

# Physiology of Fitness

Third Edition



Brian J. Sharkey

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**NOT FOR RESALE**

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# PREFACE

*After only 4 months of training, there I was poised on the starting line for the longest run of my 35 years, a 7-mi road race. As the gun went off and the crowd surged forward on a wave of adrenaline, I was swept along by a series of sensations, ranging from excitement . . . to control . . . to concern . . . to impending exhaustion. When I plodded around the last corner and headed for the finish line, I reached for the finishing “kick” I once knew as a high school runner—but it wasn’t there. Obviously I had lost it somewhere along the way. But during that run and in the months preceding it, I had literally discovered myself. As I sought fitness along the roads and trails, I made progress in other areas as well. Today, years later, I am confident that the passage to fitness marked a turning point in my life.*

Those words appeared in the prefaces of the first and second editions of this book. The second edition published in 1984 went on to say

*Today, several passages and turning points later, I continue to learn about fitness and life. The medium of discovery these past few years has been cross-country skiing. Some time after I passed the age of 40 I sought new challenges, experiences, and a new way to seek the rewards of fitness, so I took up cross-country skiing. In addition to training for the sport, I studied cross-country skiing in the laboratory and in the field. This intense personal and professional involvement with one of the most demanding of sports has provided new information and insights concerning fitness and how it can be achieved.*

Now as I begin this third edition, I feel compelled to reveal the experiences and events that influenced my approach to this revision. Age and job demands made the maintenance of fitness more difficult and performance less gratifying. A major career and geographic change challenged me to be adaptable and to enjoy new friends and activities instead of lamenting the loss of old ones. And, as I approached my 50th year, I watched as illness temporarily subdued some vigorous friends, and I realized again the values and limits of fitness and other health habits.

These experiences were integrated with new research on fitness and health; new findings concerning cholesterol and heart disease; prudent approaches to diet and nutrition; new perspectives on aging; and a bright prognosis for fitness, health, wellness, and longevity. Age, experience, and 3 decades of research have tempered the unabashed enthusiasm of the first edition, softened the performance orientation of the second, and produced a more balanced approach, with understanding, empathy, and opportunities for all to enjoy. Above all, I'm even more convinced of the value of the active lifestyle.

So join me again as we continue to explore the developing story of fitness. *Physiology of Fitness* is an up-to-date guide to the prescription of exercise for health, fitness, and performance. You've seen other fitness books and may have read a few, but if you're still starved for information and explanations, I think you've found what you have been seeking. This book is for the individual who wants to develop a deeper understanding of fitness, for the enthusiast who wants to know why and how the body responds, for the newcomer who needs more motivation, or for the skeptic who needs more proof. I set out to write the thinking person's fitness book—I hope you'll say I succeeded.

The book is divided into five parts that explore the dimensions of fitness. Each part is subsequently divided into chapters, and each chapter begins with a list of objectives that outlines the territory covered in the text. Figures and tables provide technical and practical information. The practical information will help you determine your best avenue to fitness and the technical material will help you probe the physiological dimensions of fitness.

This book is about fitness and its relationship to health and performance, but it is concerned with other things as well—things like self-discovery, experience, understanding, achievement, and the quality of life. Invest in fitness and you will earn immediate health dividends. In time you'll reap more substantial rewards—the capital gains of vitality, high-level health, and performance. And as your interest in fitness continues to grow and mature, you will harvest the accumulated wealth of your endowment—your potential. You should by all means spend time developing your intellectual, artistic, emotional, and spiritual gifts, but if you ignore the physical you may never experience all that life has to offer.

Proceed in good health, and soon you will begin to experience what an eloquent friend has termed that “state of grace” called fitness.

