Understanding & Interpreting Food & Health Scientific Studies

Guidance For Food & Nutrition Communicators

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International Food Information Council

The International Food Information Council (IFIC) is a 501(c)(3) nonprofit educational organization with a mission to effectively communicate science-based information about food safety, nutrition, and sustainable food systems, serving the public good. To fulfill this mission and demonstrate its thought leadership in action, IFIC: 1) delivers best-in-class research and consumer insights to inform food, nutrition, and health stakeholders; 2) promotes science communications to positively impact consumer behavior and public health; 3) and convenes critical thought leaders to advance the food systems dialogue and science-based decision-making.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The public demonstrates sustained, heightened interest in food and health topics. Assorted sources of both traditional and social media convey content fluctuating in credibility. Communicators focused on food and nutrition science and related health outcomes, such as journalists, educators, health professionals, as well as regulatory and policy officials, are the information conduits shaping public knowledge, attitudes, and beliefs toward food and health. Communicators themselves are pressured to process large and often complex quantities of information so they can transmit recommendations and insights to their colleagues, clients, consumers, readers, viewers, and followers, who may have varying levels of science and health literacy.

This transmission of information to the public can have a lasting impact on public health outcome trends, scientific understanding, and the subsequent relay of information to peers. **This guidance document aims to improve understanding of scientific publications to enhance communicator effectiveness. In turn, communicators will better support the public in making informed food and health decisions.**

Guidance Goals At-A-Glance

Science is a process with recurrent discussion and debate. Effectively interpreting these discussions and debates can directly impact how communicators engage with their audiences and what information is shared.

- This guidance document encourages critical thinking to support communicators in understanding and interpreting scientific study publications. It will aid communicators in remaining vigilant for inaccurate information propagation.
- Scientists communicate through scientific publications that communicators read and comprehend to prepare communication content for the public. This guidance document explores scientific hierarchy, different types of food and health scientific research, and the main sections of scientific publications: abstract, introduction, methodology, results, and discussion/conclusion. A glossary of scientific terms appears at the end. (Italicized terms in the body of the text will have definitions listed in the glossary.)
- To enhance communicators' abilities to explain research to various audiences in a competitive digital landscape, this document is intended to give communicators a critical foundational understanding of the types of studies often used among food and health researchers as well as orient them toward considering the current body of research for context. Building foundational knowledge promotes credible communications that will inform and may help improve consumer food and health decisions.

BACK TO TOP

INTRODUCTION

Food and health research inspires attention-grabbing content, especially headlines in both traditional and social media. Those in communication roles, including journalists, educators, health professionals, as well as other public health and regulatory and policy experts, want and need credible information as consumers and the broad public pose an endless series of questions in food and health: How is food grown? What should I eat to protect my health? What can you tell me about this ingredient's safety?

While media headlines are not necessarily the bottom line, they are crafted to grab attention, to implant memorable conclusions, and to stir action. Ideally, food and health headlines inspire readers to consume the full content to learn more and support healthful behavioral and lifestyle choices.

Unfortunately, many provocative headlines originate from just a single research study, or more likely, the press release for that study, due to pressure from the constant media cycle. Celebrity culture and dubious appeals to nature (i.e., eat only "natural" foods) are equal fuel for garishly compelling headlines. Other innovations, such as artificial intelligence, may shape communication, and such tools will need to be monitored for usefulness and applicability.[1]

This guidance document aims to improve understanding of scientific publications to enhance communicator effectiveness. In turn, communicators will better support the public in making informed food and health decisions.

Content aims to compel people toward the latest food, beverage, and/or supplement perceived to hold promise for good health or may use fear to drive consumers away from certain foods and ingredients even if the science shows these are safe and beneficial. Therefore, communicators should be aware of the drawbacks of focusing media reports on single studies and have a good understanding of the scientific process and how science is translated into recommendations. This will increase the public's understanding of the research and increase communicator capacity to positively impact public health.

Information Processing As Science Evolves

The brain tends to process information rapidly, influenced by emotion and intuition.[2] Instead of using logical reasoning and self-reflection, individuals apply mental shortcuts or heuristics to assess and draw conclusions. People can learn to implement the steps of critical thinking, yet critical thinking's sophistication is not always inherent, hence the need for this guidance document as an educational resource.

The notion that consumers are busy, overloaded with information, and susceptible to hasty impressions while scrolling through digital media is not new—and certainly not unique to food and health content. Confused and frustrated by the tremendous amount of food and health information communicated today, some people seek simple certainties to help improve health through diet and lifestyle. While many people would like one resource to tell them everything they need to know to make an educated decision, one study almost never provides 100% assurance or the full story. Science, the knowledge creation process, is not an endpoint but more of an enduring evolution. Despite provocative headlines that may furiously feed fads pronouncing the final word on a given topic, much of science is not resolved, but rather a step in the discovery process. Studies continue, and headlines propagate.

Is the solution to this conundrum to simply give more information or resources to audiences to help them understand science better? Well-intentioned attempts to set the record straight and provide more facts will often involve communicators dispersing additional content. However, increasing content, growing information availability, even if credible, may support adverse expansion in the knowledge gap[3] where those in higher socioeconomic status groups benefit more from the information while those in lower socioeconomic status groups fall further behind. Mechanisms for this gap are explicated elsewhere,[4] but the bottom line is adding more information may not deliver the assurance of clarity.

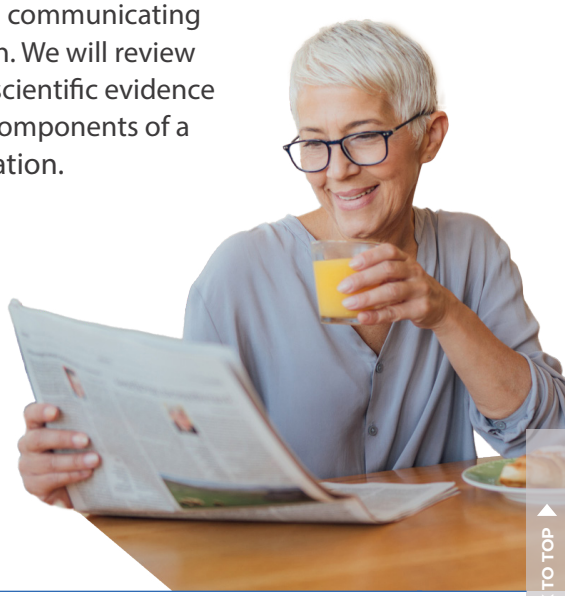
Communicators As Critical Thinkers

Influential communicators are among the significant information conduits of today's food and health science. These stakeholders determine, in large part, what consumers hear, read, and believe about food and health. That comes with the responsibility to provide facts in perspective to help people determine how the findings may affect their own behavior and health. Fulfilling this responsibility requires communicators to critically review and think before cascading content to consumers. News releases and study abstracts, although helpful for previewing research, do not provide all the information necessary to report findings accurately and responsibly to the public. Communication informed by critical thinking serves to help the public more competently deduce inferences and understand the limitations of their own knowledge and thinking.[2]

The Purpose Of This Resource

This guidance document aims to improve understanding of scientific publications to enhance communicator effectiveness. In turn, communicators will better support the public in making informed food and health decisions.

While this guidance document dives deep into research methods and science communication, it is not as comprehensive as a textbook and should not be seen as the only credible source on this topic. Our hope is that this document is used as a guide to better understanding of science by those reporting on and communicating scientific research. We will review the hierarchy of scientific evidence and dissect the components of a scientific publication.

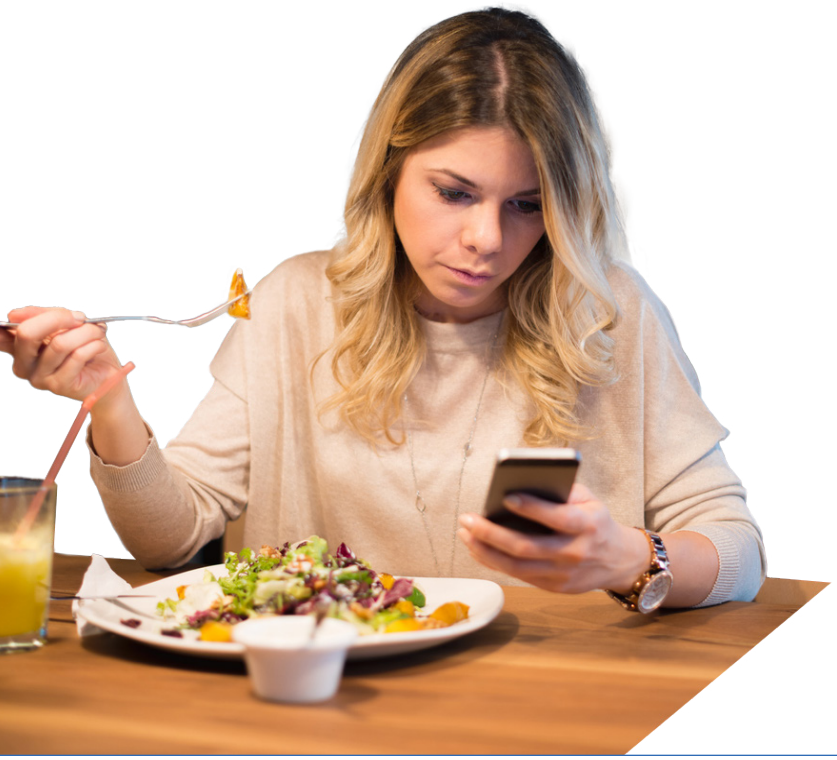


BACKGROUND

Navigating Consumer Trust

To consumers, seemingly contradictory studies about food and health frequently appear in the media, compelling many to wonder why researchers keep probing topics that consumers thought were settled. While asking, "Why can't researchers just get it right?", consumers also wonder where and with whom to place their trust. The 2023 International Food Information Council (IFIC) Food & Health Survey[5] indicated that 67% of respondents trust (a lot or a little) the food and nutrition content on social media. LinkedIn is reported as the most trusted with 52% saying they trust LinkedIn a lot. In terms of government agencies, 61% of respondents trust the U.S. Food and Drug Administration to determine if certain ingredients should be allowed in the food supply.

