

FIFTH EDITION

Research Methods in Physical Activity

The background of the cover is a complex, abstract composition. It features a dark blue base with various shades of blue, green, and purple. A prominent feature is a bright, multi-pointed starburst or lens flare on the left side, with lines radiating outwards. To the right of the starburst is a large, glowing orange sphere with a bright white highlight on its upper left, giving it a three-dimensional appearance. The overall texture is painterly and dynamic, with various geometric shapes and organic forms blending together.

Jerry R. Thomas • Jack K. Nelson
Stephen J. Silverman

RESEARCH METHODS IN PHYSICAL ACTIVITY

Fifth Edition

Jerry R. Thomas, EdD

Jack K. Nelson, EdD

Stephen J. Silverman, EdD



Human Kinetics

Preface

With the publication of this fifth edition, 20 years have passed since the first edition was published in 1985. We want to take this opportunity to thank all the people who have used this book over the years. We hope you have learned a lot about research methods in the study of physical activity. Maybe you've even enjoyed a few of the humorous stories, jokes, and pictures we've included to enliven the reading. We were particularly pleased to note the paper by Silverman and Keating (2002) in *Research Quarterly for Exercise and Sport* that indicated that 71% of the people responding to their survey about the research methods course used our book. Their survey results clearly show that the content of this book is well aligned with the topics teachers of research methods believe are important. We are also delighted that many of the other English-speaking countries also use this book—*Good on ya' mates!!* In addition we appreciate that earlier editions have been translated into Chinese, Japanese, and Portuguese.

Dr. Stephen Silverman has joined us as a coauthor on this edition. Because Dr. Jack Nelson retired, but continued to provide input and assistance in this revision, we needed to provide for a transition of authorship. Dr. Silverman is a well-known scholar and methodologist in physical education pedagogy, and at the writing of this edition, he is the editor-in-chief of *Research Quarterly for Exercise and Sport*. He brings considerable expertise and research experience to this fifth edition.

The main use of this text still appears to be in the first graduate-level research methods courses, although it is also being used in undergraduate research methods and as a resource for research planning and analysis. Our use of the term *physical activity* in the book title is meant to convey the broadly conceived field of study often labeled kinesiology, exercise science, exercise and sport science, human movement, sport studies, or physical education as well as related fields such as physical therapy, rehabilitation, and occupational therapy. We hope everyone who reads, understands, plans, carries out, writes, or presents research will find the book a useful tool to enhance their efforts.

The fifth edition remains organized as the fourth edition was, as follows:

- *Part I* is an overview of the research process including developing the problem, using the literature, preparing a research plan, and understanding ethical issues in research and writing.
- *Part II* provides an introduction to statistical and measurement issues in research, including statistical descriptions, power, relationships among variables, differences among groups, nonparametric procedures, and measurement issues in research.
- *Part III* presents the various types of, or approaches to, research including historical, philosophical, research synthesis, survey, descriptive, epidemiological, experimental, and qualitative.
- *Part IV* is designed to help you complete the research process, including writing the results and discussion, organizing the research paper, developing good figures and tables, and presenting research in written and verbal forms.
- Appendixes include statistical tables, a brief historical overview of the field, and sample forms for securing permission to use humans and animals in research.

Although the format of the book remains similar to that of the fourth edition, we have made a number of changes that we hope improve and update the text. Various people have read and reviewed the previous edition and provided helpful comments, including the many students we

have taught and faculty who use the book to teach research methods. We truly do pay attention to the things you tell us. However, sometimes when we read reviews, we feel like Day (1983, p. xi), who said that a reviewer described his book as both good and original, but then went on to say that “the part that is good is not original and the part that is original is not good.” Following is a short review of the changes for this fifth edition:

- *Part I: Overview of the Research Process.* Each chapter has minor revisions with updates of information and more recent reports. We strive in each new edition to keep the chapter about using library techniques up-to-date and always ask our university librarian to review and evaluate what we have presented.