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# INTRODUCTION TO FITNESS

This chapter will help you

*become familiar with the terms, definitions, and  
benefits of fitness,*

*understand the relationships between fitness, health,  
and wellness, and*

*compare your current level of fitness to recommended  
and typical values.*

We can approach the study of fitness in at least two distinctly different ways. One is objective and physiological; the other is subjective, emotional, and psychological. The former is concerned with calories, heartbeats, and quantifications of exercise, whereas the latter “tunes in” on sensations, “turns on” with activity, and “gets high” on hormones. I will begin with the physiological approach to help you understand how fitness provides the foundation for high-level health and contributes to the joy of living. I will then move from the objective to the subjective, from the physiological to the psychological. As you become involved in the active lifestyle you will certainly experience both. After months of systematically working toward your fitness goals you may relish a mellow period, when you seek the sheer joy of movement. Months later you may feel the need to train intensively again. Feelings, moods, and motives change and you should not ignore them.

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**Exercise physiology** explores the immediate and long-term effects of exercise on the function of muscles, organs, and systems of the body and the relationship of activity and fitness to health. Although scientists studied some aspects of exercise before the turn of the century, and

German, French, and English researchers did landmark work in the early 1900s, modern exercise physiology probably had its roots in Scandinavian laboratories and at the Harvard Fatigue Lab in the 1930s (Horvath & Horvath, 1973). As you can see, exercise physiology is a relatively young science.

The physiology of fitness began to receive serious scientific attention in the 1950s, when studies of British bus drivers and civil servants linked regular exercise to a lower risk of heart disease (Morris, Heady, Raffle, Roberts, & Parks, 1953). Before that the major incentive for fitness was military preparedness. During the two world wars and the Korean War, U.S. military leaders, concerned about the fitness levels of draftees, called for greater attention to fitness in the schools. Today, we value fitness for its relationship to health and for its contributions to performance in work or sport.

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## Fitness Components

Although fitness means many things to many people, in this book it refers to specific components—aerobic and muscular fitness.

### *Aerobic Fitness*

**Aerobic** means in the presence of oxygen, as contrasted with **anaerobic**, meaning in the absence of oxygen. Aerobic fitness is defined as the capacity to take in, transport, and utilize oxygen. Aerobic fitness is developed and maintained through large-muscle activities such as walking, jogging, cycling, swimming, and others that allow sustained metabolism.

Because aerobic fitness involves so many important organs and systems (respiration, heart and circulation, muscles), it tells a lot about the health of these components and about health in general. That is, when aerobic fitness improves, physical and mental health are enhanced. The benefits of aerobic exercise and fitness include

- improved circulation, respiration, and fat metabolism;
- reduced stress levels, body fat, and risk of heart disease;
- stronger bones, ligaments, and tendons;
- weight control;
- more energy and less fatigue;
- enhanced mood, self-concept, and body image;
- greater emotional stability; and
- a more positive outlook.

The increased capacity and adaptability associated with aerobic fitness can add life to your years, not just years to your life.

In the early 1960s less than 5% of the adult population in the United States engaged in regular aerobic exercise. At that time heart disease was epidemic and getting worse. But times have changed. Recent polls show an increase in the number of active adults and a decline in the incidence of heart disease. Walkers, runners, cyclists, and aerobics participants are everywhere, exercising for health, for weight control and appearance, for performance, or for the fun of it. Many are active year-round, swimming and cycling in the summer and alpine and cross-country skiing in the winter. Doctors encourage patients to exercise for preventive health or rehabilitation, and many are taking the advice.

Even psychiatrists have discovered fitness. They prescribe physical activity, and some even run with their patients. Aerobic exercise reduces anxiety and depression; it serves as a tranquilizer and can even help you fall asleep. Some think it makes one more productive, even more creative. Yes, we are caught up in a veritable mania for fitness, a bona fide trend, not a fad (Naisbitt, 1984). Fitness and other aspects of the healthy lifestyle are beginning to lower health care costs. However, some segments of society have ignored the trend. Later in this chapter we'll examine the status of fitness and see that there is still much work to be done.

