

ACSM'S **Clinical Exercise** **Physiology**

Second Edition



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ACSM'S Clinical Exercise Physiology

Second Edition

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Second Edition

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Dedication

This book is first dedicated to the pioneers in clinical exercise physiology, several of whom were my teachers and mentors, all of them lifelong friends.

To Paul Ribisl who, when recruiting for the first graduate exercise science class at Wake Forest University in 1978, took a big chance on a not-so-good student.

To Henry Miller who taught me (among many other things) venipuncture techniques and when I finally was successful gave me a high five. Both of us forgot the needle was still in the arm of my volunteer. She didn't bleed to death, but it was close. She married me anyway.

To the late Ed Fox, my major professor and dissertation advisor at The Ohio State University, who passed away — far too young.

To Noel Nequin, who in 1979 was searching for a director for his program and, after calling Phil Wilson at the University of Wisconsin — LaCrosse (who had no candidates), called Paul Ribisl at Wake Forest (who had one student graduating that semester). Luckily that person was me, and we remain great friends to this day.

To Dan Benardot who recruited me to Georgia State University and taught me how to work with and assess elite athletes including gold medal-winning Olympic teams. He also became one of my closest friends. We traveled the world together both professionally and with our families. It was an honor to have served as Best Man at his wedding to Robin.

To Yves Vanlandewijck of Leuven, Belgium, who introduced me in 1995 to his work with athletes who had physical or intellectual impairments. Since that time, we have served together on the Sports Science Committee of the International Paralympic Committee (IPC), traveled around the world, coordinating research projects at IPC-sanctioned events, including Paralympic Games, and edited two books together that are part of the IOC series. He also skillfully extracted me from a ravine after a very bad snowmobile accident in Whistler, Canada, on March 19, 2010.

Finally, this book is dedicated to my family: to Deon, my wife of 45 years; my daughter Jessica and her husband Daniel; my son Aaron and his wife Joellyn; and to the four most amazing grandchildren in the world, Alison, Annalee, Kinsley, and Andy. All of you inspire me every day to be the greatest husband, father, and Papaw. I love all of you more than you can imagine.

Walter R. Thompson, PhD, FACSM, ACSM-CEP, RCEP, PD

To my mentors, Pete Brubaker, Lenny Kaminsky, Kerrie Moreau, and Ross Arena. Each of these incredible individuals has had a profound impact on not only my growth as a professional but most importantly as a person. Despite their renowned professional achievements and international recognition, each is as humble as the next and has always made time for me regardless of their inconceivable workloads. They serve as my North Star and I am honored to be able to refer to them as close colleagues and lifelong friends.

Most of all, this book is for my parents, Sera and Haluk, and sister, Hale, for being a strong and supportive presence throughout my life; to my dear wife and colleague, Hannah, for showing limitless patience (...can't express that enough) and unwavering support through my academic and life pursuits; and to my daughter Lillian, who is a constant reminder of what is truly important in life and has the ability to dissolve any work-related stress as soon as I see her bright smile. My accomplishments to date would not have been possible without the love and guidance they provided in every stage of my life.

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Foreword to the First Edition

For many years, the American College of Sports Medicine (ACSM) has been a leader in the training and certification of clinical exercise physiologists (CEPs). The history is impressive and has led to the publication of this landmark book, the first edition of *ACSM's Clinical Exercise Physiology*. On May 2, 1972, at the annual meeting of ACSM in Philadelphia, a special interest group was convened, and it recommended that ACSM initiate definitive guidelines for the conduct of exercise testing and prescription; in December 1972 at a workshop in Aspen, Colorado, a subcommittee presented their first thoughts. Physicians, physiologists, and physical educators, representing 32 laboratories from 19 states and 3 Canadian provinces, reviewed the proposed guidelines, and in 1975, the first edition of *ACSM's Guidelines for Exercise Testing and Exercise Prescription* was published. Dr. John Faulkner, the 15th president of the ACSM (1971–1972), and Dr. Karl Stoedefalke are credited as chairs of that publication, which numbered 48 pages. The Behavioral Objectives appearing in that first edition were an initial attempt to define the role of what would become the CEP. *Guidelines*, now in its 10th edition at 472 pages, no longer contains the Behavioral Objectives. Now known as Performance Domains and Associated Job Tasks, they are so comprehensive that they are accessed as an online adjunct of *Guidelines* (<https://www.acsm.org/get-stay-certified>).

We have come a long way from that first edition. The role of the CEP in medical practices; in commercial, community, and medical fitness centers; and in corporate wellness programs has now been well defined. Today the CEP is an integral member of the team, providing continuous care to patients and the apparently healthy. They work side by side with physicians, nurses, physical therapists, occupational therapists, nutritionists, and other members of the health care team. ACSM's support certifications to prepare and accredit the CEP include the Exercise Physiologist, CEP, and Registered CEP. This book, *ACSM's Clinical Exercise Physiology*, will help build the foundation of knowledge necessary to be successful in clinical exercise physiology courses and to sit for these certification examinations.