- *Part II: Statistical and Measurement Concepts.* We strive in each edition to increase the relevance of the examples and provide students with easy-to-understand calculations for basic statistics. Using the learning activities in the instructor guide and the approaches to statistical analyses in the appendix, students should grasp basic understandings about statistical techniques. In the fourth edition we changed to a more unified approach to parametric and nonparametric techniques, and we maintain that approach here. We have developed a new chapter in this section called “Using Power to Plan and Interpret Research.” In the fourth edition this was part of chapter 6, but because of its importance, we have separated it out and expanded the information.

- *Part III: Types of Research.* We have continued our use of expert authors to present coherent views of historical research (Nancy Struna), philosophical research (Scott Kretchmar), and epidemiological research in physical activity (Barbara Ainsworth and Chuck Matthews). These three types of research are outside our expertise, and we wanted them presented effectively by expert scholars. Another significant revision in this section is the qualitative research chapter. The many changes in the field have prompted us to expand and update our discussion on qualitative research. We also have expanded the sections on quasi-experimental and single-subject research. In addition, we have made minor revisions and updates to all of the other chapters in this part.

- *Part IV: Writing the Research Report.* The two chapters in this section remain essentially the same, with minor changes and updates of material.

We are also grateful to the literary executor of the late Sir Ronald A. Fisher, F.R.S., to Dr. Frank Yates, F.R.S., and to Longman Group Ltd., London, for permission to reprint tables A.3 and A.5 from their book *Statistical Tables for Biological, Agricultural and Medical Research* (6th ed., 1974).

As we have said in each edition, we are grateful for the help of our friends, both for help that we acknowledge in various places in the book, and in other places where we have inadvertently taken an idea without giving credit. “After the passage of time, one can no longer remember who originated what idea. After the passage of even more time, it seems to me that all of the really good ideas originated with me, a proposition which I know is indefensible” (Day, 1983, p. xv).

We believe this book provides the necessary information for both the consumer and the producer of research. Although no amount of knowledge about the tools of research can replace expertise in the content area, good scholars of physical activity cannot function apart from the effective use of research tools. Researchers, teachers, clinicians, technicians, health workers, exercise leaders, sport managers, athletic counselors, and coaches need to understand the research process. If they do not, they are forced to accept information at face value or on the recommendation of others. Neither is necessarily bad, but the ability to carefully evaluate and reach a valid conclusion based on data, method, and logic is the mark of a professional.

Inserted into various chapters are humorous stories, anecdotes, sketches, laws, and corollaries. These are intended to make a point and enliven the reading without distracting from the content. Research processes are not mysterious events that graduate students should fear. To the contrary, they are useful tools that every academic and professional should have access to; they are, in fact, the very basis on which we make competent decisions.

Jerry R. Thomas
Jack K. Nelson
Stephen J. Silverman

Dear Student of Research Methods:

Before you begin this course, your potential as a research methods student should be evaluated. *Score one point for each of the following statements that applies to you.*

You might be a research methods student if . . .

your library carrel is better decorated than your apartment.
you have ever brought a scholarly article to a bar or coffee shop.
you rate coffee shops on the availability of outlets for your laptop.
you have ever discussed academic matters at a sporting event.
you actually have a preference between microfilm and microfiche.
you always read the reference lists in research articles.
you think the sorority sweatshirt Greek letters are a statistical formula.
you need to explain to children why you are in the 20th grade.
you refer to stories as "Snow White et al."
you wonder how to cite talking to yourself in APA style.

Scoring Scale

5 or 6—Definitely ready to be a student in research methods
7 or 8—Probably a master's student
9 or 10—Probably a doctoral student

Humorously yours,
Professors of Research Methods

Acknowledgments

As in any work, there are numerous people who contributed to this book and whom we should recognize. Many of these individuals are former students and colleagues who have said or done things that better developed our ideas as expressed in these pages. Also, a number of faculty members who have used previous editions have either written reviews or made suggestions to us that have improved the book. While we cannot list or even recall all of these contributions, we do know you made them, and we thank all of you.

In particular, we thank Karen French at the University of South Carolina, Dick Magill at Louisiana State University, Brad Cardinal at Oregon State University, and Kathi Thomas at Iowa State University for allowing us to use materials that were published jointly with them. Scott Kretchmar, Nancy Struna, Barb Ainsworth, and Chuck Matthews made an invaluable contribution with their chapters on research methods in philosophy, history, and exercise epidemiology, topics that we simply could not write about effectively.

