



Scientific Method

LEARNING OBJECTIVES

As a result of reading this chapter, students will:

1. Explain how to seek the truth about health products, especially when hearing conflicting information.
 2. Describe six characteristics of scientific testing.
 3. Analyze the importance of learning about valid and reliable scientific testing and research practices and their application when attempting to select a health-related product or therapy.
 4. Assess the impact of television infomercials or fitness magazine ads on people who want to lose weight or gain muscle mass.
-

■ WHAT ARE THE CHARACTERISTICS OF SCIENTIFIC TESTING?

How many times in our lifetime do we hear someone tell us about a “proven” remedy for some condition or disorder that we may have. For example, it may have been expressed similar to this, “I heard that cherry juice will cure gout.” How do we learn whether cherry juice will really cure gout? We need to know if the statement is fact or hearsay. While studying information for personal health consumerism, whether it is part of mainstream medicine or complementary and alternative therapies, individuals should learn how to assess whether a treatment modality has been scientifically tested. After reviewing the research results, one could say whether the treatment is legitimate. Research involves scientific testing of a theory or idea, and the research procedures to be used should be based on several characteristics.

Characteristics of Scientific Testing

The first characteristic of scientific testing is that the research should be self-correcting.^{1,2} In other words, if the results of a research study are later found to be false, the research should be conducted again so that the conclusions or results may be modified. When conducting research, the truth is not found in one experiment or study; it often

requires many studies to find the truth. An example of how attitudes change based on scientific study is the belief about acupuncture, a traditional Chinese medicine treatment. For years, western medical and health professionals believed that acupuncture was quackery. Granted, there are still those who do, but the National Center for Complementary and Alternative Medicine (NCCAM) has conducted several studies demonstrating the effectiveness of acupuncture in treating pain (i.e., low back pain, headaches, osteoarthritis) as well as providing other benefits.³ See **BOX 2.1**. Many studies are needed to find the truth, and that is what sound research does.

Second, the study requires objectivity.^{1,2} The findings must not be biased by the researcher’s personal beliefs, perceptions, values, or emotions. When planning the study, the

Box 2.1

U.S. Medical Physicians Becoming Certified in Acupuncture

Rather than declaring acupuncture a bogus treatment modality, numerous medical physicians here in the United States are now becoming certified in acupuncture techniques. Many now view acupuncture as a valuable medical treatment.

researchers must develop rules and procedures for the research (such as formulating specific hypotheses or research questions and setting significance levels). If the research involves a pen and paper or Internet survey, the coding procedure and statistical analyses should be planned in advance. Quantitative research methods are those in which a value, score, or scale is used. Objectivity is met fairly easily because the researcher is working with numbers.

Problems with objectivity come when researchers have not specified methods that measure qualitative research. For instance, if researchers were to measure the degree to which individuals liked or disliked television advertisements for medicines or acupuncture to cure addictions, they could record the number of times (quantitative research) the subjects changed the channel. However, if they attempted to base the level at which individuals liked or disliked television advertisements by the looks on subjects' faces (qualitative research), the results would more than likely be biased.

A third characteristic is that the findings must be made public.^{1,2} Most researchers attempt to publish their findings in peer-reviewed professional journals. Certainly, findings may be made public by mass media (television, Internet, radio), but peer review is essential.

A fourth characteristic is that the experiments must be reproducible by other scientists at later times.^{1,2} This requires other scientists to replicate the same research process using the same research design and methodology.

A fifth characteristic is that the experiment must be empirical,^{1,2} a word derived from the Greek word for experience or observation.⁴ If the research is experimental, the scientist may manipulate a variable and then observe the results. Qualitative research may entail observing without manipulating any variables. An example of the latter is Jane Goodall's studies of chimpanzees (see **FIGURE 2.1**) from the 1960s to the 1990s, when she observed and recorded



FIGURE 2.1 Chimpanzee.

them in their native environment, the Gombe Stream National Park, located in Tanzania in southeastern Africa.⁵ Jane Goodall watched and observed but did not try to interact with the chimpanzees in any way. In other words, she did not manipulate the variables (the chimpanzees) and bias her research.

A sixth characteristic is that science should be predictive.^{1,2} Such predictions are demonstrated in scientific theories that arise as a result of research studies. The predictions allow for further research that tests the theories. At times, such theories are found not to be true, and more research and theories are subsequently conducted and planned.

It is true that scientific testing takes much time and money just to prove that a product or treatment will work.



