FUNDAMENTALS OF SPORT AND EXERCISE NUTRITION

Marie Dunford

Human Kinetics' Fundamentals of Sport and Exercise Science Series

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Marie Dunford, PhD, RD

Fundamentals of Sport and Exercise

Nutrition

运动营养学基础

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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: info@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 8372 0999
e-mail: info@hkaustralia.com

New Zealand: Human Kinetics, P.O. Box 80, Torrens Park, South Australia 5062
0800 222 062
e-mail: info@hknewzealand.com

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To my husband, Greg.

C'est le ton qui fait la chanson.

It's the melody that makes the song.

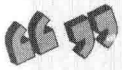
Series Preface

The sport sciences have matured impressively over the past 40 years. Subdisciplines in kinesiology have established their own rigorous paths of research, and physical education in its many forms is now an accepted discipline in higher education. Our need now is not only for comprehensive resources that contain all the knowledge that the field has acquired, but also for resources that summarize the foundations of each of the sport sciences for the variety of people who make use of that information today. Understanding the basic topics, goals, and applications of the subdisciplines in kinesiology is critical for students and professionals in many walks of life. Human Kinetics has developed the Fundamentals of Sport and Exercise Science series with these needs in mind.

This and the other books in the series will not provide you with all the in-depth knowledge required for earning an advanced degree or for opening a practice in this subject area. This book will not make you an expert on the subject. What this book will do is give you an excellent grounding in the key themes, terms, history, and status of the subject in both the academic and professional worlds. You can use this grounding as a jumping-off point for studying more in-depth resources and for generating questions for more experienced people in the field. We've even included an annotated list of additional resources for you to consult as you continue your journey.

You might be using this book to help you improve your professional skills or to assess the potential job market. You might want to learn about a new subject, supplement a textbook, or introduce a colleague or client to this exciting subject area. In any of these cases, this book will be your guide to the basics of this subject. It is succinct, informative, and entertaining. You will begin the book with many questions, and you will surely finish it with many more questions. But they will be more thoughtful, complex, substantive questions. We hope that you will use this book to help the sport sciences, and this subject in particular, continue to prosper for another generation.

Key to Icons



Look for the giant quotation marks, which set off noteworthy quotes from researchers and professionals in the field.

Nutrition Bites include quirky or surprising "Did you know?" types of information.

Success Stories highlight influential individuals in the field. Through these sidebars, you will learn how researchers and professionals apply their knowledge of the subject to their work, and you'll be able to explore possible career paths in the field.

Preface

Fundamentals of Sport and Exercise Nutrition is an introduction to the exciting world of nutrition as a way to enhance training, speed recovery, and reach peak performance. Nutrition is a relatively new field, just over a hundred years old, and sport and exercise nutrition is very new, coming into its own in the 1980s. More research is being conducted and many new products are being created to help athletes improve training and reach peak performance. Athletes are bombarded with information about performance-enhancing supplements. A few of these supplements, such as creatine, may be helpful to some athletes, but many are unproven or not effective. Some supplements are even contaminated with banned substances.

Sport and exercise nutrition is on the cutting edge, a very exciting place to be. But sometimes it can be a confusing place. Because nutrition is a young scientific field, information can be contradictory, incomplete, or nonexistent. For example, what is the best weight loss diet? Some say it should be low in fat, whereas others say it should be low in carbohydrate. How does this debate apply to athletes who need sufficient carbohydrate daily to be able to train and don't want to lose muscle mass in the process of dieting? These questions cannot be answered definitively, but there is sufficient information to make sound recommendations while more research is completed.

Additionally, the application of the information is not always easy. Should an athlete drink water or a sport beverage? Which is a better snack—a high-protein bar or a high-carbohydrate bar? Will supplement X enhance performance? The answers to these questions depend on the situation. For example, if the athlete needs only fluid, then water is an appropriate beverage. However, if both fluid and carbohydrate are needed, then a sport beverage is the better choice.

