of public health interventions, including cost data. https://www.healthevidence.org/search.aspx

National Institute for Health and Care Excellence (NICE) Glossary, 2022
https://www.nice.org.uk/Glossary

Health Evidence Glossary, McMaster University, 2022
https://www.healthevidence.org/glossary.aspx

How to appraise the literature: Basic principles for the busy clinician - part 1: randomised controlled trials, Alkadhimi, A; Reeves, S; DiBiase, A. *BDJ*, Volume 232, April 8, 2022, p 475-481 https://www.nature.com/articles/s41415-022-4096-y

How to appraise the literature: Basic principles for the busy clinician - part 2: systematic reviews and meta-analyses, Alkadhimi, A; Reeves, S; DiBiase, A. *BDJ*, Volume 232, April 22, 2022, p 569-575 https://www.nature.com/articles/s41415-022-4151-8

How to apply evidence-based principles in clinical dentistry, Durr-e-Sadaf. *Journal of Multidisciplinary Healthcare*, Volume 12, February 11, 2019, p 131-136 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6375114/

From dental science to clinical practice: Knowledge translation and evidence-based dentistry principles, Afrashtehfar, K; Assery, M. *Saudi Dental Journal*, Volume 29, Issue 3, July 2017, p 83-92
https://www.sciencedirect.com/science/article/pii/S1013905217300160

Developing evidence-based dentistry skills: How to interpret randomized clinical trials and systematic reviews, Kiriakou, J; Pandis, N; Madianos, P; Polychronopoulou, A. *Progress in Orthodontics*, Volume 15, Article 58, October 30, 2014, p 1-8
https://progressinorthodontics.springeropen.com/articles/10.1186/s40510-014-0058-5

Systematic reviews and meta-analysis: Understanding the best evidence in primary healthcare, Gopalakrishnan, S; Ganeshkumar, P. *Journal of Family Medicine and Primary Care,* Volume 2, Issue 1, January-March 2013, p 9-14
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3894019/

Research design hierarchy: Strength of evidence in evidence-based dentistry, Pai, B; Rajesh, G; Shenoy, R. *Journal of Interdisciplinary Dentistry*, Volume 2, Issue 3, 2012, p 158-163 https://www.jidonline.com/article.asp?issn=2229-5194;year=2012;volume=2;issue=3;spage=158;epage=163;a