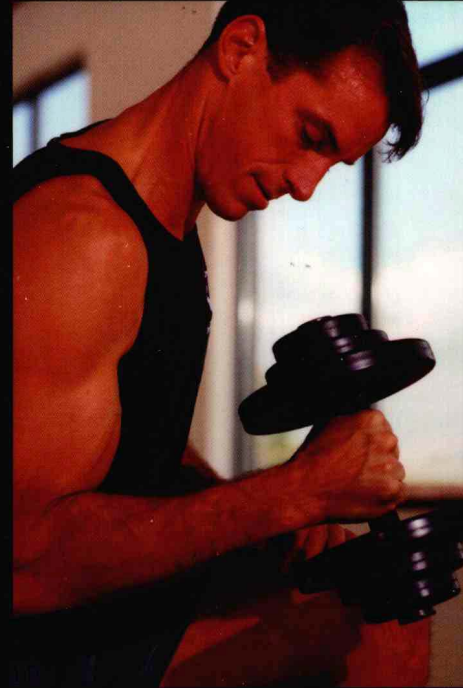


Third Edition

Dynamics *f*

Strength Training and Conditioning



Gary T. Moran
George McGlynn

Third Edition

Dynamics of Strength Training and Conditioning

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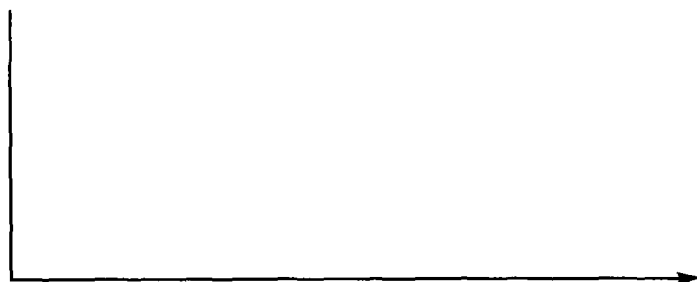
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To my wife, Ingeborg, and my son, George.

George McGlynn

To my sister, Deborah Denise Brown, and in memory of my
grandmother, May Sheehan, for their unconditional love.

Gary Moran



preface

Since the completion of the second edition, there have been a number of advances and refinements in the area of muscle strength and endurance. As with the second edition, the purpose of the third edition is to give clarity to this new information by providing a simple, logical, and individualized approach to strength and endurance training. Further, our intent is to enable the reader to distinguish between what is valid and safe from what is false and potentially dangerous. The book also is intended to be a practical guide for understanding the physiological basis for muscle strength and endurance and the most efficient and effective strength-training techniques. The information presented here represents a consensus of presently available scientific evidence.

The text is intended primarily for college classes in physical fitness, conditioning, strength and weight training, circuit training, and bodybuilding as well as for the average person who wishes to increase her or his strength and endurance. The information presented reflects the latest research while helping readers to avoid useless products and dangerous practices.

Approach and Features

The goal of this book is to bridge the gap between scientific knowledge and the application of that knowledge and also to provide you with the most efficient and up-to-date methods of strength training to insure that your body's adaptations from the training are beneficial and safe. The book also answers basic questions about how to select and prepare for physical training and how this training affects you physically over both short and long periods of exercise.

- *An individualized approach.* A sequence of simple tests enables you to evaluate not only your present muscle strength and endurance, but also your cardiorespiratory endurance, body density, and flexibility. The first part of the book describes the benefits of strength training, basic fundamentals and exercises, motivational and mental concentration techniques, and muscle training procedures.
- *Currentness.* Other important areas covered are cardiorespiratory endurance; strength training for women, the aged, and the young; injuries; nutrition; drugs; flexibility; and an analysis of various strength-training equipment.

New to this Edition

The third edition has been updated to integrate the latest guidelines from the American Heart Association (AHA), the American College of Sports Medicine (ACSM), and the American Academy of Pediatrics (AAP) to provide readers with the most current information available.

- Chapter 1, *Introduction*, now includes new coverage of the distinctions between acute and chronic adaptations to strength training, and introduces the SAID principle. Additionally, the section on *Age and Exercise* has been expanded to include the effects of strength training on adolescents, as well as the benefits to older adults.
- Chapter 3, *Fundamentals of Weight Training*, contains new information on strength-testing protocol for repetition maximum, ACSM weight training recommendations for the aged, and recommendations for proper breathing during weight lifting.