In addition to providing patient care, health professionals serve as science communicators. The 2022 IFIC Food & Health Survey[6] showed that consumers put their trust in health professionals regarding what food to eat and what to avoid. Sixty-six percent of respondents ranked registered dietitian nutritionists (RDNs) with the most trust, and 66% also ranked the broad category of personal healthcare professionals as the most trusted. Wellness counselor or health coach followed at 56%.



Similarly, a report from the Pew Research Center[7] indicated consumers trust medical as well as food and nutrition practitioners, such as RDNs: 60% of respondents had a mostly positive view of RDNs; 60% thought that RDNs care about people's best interests; and 54% said that RDNs do a good job. A 2021 survey conducted by the Academy of Nutrition and Dietetics found that 70% of respondents indicated that registered dietitian nutritionists were the most trusted source for information about what types of food to eat.[8]

People and social networks in general are also a source of food and health information to others. When making diet choice decisions, the 2017 IFIC Food & Health Survey[9] revealed when respondents were following a specific diet, one in three were influenced by a friend or family member to follow that diet. In 2023, the survey showed when people adopt a new eating pattern/diet, 15% did so because of a recommendation from a personal healthcare provider. These data indicate that consumers turn to credentialed professionals as well as to other consumers (who are both impactful communicators) for food and health information and advice, thus the burden increases on communicators to reach wide audiences with credible content.

BACK TO TOP

Consumer Fear & Inaccurate Information

In addition to messenger credibility, consumers must navigate message content, which may include *misinformation*, *disinformation*, or *mal-information*.[10,11,12] Scholars debate the definitions, but in general, misinformation is wrong or misleading information; disinformation is deliberately false information intended to deceive; and mal-information is based on reality but used to inflict harm on a person, organization, or country.[13,14]

Inaccurate information may negatively impact health and even block innovation because of public fear. Let us consider a food example: eating enough daily servings of fruits and vegetables is a cornerstone of dietary recommendations. Achieving recommended intakes has been associated with lower all-cause mortality and reduced risk of cardiovascular disease, certain types of cancer, and other conditions.[15] Despite efforts by health professionals and public health programming to promote consumption, approximately 10% of U.S. adults meet fruit and vegetable consumption recommendations.[16] Reasons for inadequate consumption vary, including accessibility and affordability, but some consumer messaging serves as a barrier to consumption. For example, messages admonishing consumers about pesticide residues on conventionally grown fruits and vegetables and promoting the exclusive consumption of organically grown counterparts may have unintended consequences.

Information such as this lacks context to help consumers make food decisions and leads to unfounded fear that may adversely impact public health. This inaccurate information recklessly bypasses credible information on how both conventional and organic produce are healthy and safe to consume. Some contend that the messages have been shown to invoke unfounded fear in consumers, demotivating them from purchasing fruits and vegetables, and possibly driving more vulnerable populations away from fruit and vegetable consumption.[17]

Managing Misinformation[18]

Communicators may face inaccurate information when preparing to communicate about scientific studies. Inaccurate information can be misinformation, disinformation, or mal-information[10,11,12] and may appear in both traditional and social media. In general, misinformation is wrong or misleading information; disinformation is deliberately false information intended to deceive; and mal-information is based on reality but used to inflict harm on a person, organization, or country.[11,14]

The following will assist food and health communicators in managing misinformation:

1. Consider the audience, including their wants and needs.
2. Ask questions to better understand audience knowledge, attitudes, and beliefs. Align around shared values.
3. Minimize repeating inaccurate information. Keep the facts simple and put facts into context emphasizing scientific consensus. Remember audience values.
4. Now may not be the right time to address or correct inaccurate information. Your audience may not exhibit readiness to listen.

BACK TO TOP

Science & Its Communication

Science is the practice of processing ideas, and "its aim is to produce knowledge, to understand and explain some aspect of the world."[19] Knowledge production is ongoing, a pursuit that does not terminate but undergoes repeat study. To be scientific means the question or problem can be studied through verifiable observation. In other words, "scientific questions are questions that can be answered by making observations that identify the conditions under which certain events occur."[19]

The scientific process, inclusive of how studies are designed, conducted, and reported, is a road of discovery, one where knowledge is gained about the universe through the observation of measurable evidence.[20] Despite what some may prefer, this road is not usually linear, lacking direct and tidy advancement from points A to B; instead, researchers may take different directions of exploration, causing the road to twist, turn, and sometimes even backtrack or terminate before the facts are uncovered. Even then, the facts may be only part of a larger, partially understood phenomenon, one that requires more research to determine more answers. Concluding one scientific study often gives rise to the next exploration.[19]

Scientists communicate with each other through publications in scientific journals using discipline-specific terminology. In language that conveys the degree to which they are certain, scientists often do not provide absolute statements of what is true or not true. Findings may fall on a continuum. The scientific process often generates much debate. Tracking the debate may help array new research into context. Scientists submit their study manuscripts for peer review, a process where other experts in the field closely examine and critique the work. Peer reviewers ask questions to elucidate understanding; they request and require changes, and sometimes, they reject the manuscript submission for a variety of reasons, including failure to meet the requirements of the publication or accepted scientific rigor.

In these discussions and debates, almost no one has the final word, as it is rare that a single study provides a final, complete answer.[21] In fact, occasionally, older, accepted research results are revisited, reconsidered, and sometimes rejected. With the benefit of new information or technology, scientists sometimes see accepted results in a new light. The publication of research findings allows researchers to obtain input on their work, which not only confirms or contradicts their

BACK TO TOP

results but also adds to the body of literature on a subject and helps shape future research. Changes in understanding may lead to changes in dietary recommendations, and such changes are not a failure of scientific investigation but a part of continual refinement.

Dialogues characterized by cycles of revisions, conjectures, assertions, and contradictions are frequently key to investigating a topic. Although such cycles often frustrate nonscientists and can contribute to increasing public skepticism about advice on food and health, it is important to understand that science is usually evolutionary, not revolutionary.[21,22,23] Because scientific research explores the unknown, uncertainty is an unavoidable part of investigations. Repetition in research and analysis helps yield emerging certainties—until they are questioned again. Regarding trust in science, the Pew Research Center reported that 73% of U.S. adults have a great deal or fair amount of confidence in scientists to act in the public's best interest yet trust in scientists has fallen from 39% in 2020 to 23% in 2023.[24]

Next, this paper will examine different types of research studies, exploring some commonalities and differences, and in doing so, will help communicators understand and interpret common study designs as they create messages for the public. This understanding will help support communicators in building trust with their audiences and promoting trust in science.

Communicators have the opportunity to inspire consumer trust through credible science communication.

TYPES OF RESEARCH STUDIES

Researchers choose from different study designs to answer research questions and test hypotheses. The following section explores some of the most common *research designs* for communicators to understand as they prepare to communicate research findings to audiences.

A customary approach to research has been described as a process comprising steps where researchers collect and analyze information.[25,26] Those steps include:

1. Identifying a research problem—the issue or problem and its justification for research
2. Reviewing the existing literature—what is known and unknown about the problem; the foundation
3. Specifying the purpose for the research—why perform this research; addressing research questions and/or hypotheses
4. Choosing a research design—the research plan; roadmap
5. Collecting data—deciding who will participate in the research; providing an intervention, where appropriate, and measuring something pertinent to the *participants*
6. Analyzing and interpreting data—making sense of the participants' information
7. Reporting and evaluating the results of the research—writing the research manuscript and submitting it for review by experts.

This process gives rise to different types and levels of evidence, known as the hierarchy of evidence.[27] Thinking about evidence in a hierarchy is one way to rank research based on its strength for cause and effect. (See page 9)

Although research is viewed in an overall hierarchy, it should still be individually evaluated. Scientific research that is higher on the hierarchy can possess some methodological problems.[28] Strengths and limitations of a study shape evidence quality. A study design may be considered high quality for a particular question in a specific context but may lack the ability to answer a particular question. For example, a communicator may try to address a topic pertaining to people with obesity, but the study comprised people who did not have obesity. This study may not apply. A different study, including one ranking lower on the hierarchy, could be sufficient to answer the communicator's question.

