

RESISTANCE

A PROFESSIONAL GUIDE TO

TRAINING

AN INSTRUCTOR HANDBOOK



A comprehensive and informative guide to resistance training theory and techniques intended to advance the knowledge of current and future certified fitness instructors.

AARON TEWS
BSc Kin, FMS, BCRPA Trainer of Trainers

**A Professional Guide To
Resistance Training
- An Instructor's Handbook -**


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SECTION

Resistance Training Theory **A**



CHAPTER

Introduction

ONE

Chapter Summary

Topics covered in this chapter are:

- Brief History
- Leaders in Fitness
- Resistance Training Terminology
- Components of Fitness
- Reasons to Resistance Train
- Muscle Training Goals
- Code of Ethics
- Scope of Practice

Learning Objectives

After reading this chapter, you should be able to:

- Describe the transition from treating symptoms of hypokinetic disease to treating the disease itself
- Name and describe the contribution of several influential leaders in physical fitness
- Be able to define the terms resistance training and strength training
- Describe the components and elements of physical fitness
- Understand the reasons why a person may want to begin resistance training
- Distinguish between muscular strength, muscular endurance and muscular power
- Describe the guidelines for sensible resistance training
- Understand the code of ethics under which fitness professionals operate
- Identify the Scope of Practice for the BCRPA Weight Training Leader

Brief History

The physical activity in our daily lives has significantly decreased in last half century. In some cases, our physical activity has been all but eliminated. We no longer have to fight or work physically for our food. Instead, we fight our way through traffic in our vehicles to go to the grocery store.

Since the 1900's, the amount of physical activity in the average person's life has decreased by approximately 50%. In fact, today we are less than 1% as active as our early ancestors and as a result, suffer from hypokinetic (lack of movement) diseases. In the 1960's, people began dying from heart disease in epidemic proportions due to sedentary lifestyles, over-fatness, high blood pressure, and mental stress. Regular physical activity was not prescribed as the treatment for heart disease in the sixties. The 1970's represented an era dependent upon doctors to make people well. Doctors developed treatments for the *symptoms* of health problems - heart transplants, bypasses, angioplasty, angiograms, pacemakers, blood pressure medication - instead of finding *solutions* to the health crisis. In the 1980's and through the 1990's, the healthy lifestyle concept emerged. To promote healthy lifestyles, phrases such as 'you are what you eat' and 'healthy body, healthy mind' were used in advertising and fitness slogans. Today, regular physical activity is recommended as a treatment for problems ranging from chronic fatigue and fibromyalgia to stress and diabetes.

Some good news for those living in British Columbia. According to the 2012/13 Annual Service Plan Report¹, the British Columbia Ministry of Health's Goals, Objectives, Strategies and Health Indicators are as follows:

Goal 1: Effective health promotion, prevention and self-management to improve the health and wellness of British Columbians.

Objective: Individuals are supported in their efforts to maintain and improve their health through health promotion and disease prevention.

Strategies

- Work with health authorities, family doctors, primary care providers, community partners and others to advance the health of women and children through comprehensive and effective programs and services.
- Support communities, including schools, workplaces and municipalities, to strengthen healthy living opportunities with a focus on healthy eating, physical activity, reduced salt and sugary drink consumption, tobacco reduction and responsible alcohol use in order to reduce childhood obesity and the prevalence of chronic disease.
- Support families and individuals to invest in their own health through programs and incentives that lead to healthy lifestyle choices.
- Provide supports for older people and frail seniors, including supports to prevent falls and injuries, and to promote independence.
- Improve health outcomes for Aboriginal people and communities and provide culturally safe health services to all Aboriginal people in British Columbia.
- Protect the health of families and individuals, and support healthy communities through policies and programs such as food safety and drinking water quality practices.

Health Indicators - B.C. leads the country in a number of health indicators including:

- Highest life expectancy at birth
- Lowest mortality rate from heart attack, stroke and all cancers
- Lowest incidence rate for cancer
- Lowest smoking rate
- Lowest obesity rate

> **NOTE** <
Refer to
Appendix B
for a glossary
of terms used
throughout the
book.

FACT

Approximately
75 % of skeletal
muscle is water,
20 % is protein
and the
remaining 5 % is
made up of
inorganic salts
and other
substances.

Source: Statistics Canada

Obesity in Canada

In the 2007 Canadian Community Health Survey was conducted and found the following interesting, but scary statistics about Canadian Obesity.