Dr. Walt Thompson, the 61st president of the ACSM (2017–2018), has assembled a remarkable team of scientists and clinicians to write this first edition. Within these 19 chapters are the foundations for the science of clinical exercise physiology. The book should be used in advanced undergraduate and graduate exercise science curricula in colleges and universities. It should also be found on the bookshelves of every clinician and exercise professional around the world. It is, clearly, the most comprehensive clinical exercise physiology book in print. Having served as presidents of ACSM, we congratulate Dr. Thompson and his writing team for assembling this impressive, inspiring, and remarkable resource for exercise physiology and its clinical applications.

| | |
|-----------------------|-----------|
| Howard G. Knuttgen | 1973–1974 |
| Charles M. Tipton | 1974–1975 |
| Roy J. Shephard | 1975–1976 |
| David L. Costill | 1976–1977 |
| James S. Skinner | 1979–1980 |
| David R. Lamb | 1980–1981 |
| Henry S. Miller, Jr. | 1981–1982 |
| William L. Haskell | 1983–1984 |
| Peter B. Raven | 1987–1988 |
| Barbara L. Drinkwater | 1988–1989 |
| Lyle J. Micheli | 1989–1990 |
| Neil B. Oldridge | 1990–1991 |
| Brian J. Sharkey | 1991–1992 |
| Robert C. Cantu | 1992–1993 |
| Russell R. Pate | 1993–1994 |
| Timothy P. White | 1994–1995 |
| Steven N. Blair | 1996–1997 |
| Charlotte A. Tate | 1997–1998 |
| Paul D. Thompson | 1998–1999 |
| Barry A. Franklin | 1999–2000 |
| Angela D. Smith | 2001–2002 |
| Edward T. Howley | 2002–2003 |

| | | | |
|--------------------------|-----------|-----------------------|-----------|
| W. Larry Kenney | 2003–2004 | William W. Dexter | 2013–2014 |
| William O. Roberts | 2004–2005 | Carol Ewing Garber | 2014–2015 |
| Carl Foster | 2005–2006 | Lawrence E. Armstrong | 2015–2016 |
| J. Larry Durstine | 2006–2007 | Elizabeth Joy | 2016–2017 |
| Robert E. Sallis | 2007–2008 | Kathryn H. Schmitz | 2018–2019 |
| Melinda Millard-Stafford | 2008–2009 | William E. Kraus | 2019–2020 |
| James M. Pivarnik | 2009–2010 | NiCole R. Keith | 2020–2021 |
| Thomas M. Best | 2010–2011 | L. Bruce Gladden | 2021–2022 |
| Barbara E. Ainsworth | 2011–2012 | Anastasia Fischer | 2022–2023 |
| Janet Walberg Rankin | 2012–2013 | Irene Davis | 2023–2024 |

Foreword to the Second Edition

As international organization presidents dedicated to the advancement of clinical exercise physiology, we are pleased to write this Foreword to the second edition of *ACSM's Clinical Exercise Physiology*. Echoing the words of the former ACSM presidents who authored the Foreword to the first edition, we believe that the role of the clinical exercise physiologist (CEP) is well defined all over the world. They are now a recognized part of the health care team taking care of patients with a variety of both acute and chronic illnesses. Although the history of clinical exercise physiology may be in cardiac rehabilitation and pulmonary rehabilitation, today's CEP helps in the treatment plan of patients with diabetes, metabolic syndrome, peripheral arterial disease, and many other disease states that can benefit from therapeutic exercise programs. Outside of rehabilitation, the CEP also plays a vital role in the prevention of chronic disease and disability. Contemporary CEPs can be found in hospitals and medical centers, physician's office and clinics, as well as in commercial, community, corporate, and medical fitness centers.

Dr. Walt Thompson and Dr. Cemal Ozemek have recruited the world's experts to contribute to this second edition. All 19 chapters are relevant to the practice of clinical exercise physiology and can be applied immediately to CEP practice. We encourage anyone who teaches advanced undergraduate and graduate classes in CEP to consider using this extraordinary text in their classrooms. The text and ancillaries (question bank, videos, journal activities, slide decks, test generator, and image bank) are

simply extraordinary. We are pleased to add our names in the support of this second edition of *ACSM's Clinical Exercise Physiology*.

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Preface

The concept for ACSM's *Clinical Exercise Physiology* was launched in December 2015 with the approval of the American College of Sports Medicine (ACSM) Publications Committee, Committee on Certification and Registry Boards, Administrative Council, and the Board of Trustees. It had been determined that there was a need to re-envision the existing ACSM's *Resource Manual for Guidelines for Exercise Testing and Prescription* to meet the evolving needs of the field. The *Resource Manual* was originally developed as a comprehensive, explanatory companion text to ACSM's *Guidelines for Exercise Testing and Prescription*. As an outcome of this strategy, two additional resources to be paired with *Guidelines* were recommended for development and were to be called: ACSM's *Exercise Testing and Prescription* and ACSM's *Clinical Exercise Physiology*. Authors of the current book have provided thorough updates within each chapter to reflect advancements and current best practice recommendations in the respective topic areas.