This guidance document will now explore different research designs along with approaches under those designs to help researchers better understand problems or questions in food and health. Different designs allow researchers to draw different types of conclusions that shape public health.

BACK TO TOP

Hierarchy Of Evidence

Different types and levels of evidence span what is known as the hierarchy of scientific evidence. Researchers consider the hierarchy of evidence when evaluating the body of research to answer a particular question. Thinking about evidence in a hierarchy is one way to rank research based on its strength, and ultimately, how it should be applied and communicated. Animal research, translational studies, anecdote, and expert opinion are considered the lowest level of evidence. Ascending the hierarchy, the next three levels of evidence broadly include observational research, with increasing strength: cross-sectional studies; case-control studies; and cohort studies. Randomized controlled trials (RCTs) rank ahead of observational research on the hierarchy. RCTs comprise a study design that tests an intervention against a control or against the routine intervention/level of care. RCTs help control for bias in ways observational research could not. Systematic reviews and meta-analyses are situated at the top of the hierarchy. These methods are considered the highest quality research design.

Although research is viewed in an overall hierarchy, it should still be individually evaluated for rigor. Furthermore, when making comparisons across studies (e.g., comparing two research papers covering different studies), consider the patient/population, intervention, comparison, outcome, time frame, and setting/study design. Understanding populations may need observational evidence while randomized evidence is useful for understanding average treatment effects.

BACK TO TOP

Types Of Research

There are three types of research designs, which are also called research approaches, including *qualitative*, *quantitative*, and *mixed methods*, which is a combination of qualitative and quantitative. To simplify, qualitative research may be thought of as using open-ended interview questions to gather data as words whereas quantitative research uses closed-ended questions and instruments to collect data as numbers. Qualitative approaches help explore and understand meaning that has been ascribed to a social or human problem.[29] Researchers may look at the work through perspectives that value subjectivity to collect data in the participants' settings and perform the analysis.

Examples of qualitative methods include *thematic analysis*, *grounded theory*, *phenomenology*, and *case studies*. (Note that case studies may also use quantitative data.) Data may be collected with in-depth interviews, focus groups, surveys, or even just observing existing social artifacts like social media posts. Researchers may collect and analyze data simultaneously. One approach involves researchers continuing to sample participants until the researchers have reached the point of saturation, which is when they cease learning new information from an additional round of data collection. However, it is important to note that this threshold rarely occurs—which means scientific research in most areas never stops. In another approach, researchers will sample a fixed number of units of observation (e.g., people or communities).

Quantitative research is an approach to test theories with hypotheses and/or research questions by examining the relationship(s) among *variables*. While one can investigate the relationship between or among variables in qualitative research too, quantitative research uses instruments to measure variables and statistics to support analysis. The strength of the data shapes if and how the findings are extrapolated.[29,30]

Quantitative research tends to be either descriptive or analytic. A cross-sectional descriptive study collects data from a single time point and may be used to generate a hypothesis or answer questions about what, who, where, and when. An analytic study tests a hypothesis and tries to answer why and how a phenomenon occurs or make predictions.

BACK TO TOP

Researchers may combine qualitative and quantitative approaches for a mixed methods study design, and it is not unusual for research to fall along a continuum of qualitative to quantitative rather than identify strictly as one or the other.

Quantitative research can be further divided into two categories: observational and experimental.

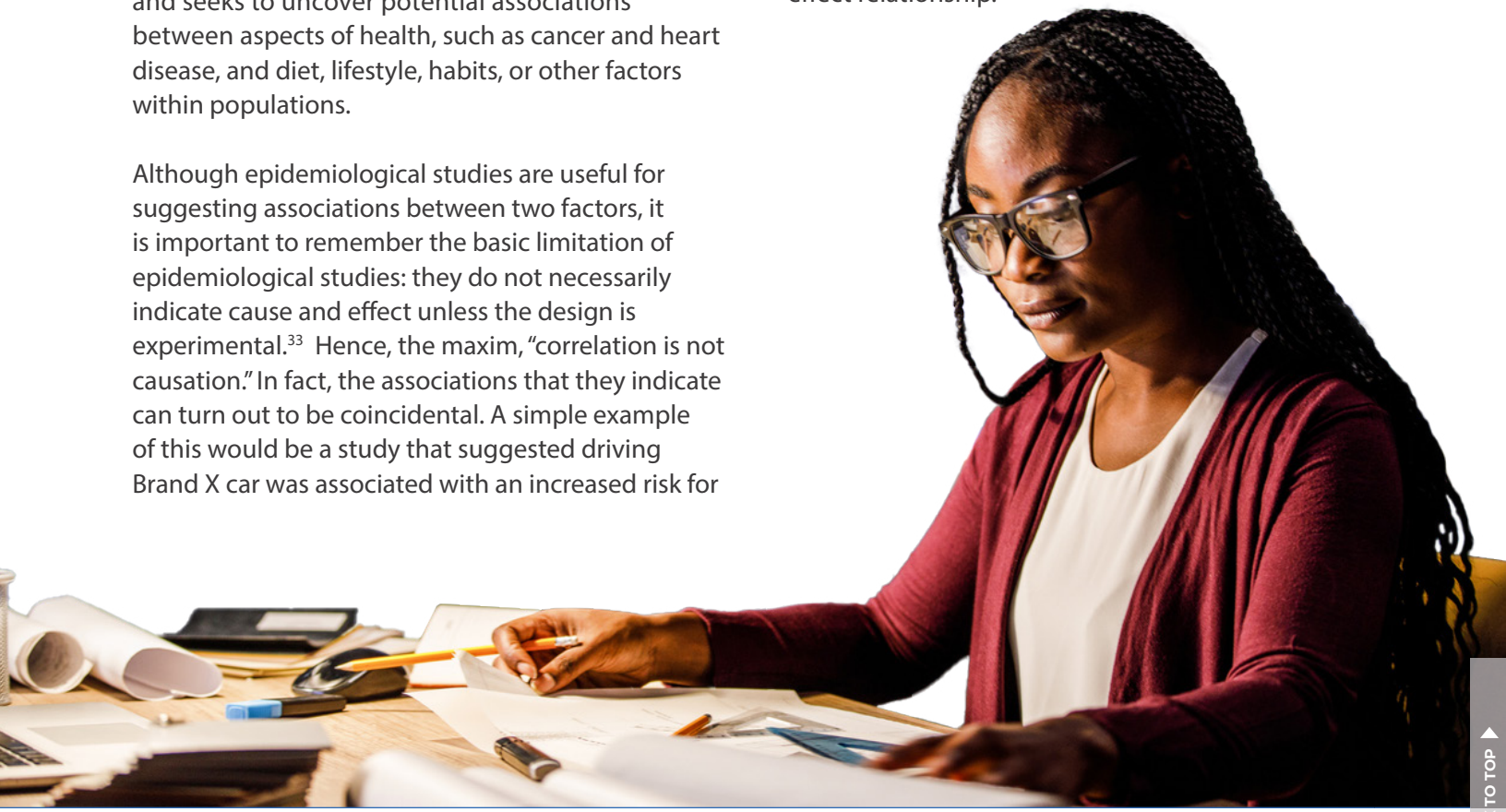
Observational Research

Observational research is a type of study design that involves an examination of specific factors in defined groups of subjects to investigate the relationships between those factors and aspects of health or illness.[31] For example, an observational study may focus on the body weight of healthy women aged 50 years or older and its association with blood pressure in that group.

Epidemiology, which is often utilized in food and health scientific discussions, is the study of the distribution and determinants of diseases or other health outcomes in human populations.[32] Epidemiological research is often observational and seeks to uncover potential associations between aspects of health, such as cancer and heart disease, and diet, lifestyle, habits, or other factors within populations.

Although epidemiological studies are useful for suggesting associations between two factors, it is important to remember the basic limitation of epidemiological studies: they do not necessarily indicate cause and effect unless the design is experimental.[33] Hence, the maxim, "correlation is not causation." In fact, the associations that they indicate can turn out to be coincidental. A simple example of this would be a study that suggested driving Brand X car was associated with an increased risk for cardiovascular disease. In this case, the fact that the car was Brand X was a coincidence because there is no mechanism to explain how Brand X car could cause cardiovascular disease. Instead, the association revealed by the study may have been confounded by driver characteristics (e.g., sex, age, weight, etc.) and the disease. Another example is one where eating ice cream is said to cause an increased risk for shark attacks. In this case, however, people tend to eat ice cream during warmer months when they also experience weather appropriate for swimming in the ocean potentially exposing them to sharks, but ice cream consumption does not cause sharks to attack.

Just as all research should be put into context, observational research, which describes much of epidemiology, may be most revealing when considered in the context of what experimental research suggests about a subject.[34] For example, to assess whether an association discovered in an epidemiological study is real and not the result of bias or *confounding factors*, researchers may conduct experimental research, such as a *randomized* clinical trial, to confirm a suspected cause-and-effect relationship.