- Chapter 6, *Evaluation and Self-Assessment*, includes a new section on strength evaluation which addresses the reasons for monitoring strength.
- Chapter 9, *Advanced Training*, includes new coverage of power and speed exercises. The plyometrics section now includes an explanation of the term “stretch-shortening cycle.”
- Chapter 10, *Exercises*, has been organized by body regions (i.e., chest, upper back, and shoulder exercises; arm exercises; lower back and abdominal exercises; and lower body exercises), and now includes new anatomical illustrations to show the muscles affected.
- Chapter 11, *Women and Weight Training*, now includes a new section of the Female Athlete Triad, including warning signs of eating disorders. Also, the discussion of the physiological differences between women and men as they relate to weight training has been expanded.
- Chapter 14, *Injuries*, now includes runner’s knee and suggestions on how to prevent it.
- Chapter 16, *Drugs*, contains a new list of supplements banned by the International Olympic Committee. New coverage of dietary supplements, androstenedione, DHEA, creatine phosphate, and HMB have been added to this chapter. Their side and after effects are also discussed.
- Chapter 17, *Equipment*, expands its coverage of resistance machines, including free weights and isokinetic machines.
- New Appendix H provides web site addresses for selected chapters as a resource for further information.
- New Appendix I provides the ACSM position statement for cardiorespiratory and muscular fitness, and flexibility in healthy adults.
- A new detachable Weight Training Record Card for personal recordkeeping is located inside the back cover of the text.
- Critical Thinking exercises provide brief scenarios of actual situations in selected chapters that challenge the reader to apply the content studied to resolve the problem identified. Possible resolutions are provided at the end of those chapters.
- New Review Questions conclude selected chapters and help to reinforce the content learned.

Pedagogy

Each chapter begins with chapter objectives. Critical thinking exercises and resolutions, glossaries, and references are presented in selected chapters to reinforce content and provide additional resources.

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chapter 1

introduction

Objectives

After studying this chapter you should be able to

1. Describe some of the misconceptions concerning strength training.
2. Describe the physiological benefits of strength training.
3. Describe the psychological benefits of strength training.
4. Describe the body's adaptation to strength training.
5. Describe the benefits of strength training for the aged.
6. Describe growth changes during youth.
7. Define body building.
8. Define muscle endurance.
9. Define muscle power.
10. Define muscle strength.
11. Define conditioning.
12. Define weight lifting.
13. Define power lifting.
14. Define weight training.
15. Define the SAID principle.

IMPORTANCE OF STRENGTH TRAINING

Little doubt remains today as to the importance of muscular strength and endurance in competitive sports and in the demands of everyday physical activities. Whether you are an athlete looking for increased performance, a sedentary individual dissatisfied with your present lifestyle, or just someone in search of a healthful and satisfying exercise experience, strength training can play a major part in meeting your needs. All that you need is a willingness and determination to take on a new and exciting challenge.

MISCONCEPTIONS

Muscle strength training for many years had been associated with physical fitness. The individual who spent hours in the gym lifting weights had always been considered the model of fitness. We know today, however, that strength training, though essential, is only one aspect of total body fitness. In the past many competitive athletes generally avoided strength training because they thought such training exercises were detrimental to the development and maintenance of certain sports skills. Fears that strength training would bring muscle-boundness, loss of flexibility, and reduced coordination were generally accepted. Current research, however, tells us these concepts are erroneous. Strength training is essential for competitive athletes and also plays a role in determining one's physical fitness level. It is not unusual to see weight lifters engaged in long-distance running and competitive long-distance runners spending more time in weight training. In addition, we now know that resistance training not only leads to increased strength and power but also increases flexibility. The latter benefit puts to rest outdated fears of muscle-boundness.

MUSCLE STRENGTH, ENDURANCE, POWER, AND CONDITIONING

The terms strength, muscle endurance, and power are sometimes used interchangeably. However, each of these terms has its own definition. Muscle strength is the amount of force that can be exerted by a muscle group for one movement or repetition. Muscle endurance is the ability of the muscle group to maintain a continuous contraction or repetition over a period of time. Power is simply the product of strength and speed and the ability of the muscle to produce high levels of force in a short period of time. Conditioning is the development of high levels of skeletal muscle strength and endurance, and a high level of cardiorespiratory endurance. This enables one to perform at a high work level for prolonged periods. The muscle system is the foundation of all physical exercise. No matter what activity you participate in, your muscle strength, endurance, and power determine your exercise limits.