If you adopt this book for your class, we hope you will make use of the class teaching materials available on the Human Kinetics Web site. Included are over 300 Microsoft PowerPoint® slides, learning activities, test questions, and other course materials. We thank Phil Martin from Pennsylvania State University for his contributions to these materials.

Finally, we thank the staff at Human Kinetics, in particular Holly Gilly, our developmental editor for this edition, for their support and contributions. They have sharpened our thinking and improved our writing.

Jerry R. Thomas
Jack K. Nelson
Stephen J. Silverman

Library of Congress Cataloging-in-Publication Data

Thomas, Jerry R.

Research methods in physical activity / Jerry R. Thomas, Jack K. Nelson, Stephen J. Silverman.-- 5th ed.

p. cm.

Includes bibliographical references and index.

ISBN 0-7360-5620-3 (hardcover)

1. Physical education and training--Research. 2. Health--Research. 3. Recreation--Research. 4. Dance--Research. I. Nelson, Jack K. II. Silverman, Stephen J. III. Title.

GV361.T47 2005

613.7'1'072--dc22

2005005754

ISBN-10: 0-7360-5620-3

ISBN-13: 978-0-7360-5620-5

Copyright © 2005 by Jerry R. Thomas, Jack K. Nelson, and Stephen J. Silverman

Copyright © 2001, 1996, 1990, 1985 by Jerry R. Thomas and Jack K. Nelson

All rights reserved. Except for use in a review, the reproduction or utilization of this work in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including xerography, photocopying, and recording, and in any information storage and retrieval system, is forbidden without the written permission of the publisher.

The Web addresses cited in this text were current as of February 22, 2005, unless otherwise noted.

Acquisitions Editor: Loarn D. Robertson, PhD; **Developmental Editor:** Holly Gilly; **Assistant Editors:** Amanda M. Eastin and Bethany J. Bentley; **Copyeditor:** Patsy Fortney; **Proofreader:** Kathy Bennett; **Indexer:** Betty Frizzéll; **Permission Manager:** Dalene Reeder; **Graphic Designer:** Fred Starbird; **Graphic Artist:** Denise Lowry; **Photo Manager:** Sarah Ritz; **Cover Designer:** Jack W. Davis; **Photographers (interior):** Dan Wendt. Photo on page 282 by Sarah Ritz; **Art Manager:** Kelly Hendren; **Illustrators:** Accurate Art, Gretchen Walters, and Kelly Hendren; **Printer:** Edwards Brothers

We thank the University of Illinois, HDC Engineering, and Follett's Bookstore in Champaign, Illinois, for assistance in providing the location for the photo shoot for this book.

Printed in the United States of America 10 9 8 7 6 5 4 3

Human Kinetics

Web site: www.HumanKinetics.com

United States: Human Kinetics, P.O. Box 5076, Champaign, IL 61825-5076

800-747-4457

e-mail: humank@hkusa.com

Canada: Human Kinetics, 475 Devonshire Road Unit 100, Windsor, ON N8Y 2L5

800-465-7301 (in Canada only)

e-mail: orders@hkcanada.com

Europe: Human Kinetics, 107 Bradford Road, Stanningley, Leeds LS28 6AT, United Kingdom

+44 (0) 113 255 5665

e-mail: hk@hkeurope.com

Australia: Human Kinetics, 57A Price Avenue, Lower Mitcham, South Australia 5062

08 8277 1555

e-mail: liaw@hkaustralia.com

New Zealand: Human Kinetics, Division of Sports Distributors NZ Ltd., P.O. Box 300 226 Albany, North Shore City, Auckland