BACK TO TOP

Toxicology Research: Supporting Food & Ingredient Safety

Toxicology research is a type of experimental research that may be used to assess food and ingredient safety. Toxicology is a specialized field that seeks to understand how chemicals, substances, or situations impact people, animals, and the environment.[40] Often described as the "Science of Safety," toxicology assumes all substances have the potential to be toxic under certain conditions—even a beneficial nutrient, if consumed in excess, may lead to toxicity.

Toxicologists perform research to explore equipment, ingredients, and chemicals, such as cell phones, aloe vera, and lead to understand the potential hazard of these substances combined with epidemiological data for exposure levels to understand overall risk. Their research generates knowledge used by regulatory authorities and policymakers. Governments take steps to protect citizens by making decisions based on toxicological research and epidemiological exposure data, decisions to limit or avoid exposure to substances of concern. For example, individual states within the U.S. create drinking water standards from toxicological research that includes risk assessments.

Experimental Research

In experimental or interventional research, human participants or animal subjects are selected according to relevant characteristics and are then randomly assigned to either an experimental group (i.e., treatment or intervention) or to a control group, which may receive the typical or standard care or may receive no treatment.[35] Thus, the distinction between observational and experimental research is that the factor of interest (e.g., a treatment) is provided in experimental research.

Clinical trials deal with the experimental study of human participants. Trials may attempt to determine if the findings from basic research apply to humans or confirm the results of epidemiological research. Studies may be small, with a limited number of participants, or they may be large intervention trials that seek to discover the outcome of treatments on entire populations. Gold standard clinical trials are *double-blind* placebo-controlled studies that use random assignment of participants to experimental and control groups.

In a randomized experiment, researchers randomly assign treatment to participants that can reduce bias in research and increase researchers' confidence in inferring causality. The experimental group(s) is(are) given a treatment/intervention, and the results are compared with those for the control group (also known as comparator group), which did not receive the intervention or who may have received a placebo. Researchers then attribute differences in results to the treatment: they conclude the effect was caused (or was not caused) by the treatment. Controlled experimental research is not guaranteed free of error, however. Sometimes these flaws are easily spotted, but in many cases, it is worth consulting topical experts. (Note that in quasi-experimental research, participants are non-randomized.[36])

The double-blind placebo-controlled randomized study is a type of experiment, often considered the gold standard of experimental design, that provides dependable findings that restrict bias introduced by either the participant or the researcher. Neither

BACK TO TOP

Researchers may use surveys, such as written questionnaires or verbal interviews, in a variety of quantitative approaches, including observational and experimental work.

the participant nor the researcher conducting the study knows whether the treatment or the comparator treatment (sometimes a placebo) has been administered. Steps are taken to design the treatment and the comparator/placebo so that they look virtually identical (i.e., appearance, smell, taste), if possible. *Blinding* in the study is crucial. This decreases the possibility that a participant's personal beliefs will undermine the study's validity, and it prevents the researcher's expectations from influencing the test results.[19] Blinding may be impossible in nutrition research where participants may determine if they are receiving the intervention diet or control diet.

Basic research is another type of experimental research that generates data by investigating biochemical substances or biological processes.[37] Scientists often employ basic research to confirm observations or to discover how a process works. For example, an experiment might take place to examine how vitamin E may help reduce oxidation of low-density lipoprotein cholesterol, a process that plays a role in the development of heart disease. A mechanistic clinical trial can be used to investigate biological or behavioral processes as well as disease pathophysiology.[38] Scientists may decide it is prudent to conduct mechanistic studies before embarking on clinical trials. For example, a mechanistic study may answer questions about how an active substance affects healthy or unhealthy bodily organs. Knowledge from that work may then inform expansion into clinical trials.[39] This basic research is part of a larger effort to understand how diet can help reduce the risk of heart disease, for example.

Basic research may be conducted in vitro (i.e., in test tubes), ex vivo (out of the living), or in vivo (using animals, cell models, or humans), or simulated situations. Research with animals is an important tool in determining how humans may react when exposed to particular substances. However, due to differences in physiology and the fact that animals are routinely exposed to levels of compounds far higher than those that humans would typically encounter, one cannot assume that results from animal studies are completely *generalizable* to humans.

Survey Research

Researchers may use surveys, such as written questionnaires or verbal interviews, in a variety of quantitative approaches, including observational and experimental work. A survey helps capture information, including participant knowledge, attitudes, beliefs, behavioral intentions, and quantification of typical or past behavior, and so forth from a small to very large number of respondents. Researchers review and process the data, and results from the sample may help researchers make claims about a population.[41] Surveys could be *cross-sectional*, at one point in time, or they may be *longitudinal* where data are collected repeatedly over time. Participants may self-administer a questionnaire, or someone from the research team may work with the participant in an interview format.

Systematic Reviews & Meta-analyses

Researchers perform systematic reviews and meta-analyses synthesizing existing evidence to help answer a question or to guide policy. A *systematic review* includes an examination of all the evidence that meets eligibility criteria and an accounting to minimize bias within the scientific literature

BACK TO TOP

selection.[42] Researchers may employ systematic review tools, like the Cochrane Risk of Bias tool, to assess bias. This contrasts with a *narrative review* that provides evidence to support the author's perspective but may exclude opposing citations.

A *meta-analysis* is a statistical method of combining results from separate studies to derive overall conclusions about a question or hypothesis.[42] Meta-analyses help reconcile differences among studies in terms of their *statistical power* or sample sizes or to aggregate relevant findings across studies.

Meta-analysis is most appropriate when examining studies that look at the same question and use similar methods to measure relevant variables.

For example, using one type of meta-analysis, scientists examined the relationship between weight reduction and blood lipid levels.[43] Although individual studies showed inconsistent results, pooling data from 70 similar studies showed *significant* decreases in the levels of total cholesterol and other blood lipids due to weight loss.

Meta-analysis is not without limitations, however. Data from flawed studies may be included, or the analysis may include data from studies that used different patient populations, interventions, or outcomes making dissimilar comparisons.[44] Publication bias may also impact the evidence available for analysis.

10 Red Flags Of Junk Science[84]

This list helps communicators and anyone determine the credibility of scientific findings. Considering these points provides an additional step to understanding and interpreting food and health research. Refer to the Managing Misinformation sidebar for when encountering these red flags. (See page 5)

- ✗ Recommendations that promise a quick fix.
- ✗ Dire warnings of danger from a single product or regimen.
- ✗ Claims that sound too good to be true.
- ✗ Simplistic conclusions drawn from a complex study.
- ✗ Recommendations based on a single study.
- ✗ Dramatic statements that are refuted by reputable scientific organizations.
- ✗ Lists of "good" and "bad" foods.
- ✗ Recommendations made to help sell a product.
- ✗ Recommendations based on studies published without peer review.
- ✗ Recommendations from studies that ignore differences among individuals or groups.

BACK TO TOP

11 Common Fallacies In Reasoning And Thinking[79,80,81]

There are many fallacies in reasoning and thinking. This is a list of some of the more common myths and missteps to help communicators guard against shortfalls in reasoning and thinking:

Ad hominem: Attacking the person making an argument instead of interrogating the argument. For example, someone explaining the science and safety of plant biotechnology (GMOs) is only doing so because they are a shill for an agriculture company.

Anecdotes: Using personal experience as generalizable evidence. One person's success or failure may not generalize to a population.

Appeal to authority, appeal to irrelevant authority: Claims that something is true based on the position of an assumed authority.

Appeal to nature: Natural is not necessarily better; discounts threats present in nature, including pathogens and predators.

Appeal to tradition: How we have always done it or used to do it must be best; romanticizing the past.

Bandwagon: Asserts a claim is true because many people believe it is true.

Fallacy: Also known as the argument from fallacy, rejects a conclusion because it is derived from an argument that contains a fallacy.

False choice / False dichotomy: Reduces a complex issue into two choices; shows up as black-or-white, this-or-that when there may be more than two options.

Genetic fallacy: Concludes that the origins of a person, idea, institute, or theory determine its character, nature, or worth. Related to ad hominem.

Hasty generalizations: Make conclusions based on a small sample; anecdotal.

Post hoc ergo propter hoc: Because B occurred after A, B caused A.

For more examples of fallacies, visit Thinking Is Power: thinkingispower.com.

BACK TO TOP

CRITICALLY REVIEWING SCIENTIFIC STUDIES

Published research generally follows an established format to enhance communication among scientists and to facilitate replication of the study. The following section of this guidance document highlights important information to expect and questions to ask when examining research publications. This information should help communicators understand each part of the study and enhance their ability to explain research results and provide valuable insights to various audiences.