In addition, there are other terms that are commonly misused; therefore it seems appropriate to define them before any further discussion.

Weight Lifting is a competitive sport where an individual is judged on the amount of weight that can be lifted relative to weight classification. The clean and jerk and snatch are the two standardized Olympic events in this competition.

Power Lifting is a competitive sport where the goal is to lift the greatest amount of weight from three exercises (bench press, squat, and dead lift).

Weight Training is an exercise program where free or stationary weights are used for the purposes of increasing strength, endurance, flexibility, skill, and power.

Bodybuilding is an exercise program utilizing free or stationary weights to change body shape and form.

WHY DO PEOPLE LIFT?

The reasons people lift weights are as varied and numerous as the people who lift. The weight room may be the most democratic of settings in all of sports and society. People of both sexes, and all ethnic, socioeconomic, and age groups lift weights. The reasons may be to improve sport performance, improve physical appearance, improve fitness level, enjoyment of the physical activity, or a combination of the preceding.

BENEFITS OF STRENGTH TRAINING

Properly designed resistance programs' benefits are many and have practical implications for many populations. The ability of the human body to generate force is also highly related to performance in most sports and a variety of everyday physically demanding activities.

The main attributes developed by strength training are muscular strength and endurance, power, flexibility, and body composition. Certain weight training programs can also lead to development in cardiorespiratory endurance. These basic elements of fitness are discussed in detail in chapter 3.

Strength is essential to a variety of everyday physical activities. Even though strength is a relative factor related to the demands of the activity, all individuals need a minimum level of strength. Those with low levels of strength run a greater risk of injury in lifting or while engaging in other physical activity. Performance in recreational sports and athletics is enhanced by high levels of strength. Strong abdominal muscles provide important protection against lower back problems. Strength training is also an essential part of physical rehabilitation. Common sports injuries such as tennis elbow, rotator cuff, ligament and tendon strains respond well to muscle strength programs. Better posture accompanied by more aesthetic appearance are also benefits from strength training.



Critical Thinking 1-1

A student baseball player has decided not to participate in a strength-training program. He has heard that strength training will have a detrimental effect on his skill and coordination.

What could you tell him that will allay his fears?

BODY BUILDING

Many individuals lift weights to improve body shape and form and have little interest in athletic performance. Muscle size and definition take priority over strength and endurance gains. Body building refers to the body's morphology or form and structure that depend mainly on inherited or genetic factors. While your body type or build can be altered only slightly, substantial changes can take place in body composition by decreasing body fat and adding muscle mass. When you exercise you burn more calories than when you are sedentary; therefore you start to lose weight, provided your food intake remains the same. A strength and endurance program results in an increase of muscle tissue with a decrease in stored fat. Your body dimensions will change, resulting in a slimmer waist, trimmer hips and thighs, and improved overall appearance.

Table 1.1 lists in more detail the benefits that you may experience as a result of weight training.

Table 1.1

Benefits of Weight Training	
Increase in	
	Muscle strength
	Muscle endurance
	Strength of bones and ligaments
	Thickness of cartilage
	Capillary density in the muscle
	Muscle mass (hypertrophy)
	Longer duration of effort before exhaustion—stamina
	Increased flexibility
	Speed and power
	Blood volume and hemoglobin
	Muscle enzyme levels
	Skill
	Maximal work capacity
	Equalization of muscle development
Decrease in	
	Body fat
	Stress and tension
	Resting heart rate
Additional benefits may	
	Help prevent injuries
	Help rehabilitate injuries
	Improve function of cardiorespiratory system
	Alter metabolism to improve caloric utilization
	Facilitate quicker recovery from workouts or competitions
	Increase self-image and confidence
	Improve appearance
	Increase feeling of well-being
	Naturally induce fatigue and relaxation