Case Study

Abbey is a college student in her senior year. Her major is health education, and she believes it is important to practice healthy behaviors, but she has had many rigorous courses over the past 2 years and has been working 30 hours per week. As a result, Abbey has not had time to exercise, and she has not eaten very nutritiously. Abbey perceives that she is overweight and out of shape. One day she is watching a 20-minute infomercial on television promoting a fat-burning product. She is impressed about the before and after results of three individuals who recounted their experience using this "wonder" drug and how their lives had changed due to all the weight they had lost. Even though the product is very expensive, Abbey is seriously considering buying it.

Questions:

1. How can Abbey learn whether the product has been scientifically tested?
2. What steps are taken to conduct scientific testing of drugs and products?
3. Do you believe that a drug will be the answer to Abbey's problems? Why or why not?

To identify effective health or medical treatments, however, the research must require exemplary scientific testing characteristics, and the researchers have to plan an appropriate research design depending on what is to be tested.

The next section will give you a brief overview of what is involved in scientific testing, starting with information about research design.

■ WHAT ARE THE TYPES OF RESEARCH DESIGNS?

Research design is divided into two main categories: experimental and quasi-experimental.⁶ If it is experimental, the subjects are randomly selected or assigned into either a treatment or a control group. If it is quasi-experimental, comparison groups are not randomly selected, and many factors may cloud (or confound) the findings. Confounding factors (variables) may relate to both the cause and effect or outcome. For example, it could be that a statistical analysis shows that ice cream sales and heat stroke are highly positively correlated (related). A researcher could determine that eating ice cream causes heat stroke. The confounding factor, of course, is the summer season. More people eat ice cream in the summer and the summer weather is a factor in causing heat stroke. A research study may be valuable, but confounding factors need to be accounted for.

Studies are conducted in a variety of ways, ranging from pen and paper survey studies to laboratory experiments.^{1,2,6} Studies may involve researching historical facts from archived materials. They may involve analyzing data from large populations over a span of years. They may involve conducting case studies on a limited number of individuals. Please refer to **BOX 2.2** for types of research study designs. No matter the type of study design, however, the researcher must abide by scientific research characteristics.

Finally, numerous types of data may be collected. Blood or other body fluids may be drawn and examined in laboratory experiments. Morbidity and mortality statistics and historical data may be sought from local, state, or national databases. Surveys may be used to collect demographic, knowledge, attitude, and behavioral information (via tele-

phone, personal interview, or paper and pencil). As described, the researchers must carefully select the type of research design most appropriate for the particular study and determine the type of data to be collected. We, as health consumers, should become knowledgeable about the steps taken when conducting scientific research so we can determine if a health product or service is one that we should purchase. The steps in scientific research are summarized in the following section.

■ WHAT ARE THE STEPS IN SCIENTIFIC RESEARCH?

Depending on the type of research study, the scientific process may be somewhat different, but the steps listed here are very appropriate for health professionals. A needs assessment⁷ may be one of the first steps completed so that a researcher can identify health or health behavioral problems existing in a community, county, or state. It is beneficial if the researcher can use findings from fairly current needs assessments because it saves a great deal of time. Usually, several health and health behavioral problems are identified within needs assessments; therefore, the researcher determines which health problems will be researched. For example, a county (parish) needs assessment may reveal high rates of diabetes, heart disease, hypertension (high blood pressure), lung cancer, sexually transmitted diseases, tobacco use, and teen pregnancy. The researcher cannot investigate all these problems at one time, but needs to select one or two for further investigation. Depending on the purpose, researchers can conduct their research in many ways. The researcher might develop an educational program that would be tested for effectiveness or the researcher might investigate the reasons (variables) related to the health problem (e.g., relationship of tobacco use to lung cancer).

A literature review is important because the researcher can identify studies that could be replicated or used as a guide. The literature review may include researching library databases such as ERIC (educational studies), Medline (medical studies), Sociofile (sociology database), or PsychInfo (psychology-behavioral database). Most of the journal articles found in the databases will be research-based. A review of dissertations or theses written during the past few years may also be accessed. The researcher could conduct Internet searches from sources such as PubMed and NCCAM Web sites.