- The self-reported rate of adult obesity (age 18+) was 17%. The actual rate of obesity is likely much higher, closer to 25%.
- Across Canada, self-reported rates of obesity have increased from 2003 to 2005 and again in 2007.
- Obesity rates for both men and women increase with age, starting at age 20 and continuing until age 65.
- After age 65, obesity rates decline.
- In 2005, the measured rate of obesity for youth 12 to 17 was 9.4%, almost two times higher than the self-reported rate (4.9%).
- Self-reported data from 2002/03 suggest that obesity rates are high among First Nations adults (36.0%), youth (14.0%) and children (36.2%).
- In 2007, the self-reported obesity rate among off-reserve Aboriginal adults was 24.8%, compared to 16.6% for non-Aboriginal adults.
- Unlike other health issues such as mortality or life expectancy, for which there is a clear disadvantage for those with lower income, the relationship between income and obesity is not clear.
- In 2005, obesity-related chronic conditions accounted for \$4.3 billion in direct (\$1.8 billion) and indirect (\$2.5 billion) costs – a figure that may be an underestimation of the total costs of excess weight in Canada.

FACT

By the age of 65, individuals who haven't engaged in exercise on a regular basis may incur a decrease in their muscular strength level by as much as 80 percent.

Over the past several years, Canada has experienced an alarming increase in obesity rates among adults, children and youth.

Obesity in the survey was defined as a Body Mass Index or BMI of >30 kg/m. Obesity is a contributor to chronic diseases, such as diabetes (Type II), cardiovascular disease, hypertension and liver disease, as well as breast, colon and prostate cancer. In short, one of the only alternatives to poor health is to get fit and stay healthy. Easier said than done, but one of the reasons many are seeking assistance starting the health and wellness journey from certified and trained health professionals.

Leaders in Fitness

Over the years, many people have promoted the endless benefits of regular physical activity. This could be considered a very subjective list. In particular:

Dr. Kenneth Cooper wrote the book 'Aerobics' and, in so doing, coined the term used to describe the activity so many are involved in. Dr. Cooper promoted the importance of physical fitness and became respected in the process.

Bonny Pruden introduced the concept of combining exercising and music together.

Jane Fonda has been credited with starting the whole fitness video craze although her old videos lacked some important concepts of fitness safety (e.g. the danger of ballistic stretching). Ms. Fonda has literally sold *millions* of fitness videos.

Charles Atlas (born Angelo Siciliano) has long been associated with the mail-in fitness course advertising campaign in magazines and comic books. Remember the ads - skinny kid gets sand kicked in his face, takes Atlas' course, beats up bully and reunites with girl? This ad gave every young boy hope of becoming a man that nobody would mess around with – a concept many ads today use to sell products!

Arnold Schwarzenegger is responsible for mainstreaming strength training and

bodybuilding. What else can really be said about this legend?

Marc LaLonde, the Honourable Minister of Health, published a book in the 1970's titled *A New Perspective on the Health of Canadians*. In the book, the Canadian government recognized that the medical profession was not providing the needed approach to health. The book's focus was on the prevention of disease as opposed to the medical profession's treatment of disease.

PARTICIPACTION was a positive health related advertising campaign that began in the 1970's and had a major impact on Canadians. One of the early promotions equated the "average 30 year old Canadian at the same fitness level as a 60 year old Swede."

Jillian Michaels, a personal trainer on the TV show *The Biggest Loser*, has been an influential figure in health and fitness. She not only focuses her energy on helping overweight people eat healthier and exercise, she also has workout videos as well as speaking engagements. Because she suffered from obesity herself, she understands where people are coming from and the challenges people are facing when it comes to exercise, eating healthy and enjoying life. She realizes that along with physical workouts, people must conquer their emotional issues. She helps people understand themselves and what led them to their obesity or their inactivity. Once this understanding is there, they can move towards a healthier lifestyle.

Beto Perez, is the creator of Zumba Fitness, a Latin inspired dance fitness program. The goal behind Zumba "is to spread the philosophy of health & happiness and loving everything you do, especially your workout!" Beto created Zumba in 2001 and now over 6 million people participate in this fitness program all over the world. Zumba has helped millions reach their fitness goals.

Mark Sisson was a pioneer in the field of Paleo / Primal nutrition and exercise practices which have now garnered major public acclaim and support from the scientific community. The trends of modified Paleolithic eating and minimum effort, maximum gain training have proven effective for millions and Mr. Sisson did much to foster this movement.