0064 9 448 1207

e-mail: info@humankinetics.co.nz

Contents

Preface xi

Acknowledgments xv

■ Part I Overview of the Research Process	1
Chapter 1 Introduction to Research in Physical Activity	3
▪ <i>The Nature of Research</i> 3 ▪ <i>Unscientific Versus Scientific Methods of Problem Solving</i> 10 ▪ <i>Alternative Models of Research</i> 14 ▪ <i>Types of Research</i> 17 ▪ <i>Overview of the Research Process</i> 20 ▪ <i>Summary</i> 22	
Chapter 2 Developing the Problem and Using the Literature	25
▪ <i>Identifying the Research Problem</i> 25 ▪ <i>Purpose of the Literature Review</i> 29 ▪ <i>Basic Literature Search Strategies</i> 31 ▪ <i>Steps in the Literature Search</i> 32 ▪ <i>Summary</i> 49	
Chapter 3 Presenting the Problem	51
▪ <i>Choosing the Title</i> 51 ▪ <i>Writing the Introduction</i> 52 ▪ <i>Stating the Research Problem</i> 54 ▪ <i>Presenting the Research Hypothesis</i> 56 ▪ <i>Operationally Defining Your Terms</i> 57 ▪ <i>Basic Assumptions, Delimitations, and Limitations</i> 58 ▪ <i>Justifying the Significance of the Study</i> 59 ▪ <i>The Differences Between the Thesis and the Research Article</i> 61 ▪ <i>Summary</i> 61	

Chapter 4	Formulating the Method	63
	▪ <i>How to Present Methodological Details</i> 64 ▪ <i>Why Planning the Method Is Important</i> 64 ▪ <i>Two Principles for Planning Experiments</i> 64 ▪ <i>Describing Participants</i> 65 ▪ <i>Describing Instruments</i> 67 ▪ <i>Describing Procedures</i> 68 ▪ <i>Describing Design and Analysis</i> 72 ▪ <i>Establishing Cause and Effect</i> 73 ▪ <i>Interaction of Participants, Measurements, and Treatments</i> 74 ▪ <i>Summary</i> 75	
Chapter 5	Ethical Issues in Research and Scholarship	77
	▪ <i>Seven Areas of Scientific Dishonesty</i> 77 ▪ <i>Ethical Issues Regarding Copyright</i> 83 ▪ <i>Model for Considering Scientific Misconduct</i> 85 ▪ <i>Working With Faculty</i> 86 ▪ <i>Protecting Human Participants</i> 88 ▪ <i>Protecting Animal Subjects</i> 90 ▪ <i>Summary</i> 91	
■ Part II	Statistical and Measurement Concepts in Research	95
Chapter 6	Becoming Acquainted With Statistical Concepts	97
	▪ <i>Why We Need Statistics</i> 97 ▪ <i>Use of Computers in Statistical Analysis</i> 99 ▪ <i>Description and Inference Are Not Statistical Techniques</i> 99 ▪ <i>Ways to Select a Sample</i> 99 ▪ <i>Justifying Post Hoc Explanations</i> 101 ▪ <i>Difficulty of Random Sampling and Assignment: How Good Does It Have to Be?</i> 101 ▪ <i>Unit of Analysis</i> 102 ▪ <i>Measures of Central Tendency and Variability</i> 103 ▪ <i>Basic Concepts of Statistical Techniques</i> 107 ▪ <i>Summary</i> 110	
Chapter 7	Statistical Issues in Research Planning and Evaluation	113
	▪ <i>Probability</i> 113 ▪ <i>Meaningfulness (Effect Size)</i> 115 ▪ <i>Power</i> 116 ▪ <i>Using Information in the Context of the Study</i> 119 ▪ <i>Reporting Statistical Data</i> 122 ▪ <i>Summary</i> 123	

Chapter 8 Relationships Among Variables 125

- *What Correlational Research Investigates* 125
- *Understanding the Nature of Correlation* 126
- *What the Coefficient of Correlation Means* 132
- *Using Correlation for Prediction* 135
- *Partial Correlation* 138
- *Uses of Semipartial Correlation* 139
- *Procedures for Multiple Regression* 139
- *Multivariate Forms of Correlation* 141
- *Summary* 144

Chapter 9 Differences Among Groups 147

- *How Statistics Test Differences* 147
- *Types of t Tests* 149
- *Interpreting t* 154
- *Relationship of t and r* 157
- *Analysis of Variance* 157
- *Analysis of Covariance* 171
- *Experimentwise Error Rate* 171
- *Understanding Multivariate Techniques* 172
- *Summary* 176