---

Some authorities include body composition, the proportion of fat and lean tissue, as a component of fitness. Although I agree with the need to maintain a relatively low percentage of body fat and believe that aerobic exercise is the best way to lose unwanted fat, I treat body composition and body fat in a separate section. Why? Exercise, by itself, may not be enough to control body weight and fat. Food intake is also an important part of the energy balance equation. You'll learn more about body fat and body composition in Part III, Fitness and Weight Control.

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## ***Muscular Fitness***

Strength, muscle endurance, and flexibility—the components of muscular fitness—were once viewed as the essence of fitness, but lost some favor during the rise of aerobic exercise. Today they are making a comeback based on sound health benefits and on what they do for appearance, self-concept, and performance.

Muscle tone and flexibility contribute to good posture and can help prevent the lower back problems that plague millions of Americans. As the years pass and strength and flexibility decline, your ability to engage fully in life diminishes. Countless senior citizens face retirement unable to enjoy the fruits of their labor. They paid attention to fiscal fitness but failed to prepare physically.

Muscular fitness helps in other ways. It can help you cope with the demands of your job. It can improve your performance in an activity or sport. It can boost your ego and improve your figure (or physique). When combined with aerobic fitness it may even improve your sex life! “Ridiculous,” you say. “Fitness is

not a panacea, a cure-all.” Of course it isn’t. But in a society dedicated to the automobile, remote control devices, and robots, fitness may be just what the doctor ordered. In an age when we face the threat of a genuine energy crisis, who will be better able to adapt and survive? The fittest, that’s who!

## **Fitness, Health, and Wellness**

Are fitness, health, and wellness synonyms, words with the same or nearly the same meaning? Although they are often used interchangeably in casual conversation, and although there is some overlap, the words have distinctly different connotations to exercise physiologists and other health professionals.

### ***Fitness and Health***

A positive relationship exists between fitness and health. As fitness improves, health risk declines and life expectancy inches upward. However, that doesn’t imply that continued increases in fitness will continue to yield improvements in health status. On the contrary, excessive amounts of exercise can cause health to decline. The path to fitness carries risks as well as benefits. The proper amount yields optimal health, yet too much promises illness or injury. Too much exercise leads to muscle and skeletal injuries, suppression of the immune system, and a decline in resistance to infection. Too much weight loss can lead to hormonal problems and mineral deficiencies. So to be accurate we say that regular, moderate activity is associated with health. Fitness, which is partially inherited, is less likely to be correlated to health than is the amount of regular, moderate activity. Of course, regular activity improves fitness—to a point.

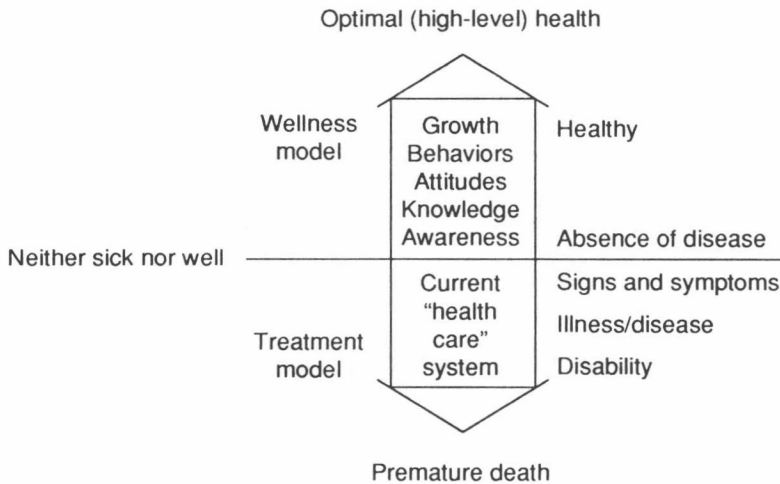
Other health-related aspects of fitness include greater attention to a healthy diet, improved weight control, reduction or elimination of cigarettes, reduced stress, better sleep patterns, and other manifestations of the healthy lifestyle. So fitness contributes to health in many ways, and we’ll explore them throughout this book.