Michelle Obama created the "Let's move" initiative to teach children the importance of eating healthy and staying active. She has been recognized as a children's health advocate as she has been bringing awareness to childhood obesity all across America through her lets move initiative. She provides parents and children with helpful information and tips to living a healthier life. She also provides schools with healthier foods as well as encouraging physical exercise.

Greg Glassman and Lauren Jenai founded **CrossFit, Inc.** in 2000. It has been promoted as an exercise philosophy crossed with a competitive sport. Crossfit incorporates many fitness elements such as high-intensity interval training (HIIT), Olympic-weightlifting, plyometrics, powerlifting, gymnastics, and calisthenics. In an article in the *Globe and Mail* (January 11, 2008), Dr. McGill was quoted saying the risk of injury from some CrossFit exercises outweighed the benefits when they are performed with poor form in timed workouts. There are inherent risks with all activities, but increases with high-risk activities. There is a definite crossfit dichotomy - you are either die-hard Crossfitters or total anti-crossfit.

A few other well respected leaders in the field of health and wellness new are (in no particular order): **Gray Cook, Charles Poliquin, Eric Cressey, Mike Robertson, Bill Hartman, Dan John, Mike Boyle, Vladimir Janda, Bret Contreras, David Behm, Shirley Sahrmann, and John Berardi**

For great online information, check out these sites for current information:

- kinesiologists.ca
- NSCA
- t-nation.com (not for the easily offended).

Today, millions of people incorporate a strength training component into their regular exercise program, but it has not always been this way. In the past, strength training was saddled with myths such as lifting weights would result in bulky physiques, athletic performance would

FACT

Muscles are comprised of muscle fibers. Each fiber is thinner than a human hair and can support up to 1,000 times its own weight.

be hindered, flexibility would significantly decrease and coordination would be impaired. Strength training was first used in the rehabilitation of injuries only 80 years ago - a relatively new concept.

Scientific research has debunked the myths surrounding resistance training. For example, scientific evidence has proven that flexibility can be maintained and even improved if a proper strength training program is coupled with a stretching program. In addition, scientists have proven that sports performance for both the professional and recreational athlete can be improved when a well designed resistance training program is followed. All athletes, from recreational triathletes to professional basketball players, have improved their performance through strength training.

Since the scientific research community has become interested in strength training, findings have resulted in dramatic facility and equipment improvements. Dark, damp basements with old rusted steel plates have given way to bright and modern facilities with fully computerized equipment. As well, the trial and error method of training has been replaced with university graduates applying modern scientific training principles to produce safe and effective training programs. Strength training instructors must strive to continually improve training techniques through practice and by keeping up to date with the current *scientific* literature.

It is important, as an instructor, to remember that the reason for training is to improve personal health. People should be treated as individuals and their training program design

Figure 1-1: Guidelines for Sensible Strength Training

Establish strength training goals. Be aware of what is to be accomplished through the training program - lose weight, improve muscular strength, muscular power and/or muscular endurance, get huge, rehabilitate an injury or improve cardiovascular fitness.

Engage in an effective and efficient strength training program. Ensure the program is based upon scientific principles, time and energy are not wasted, exercises are appropriate, and training equipment (modality) is appropriate for ability and knowledge.

Safety must be of utmost concern. Perform exercises that do not hurt. Be sure to have medical clearance before beginning an exercise program. When unsure, err on the side of caution. Perform exercises properly - technique, technique, technique!

Have a fitness assessment prior to beginning a strength training program. An assessment sets your fitness baseline and determines weak and strong areas. Do not have assessments too regularly to avoid discouragement when dramatic results slow down.

Aim for total fitness. Strength training is only one area of overall fitness. Remember to train for cardiovascular fitness, muscular strength, muscular endurance, and flexibility. Be well balanced!

Develop sound nutritional habits. If you do not eat sensibly, results will be slow. Remember that you are what you eat!

Avoid over-training. Too much too soon makes exercise uncomfortable and decreases interest. Over-training decreases performance and slows results. Exercise should be enjoyable and not feel like a contest.

Keep a strength-training diary. A detailed strength training diary will help evaluate program effectiveness. In times of plateaus, the diary may serve as an excellent motivator!

Strength train for the health of it! If driving to the gym across town takes up lots of time and raises stress levels think about exercising at home. Exercise for the health benefits. Make exercise a part of your lifestyle.

Ensure your strength training program is enjoyable. A boring strength training program results in, well, boredom! A professionally designed program is creative, maintains interest levels, and is safe and effective.

should be based on the premise of individuality. Generic resistance training programs only reflect the lack of imagination, training and skill of a certified instructor.