This book, *ACSM's Clinical Exercise Physiology, 2nd edition*, fulfills a vision to create an advanced undergraduate and graduate textbook that could be used worldwide. International experts were selected to write key chapters, reflecting the work CEPs do every day in hospitals and medical centers; in neighborhood programs like commercial health clubs, corporate wellness programs, university recreation centers; and in not-for-profit family-oriented community fitness centers. Although the book is primarily intended to be used in college and university classrooms, it can also be of benefit to anyone studying for the ACSM Clinical Exercise Physiologist certification.

ORGANIZATION

The logical presentation of material provides a format that can be used over the course of one to two semesters in any college or university offering advanced undergraduate or graduate classes in clinical exercise physiology. Organized

in a semisequential manner, the first chapter details the history of clinical exercise physiology. The second chapter provides an overview of the life cycle from birth to death with a special focus on women and children. After these two introductory chapters, the book builds sequentially, each chapter increasingly becoming more independent. Chapters 3 and 4 review the benefits and risks associated with exercise and physical activity and introduce preparticipation health screening, followed by a detailed description of how to develop exercise programs for the apparently healthy client. These chapters provide the foundation for subsequent topics that are more specific, such as cardiovascular disease, respiratory disease, diabetes, physical and intellectual impairments, cancer, diseases and conditions of the bones and joints, immunological disorders, and behavior and mental health as they relate to exercise. Chapter 16 focuses on multiple disorders (co- or multimorbidities), followed by environmental and genetic impacts. The final chapter describes and outlines potential legal issues facing the CEP.

FEATURES

Several features of this book distinguish it from other clinical exercise physiology books available today. First, there is a **single chapter dedicated to electrocardiography** written specifically for the CEP. Many electrocardiography books are written by and for clinicians, but seldom are there any directed to what the CEP might encounter during exercise testing or in a rehabilitation program. The electrocardiography chapter focuses primarily on those conditions typically seen by the CEP and does not include obscure, confusing, or abstruse conditions. Included also are many examples that can be used for review purposes. A second unique feature is **chapter review questions** (with answers) and **case studies**. Most of the chapters have multiple case studies, but what makes this unique is that each has accompanying **review questions** and short answers.

ADDITIONAL RESOURCES

ACSM's *Clinical Exercise Physiology* includes additional online resources for students and instructors.

Students can access:

- Question Bank
- Videos
- ECG Animations

Approved adopting instructors will be given access to the following resources:

- PowerPoints
- Test Bank

- Image Bank
- Answers to Text Questions

See inside the front cover of this text for more details, including the passcode you will need to gain access to the Web site.

Updates for the book can be found at <https://www.acsm.org/education-resources/books/acsm-book-updates>.

Acknowledgments to the Second Edition

Much appreciation should be noted to many groups and individuals for the concept, development, writing, and future success of the first and second editions of this book. Any omission of appreciation is entirely our fault. First, thanks to the ACSM Publications Committee, Committee on Certification and Registry Boards, Administrative Council, and the Board of Trustees for having the vision to recognize the potential significance of this book to ACSM and to college classrooms worldwide. Second, thanks to our publisher, Wolters Kluwer, who took a chance on this book and then put every available resource into making it the very best it could be. The superior quality of this book and its ancillary materials are attributable to our publisher, who believed in the project even more than we did, and for that we are grateful. ACSM is thankful and appreciates that each author worked hard with considerable investment of their personal resources and time — time they could have spent with family and friends. This book is an example of the collective efforts of an incredibly talented and dedicated writing team. We have tested the patience, benevolence, generosity, and goodwill of many people during the course of this project. For that, we would like to personally thank each author, ACSM Chief Operating Officer Katie Feltman, ACSM Assistant Director of Publishing Angie Chastain, Wolters Kluwer Senior Development Editor Amy Millholen, and our development editor

Laura Bonazzoli, the incredibly talented word magician for the first edition who crafted the language and phrasing just right. This book could not have been possible without the four of them. We would also like to thank the present and past presidents of ACSM who agreed to author the Foreword for the first edition and to the president of all the major clinical exercise physiology professional societies around the world who agreed to author the Foreword for this second edition. They are all heroes of ours. Finally, we would like to thank our families, who often wondered why husband, Dad, Papaw would suddenly disappear, later to be found pounding at the keyboard during brief moments of inspiration. Walt thanks Deon, Jessica, Aaron, Daniel, Joellyn, Alison, Annalee, Kinsley, Andy, and Molly (the Thompson dog who probably showed the greatest patience). Cemal firstly thanks Walt for inviting and trusting him to serve as an editor. It was a career high point to work with you and it was truly impressive watching you conduct this massive undertaking while making it look seemingly effortless. And thank you to Hannah and Lily for their infinite support throughout this process.

**Walter R. Thompson, PhD, FACSM,
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