If you need more information about sport and exercise nutrition, then *Fundamentals of Sport and Exercise Nutrition* will be an invaluable resource. It is an overview of the subject matter and provides a mix of current evidence and the application of that information to athletes in various sports. It is written to inform, enlighten, and inspire further investigation. Each chapter summarizes the current body of knowledge and practice and can be used as a reference by athletes, those who work with athletes, students, and instructors who touch on sport and exercise nutrition in their courses.

The primary purpose of the book is to present introductory information about the field of sport and exercise nutrition. Part I is an introduction to and history of the field. It clarifies some of the terminology used such as exercise nutrition, sport nutrition, and sport dietitian. The first chapter answers a very basic question: What is sport and exercise nutrition? Chapter 2 discusses sport nutrition on a more personal level by exploring what you can do in this exciting field. It talks about the kinds of jobs available in sport nutrition and the education necessary for

those jobs. You may want to become a board-certified sport dietitian and counsel competitive athletes.

Part II of the book summarizes current sport nutrition knowledge. It begins with an explanation of energy balance and imbalance in chapter 3. A very simple but important concept is "energy in" (food) and "energy out" (metabolism and exercise). The six chapters that follow are devoted to each of the six essential nutrients—carbohydrate, protein, fat, vitamins, minerals, and water. These nutrients are the heart of sport nutrition.

The nutrients themselves are important, but any book about sport nutrition would fall short without extensive coverage of body weight, body composition, and performance. These are addressed in chapter 10. Body weight is particularly important for athletes whose weight needs to be certified, such as wrestlers and boxers. However, for most athletes weight is a reflection of something much more important to performance—body composition. In many sports, athletes try to attain a relatively high percentage of muscle and a relatively low percentage of body fat. The most appropriate competitive weight and body composition is influenced by the sport or the position played and the athlete's genetic predisposition to leanness.

Unfortunately, in the quest to reach a certain weight or body composition, an athlete may become overly restrictive and obsessed with food intake. Normal eating can become disordered and, eventually, can result in an eating disorder such as anorexia or bulimia. Anyone who works with athletes must be aware of the warning signs and intervene as soon as possible. The final chapter addresses these issues and also explains the female athlete triad. The female athlete triad involves three interrelated factors unique to female athletes: energy availability, menstrual function, and bone mineral density.

Information about dietary supplements is integrated throughout the chapters. This organization is intentional because questions about supplements naturally flow from discussions of essential nutrients and energy balance. Supplementation is complementary to, not exclusive of, dietary intake, so it makes sense to address food and supplements at the same time. For example, a discussion of the nutrient protein would be incomplete without addressing protein supplements. Many supplements are marketed to athletes to help them enhance their energy levels, lose weight, and increase muscle mass quickly, and all of these issues are addressed.

This book includes user-friendly features. Each chapter begins with a list of objectives and ends with a list of summary points. Numerous boxes highlight interesting topics, myths, and popular beliefs. Each chapter features a person who has been successful in the field of sport and exercise nutrition.

Fundamentals of Sport and Exercise Nutrition is a summary of the essential issues related to sport and exercise nutrition. The scientific information has been distilled, not diluted, and the application of this information naturally follows. The book is written for those who want to improve their knowledge and understanding of an important aspect of sport performance and exercise training. You can feel confident about your understanding of the field of sport and exercise nutrition with this one-stop, go-to resource!

Acknowledgments

I would like to thank Mike Bahrke, acquisitions editor, not only for contacting me about writing this book, but also for providing a steady hand during its development. Maggie Schwarzentraub is a skilled and understanding developmental editor. Thanks for giving me enough rope to do my job but not enough to hang myself. Special thanks to my colleagues who agreed to be featured in the success stories in each chapter. Sport and exercise nutrition has come into its own because of such dedicated people, and each of you is an inspiration. To all those named and unnamed, thank you for your contributions to this book.