Chapter 10 Nonparametric Techniques 179

- *Chi Square: Testing the Observed Versus the Expected* 181
- *Procedures for Rank-Order Data* 185
- *Correlation* 186
- *Differences Among Groups* 188
- *Summary* 191

Chapter 11 Measuring Research Variables 193

- *Validity* 193
- *Reliability* 197
- *Methods of Establishing Reliability* 200
- *Intertester Reliability (Objectivity)* 202
- *Standard Error of Measurement* 202
- *Using Standard Scores to Compare Performance* 204
- *Measuring Movement* 205
- *Measuring Written Responses* 205
- *Measuring Affective Behavior* 205
- *Scales for Measuring Affective Behavior* 207
- *Measuring Knowledge* 209
- *Item Response Theory* 210
- *Summary* 211

■ Part III Types of Research 213

Chapter 12 Historical Research in Physical Activity 215

- *Research Paradigms* 215
- *Lines of Inquiry and Topics* 217
- *Designing the Research* 220
- *Working With the Evidence* 220
- *Summary* 228

Chapter 13	Philosophic Research in Physical Activity	231
	▪ <i>Identifying the Purposes of Philosophic Research</i> 232 ▪ <i>Locating a Research Problem</i> 235 ▪ <i>Analyzing a Research Problem</i> 236 ▪ <i>Summary</i> 243	
Chapter 14	Research Synthesis (Meta-Analysis)	247
	▪ <i>Using Meta-Analysis to Synthesize Research</i> 248 ▪ <i>Presenting Effect Size Data</i> 256 ▪ <i>Summary</i> 257	
Chapter 15	The Survey	269
	▪ <i>The Questionnaire</i> 269 ▪ <i>The Delphi Method</i> 280 ▪ <i>The Personal Interview</i> 281 ▪ <i>The Normative Survey</i> 284 ▪ <i>Summary</i> 284	
Chapter 16	Other Descriptive Research Methods	287
	▪ <i>Developmental Research</i> 287 ▪ <i>The Case Study</i> 290 ▪ <i>Job Analysis</i> 293 ▪ <i>Observational Research</i> 293 ▪ <i>Unobtrusive Research Techniques</i> 297 ▪ <i>Correlational Research</i> 298 ▪ <i>Summary</i> 299	
Chapter 17	Physical Activity Epidemiology Research	301
	▪ <i>Observational Versus Experimental Research</i> 303 ▪ <i>What Is Epidemiology?</i> 303 ▪ <i>Physical Activity Measurement Definitions</i> 305 ▪ <i>Assessment of Physical Activity</i> 306 ▪ <i>Epidemiologic Study Designs</i> 309 ▪ <i>Reading and Interpreting a Physical Activity Epidemiologic Study</i> 318 ▪ <i>Summary</i> 320	
Chapter 18	Experimental and Quasi-Experimental Research	321
	▪ <i>Sources of Invalidity</i> 322 ▪ <i>Threats to Internal Validity</i> 323 ▪ <i>Threats to External Validity</i> 326 ▪ <i>Controlling Threats to Internal Validity</i> 327 ▪ <i>Controlling Threats to External Validity</i> 329 ▪ <i>Types of Designs</i> 330 ▪ <i>Summary</i> 343	