### ***Health and Wellness***

For many years health was defined as the absence of disease, and that is how many people still use the term. But in recent years the definition of health has been expanded to include a state of complete physical, mental, and emotional well-being, not merely the absence of disease or infirmity. In that context the relationship of fitness to health becomes more clear. The relationship of health and wellness is equally clear. Ardell (1984) defined wellness as “a conscious and deliberate approach to an advanced state of physical and psychological/spiritual health” (p. 5). So wellness is movement toward an advanced state of health, also called optimal or high-level health.



Although the old view of health placed illness on one side of a line and health on the other, with doctors and the treatment-oriented health care system defending the latter against the former, wellness is viewed as a dynamic, fluctuating state of being, a process where you—the individual—are responsible for your health (see Figure I.1). The health care system and traditional medicine are treatment oriented, and workers in the system focus on correcting the problems brought on by illness, injury, or disease. Wellness involves health promotion and disease prevention, focusing on behaviors that lower the risk of illness or injury. The treatment system employs an army of high-priced professionals and costs billions of dollars. Wellness depends on individual responsibility, low-cost helpers, and reduced reliance on health professionals. Because “preventive health” sounds silly and “health promotion” sounds like advertising, the term **wellness** has caught the public fancy, and fitness/wellness programs are catching on at every level of society and in every age group, from kids to senior citizens.



**Figure I.1.** The health continuum.

## ***Fitness and Wellness***

The first version of this book preceded all but the earliest stages of the wellness movement (Sharkey, 1974). But optimal health, or wellness, is what this book is all about. Fitness is an essential component of high-level health or wellness. Fitness requires individual initiative, and it helps prevent disease, leads to better physical health, and provides the springboard to enhanced psychological health. But excess emphasis on the physical side of wellness can interfere with health and with the balance of the physical, emotional, spiritual, social, occupational, and intellectual components of wellness. In fact, fitness is but one part of the

physical dimension, which also includes nutrition, health habits, environmental concerns, and safety. But fitness can contribute to other dimensions of wellness, such as the emotional, social, and occupational, and some would add that fitness has the potential to enhance the intellectual and spiritual dimensions as well. Subsequent chapters explore these relationships in more detail.

## Fitness and the Active Lifestyle

My goal in writing this book is to help you achieve an active lifestyle, in which vigorous physical activity is an important part of every day. To achieve that end we'll muddle through some facts and figures and present an objective, factual approach to fitness, but we won't stop there. Before you've finished the book I hope you will be hopelessly addicted to physical activity. When that happens you will plan each day around your activity—the most important part of the day. And if for some reason you are unable to participate, you will sense something essential is missing. When you experience withdrawal symptoms after a day or more of inactivity, you will know you are hooked on physical activity, compelled to live an active lifestyle for the rest of your years.

But what if you become injured or ill, what then? There are a few valid excuses to avoid regular activity, including acute illness, fever, or serious injury that requires immobilization. In most other cases there is an activity suited to your condition.

### Exercise and fitness can be used for

- **prevention of degenerative conditions brought on by inactivity,**
- **rehabilitation following injury, operation, or chronic disorder, and**
- **performance and enjoyment in work, recreation, or sport.**

## Prevention

Some years ago Kraus and Raab (1961) wrote a book entitled *Hypokinetic Disease*. They contended that lack of activity was a major factor in the development of heart and other degenerative diseases. Today, health experts agree that sanitation and medical science have achieved about as much as can be expected in the war against sickness and death. Additional dollars for health care cannot and will not achieve what can be earned if each of us adopts better health habits, including an active lifestyle. Every major epidemiological study lists regular physical activity as an essential component of health and longevity. Because so many adults are inactive, it is likely that increases in the level of activity in the population would have *more* effect on lowering the incidence of heart disease