Contents

I

PART

Welcome to Sport and Exercise Nutrition

Part I consists of two chapters that introduce the field of sport and exercise nutrition. Chapter 1 begins with a history and includes a time line. Sport nutrition emerged from the fields of nutrition and exercise physiology and maintains a close relationship with these fields today. However, sport nutrition and exercise physiology have developed into separate disciplines.

Each field related to athletics, whether it is nutrition, exercise physiology, or training, has developed to the point at which there are recognized credentials for those who work in that field. Chapter 2 explains the kinds of jobs available in the growing field of sport nutrition and the credential needed to be a sport dietitian. The chapter also explains about scope of practice and how to know the limits of professional training. In many cases, if you work with athletes, you need to know about sport nutrition because you are involved with coaching or training. However, if sport nutrition is not your primary area of expertise, you must also know when to refer an athlete to someone with more specific training.

CHAPTER 1

What Is Sport and Exercise Nutrition?

In this chapter, you will learn the following:

- ✓ What sport and exercise nutrition involves
- ✓ How sport and exercise nutrition emerged from exercise physiology laboratories
- ✓ The goals of sport nutrition and how they build on general nutrition
- ✓ Why sport nutrition is considered both an art and a science

"To eat
is a necessity, but to
eat intelligently is an art."

Francois de la Rochefoucauld,
French author (1613-1680)

At the 1904 Olympics held in St. Louis, Thomas Hicks won the gold medal in the marathon. The race was run in temperatures near 32 °C (89.6 °F), and there were only two places along the route for water. At the 30-kilometer mark (18.6 miles), he asked for water but received a wet sponge to suck on and the white of an egg. A few kilometers later, nearing collapse, he received two eggs, a sip of brandy, and a small dose of strychnine (erroneously thought to be a stimulant and later used as a rat poison). Over the final 2 kilometers that included two hills, he was given two more eggs and two more shots of brandy, purportedly one for each hill. He finished the race but was unable to receive his trophy because he was in medical distress. So much for the prevailing advice on sport nutrition at the time!

Sport nutrition, which can also be called exercise nutrition, is the application of nutrition principles for the purpose of improving training, recovery, and performance. Exercise nutrition is a logical name for this discipline because it also reflects the close relationship between the academic fields of **exercise physiology** and nutrition. However, the field is much more commonly called sport nutrition. Sports are competitive physical activities, although the term is being expanded to include other competitions (interestingly, poker tournaments are now being covered in the sports section of some newspapers). Although *exercise nutrition* is perhaps a better term, *sport nutrition* is likely to remain the most widely used term and is used throughout this book.

sport nutrition—The study of nutrition for the purpose of improving training, recovery, and performance.

exercise physiology—The study of how the body adapts to exercise.

Origins and History of Sport Nutrition

Athletes have always been advised about what to eat, but the academic field now known as sport nutrition began in the exercise physiology laboratories. Historians consider the first studies of sport nutrition to be those of carbohydrate and fat metabolism conducted in Sweden in the late 1930s. In the late 1960s Scandinavian scientists began to study muscle glycogen storage, use, and resynthesis associated with prolonged exercise. Technology was also developed to help those scientists

measure human tissue responses to exercise. In 1965 something else was born in the laboratory. At the University of Florida a team of researchers led by Dr. Robert Cade developed a scientifically formulated beverage for the school's football team. It bears his name and that of the school's mascot—Gatorade.

In the 1970s exercise physiologists worldwide, but particularly in the United States, began to develop exercise physiology laboratories at universities and to study trained athletes. Distance runners and cyclists were most frequently studied because these athletes were in danger of depleting their glycogen stores and these sports could be simulated easily in the laboratory with the use of treadmills and stationary bikes. Research facilities at military and astronaut training centers also were developed because these individuals need to be in top physical condition. Much of the initial published research focused on the use of carbohydrate.