Abstract

The *abstract* of a published study briefly recounts some key questions about what was studied, how the research was performed, and selected results; often presented in a structured format. Presented as a prose table of contents, the abstract's primary purpose is to allow readers to make an initial evaluation of whether a study is of interest without having to read the complete paper. As such, abstracts do not provide enough detail to enable readers to assess the validity of the study or to put the study into context; therefore, it is necessary to thoroughly read the full publication.[45]

Communicators may find themselves working under tight deadlines, tempted to rely too heavily on the abstract and/or a corresponding press release instead of critically reviewing the original published study. However, the abstract and press release are not substitutes for the research publication because they do not provide enough information to perform a critical review that would inform contextual communications content. One systematic examination of press releases from academic medical centers found that press releases often contained exaggerations and promotion of preliminary findings without reporting enough details to completely assess the research.[46]

Introduction

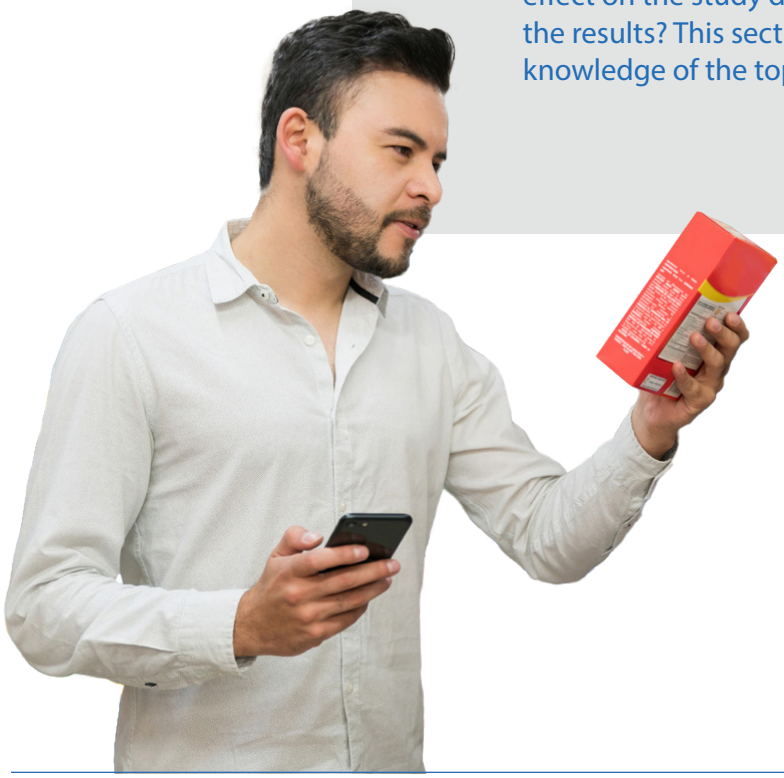
The introduction section welcomes readers to the study and presents the question that the researcher seeks to answer or the problem or hypothesis that the study addresses.[45] It explains why the study was conducted, which helps the reader understand the potential importance of the research. The introduction also expands on how the research was conducted. Introductions usually comprise two parts: the Background and the Purpose.

Background: The background information presented in the introduction of a study tells why researchers think the study is important. It should reflect a comprehensive knowledge of the body of research on the subject and should brief the reader on the previous studies that support the concepts or theories of the current study and those that do not. In essence, it apprises the reader of current thinking and presents the rationale for pursuing the study.[26]

Purpose: The purpose essentially defines the study. It dictates how a study was conducted: the research design, the variables that were measured, how information was collected and analyzed, and what conclusions may be drawn.[47] Ask yourself if the study design will answer the research question and allow for hypothesis testing. In some instances, you may find the study design does not seem appropriate to achieve the stated purpose. For example, the type of study may not yield the type of information required to answer the stated question, or the study population may not fit the purpose.

Key Questions To Ask When Critically Reviewing The Introduction Section Of Scientific Studies

- What are the study's inherent limitations? Consider some of the common limitations before reading the publication.
- Has the researcher presented an inclusive Background comprising important points that could have a meaningful effect on the study design or on the interpretation of the results? This section should present comprehensive knowledge of the topic or problem.



BACK TO TOP

Methodology

The methodology section describes how the study was conducted.[45] This section should enable critical readers to determine whether the research is *valid*, or accurate. Does the design support the purpose? The methodology section warrants careful review. It explains how the research was conducted and should give information in enough detail for the reader to evaluate the study. It should also enable the reader to understand to whom or what the study results apply. Important information featured in the methodology section may appear under subheadings and include the following:

- Setting of the study, such as a clinic, laboratory, community, etc. Speaks to conditions, control, and generalizability. A study performed where participants lived in a lab may not yield results that perfectly apply to community-dwelling people.
- How variables were controlled. Did researchers adjust for specific subject qualities or outside influences that could affect the results?
- Sample size and sampling procedures. Is it appropriate, minimizing bias?
- Number of study groups. Is there a group for each treatment or control?
- Treatment or variables observed. Is there a full description of the intervention, such as a dietary protocol or exercise regimen?
- Study duration. When did the study start and end?
- Data collection processes, including surveys and/or other instruments. Are the tools validated and credible?
- How and by what statistical procedures were the data analyzed? Were the proper statistical tests performed?

Procedures outlined in the methodology section inform the presence or absence of *validity*.

PICOTS

Researchers may employ the *PICO*, *PICOT*, or sometimes *PICOTS* approach to operationalize their work.

Patient or population and problem studied;

Intervention tested (or if an observational study, the exposure or factor of interest);

Comparator for the intervention;

Outcome of interest;

Time frame for follow-up; and

Setting or study design.[48]

BACK TO TOP

Predatory Journals

Communicators should be aware of and avoid using publications in predatory journals. Predatory journals are publications posing as credible, but they deceive researchers and could threaten public trust in science. Motivated by profit, predatory journals tend to misrepresent their practices regarding peer review while having authors pay to publish. Some of the common characteristics: insufficient peer review; falsifying their impact factor or advertising dubious metrics; promising unrealistic publication timelines; poor copyediting; fake or uncredentialed editorial board; aggressive marketing; and much more. Consult these citations for some tools to help communicators identify and avoid predatory journal publications.[82, 83]

Randomness In Selection & Assignment:
It should be noted that random selection and random assignment are different concepts. First, let's walk through *random selection*. The term random sample is familiar to many people, but exactly how participants, the sample, are selected for the study is of crucial importance. Among other things, the sampling method affects to whom the study results may be relevant.[49]

If the participants are selected randomly, that is, via a procedure where all individuals in a population under study have an equal chance of selection, then the study results may be generalizable to that population. Researchers may use a computer to generate random numbers, and the numbers will dictate if the study participant is part of the treatment or part of the control. Some research calls for complex sampling, such as the sampling approach for the National Health and Nutrition Examination Survey (NHANES) using multistage, stratified probability sampling design.[50] In a fictious example far less robust than NHANES sampling, calling people randomly from a directory of telephone numbers between the hours of 1:00 pm and 3:00 pm is not true random sampling of the entire population of the U.S. The sample may contain irregularities such that only certain people are home during that time while everyone else is unavailable; people home or available during that time frame may not be completely representative of the population.

When planning the division of participants for the groups in the experiment, random assignment can be utilized. *Random assignment* ensures that all subjects have an equal chance of being in the experimental and the control groups and increases the probability that any unidentified variable will systematically occur in both groups with the same frequency. *Randomization* is crucial to control for variables that researchers may not be aware of or cannot adequately control but that could affect the outcome of an experimental study.

To estimate an effect of a treatment, researchers carefully control for as many variables as feasible that could affect the outcome of a study. Some of the variables are obvious, such as age, body weight, and sex. To control for these differences, researchers may match subjects in experimental and control groups so that they have similar characteristics. Some variables, such as heredity, are more difficult to control for. Still others may remain unknown. By randomly assigning subjects to study groups, the influence of such variables is minimized and any differences in results between groups can be attributed to the treatment in the long run.

Sample Size: Researchers work to ensure they have a sample size large enough to find an effect. *Power* is the ability of a test to detect significant