As more scientific research is conducted in the area of resistance training, many theories and ideas will change. Even current scientific information has more than one theory to explain certain biological processes. For example, both the Hyperplasia Theory and the Hypertrophy Theory attempt to scientifically explain the process of muscle size increases. This book does not attempt to dictate what theories or methods should be accepted, but attempts to provide unbiased information, enabling the strength training instructor to make his or her own decision.

Reasons to Resistance Train

Millions of people are resistance training, but what are their reasons for doing so? People will train for improvements in general health, visual impact, injury prevention, injury rehabilitation, and athletic improvement.

Specifically, improving general health through resistance training will make everyday efforts easier to perform, improve job performance in physical jobs, make you look and feel better (very closely related), decrease the chance or severity of an injury, shorten the recovery time from surgery or injury, improve coordination, increase mobility and range of motion, and regain muscle balance.

Muscle Training Goals

Once the purpose for training is established, it is important to determine specific training goals. Training programs can be designed to improve muscular strength or endurance, or muscular power mutually or exclusively. Muscular size increases would fall into the category of muscular endurance because the benefits occur with multiple repetition sets.

It is important to train both efficiently and effectively, and to avoid injury. For resistance training programs to be effective and efficient, it is wise to follow certain guidelines (Figure 1-1: Guidelines for Sensible Training). Guidelines are *suggestions* for sensible training only - certain training regimes will require a variation of these guidelines.

FACT
The human body has more than 600 muscles. Skeletal muscle is the body's largest tissue, accounting for approximately 45 percent of body weight in men and 36 percent in women.

Resistance Training Terminology

The term strength training is often used synonymously with the term resistance training. The definition of resistance training is the process of improving muscular strength, muscular endurance, muscular power and/or muscular size using any resistance training modality - free weights, variable or fixed resistance machines, isometric exercises, isotonic machines, isokinetic machines (pneumatic or hydraulic), body/limb resistance, rubber tubing, etc. The term strength training is often defined as the process of improving muscular strength using any training modality - free weights, variable or fixed resistance machines, isometric exercises, isotonic machines, isokinetic machines (pneumatic or hydraulic), body/limb resistance, rubber tubing, etc.

Components of Fitness

It is important to understand the placement of resistance training in relation to health and overall well being. General health consists of a balance between such components as stress management, nutrition, spirituality, and physical fitness.

Physical fitness is often divided into four components, including cardiovascular fitness, muscular strength, muscular endurance and flexibility.

Cardiovascular Fitness is defined as the ability of the heart, blood vessels, blood, and circulatory system to supply fuel, specifically oxygen, to the muscles during sustained activity. A fit person can endure aerobic physical activity for relatively long periods of time without undue stress.

Muscular Strength is defined as the force a muscle or muscle group can exert against a resistance in one maximal effort. It is also referred to as a maximum voluntary

contraction (MVC). This is important for such activities as putters of the shot, discus throwers and competitive weight lifters. *Muscular Power* is the force a muscle or muscle group can exert during a specific period of time.

Muscular Endurance is defined as the ability of a muscle or muscle group to perform repeated contractions over an extended period of time. In contrast to muscular strength, muscle endurance is characterized by 2 or more repetitions.

Flexibility is defined as the range of motion about a joint. It is affected by muscle length, joint capsule and other factors. A flexible person can move the body through a full range of motion at work and play without injury.

Training programs are designed to change specific components of physical fitness and each component will be examined in detail throughout the book.

Code of Ethics

All instructors should be aware of the parameters in which they operate. Many associations and organizations follow a written set of ethical guidelines. An example of ethical guidelines are listed below.

Provide qualified instruction

- a. Screen health and exercise history of all participants and establish individual fitness goals.
- b. Offer modified exercise options for those with special needs.
- c. Be certified in first aid, CPR and emergency procedures.
- d. Accurately represent your qualifications.
- e. Recommend clients with conditions outside your area of expertise to other professionals.

Ensure a safe exercise environment.

- a. Maintain a clean, well-lit and ventilated facility that meets the governmental regulations and insurance guidelines.
- b. Maintain all equipment.
- c. Establish emergency protocols.

Stay educated.

- a. Pursue continuing education.
- b. Facilitate continuing education of staff.
- c. Meet the provincial standards for instructor knowledge.
- d. Obtain specialized training before teaching special populations.

Foster a life-long commitment to fitness.

- a. Encourage participants to follow regular exercise programs.
- b. Keep track of progress.

Show respect.