Now it is time for the researcher to plan the research study. First, the researcher will develop the hypotheses or research questions; of which there might be four or more. These questions are the basis of the study. Next, the researcher will plan the research design and methodology and set the statistical level of significance. The researcher has to determine if this type of research requires being 95 percent confident about the results or whether the results should be 99 percent certain. Once the research questions,

Box 2.2

Research Study Designs

- *Case studies:* Observation of people
- *Laboratory experiments:* Controlled environment
- *Epidemiological studies:* Analyze data from various population groups
- *Controlled clinical trials:* May involve a number of people using an experimental group and a control group

Box 2.3**Steps in Scientific Research**

1. Identify a problem.
2. Review existing research based on the problem.
3. Develop either hypotheses or research questions.
4. Plan the research design and methodology (complete with the type of statistics to be used and the statistical level of evaluation).
5. Collect and analyze the data.
6. Describe the results of each hypothesis or research question.
7. Publicize the results in peer-reviewed journals.
8. Other researchers may replicate the study.

design and methodology are set, it's time to collect the data, which comprises many forms: bodily liquids, body measurements, oral communication, pen and paper tests, and others. The researcher may conduct blood draws to analyze blood content levels of certain substances (e.g., glucose, lipids, hormones) before and after exercise performance. If the researcher has planned an educational program, a pre and post pen and paper test may be given to assess gains in knowledge and changes in attitudes and behaviors. No matter what the data is composed of, the statistical results are carefully recorded and analyzed.

Once the statistical work has been completed, the researcher will write the results in a formal manuscript. The manuscript is then sent to professional journals for publication and presented at professional conferences and/or seminars. It is important for the findings to be peer reviewed

because it is a means to validate the study design, methodology, and results.^{1,2} The steps in scientific research are summarized for you in **BOX 2.3**.

■ COULD YOU APPLY WHAT YOU HAVE LEARNED?

You are taking a basic research class at the undergraduate or graduate level and you have been asked to conduct a study. Your professor has told you that the study has to be a survey to assess knowledge, attitudes, and behaviors about a health topic. Because you are interested in learning more about herbal supplements, you decide that will become your health topic.

Preliminary Information

Your professor has suggested that you use college students to collect data from because they are available and would reduce time and expenses.

Of benefit to you, a health needs assessment was conducted at your university and it revealed several health problems: a large percentage of college students were overweight, did not regularly exercise, felt stressed out, were not eating nutritiously, and were not sleeping well.

Your Task

Using the needs assessment results and the steps in conducting research, describe how you would set up this study. You need to determine what you want to learn about herbal supplement use.

Step 1: Use one or more of the problems identified from the college needs assessment.

Step 2: Identify two or more databases you would use to learn about related studies.

Step 3: Formulate three research questions.

*In the News*

A news article published on June 15, 2010, described a study wherein smokers with higher levels of vitamin B6 and an essential amino acid were found to have less risk of developing lung cancer than those lacking the nutrients. This was a study of nearly 400,000 participants that included current and former smokers in 10 European countries.

Questions:

1. If people read this account, how might they interpret the results?
2. What might smokers do as a result of reading about this study?

Further information was also presented in this news article. The researchers did not conclude that consuming more of the nutrients would reduce the risk of getting lung cancer, and they did promote the message that it was important for smokers to give up the habit.

We as health consumers need to research information about health and medical treatments, but we must be careful not to misinterpret what we read and hear. Furthermore, most of us do not have time to find information about every medicine and treatment that we use in our everyday lives. It becomes problematic and confusing when we are unsure if a medical or health product or therapy really works. So how can we more easily obtain help?

Step 4: Plan your research design.

- What would be the best way to collect your data?
- How many participants do you want to include in your study?
- Could you do a study to investigate if herbal supplement use is related to one or more health problems identified from the college needs assessment?
- Can you think of any confounding factors that would bias your research?

When the steps in scientific research are followed, although it seems to be a slow and precise process, we can usually trust that the findings are the truth. Researchers have to be careful, however, when interpreting and publishing research results because people can become confused about the meaning of those results. See In the News for a published account of a recent research study.

■ **HEALTH CONSUMERS: CAN WE TRUST WHAT WE READ AND HEAR ABOUT HEALTH AND MEDICAL TREATMENTS?**

These days, we health consumers are bombarded with mega amounts of information. This often causes uncertainty when attempting to make a rational decision about what product, medicine, treatment, and/or therapy we should buy and use. We cannot always trust what we read and hear. Because there are many problems with health information (as listed in **BOX 2.4**), health consumers need to be able to find accurate sources.

■ **WHERE CAN WE FIND VALID, RELIABLE, AND EVIDENCE-BASED HEALTH INFORMATION?**

We should have faith in a claim if the source demonstrates that the treatment, product, or medicine is the result of evidence-based research. This is research that has been planned and executed using the techniques previously discussed in this chapter. If that has occurred, we can be assured that the health or medical product has been scientifically tested. A red flag should go up, however, when we hear or read promises from some source touting untested or unusual remedies for chronic or incurable diseases.