Some research on protein was conducted, but studying protein was much more difficult than studying carbohydrate because protein is found in so many different places in the body. Bodybuilders were particularly interested in knowing more about how to obtain the maximum amount of protein and the highest rate of protein synthesis in skeletal muscles, but there was little research to answer their questions. Some scientists questioned whether

Nutrition Bite

Athletes have always been given advice about what to eat, some of which seems rather odd today. Here is a sample:

- In the ancient Olympics, eating goat meat was advised because it was thought to confer strength.
- Athletes in ancient Greece were advised to eat dried figs as part of their training diet.
- Milo of Croton, a five-time ancient Olympic wrestling champion, reportedly ate 20 pounds (9 kg) of meat, 20 pounds (9 kg) of bread, and 18 pints (8.5 l) of wine a day, although such an intake would be impossible.
- Brandy drinking was a marathon race strategy at the 1904 and 1908 Olympics.
- When Mary Decker (Slaney) was smashing track records as a teenager in the 1970s, her admission that she ate a plate of spaghetti the night before a race brought surprise and laughter from the press.

1910-1929

1913
First vitamin (vitamin A) is discovered in the laboratory.

1917
The American Dietetic Association is established to improve public health.

1919
Harris and Benedict publish a study about basal metabolism in man.

1927
The Harvard Fatigue Lab is established. The lab's work is at the forefront of the field of exercise physiology.

1929
Nobel Prize is awarded to Frederick Hopkins and Christiaan Eijkman for the discovery of vitamins.

1930-1949

1937
Hans Krebs discovers the citric acid cycle, eventually known as the Krebs cycle. In the 1950s he receives a Nobel Prize and is knighted for his work.

1938-1939
Carbohydrate and fat metabolism studies are conducted in Stockholm. These are considered the first studies in sport nutrition.

1941
Establishment of nutrient intake standards in the United States, known as the Recommended Dietary Allowances (RDAs)

1945
Albert Behnke and colleagues devise an underwater weighing system for measuring body composition. It is the standard for almost 40 years.

1950-1969

1950
Keys and colleagues publish groundbreaking work on human starvation.

1954
American College of Sports Medicine is founded.

1956
Siri equation for determining body composition is published.

1965
Gatorade is created at the University of Florida.

1966-1967
Bergstrom and colleagues publish groundbreaking studies linking diet, muscle glycogen, and physical performance.

(continued)

bodybuilding was a sport; many considered it more of a sideshow compared to other athletic competitions. For these and other reasons, bodybuilders began to learn about nutrition via personal experimentation and trial and error. Although there is more research on protein today, many of the fundamental questions about the amount and timing of protein intake remain because of the difficulty of studying these subjects. The optimal amount of protein intake for athletes continues to be a controversial subject.

As is the case with much laboratory research, knowledge leads to application. This resulted in more collaboration between exercise physiologists and nutritionists, particularly beginning in the 1980s. For example, exercise physiologists were discovering that endurance athletes, such as marathon runners and long-distance cyclists, benefited from consuming approximately 8 grams of carbohydrate per kilogram of body weight daily. But what food and beverages did athletes need to eat to obtain this much carbohydrate? Would such a high-carbohydrate diet meet the body's other nutritional needs to maintain good health? The expertise of nutritionists was needed for translating scientific information into practical applications.

The 1980s marked the emergence of the field known as sport nutrition. Considering its importance in supporting excellent athletic performance, sport nutrition as a specialized discipline developed relatively late. Initially, much of the focus was on endurance athletes, which paralleled the exercise physiology research that was being conducted. In fact, athletes were typically characterized as either endurance or strength athletes. Endurance athletes often focused primarily on carbohydrate intake; strength athletes focused primarily on protein intake.