- a. Exchange knowledge and experience with other professionals for the benefit of all.
- b. Never discredit individuals, associations or facilities through conduct or comment.
- c. Never discriminate.

Practice honesty in business.

- a. Do not mislead through advertising.
- b. Follow through on all contracts with clients.

Scope of Practice

The British Columbia Recreation and Parks Association (BCRPA) and the National Fitness Leadership Advisory Council (NFLAC) have established specific boundaries and guidelines for the BCRPA Weight Training Leader known as the Scope of Practice. These guidelines are

appropriate for all certified weight training instructors, regardless of certifying association.

The BCRPA Weight Training Leader is able to:

- Provide initial health screening.
- Design, modify and instruct safe, effective and appropriate basic / orientation exercise programs to meet the needs of apparently healthy individuals or special populations who have received medical clearance in a weight room setting.
- Provide weight room monitoring and equipment orientation.
- Ensure a safe exercise environment.
- In order to work with special populations, a BCRPA Weight Training Leader must obtain specialized training and consult with appropriate health care professionals.
- Act as a resource and refer to appropriate health care providers when dealing with clients who have conditions that the Fitness Leader is not specifically accredited to address.

CHAPTER

Anatomy

TWO

Chapter Summary

Topics covered in this chapter are:

- Human Skeleton
- Articulations
- Movement of Synovial Joints
- Anatomical Regions & Directional Terms
- Planes of the Body
- Skeletal Muscles
- Muscle Actions
- Sliding Filament Theory

Learning Objectives

After reading this chapter, you should be able to:

- Distinguish between gravitational and functional stress.
- Describe the functions and benefits of the skeletal system and relate them to resistance training.
- Describe articulations (joints).
- Describe the movements of synovial joints.
- Describe common articulation injuries.
- Describe the types of muscle.
- Describe skeletal muscle properties, functions and common criteria used to name them.
- Name the major muscles, relational planes, bones, anatomical regions, and directional terms of the body.
- Understand the basics of the sliding filament theory.

Anatomy

Human Skeleton

The human skeleton is composed of a total of 206 bones. The axial skeleton (rib cage, spine, etc.) consists of 80 bones and the appendicular skeleton (limbs) consists of 126 bones. Figure 2-1 outlines anterior and posterior views of the skeletal system.

Healthy strong bones are a benefit to all individuals, but the process of developing strong bones through strength training must be approached with caution and proper nutritional support. For instance, if a child engages in a rigorous strength training program and uses improperly adjusted training equipment, damage may occur to a bone's growth plate (epiphyseal plate). Although the possibility of damaging an epiphyseal plate is remote, it does exist. Instructors should encourage children to participate in gravitational stress-type activities such as running, but not to excess (e.g. marathons) and body-weight exercises.