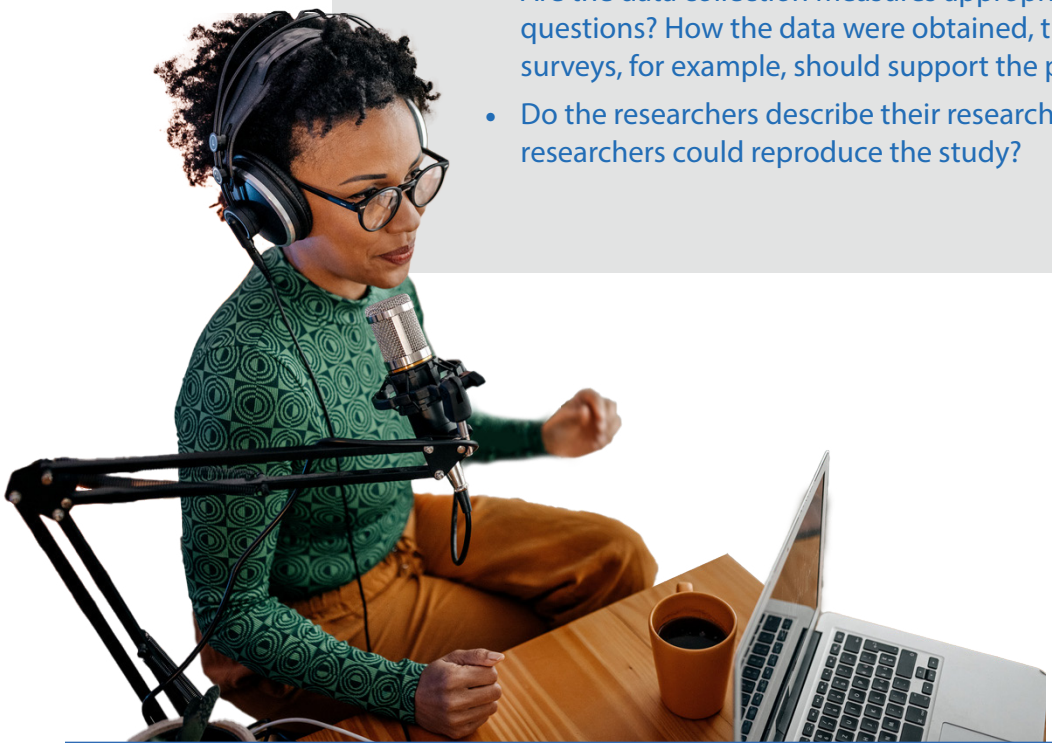
BACK TO TOP

differences in a population when the differences exist.[51] Researchers may use a formula to calculate the appropriate number of participants based on certain variables. For example, when studying the effect of a drug, a researcher may decide that the sample size of 100 people is adequate because the effect is easily noted: how many pounds did those in the treatment group lose compared with those in the control group? However, when assessing the average fruit and vegetable consumption among children who participated in a school-based intervention program, several thousand children may be necessary because the increase from such an intervention is likely to be relatively small. The diets of the children in the experiment and in the control groups may not differ much in terms of fruit and vegetable intake, and therefore, the effect of the intervention might not be noticed. Researchers can spot a small effect with a larger sample size. Larger sample sizes support precision. However, at some point, increasing the sample size produces diminishing returns and consumes more resources.[52]

A small sample size, however, does not necessarily mean the study is flawed. Small samples may help identify large differences.[52] Consider that some studies may have smaller sample sizes because of the design and variables to control. The researcher should communicate their justification for the sample size.

Key Questions To Ask When Critically Reviewing The Methodology Section Of Scientific Studies

- Does the research design fit the study's purpose?
- Are there any major design flaws in this study? Look for adequate sampling, for example.
- Are the data collection measures appropriate to answer the study questions? How the data were obtained, through focus groups or surveys, for example, should support the purpose of the study.
- Do the researchers describe their research methods clearly so other researchers could reproduce the study?



BACK TO TOP

Results

This guidance document will specifically focus here on the results section of a quantitative research study, due to the prevalence of these types of studies dominating food and health science communication efforts.

A primary outcome of a study should have been identified prior to data analysis. The study design and statistical analysis plan were developed to answer the primary outcome of the study. The authors may also present secondary outcomes, but the primary outcome should be given emphasis. The results section provides data and statistical analyses. It is where we find answers to problems, questions, or hypotheses outlined in the purpose statement and introduction.

Statistics are used to convey the existence and strength of relationships.[45] The field of statistics is based on the quantification of information. Descriptive statistics present the information in an organized fashion to facilitate interpretation. Examples include percentage, frequency, mean, and standard deviation. Descriptive statistics help summarize but do not provide information about cause and effect; instead, this is the realm of inferential statistics. Inferential statistics often involve making inferences from the results from the sample studied and extrapolating them to a larger population.[53]

As noted in previous sections, qualitative research reports differ from quantitative. Qualitative reports may emphasize how data were processed and the analysis of themes and theories. These types of reports may provide a chronological narrative of a participant's life or an in-depth description of group culture, for example. A researcher may provide a detailed case study report as well. Qualitative study reports may use participant quotes to illustrate conversations, and researcher interpretations may appear intertwined in the manuscript.[54]

Statistical Summaries: Researchers generally calculate summaries of data, including means, medians, standard deviations, ratios, ranges, and confidence intervals.[55] These summaries may be within groups (e.g., describing the baseline information for each group or how a group changed over time) or between groups (e.g., comparing the effect of an intervention between two groups). One often-used approach is to test for *statistical significance* based on P values (Refer to the American Statistical Association statement on P values for additional information.).[56] If calculated correctly, a P value is a probability: it is the probability that under a set of assumptions, the calculated results (e.g., the sample mean difference between two or more compared groups) would be equal to or more extreme than what was seen in the study. In the case of statistical significance, if that P value is less than a threshold (often referred to as alpha), researchers will conclude results are statistically significant. Often, alpha is set to 0.05, but researchers may set it to different levels (e.g., 0.10 or 0.01) depending on their study goals or standards in their field. In the case of 0.05, if there is no true difference between groups, then seeing a P value of 0.05 or less would happen about 1 out of every 20 studies.

BACK TO TOP

P values and statistical significance are tricky to interpret because they are probabilities and the true population difference between groups is typically unknown. If results are statistically significant, they still could be that rare (1 in 20) chance where there is no real difference between groups (a Type I error). Even if results are not significant, a true difference may have been missed by chance (a Type II error).

This leads to two important points. First, statistical significance or P values alone are not enough to evaluate a study. Look at the magnitude of differences between groups. Does it look like there is a meaningful difference on average, or are the effects small? Then, look at the uncertainty around those differences (which is related to the P values). If the confidence intervals are wide, it indicates the study results are uncertain for how big of a difference there is between groups. The *confidence interval* is a statistical estimate of the range of likely values of a statistic in a source population based on the value of that statistic in a study population. A narrower confidence interval indicates more certainty about the value than a wide confidence interval.[57] Second, it is important for results to be replicated and multiple forms of evidence to point to the same result. This relates to considering the totality of evidence. If multiple studies come to similar conclusions across multiple lines of evidence, it is more likely that a finding is true.

Key Questions To Ask When Critically Reviewing The Results Section Of Scientific Studies

What is the statistical significance of these results? Noteworthy results may be statistically significant, or if not statistically significant, the results could still have some public health relevance, but conclusions must not be exaggerated.[58]

- To whom do these results apply? Ensure the study sample matches the external population before making claims.
- How do these results compare to results from other studies on the subject? Consider each research study in the context of the body of research.
- Was a risk assessment mentioned (or only a hazard assessment)?
- How does potential hazard compare to risk? Attend to the differences between hazard and risk. (See page 24) Hazard assessments often generate a lot of media attention.

Discussion & Conclusion

The discussion section of a study gives the reader some insight into the study subject area and often sheds new light on the results and their meaning. Researchers may also present alternative explanations for the results as well as public health recommendations and implications of the research. Proceed cautiously with absolute conclusions professing the final word on a subject. Good research answers some questions and raises others, but most studies do not present groundbreaking findings.[26]

Whatever the conclusion, researchers must tie it back to the work performed and the results. Sometimes a publication may note conclusions or recommendations that are not adequately supported by the study. This may occur for a few

BACK TO TOP

reasons: collection of insufficient or inadequate data, overgeneralization of results, methodological problems, and/or inherent limitations of the study design. Sometimes, researchers stray from the scientific method by reporting conclusions or recommendations that are unrelated to the research question or hypothesis that was tested. Although conclusions or recommendations made in this manner may have merit, it is important to take a deeper look at whether the study was adequately designed and conducted to support the secondary conclusions or recommendations.[63]

Research publications usually conclude with a call for more research to investigate issues that remain unclear or to replicate the current study findings. Before concluding, and somewhere within the conclusion section or contained in its own aptly named section, researchers will address limitations.[64]

Research is not without limitations. Researchers are often limited by available funding or the ethics associated with working with human participants, for example, and these can restrict progress on the study and its results. Consider the characteristics of the study sample. Research on college females may generate conclusions that cannot apply to college males. An observational study design is limited in that conclusions should not be used to communicate cause and effect. Study participants may alter their behavior or falsely report their behavior to try and make themselves appear a certain way to the research team. There are many potential limitations. Expect researchers to cover those in this section.

Key Questions To Ask When Critically Reviewing The Discussion And Conclusion Section(s) Of Scientific Studies

- Do the data and results support the conclusions? Observational data should not be used to determine cause and effect.
- Do the conclusions address the purpose of the study? If not, do the study design and results support the secondary conclusions? Conclusions should speak to research questions and/or hypotheses identified in the publication. For randomized controlled trials, consult the study registration document, which is available at ClinicalTrials.gov (https://clinicaltrials.gov). Researchers may register systematic reviews in databases, such as PROSPERO (https://www.crd.york.ac.uk/PROSPERO/).
- What influence might the limitations have on the results? Consider limitations as you review the publication. For example, if the study pertains to promoting weight loss, did researchers enroll participants with obesity, or were participants' body weights within the normal range at the outset?
- How does this study add to the body of knowledge? Consider the body of research on this topic or problem and whether these findings support, extend, or challenge current thinking.
- How does this study advance the field? Researchers may learn new problems or validate tools that help other researchers.