The human body has an amazing capacity to adjust to and benefit from the many physical demands placed upon it. For example, the body is capable of adapting to many kinds of stress and even increasing its efficiency as a result of stressful stimuli. In the case of fitness training, research indicates that repeated physical stress (intensive training) will lead to increases in our functional capacity (strength and endurance). The main purpose in strength training therefore is to stress the body through a variety of exercises so that beneficial adaptations will occur. Strength training is only beneficial as long as it causes the body to adapt to the physical efforts. If the stress is limited, adaptation will not occur. If there is too much stress, then injury and deterioration will result. An important point to remember is that your physical fitness is largely a reflection of the level of your training. When you work hard, your fitness will be high. However, when you interrupt the intensity of the training, your fitness will decline. Further, individuals with low levels of strength and endurance can look forward to substantial gains in muscular strength and endurance after only a few months of rigorous exercise.

Resistance training programs are highly specific to the types of adaptations that occur. The activities of specific patterns of motor units in training will determine what tissue and what physiological systems will be affected. Resistance training therefore should be specific to one's goals.

Both acute and chronic physiological changes occur with resistance training. Acute changes are immediate responses such as increases in heart rate and breathing. Chronic changes respond to training over a period of time. Examples are enlargement of muscles (hypertrophy) and gradual increases in the number and size of myofibrils. Increases in the size of ligaments, tendons, and bones occur, as skeletal muscles become stronger. These tissues adapt in order to support increased forces. Changes in neural activation resulting from different resistance systems can produce varied types of adaptation such as increases in strength with little change in muscle size. Adaptation may also result in reduced inhibition of the central nervous system, which may be responsible for greater recruitment of muscle fibers. Cardiovascular adaptations result in cardiac wall thickness and lower blood pressure.

Resistance training has positive effects on bone, muscle and associated connective tissue. The entire muscle and skeletal systems undergo a coordinated adaptation to strength exercises. The changes in force-generating capabilities of the muscle also result in a coordinated and proportional increase in the load bearing capacity of bone and other connective tissue. The changes that occur in the property of muscle fibers are specific to the metabolic and force requirements of the resistance-training program.

It is important to remember that each person will respond differently to a strength-training program. The amount of change will depend on the muscle capacity to adapt to the training regimen. Important here is the SAID principle (specific adaptation to imposed demand). Because the type of demand placed on the body will determine the type of adaptation that will occur, the training program should be specific to the individual's ultimate goals. For example, training for peak athletic performance requires higher levels of intensity and volume than training for general health and fitness. Also training for high-speed events requires a training program that activates as many motor units as possible in the shortest period of time.

The unique thing about your strength-training program is that you are completely in charge. You make all the decisions, set your own goals, and decide when and how to exercise. Your goals in strength training are very clear and measurable, with few ambiguities confronting you. Further, you are in a no-lose situation; failure is impossible. There are no records to break, no complex skills to learn; success is there for the asking. There is an immediate payoff; you will be visibly improved by your physical

activity. Improved muscle efficiency will produce feelings of increased energy, health, and overall well-being. The benefits of training will be especially noticeable if you are in a poor level of physical condition when you begin your program.

AGE AND EXERCISE

Exercise for older persons is a comparatively recent phenomenon brought about by a change in social mores and a new perception of the role of exercise in life. Exercise programs for older persons should consist of flexibility exercises, weight training, calisthenics, and continuous fast walking or jogging. Sudden rigorous bursts of exhaustive exercise such as sprinting or lifting very heavy weights should be avoided. Older people should concentrate mainly on endurance activities that are moderate and rhythmic in nature such as jogging, walking, swimming, bicycling, and light weight lifting.

Maximum strength of men and women is generally achieved between the ages of twenty and thirty-five, and significantly high strength levels can be maintained well into advanced age. Normally a progressive decline of muscle strength takes place with age due to a reduced muscle mass brought about primarily by inactivity. Physical training, however, can significantly modify the strength decrement with aging. Older persons can expect improvements when they begin to train in later life no less than younger counterparts.

Resistance training appears to be a safe and potentially beneficial form of exercise for the great majority of the adult population, even including patients with heart disease and neuromuscular disorders. There is still a need, however, for more information on the clinical population. Aging is a very complex process, which involves a number of interacting variables. However, regular physical activity may cut across all of these variables and contribute to the physical and psychological well-being that defines healthy aging.