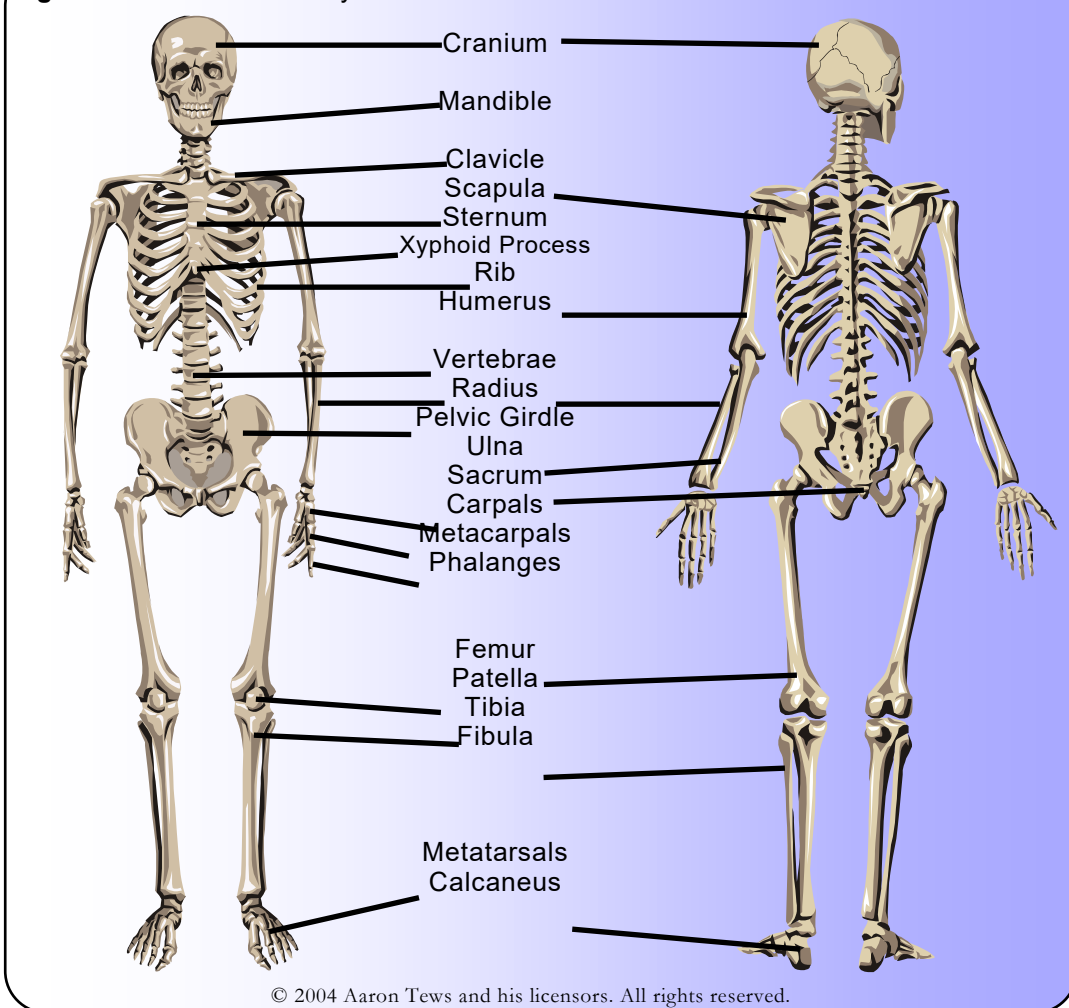
The skeletal system has several functions. The skeletal system serves as a support (provides the framework for most muscle attachment and support), allows for movement (determines the type and range of motion of movement of the body), provides protection (internal organs such as the heart, lungs, brain and spinal cord are protected by the skeletal system), functions as a mineral reservoir (inorganic compounds are stored in the bones and distributed throughout the body when needed), and is responsible for blood-cell formation (certain

bones produce blood cells for the circulatory system). Strength training on a regular basis may improve one or several of these functions and healthier bones are better equipped to resist disease (e.g. - blood disorders) and unaccustomed stresses (e.g. - falling to the ground).

One in every 2 women in the U.S. suffer from postmenopausal osteoporosis, but remain unaware of the condition until a bone is broken. Osteoporosis often begins in the mid 20's and by the early 30's, a woman may have lost up to one third of her bone calcium. Nutritional and hormonal considerations coupled with aerobics or resistance training may help prevent or reduce the severity of osteoporosis.

Elderly people must exercise caution when strength training because damage to bones

Figure 2-1: The skeletal system



may occur if the bones are excessively weak and unhealthy. Remember, prior to beginning a resistance training program, a person should obtain clearance from their doctor.

A number of factors, such as mechanical and gravitational stresses, hormones, lifestyle, injury and nutrition impact with healthy bone development and maintenance.

Mechanical stress affects bone development. When the body is subjected to prolonged mechanical stress, additional calcium and phosphate are imbedded in the bone's framework. The additional calcium and phosphate make the bones stronger and better equipped to handle prolonged mechanical stress. Mechanical stress may be gravitational or functional. Weight bearing exercises such as walking or jogging are examples of activities that provide gravitational stress. The mechanical stress placed on bones during muscle contraction is known as functional stress. Strength training is considered a functional stress and is one way to increase the tensile strength of bones. However, when stress is greater than what a bone can withstand fractures or damage to the bone architecture can occur.

The spinal column, composed of 26 bones, protects the spinal cord and provides axial support to the body. Figure 2-2 provides an anterior view of the spinal column. The cervical section is composed of 7 vertebrae including the axis and atlas. The thoracic section is composed of 12 vertebrae, the lumbar section is composed of 5 vertebrae, the sacrum is composed of 5 fused vertebrae and the coccyx is composed of 4 fused vertebrae. Vertebrae are held in place by ligaments. Between each vertebra is a soft pad known as an intervertebral disc. It is this disc that can herniate or "rupture" when a resistance training exercise is performed incorrectly.