BACK TO TOP

Communicating Risk

Absolute Risk

refers to the actual risk of an occurrence, the chance that a specific outcome will occur.

Relative Risk

puts risk in comparative terms—the outcome rate for people exposed to the factor in question compared with the outcome rate for those not exposed to the factor.

A relative risk of > 1 indicates an increased risk of the outcome under investigation; a risk of < 1 indicates a decreased risk of the outcome. Relative risk close to or equal to 1 says that the incidence rate in the exposed and unexposed is about the same. Relative risks are a commonly used measure of morbidity or mortality in medical literature. However, in many cases, absolute risk is a far more relevant statistic for the public.[59, 60]

For example, suppose that a study shows that a person who brushes their teeth only once a day is 50% more likely to have all their teeth fall out in the next 10 years than others who brush their teeth twice per day. This is the relative risk. Yet, the absolute risk that all the person's teeth will fall out may be only 1%. In this case, the relative risk makes the problem seem more important than it really is. However, relative risk can also make a problem appear to be less important than it is.

Another example, from the Canadian Task Force on Preventive Health Care, pertains to breast cancer screening.[61] Breast cancer screening in women aged 50-69 years of age reduces absolute risk of dying from breast cancer by 0.13%. Absolute risk considers the baseline risk of dying from breast cancer. Relative risk examines the reduction of risk as a proportion of the total risk. Women in the same age bracket who receive screening experience a reduced relative risk of dying of breast cancer by 21%. Therefore, it is important to consider both relative risk and absolute risk when discussing study results.

Another issue in communicating risk stems from risk assessment and the use of the terms hazard and risk. Scientists may employ those terms differently than other communicators or the media more broadly. There is an important distinction: *hazard* pertains to the ability of a substance or agent to cause adverse effects whereas *risk* considers the probability that harm will occur.[62] For example, when going to the beach, a person may consider the hazard posed by sharks in the ocean. That person standing on the beach is unlikely to experience harm. Swimming in the water with the shark speaks to risk, or the likelihood of harm befalling the swimmer.

BACK TO TOP

References

Researchers will consider other published work on the topic or problem at hand, and the most pertinent scholarly publications and relevant sources are compiled at the end of the publication in a references section. It is typical for an article to use about 25 to 30 references, but some may comprise 100 or more.[65] The references cited should pull from the most current, relevant, credible, and/or robust work, and it is common practice to cite classic, seminal papers that delve further into the past. When critically reviewing a research publication, it is common to peruse the citations and thoroughly read some of those publications, too. Experts in the subject area can usually tell if key research has been omitted from the reference list. If this is the case, the researchers may have inadequately reviewed, considered, and evaluated prior work in the field that could have benefited their current study.

Additional Considerations

Other considerations to note when critically reviewing research include funding and the appropriate use of editorials and letters to the editor. The presence of actual or perceived bias shows up in many ways, and a material connection is often part of discussions about bias. Transparency in funding helps navigate bias; yet there is evidence that funding disclosures may induce bias in readers such that it may impair their judgment about the scientific merits of research.[66] In addition to examining funding, communicators may read editorials to understand peer-reviewed research more deeply.

Funding Source: Research requires many resources, including money. Funding for research originates from a variety of sources: industry, government, philanthropies, and others. A best practice is to disclose funding and the role of the funder because transparency helps support trust and because peer-reviewed journals require this type of disclosure. Although it is interesting to note the funding source of a study, the presence of external funding is not the most important point to evaluate and does not negate the results of the research.[67]

The reason that studies are often funded by organizations that may benefit from the results is obvious. Who else but an interested party would allocate large amounts of money that good research necessitates? For example, when a company seeks approval for a new food ingredient,

BACK TO TOP

law requires the company to support adequate studies to demonstrate the ingredient's safety. The government may be less likely to invest millions of dollars to study food ingredients or products that may never come to market.

In addition to disclosing funding sources, researchers are expected to disclose other material connections that may be perceived to influence the research. Researchers may document consulting relationships with specific clients, for example. These connections are often noted as disclosures.

Ethical researchers do not manipulate data or design studies to support the funder's interests. Indeed, most funders do not want a researcher to simply endorse their views. A critical evaluation of research on its own merit is the best way to assess validity and importance. If the study methods are good, results will stand on their own regardless of who supported the research.

Editorials And Letters To The Editor: Editorials—opinion pieces written by experts in a field—are an additional tool for readers to understand a study, its meaning, and its practical implications that may accompany the published article.[68] Editorials often provide perspective on a study, discussing the study in the context of other research, as well as identifying potential flaws that may affect the applicability or the veracity of the study results.

Although letters to the editor usually appear in future journal issues following the publication of research studies, these letters can be very useful to help identify potential limitations with or implications of a study. They can be used as coaching for what to look for when critically reviewing studies.

Ultra-Processed Food

Interest in how food is grown, produced, and consumed has never been greater. That includes increased focus on the presence or absence of food processing. Communicators may identify increased research and scholarly debate around processed foods, and more research is forthcoming.[74]

Processed food is defined as a food material that has been changed in some way through a combination of ingredients together with processing steps to make the food safe to eat, shelf-stable for future use, convenient to use, tasty/palatable, and/or more nutritious.[75]

Food is processed both at home and commercially for a wide variety of reasons. Briefly, processing helps ensure year-round food availability, makes food edible, protects against post-harvest loss and contamination, adds nutrients (i.e., fortification and enrichment), and much more. Food has been processed for centuries, and much of the modern diet contains processed food.[76]

There is one small clinical trial looking at ultra-processed food and calorie intake in 20 participants.[77] In addition, there are several observational studies on the positive association of ultra-processed food consumption and adverse outcomes. On the other hand, researchers designed a 7-day meal pattern high in ultra-processed foods, a pattern that was also of high dietary quality (i.e., nutritious).[78] Nutrition and health researchers continue to debate the best way to classify the level of processing in food as a methodological tool.

Communicators should understand that the presence of processing is not cause for dismissing a food. Examine Nutrition Facts labels and other data that speak to diet quality and nutrition content.

BACK TO TOP

NEXT STEPS: COMMUNICATING MORE EFFECTIVELY

This guidance document presents information to support food, nutrition, and health communicators, such as journalists, educators, health professionals, and policymakers, engaging in critical review of food and health scientific studies. Such critical review is essential to place results into the context of the body of scientific literature on a subject and to accurately present the relevance of research to the public without hype, but rather with context. Communicators serving as information conduits are challenged to communicate credible content while sometimes combatting inaccurate information. Research communication should convey to whom the study results apply with clear language for association versus causation.

Although the various elements of a study that have been discussed affect whether a piece of research provides valid and relevant answers to a question, it is important to realize that perfect research does not exist.[26] Economics, ethics, and the current state of knowledge may limit a study in its ability to find the answers sought. These external forces are an overlay to a nonlinear scientific process. The research cycle frequently moves in many different directions, generating questions, discussions, and debates along the way. Science is a process, and researchers communicate with other scientists through scholarly publications. Communicators regularly consume research publications and translate the contents for the public.

With that in mind, how does the communicator navigate the maze of emerging scientific findings about food and health to deliver accurate, relevant information to the public? Consider all parts of the study publication, from abstract, introduction, methodology, results, discussion, and conclusions, and ask the key questions posed above. Discuss and debate the paper with trusted colleagues. Reserve judgment about a study until consulting other studies and appropriate experts to help assess the findings of the study and gauge its level of importance.

BACK TO TOP

Communicating With Context

Communicators who need to distill the findings of a study may consider contacting the study authors as well as other scientists familiar with the body of research on the topic. Experts can answer questions and provide insight. In addition, interviewing scientists other than the study author(s) can bring valuable balance. When approaching these experts, inquire about the interpretation and whether plausible alternatives exist. By asking "What's your take on this study?", a communicator may learn how other scientists view the same data, yet drawing different conclusions that may help provide overall context.

While thinking about conclusions, communicators can also probe how other experts view the study's design. Research methods are rarely perfect, and communicators need to know if there are any considerations that would alter conclusions as well as messages to the public. Engaging with experts is another opportunity to revisit generalizability, or the applicability of the study's findings to people outside the study. As noted before, cascading results to wide ranges of people, especially people different from the study's sample, is a practice communicators must guard against.

Lastly, during a discussion with the researchers and other topical experts, interrogate the big picture to explore how this study fits with the body of research. If the current paper confirms or aligns with previous research or departs from current thinking, the communicator's role is to put all research into context. Then take a moderate approach to conveying new information. Rarely is a singular finding a life-altering game changer. Communicators should acknowledge or anticipate consumer reactions to the study, communicate what is known from the study as well as the broader literature, and then provide credible, actionable content.

Key Questions To Ask When Seeking To Communicate With Context

- What emotions does the study elicit? Acknowledge potential responses.
- How can communicators clearly convey study findings based on the study design and other contextual factors, such as study population? Determine application of the results in communication content.
- How can communicators help audiences act, if appropriate? Sometimes, taking no action is warranted based on the best available evidence. Consider how this research aligns with national dietary guidelines.
- Will audiences understand that science evolves and findings from one study may undergo additional scrutiny in the future? Science is a process.