Chapter 19	Qualitative Research	345
	▪ <i>Contrasting Characteristics of Qualitative and Quantitative Research</i> 346	
	▪ <i>Procedures in Qualitative Research</i> 347	
	▪ <i>Analysis of the Data</i> 352	
	▪ <i>Concluding Remarks</i> 362	
	▪ <i>Summary</i> 363	
■ Part IV	Writing the Research Report	365
Chapter 20	Completing the Research Process	367
	▪ <i>Research Proposal</i> 367	
	▪ <i>Developing a Good Introduction</i> 367	
	▪ <i>Describing the Method</i> 368	
	▪ <i>The Proposal Process</i> 369	
	▪ <i>Preparing and Presenting Qualitative Research Proposals</i> 372	
	▪ <i>Writing Proposals for Granting Agencies</i> 373	
	▪ <i>Submitting Internal Proposals</i> 374	
	▪ <i>Completing Your Thesis or Dissertation</i> 374	
	▪ <i>Results and Discussion</i> 374	
	▪ <i>How to Handle Multiple Experiments in a Single Report</i> 378	
	▪ <i>How to Use Tables and Figures</i> 379	
	▪ <i>Summary</i> 386	
Chapter 21	Ways of Reporting Research	389
	▪ <i>Basic Writing Guidelines</i> 389	
	▪ <i>A Brief Word About Acknowledgments</i> 390	
	▪ <i>Thesis and Dissertation Format: Traditional Versus Journal</i> 390	
	▪ <i>Helpful Hints for Successful Journal Writing</i> 397	
	▪ <i>Writing Abstracts</i> 398	
	▪ <i>Making Oral and Poster Presentations</i> 401	
	▪ <i>Summary</i> 404	
■ Appendixes		405
A	Statistical Tables	405
B	A Brief Historical Overview of Research in Physical Activity in the United States	418
C	Sample Consent Forms	422

References 432

Author Index 448

Subject Index 450

About the Authors 455

PART

I

Overview of the Research Process

*The researches of many have thrown much darkness
on the subject and if they continue,
soon we shall know nothing at all about it.*

—attributed to Mark Twain



This part provides you with an overall perspective of the research process. The introductory chapter defines and reviews the various types of research done in physical activity and gives you some examples. We define science as systematic inquiry, and we discuss the steps in the scientific method. This logical method answers the following four questions (Day, 1983, 4), which constitute the parts of a typical thesis, dissertation, or research report:

1. What was the problem? Your answer is the introduction.
2. How did you study the problem? Your answer is the materials and methods.
3. What did you find? Your answer is the results.
4. What do these findings mean? Your answer is the discussion.

We also present alternative approaches for doing research relative to a more philosophic discussion of science and ways of knowing. In particular, we address qualitative research, the use of field studies, and methods of

introspection as strategies for answering research questions instead of relying on the traditional scientific paradigm as the only approach to research problems.

Chapter 2 suggests ways of developing a problem and using the literature to clarify the research problem, specify hypotheses, and develop the methodology. In particular, we propose a system for searching, reading, analyzing, synthesizing, organizing, and writing the review of literature.

The next two chapters in part I present the format of the research proposal with examples. This information is typically required of the master's or doctoral student before collecting data for the thesis or dissertation. Chapter 3 defines and delimits the research problem, including the introduction, statement of the problem, research hypotheses, operational definitions, assumptions and limitations, and significance. Chapter 4 covers methodology, or how to do the research. Included are the topics of participant selection, instrumentation or apparatus, procedures, and design and analysis. We emphasize the value of pilot work conducted before the research and how cause and effect may be established.

Chapter 5 discusses ethical issues in research and scholarship. We include information on misconduct in science; ethical considerations in research writing, working with advisors, and copyright; and the use of humans and animals in research.

Once you have completed part I, you should better understand the research process. Then comes the tricky part: learning all the details. We consider these details in part II ("Statistical and Measurement Concepts in Research"), part III ("Types of Research"), and part IV ("Writing the Research Report").

Introduction to Research in Physical Activity

*Research is to see what everybody else has seen,
and to think what nobody else has thought.*

—Szent-Gyorgyi



Mention the word *research*, and depending on his or her background, each person will conjure up a different picture. One might think of searching the Internet or going to the library; another might visualize a lab filled with test tubes, vials, and perhaps little white rats. It is important, then, as we begin a text on the subject, to establish a common understanding of research. In this chapter we introduce you to the nature of research. We do this by discussing methods of problem solving and types of research. We explain the research process and relate it to the parts of a thesis. By the time you reach the end of chapter 1, you should understand what research really involves.