> *Sports nutrition didn't exist when I began college. My great fortune was to find a wonderful lecturer, passionate scientist, and keen runner—Professor Richard Read. At dinner I noticed he was only eating lettuce and cheese in preparation for a marathon. He had read some recently published papers about a diet that could help store more muscle glycogen. I was hooked. Sports nutrition was just evolving and I could see it happen before my eyes.*
>
> **Louise Burke**, PhD, APD, sport nutrition pioneer based in Australia

During this time tremendous advances were being made in the training of athletes. By the 1990s resistance training was becoming a part of nearly all training and conditioning programs, including those for endurance athletes. Many predominantly strength athletes were beginning to incorporate more aerobic activities into their training. Strength athletes more carefully considered their carbohydrate intake, and endurance athletes were more thoughtful about their protein intake. Athletes also began to train harder and for longer periods than in the past. Nutrition was widely recognized as a way to support training and speed recovery. It became clear that the intensity and duration of training were major influences on athletes' nutritional needs.

But training is not the end point for athletes—performance is. Thus, athletes also needed to know what to eat before, during, and immediately after performance. Choosing the wrong foods or beverages before or during competition can be disastrous. Some sports, such as wrestling and boxing, require weight to be certified. If the time of the scheduled weigh-in is rapidly approaching, these athletes may try to alter their weight by inducing fluid loss or excessive sweating, strategies that can endanger both performance and health. Poor nutritional planning can result in the inability to compete or perform well.

The mid-1990s added another dimension to the field of sport nutrition—dietary supplements. In 1994 the Dietary Supplement Health and Education Act deregulated dietary supplements in the United States. The act also classified herbs and botanicals as dietary supplements and included them in the same category as vitamin, mineral, and amino acid (protein) supplements. However, because some of these herbs are stimulants, classifying them as dietary supplements has caused problems. For example, the herb

Nutrition Bite

Here are some nutrition facts that will give you food for thought:

- **Protein supplements typically contain the same kinds of protein found in milk, meat, fish, poultry, eggs, and soy.** Food and supplements are not mutually exclusive; rather, they are complementary. Thus, dietary supplements should be considered in the context of the athlete's overall nutrition plan.
- **Energy beverages typically are high in sugar and caffeine.** A highly sugared drink raises blood sugar quickly, and caffeine is a stimulant, which is why these drinks help athletes feel energetic. But the effects of both subside rather quickly, leaving the athlete in need of another energy fix.
- **Some granola bars are high in fat and low in fiber but can be advertised as "healthy."** Do some detective work by reading the ingredient label to get some idea of how granola bars differ. Any company can use the word *healthy* to describe its product.
- **A sweet potato has more carbohydrate and fiber than a white potato.** Variety is the spice of life. Why not include both in your diet?

1970-1989

1971
David Costill's lab studies the usage and synthesis of muscle glycogen during prolonged exercise on successive days. Such studies help establish how much carbohydrate endurance athletes need daily.

1972
Low-carbohydrate diets become popular with the publication of the book *Dr. Atkins' Diet Revolution*.

1978
Caffeine is suggested to improve endurance performance both in the scientific literature and the popular magazine *Runner's World*. Athletes are beginning to look to scientists for ways to improve performance.

1981
David Jenkins, a Canadian physician and nutrition professor at the University of Toronto, Canada, publishes an article on the effect of dietary carbohydrate on blood glucose. Known as the glycemic index, it becomes an important tool for diabetics and athletes.

Sports, Cardiovascular, and Wellness Nutritionists (SCAN), a subgroup of the American Dietetic Association, is established.

1983
Jack Wilmore publishes information about the body composition of athletes in various sports.

Phinney and colleagues publish a study suggesting that a high-fat, extremely low-carbohydrate diet could improve the performance of endurance athletes such as distance cyclists. Subsequent studies show that such diets are not beneficial to performance.

1985
Timothy Noakes, a South African professor of exercise and sport science, first reports a case of hyponatremia (low blood sodium) in a female distance runner. Overconsumption of water, known as water intoxication, is a likely cause.

Barbara Drinkwater's lab reports differences in bone mineral content between menstruating and nonmenstruating female athletes.

1987
Brown, Steen, and Wilmore analyze weight regulation practices in wrestlers and the effects they have on metabolism.

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