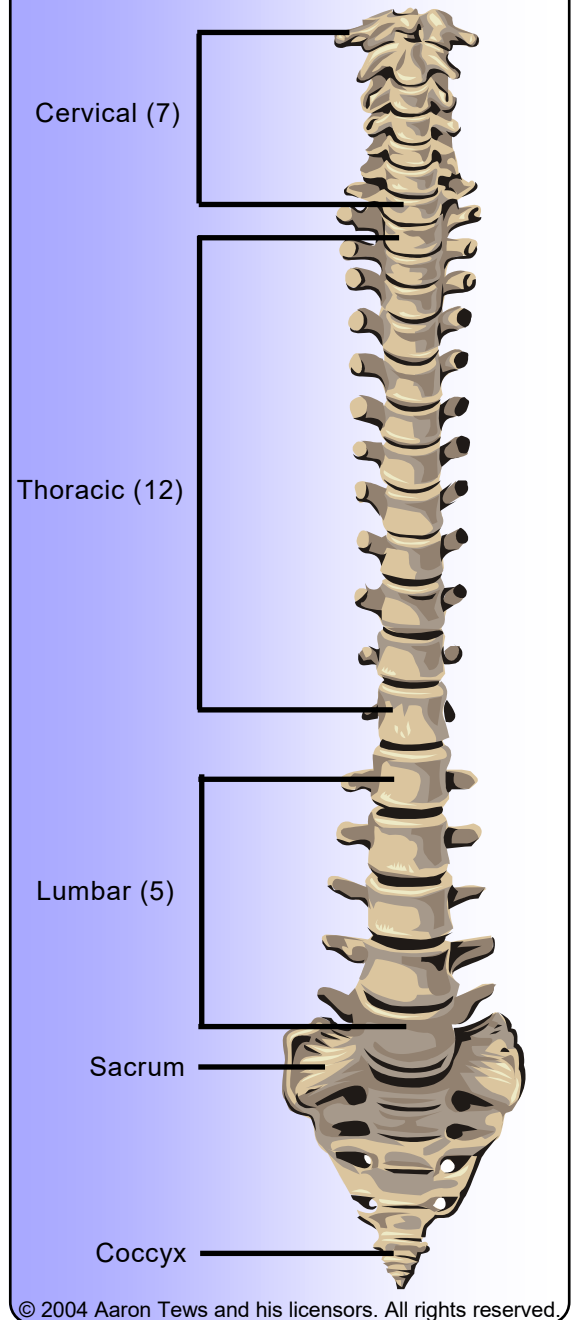
Specific terms are used to describe abnormal curvatures of the spinal column and these abnormalities may predispose a person to injury when performing certain resistance training exercises. Several abnormal curvatures of the spine include Lordosis (excessive anterior lumbar curve), Kyphosis (excessive posterior thoracic curve - hunchback), and Scoliosis (any lateral curvature of the spinal column). The natural curvature of the spinal column is referred to as the neutral position.

Articulations (Joints)

The definition of articulation is to join together in such a way as to allow motion between the parts. Many common injuries to joints are a direct result of improper technique in the weight room.

Some joints are very stable and allow little movement (e.g. sacroiliac joint) while others are very unstable and allow for extreme ranges of motion (e.g. glenohumeral joint). Joints are commonly classified by the type of connection formed at the joint or the movement of the joint.

Figure 2-2: The Vertebral Column



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CHAPTER

Leg Exercises

EIGHT

Muscle Summary

Quadriceps

Vastus medialis, Vastus lateralis, Rectus femoris, Vastus intermedius

Hamstrings

Semimembranosus, Semitendinosus, Biceps femoris

Adductors

Adductor magnus, Adductor longus, Adductor brevis, Pectineus, Gracilis

Abductors

Gluteus medius, Gluteus minimus, Tensor fasciae latae

Calves

Gastrocnemius, Soleus

Exercises

Basic Barbell Squat
Hamstrings Curl (Leg Curl)
Universal Leg Press
Lunges
Calf Raises (Standing)
Hip Flexion
Hip Abduction

Modified Deadlift
Leg Extension
Incline Leg Press
Universal Machine Squat
Seated Calf Raise Machine
Hip Extension
Hip Adduction

Muscles of the Lower Body (Legs)

Chances are, when lifting weights, a significant portion of training will be dedicated to lower body development. Strong, well-developed legs help people run faster, jump higher, throw farther, they also form a solid foundation for the rest of your body.

Many people overlook the importance of stability and balance in their training because they have been programmed to focus on muscular strength and definition instead. Building a supportive base is an important prerequisite for the safest, most effective development of strength. This often holds true for lower body development. Exercises such as the lunge are not usually performed, yet this exercise can develop the stability of the hip and knee joints effectively. Also, the balance of strength between the quadriceps group and hamstrings group is often not considered. It is recognized that the hamstrings should be about 80%+ the strength of the quads. So, as an instructor, insure balance and stability are considered and incorporated when designing training programs.