Box 2.4
Problems with Health Information

- Sources not reliable
- Nonprofessionals or pretend scientists promoting products
- Some medical professionals promoting products for their own financial gain
- Media hype on certain products—unwarranted

A health product or medical treatment should be tested to determine if it is scientifically sound. Testing will include assessing if the health product or medical treatment is valid and reliable. Validity is the extent to which the test predicts the outcome it is supposed to predict, and a test is said to be reliable if it yields consistent results.^{2,6} For example, a procedure to use stents in carotid arteries has recently been tested and approved to lessen the probability that a person will experience a stroke. The researchers would have posed a research question such as, “Will carotid artery stents lessen the probability of stroke?” The ensuing research demonstrated that the stents did lessen the probability of stroke. Moreover, after a longer period in time, it became evident across a wide population at risk for stroke that the stents were effective. The researchers could make the claim that this treatment was indeed valid and reliable.

If there is a question about the validity of health information, there are several ways to investigate.

1. Check for verification of the product or drug, such as a peer-reviewed article or report.
2. Investigate safety research on products and side effects of medicines/drugs.
3. Don’t rely on the results of one study. Remember that several studies are often required.
4. If you read a report, investigate the origin of the report. Find out if it was from a peer-reviewed study or medical institution. If not, be wary.
5. Ask your doctor.
6. Read reliable magazines and newsletters, such as the following:
 - *FDA Consumer*
 - *Consumer Reports on Health*
 - *Tufts University Diet and Nutrition Letter*
7. Obtain information from reputable sources, including
 - Governmental agencies such as the Food and Drug Administration (FDA)
 - American Medical Association
 - Volunteer agencies (e.g., American Cancer Society, American Heart Association)
 - Foundations (e.g., Arthritis Foundation)
 - U.S. Department of Health and Human Services (Office of Public Health and Sciences)
 - Trusted consumer health publications and Web sites.⁸

There are some trustworthy Internet sites. A few of these are listed for you in **BOX 2.5**.

■ **CONCLUSION**

This chapter was intended to raise your awareness of the importance of scientific research and its application in your life

Box 2.5

Trustworthy Internet Sources

- Medlineplus:* <http://medlineplus.gov>
- National Institutes of Health's Senior Health:*
<http://nihseniorhealth.gov>
- National Cancer Institute:* <http://www.cancer.gov>
- CAMline:* <http://www.camline.ca>
- Consumer Health Complete Ebsco:* <http://www3.dbu.edu/library/documents/Consumer-Ebsco.pdf> (gives directions on how to conduct your search)
- Harvard Health Publications:* <http://www.health.harvard.edu/>
- National Institutes of Health Center for Complementary and Alternative Medicine (NCCAM):* <http://nccam.nih.gov>

as a health consumer. We need to be cautious about what we read and hear, especially on the Internet and in television infomercials. To be optimal health consumers, we need to

learn the important steps of scientific research, and we need to learn how to find valid and reliable information.

Suggestions for Class Activities

Select one of the two.

1. Find a Web site that deals with health issues or the sale of health products and evaluate it for reliability and scientific soundness. Web site evaluation forms are available. Here are two links to aid you in finding a tool:
 - <http://www.sph.emory.edu/WELLNESS/instrument.html>
 - <http://www.hon.ch/HealthEvaluationTool/>
2. Exercise.
 - a) Analyze four types of exercise equipment using the Exercise Equipment Rating form provided in **TABLE 2.1**. In order to do the analysis, research necessary articles for information regarding the

Table 2.1

Exercise Equipment Rating Form

Note: The pieces of equipment listed below are heavily advertised and many are used in fitness gyms. On a scale of 1 to 5, with 5 being the highest and best number, please rate each item's effect according to fitness level, strength, muscle endurance, and cardiorespiratory endurance. Also rate how each would affect specific body parts. Research the average cost of each. Place your number in the appropriate box and total your points. The items listed below are only samples. You may use them or find different items.

F = fitness level, S = strength, ME = muscle endurance, CRE = cardiorespiratory endurance

Scale: 1 2 3 4 5
 Poor Fair Average Good Excellent

Equipment	BENEFITS				BODY PARTS AFFECTED					COST	TOTAL POINTS
	F	S	ME	CRE	Arm	Leg	Shoulder	Back	Core		
Shake weight											
Inversion table											
Exercise bike											
Elliptical machine											
Treadmill											
Fitness balls											
Ab circle pro											

Discussion Questions

1. After quantifying each of the types of exercise equipment that you chose, were you surprised at your findings? Why?
2. What advice would you offer your friends or family if they were thinking about purchasing a piece of equipment that has been heavily advertised?

particular piece of equipment. Provide a reference list.