Strength training is important to older adults for a variety of reasons. Loss of muscle mass begins at age 30 and is accompanied by decreased muscle density and increased intramuscular fat. Muscle atrophy may result from loss of muscle fibers and is directly proportional to age-related decreases in strength. From age 65 to 84 the average decline in strength is approximately 1.5 percent per year. In addition, one in three adults over age 65 falls at least once a year. Of those aged individuals who suffer hip fractures, 50 percent will die within a year and a half. Resistance training may minimize or reverse the syndrome of physical frailty, which is prevalent among the most elderly and puts them at a greater risk for falls.

Bone mass also decreases with age. Bone mass and density is regulated by loading. Loading conditions can lead to hypertrophic response in bone resorption. Strength training also enhances and preserves the durability, solidity, and wear resistance of joint tissue.

The age-related decline in bone density could be significantly impacted by strength training. In addition, resistance training will result in increased energy requirements, which can cause a decrease in the fat mass in the maintenance of lean body mass. High intensity strength training may also be safe in selected patients with well-controlled rheumatoid arthritis. Resistance training has also been found to lower systolic pressure in men and diastolic in women.

Old age causes a decline in most aspects of physical performance, including muscle strength. Resistance training can be initiated at any age and can result in improvement over pre-training levels. Strength training can prevent or reverse muscle loss along with increases in muscle strength, power and endurance, making one more mobile, active, and energetic than before. Obviously previous skill and physical activity in addition to posture, body size, and individual biomechanical differences will affect capabilities.

Critical Thinking 1-2

A senior individual said that he was afraid of engaging in strength training because it would put him at risk for high blood pressure.

How could you convince him that he should not be concerned?

The National Institute of Aging studying 6,000 adults over a twenty-five-year period found those with the lowest third of strength were nearly three times as likely to develop difficulties in walking and more than twice as likely to become disabled as those in the higher third. If a middle-aged individual cannot hold a standard twelve quart bucket full of water with her or his arm down at her or his side for at least three minutes, the National Institute on Aging recommends strength training for that individual.

YOUTH AND EXERCISE

Adolescents begin pubertal growth at varying ages. The onset of puberty can vary between ages 8 to 13 in girls and ages 9 to 15 in boys. After the onset of puberty a period of growth for boys and girls extends from one to four and one-half years. Once puberty begins, changes in body composition occur. The bigger, early-maturing children will have an advantage in absolute strength over late-maturing children because of the greater amount of muscle tissue. In boys, maximum strength occurs about nine months to a year after the peak velocity of growth in height and weight, with body weight the best indication. During adolescence, growth spurts increase first in mass and then in the ability to express strength. In girls, maximum strength occurs after a peak velocity of growth in height. The gains in height and body weight in both boys and girls are related to gains in strength and power performance. Therefore strength-training programs must be adjusted to individual differences, especially physiological age, which will determine the functional capabilities and performance and should be considered in developing resistance programs.

The American Academy of Pediatrics has recognized that a properly supervised and prescribed program may increase muscle strength and local muscle endurance, decrease injuries in sports and recreational activities, and improve performance capacity in sports and recreational activities.

Finally, if you follow the individualized exercises and guidelines presented in this book, you will be following procedures based upon sound scientific principles, which will benefit your health, and also be a source of continued satisfaction and enjoyment to you.

Glossary

Bodybuilding Exercise program that utilizes free and stationary weights to change body shape and form.

Conditioning The development of high levels of muscular strength and endurance and high levels of cardiorespiratory endurance.

Muscle Endurance The ability of a muscle group to maintain a continuous contraction or repetition over a period of time.

Muscle Power The product of strength and speed (force and velocity).

Muscle Strength The amount of force that can be exerted by a muscle group for one movement or repetition.

Power Lifting A competitive event where the goal is to lift the greatest amount of weight for three different exercises (bench press, dead lift, and squat). Explosive power is important in this event.

Weight Lifting A competitive event where the goal is to lift the greatest amount of weight for two exercises (clean/press and snatch). Skill, speed, and strength are important.

Weight Training Exercise program using free or stationary weights for the purpose of increasing strength, endurance, power, skill, and flexibility.

Solutions to Critical Thinking

- 1-1. There is substantial research that strength training is not detrimental to a learned skill if exercises are performed properly. In addition, resistance training will increase the student baseball player's speed and power, which will increase his hitting and throwing performance.