BACK TO TOP

KEY DEFINITIONS

This section comprises select terms, many of which you will see in the body of this guidance document, with definitions. These terms will help communicators understand and interpret scientific research in food and health.

Absolute Risk A term for the incidence rate that emphasizes that the number is a measured value in one population rather than a comparison of several observed values.[69] Absolute risk refers to the actual risk of an occurrence—the chance that a specific outcome will occur.[60]

Alpha A Greek letter (α) used to indicate the probability of a type 1 error.[69]

Basic Medical Research Studies of molecules, genes, cells, and other smaller biological components related to human function and health.[69]

Bias A systematic flaw in the design, conduct, or analysis of a study that can cause the results of a study not to accurately reflect the truth about the source population.[69]

Blinding (also called "masking" in some literature) An experimental design element that keeps participants and/or researchers from knowing whether a participant is in the intervention group or the control group.[69] In a double-blind experiment, neither the researchers nor the participants know who is receiving the treatment.

Case Report A report that describes one patient.[69]

Case Study A type of qualitative research that focuses on a specific program, event, or activity involving an individual.[26]

Clinical Trial Research designed to evaluate and test new interventions, such as psychotherapy or medications. Clinical trials are often conducted in four phases, each with a different purpose to help scientists answer different questions.[70] A clinical trial is a research study in which one or more human subjects are prospectively assigned to one or more interventions (which may include placebo or other control) to evaluate the effects of those interventions on health-related biomedical or behavioral outcomes.[71]

Cohort Study An observational study that follows people forward in time so that the rate of incident (new) cases of disease can be measured.[69]

Confidence Interval A statistical estimate of the range of likely values of a statistic in a source population based on the value of that statistic in a study population. A narrower confidence interval indicates more certainty about the value than a wide confidence interval.[69]

Confounder, Confounding Variable A third variable that is associated with both the exposure variable and the outcome variable and distorts the apparent relationship between the exposure and outcome.[69]

Control A participant in an observational study design, such as a case-control study, who does not have the disease being examined or a participant in an experimental study assigned not to receive the active intervention.[69]

Control Variable A variable that is held constant during observation or statistical analysis.[56]

KEY DEFINITIONS

Correlation A statistical measure of the degree to which changes in the value of one variable predict changes in the value of another.[69]

Cross-sectional Study A study that measures the proportion of members of a population who have a particular exposure or disease at a particular point in time; also called a prevalence study.[69]

Dependent Variable A variable in a statistical model that represents the output or outcome for which the variation is being studied; also called the outcome variable.[69]

Disinformation Deliberately false information intended to deceive.[13,14]

Double-blind An experimental study design in which neither the participants nor the researchers assessing the participants' health status know which participants are in an active or control group.[69]

Editorials, Letters To The Editor Opinion pieces written by experts in a field. The editorial or letter is published in the journal.[68]

Epidemiology The study of the distribution and determinants of health and disease in human populations.[69]

Experimental Study A study that assigns participants to receive a particular exposure; also called an intervention study. The active treatment/intervention is given to the experimental group.[69] The experiment may compare two or more interventions, such as diets.

Funding Source Funding for research originates from a variety of sources: industry, government, philanthropies, and others. Researchers may also disclose relationships and other material connections that may be perceived as a conflict of interest.

Generalizability The external validity of a study that allows its results to be considered applicable to a broader target audience.[69]

Grounded Theory A type of qualitative research design that seeks to understand a process, action, or interaction among a group of participants. A grounded theory study typically results in the presentation of a theoretical model.[26]

Incidence The number of new cases of disease in a population during a specified period.[69]

Independent Variable A variable in a statistical model that predicts the value of some outcome variable; also called a predictor variable.[69] The characteristic or attribute of the participant that influences the dependent variable.[26] The independent variable is the presumed cause.[56]

Longitudinal Cohort Study, Longitudinal Design A study that follows a group of individuals who are representative members of a selected population forward in time but does not recruit them based on exposure status.[69] Data are collected at multiple time points.

Mal-information Information based on reality but used to inflict harm on a person, organization, or country.[12]

Meta-analysis The calculation of a pooled statistic that combines the results of similar studies identified during a systematic review.[69]

Misinformation Wrong or misleading information shared by someone who believes the information is true.[10,11]

KEY DEFINITIONS

Narrative Review A tertiary analysis that provides a unique perspective about a topic by using evidence from the literature to support the author's commentary.[69]

Observational Study A study in which no participants are intentionally exposed to an intervention or asked to change their behavior.[69]

Outcome An observed event such as the presence of disease in participants in an observational study or the measured endpoint in an experimental study.[69]

Outcomes Research A broad term that describes research concerned with the effectiveness of public health interventions and health services; that is, the outcomes of these services.[72] See Outcome definition.

Participant An individual who has consented to participate in a research study. Data are collected from participants to answer the research question(s). Also known as a subject.[26]

Phenomenology The study of objective experiences. Also known as a phenomenological approach; a type of qualitative research design that seeks to understand the commonalities of a lived experience among a group of individuals.[26]

PICOTS A framework of patient/population, intervention, comparison, outcome, time frame, and setting/study design that is helpful for developing clinical research questions and designing intervention studies.[48]

Placebo An inactive comparison that is similar to the therapy being tested in an experimental study, such as a sugar pill used as a control for a pill with an active medication, a saline injection used as a control for an injection of an active substance, and a sham procedure that is designed to look and feel like a real clinical procedure used as a control for that active procedure.[69] Placebo treatments are used to eliminate bias that may arise from the expectation that a treatment should produce an effect.

Power, Statistical Power In statistics, the ability of a test to detect significant differences in a population when differences really do exist; the power of tests is increased when the number of participants included in the analysis is large.[69] A power of 80%, or 0.8, indicates that a study, if conducted repeatedly, would produce a statistically significant effect 80% of the time given a specified sample size and effect size.

Prevalence The percentage of members of a population who have a given trait at the time of the study.[69]

Prospective Study A study that follows participants forward in time. The term usually refers to cohort studies that recruit participants based on their exposure status.[69] Also called a longitudinal cohort study.

P Value A very small P value means that the observed test result is highly unlikely to have occurred by chance.

Random Selection A process that gives each case in the population an equal chance of being included in the study sample.[69]

Randomization, Random Assignment Assignment of participants to an exposure group in an experimental study using a chance-based method that minimizes bias arising from assignment.[69]

Randomized Controlled Trial An experimental study in which some participants are randomly assigned to an active intervention group and some participants are assigned to a control group, and all participants from both groups are followed forward in time to see who has a favorable outcome and who does not.[69]

Relative Risk Relative risk puts risk in comparative terms—the outcome rate for people exposed to the factor in question compared with the outcome rate for those not exposed to the factor. A relative risk of > 1 indicates an increased risk of the outcome under investigation; a risk of < 1 indicates decreased risk of the outcome.[59,60]

Reliability In a survey instrument, diagnostic test, or other assessment tool, a quality that is demonstrated when consistent answers are given to similar questions and when an assessment yields the same outcome when repeated several times; also called precision.[69] Stability or consistency.

Research Design The overall plan of an empirical study, including the basic approach, sampling design, and measurement of key variables.[56]

Retrospective Cohort Study A cohort study that recruits participants based on data about their exposure status at some point in the past and typically also measures outcomes that have already occurred (but happened after the baseline exposures were established); also called a historic cohort study.[69] Participants recall past occurrences.

Risk The probability of an individual in a population becoming a case during a defined period.[69] Distinguish between absolute risk and relative risk. (See page 24)

Risk Factor An exposure that increases an individual's likelihood of subsequently experiencing a particular disease or outcome.[69] Do not use a risk factor to infer cause and effect.

Sample Size The number of individuals in the study.[69] See Power definition.

Statistical Significance A classification based on a test result having a P value less than a preselected significance level (typically 0.05).[69] A P value of 0.05 indicates there is a 5% risk of concluding a difference exists when there is no actual difference.[26] Note that the scientific community debates the usefulness of statistical significance.

Systematic Review The use of a predetermined and comprehensive searching and screening method to identify relevant articles during a tertiary analysis.[69] See Narrative Review definition.

Thematic Analysis A type of qualitative analysis that focuses on organizing key ideas that emerge from single or multiple forms of collected data.[26]

Toxicology According to the National Institutes of Health National Institute of Environmental Health Sciences, toxicology is a specialized field that seeks to understand how chemicals, substances, or situations impact people, animals, and the environment.

Validity In a survey instrument, diagnostic test, or other assessment tool, a condition that is established when the responses or measurements in a study are shown to be correct; also called accuracy.[69]

Variable A characteristic or attribute of individuals in a research study. To qualify as a variable, the characteristic or attribute must vary among participants and be measurable.[26] In an experiment, the treatment is called the independent variable; the factor under investigation. The independent variable is the collection of attributes; in an experiment, for example, the intervention and the control collectively may make up a treatment variable. The dependent variable is influenced by the treatment, and the dependent variable may change because of the effect of the independent variable.

BACK TO TOP

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