- b) Answer the two discussion questions found on the form.

Review Questions

1. How are facts determined?
2. What are the characteristics of scientific testing?
3. What are the types of research design?
4. What steps are involved in conducting scientific research?
5. What are confounding factors?
6. What is the meaning of “validity” and “reliability”?
7. To what extent should people believe what they read and hear about health matters?
8. Where can valid, reliable, and/or evidence-based information be found?

Key Terms

acupuncture A traditional Chinese medicine treatment that uses stainless steel needles at specific points in the body to increase the flow of life energy known as Qi or Chi.

biased research Errors in research during the selection of subjects, the measurements used, or the treatment process (intervention).

consumer A person who buys and uses goods. In this text, it means the person who buys and uses health-related goods.

demographic A single vital or social statistic of a human population, such as the number of births or deaths.

empirical A word derived from the Greek word for experience or observation.

experimental Subjects are randomly selected or assigned into a treatment or control group.

hypnosis The induction of a person into a state of consciousness in which he or she is responsive to a suggestion/s by a therapist.

hypothesis A research statement or proposal that the subsequent study will find truthful or not.

morbidity Refers to illness or disease.

mortality Refers to deaths.

NCCAM (National Center for Complementary and Alternative Medicine) A center in the National Institutes of Health that conducts research to prove the effectiveness of complementary and alternative therapies.

needs assessment Investigation to determine health needs. May investigate at the community, county, state, or national level.

objectivity in research Findings must not be biased by personal beliefs, perceptions, biases, values, or emotions of the researcher.

peer review Peers review the study usually when it is submitted for publication. It is a means to validate the study design, methodology, and results.

predictive approach The researcher makes a guess or prediction about the research problem based on the probability that the prediction is accurate. The study tests the prediction using specialized statistical techniques.

qualitative research Research that seeks to provide understanding of human experience, perceptions, motivations, intentions, and behaviors. It requires observation and personal interaction with subjects rather than the use of a survey instrument.

quasi-experimental Comparison groups in a study are not randomly selected, and many things may cloud (or confound) the findings.

reliability The consistency of a measurement, or the degree to which an instrument measures the same way each time it is used under the same condition with the same subjects. It refers to the repeatability of a measurement.

reputable Considered to be respectable or acceptable.

research design A design that may be experimental or quasi-experimental.

research questions Rather than a statement or statements found in hypotheses, research questions are formulated. The study tests each research question for truth or not.

self-correcting research If results of a previous research study are later found to be false, the research should be conducted again so that the conclusions or results may be modified.

significance levels The levels set before a research study is begun. If the level is not met for a particular hypothesis or research question studied, the research is said to be non-significant and is rejected.

validity The strength of conclusions, inferences, or propositions. Validity is the extent to which the test predicts the outcome it is supposed to predict.

References

1. RM Institute. *The research methods knowledge base*. 2006. Available at: <http://www.researchmethods.org/rm-knowledge.htm>. Accessed November 2, 2009.
2. Patten M. *Understanding research methods: an overview of the essentials*. 7th ed. Glendale, CA: Pycszak; 2009.
3. National Institutes of Health, National Center for Complementary and Alternative Medicine. *Acupuncture*. Available at: <http://nccam.nih.gov/health/acupuncture/>. Accessed June 3, 2009.

4. alphaDictionary.com. *Empirical*. Available at: <http://www.alphadictionary.com/goodword/word/empirical>. Accessed February 28, 2009.
5. The Jane Goodall Institute. *Study corner—biography*. Available at: <http://www.janegoodall.org/study-corner-biography/>. Accessed July 1, 2010.
6. Berg K, Latin R. *Essentials of research methods in health, physical education, exercise science, and recreation*. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2008.
7. Sharma A, Lanum M, Suarez-Balcazar Y. *A community needs assessment guide: a brief guide on how to conduct a needs assessment*. Chicago: Center for Urban Research and Learning and the Department of Psychology, Loyola University; September 2000. Available at: http://www.luc.edu/curl/pdfs/A_Community_Needs_Assessment_Guide_.pdf. Accessed July 6, 2009.
8. Murray S. Consumer health information. *J Can Health Libr Assoc*. 2006;27:39–40.