The Nature of Research

The object of research is to determine how things are as compared to how they might be. To achieve this, research implies a careful and systematic means of solving problems and involves five characteristics (Tuckman, 1978):

- **Systematic.** Problem solving is accomplished through the identification and labeling of variables and is followed by the design of research that tests the relationships among these variables. Data are then collected that, when related to the variables, allow the evaluation of the problem and hypotheses.
- **Logical.** Examination of the procedures used in the research process allows researchers to evaluate the conclusions drawn.
- **Empirical.** The researcher collects data on which to base decisions.
- **Reductive.** The researcher takes individual events (data) and uses them to establish general relationships.
- **Replicable.** The research process is recorded, enabling others to test the findings by repeating the research or to build future research on previous results.

Problems to be solved come from many sources and can entail resolving controversial issues, testing theories, and trying to improve present practice. For example, a popular

applied research

Type of research that has direct value to practitioners but in which the researcher has limited control over the research setting.

hydrostatic weighing

Technique that measures body composition in which body density is computed by the ratio of an individual's weight in air and the loss of weight underwater.

topic of concern is obesity and methods of losing weight. Suppose we want to investigate this by comparing the effectiveness of two exercise programs in reducing fat. Of course, we know that caloric expenditure results in the loss of fat, so we will try to find out which program does this better under specified conditions. (Note: Our approach here is to give a simple, concise overview of a research study. We do not intend it to be a model of originality or sophistication.)

This study is definitely an example of **applied research** (more on this in the next section). Rather than try to measure the calories expended and so on, we approach it strictly from a programmatic standpoint. Say that we are operating a health club and that we offer aerobic dance and jogging classes for people who want to lose weight. Our research question is: Which program is more effective in reducing fat?

Suppose that we have a pool of participants to draw from and that we can randomly assign two thirds of them to the two exercise programs and one third to a control group. We have their scout's honor that no one is on a drastic diet or engaging in any other strenuous activities while the study is in progress. Both the aerobic dance and the jogging classes are one hour long and are held five times a week for 10 weeks. The same enthusiastic and immensely qualified instructor teaches both classes.

Our measure of fatness is the sum of skinfold measurements taken at eight body sites. Of course, we could use other measures, such as percentage of fat estimated from **hydrostatic weighing** (or total body water or some other estimate of fatness). However, we can defend our measures as valid and reliable indicators of fatness, and skinfolds are functional field measures. We measure all the participants, including those in the control group, at the beginning and the end of the 10-week period. During the study we try to ensure that the two programs are similar in procedural aspects, such as motivational techniques and the aesthetics of the surroundings. In other words, we do not favor one group by cheering them on but not encouraging the other; nor do we have one group exercise in an air-conditioned, cheerful, and healthful facility while the other has to sweat it out in some dingy room or parking lot. It is very important that we try to make the programs as similar as possible in every respect except the experimental treatments. The control group does not engage in any regular exercise.

After we have measured all the participants on our criterion of fatness at the end of the 10-week program, we are ready to analyze our data. We want to see how much change in skinfold thickness has occurred and whether there are differences between the two types of exercise. Because we are dealing with samples of people (from a whole universe of similar people), we need to use some type of statistics to establish how confident we can be in our results. In other words, we need to determine the significance of our results. Suppose the mean (average) scores for the groups are as follows:

- Aerobic dance = -21 mm
- Jogging = -25 mm
- Control = +8 mm

These values (which we made up) represent the average change in the combined skinfold thicknesses of the eight body sites. The two experimental groups lost fat, but the control group actually showed increased skinfold thicknesses over the 10-week period.

We decide to use the statistical technique of analysis of variance with repeated measures. We find a significant *F* ratio, indicating that significant differences exist among the three groups. Using a follow-up test procedure, we discover that both exercise groups are significantly different from the control group. But we find no significant difference between the aerobic dance and the jogging groups. (Many of you may not have the foggiest idea what we are talking about with the statistical terms *F* ratio and significance, but don't worry about it. All this is explained later. This book is about these kinds of things.)

Our conclusion from this study is that both aerobic dance and jogging are effective (apparently equally so) in bringing about a loss in fatness of overweight people (like the ones in our study) over 10 weeks. Although these results are reasonable, please remember that this is only an example. We can also pretend that this study was published in a prestigious journal and that we won the Nobel Prize.