Diagram 8-1 and 8-2 are superficial views of both the posterior thigh / leg muscles and the anterior thigh muscles. Although a strength training instructor is not *required* to know all the muscles in the diagram, it is suggested that an instructor learn them.

Diagram 8-2 illustrates the compartments of the thigh and leg. It is important to understand compartments because it helps one understand muscles as functional groups and injuries and syndromes (e.g. Anterior compartment syndrome).

Table 8-1 outlines the muscles and muscle groups associated with each compartment. Muscles listed in brackets are not shown on the diagrams.

Figure 2-7: Muscular system - Anterior view

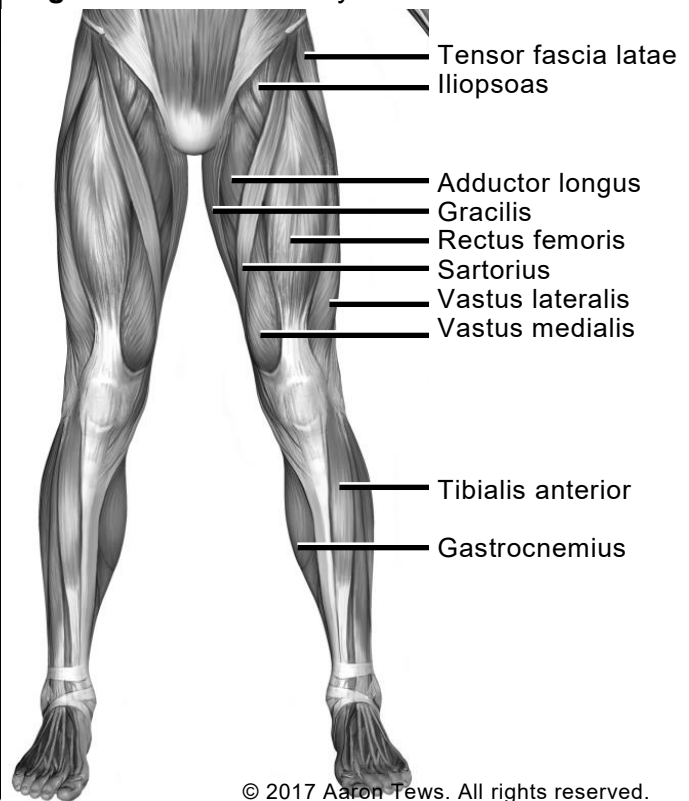


Figure 2-8: Muscular system - Posterior view

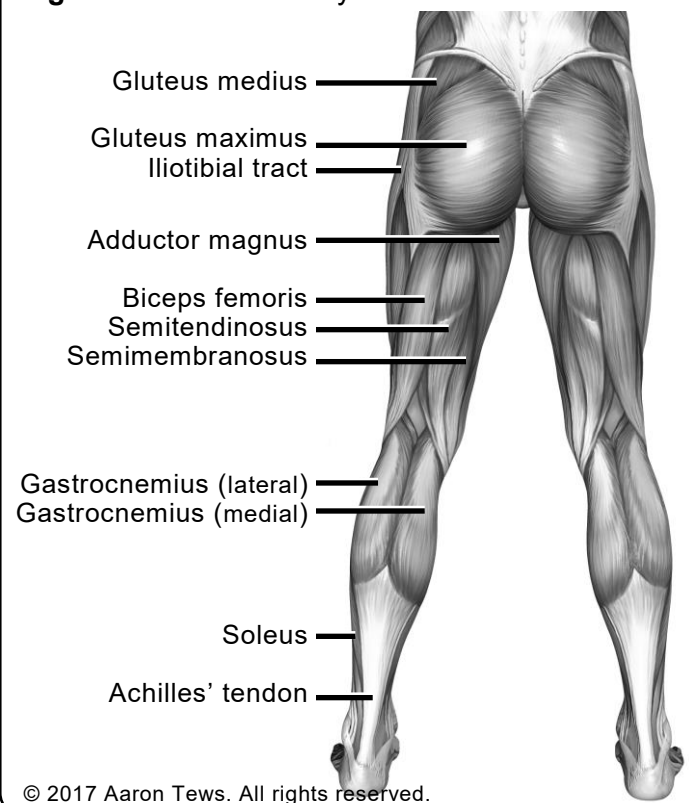


Diagram 8-2: Cross sectional view of the thigh/leg muscle

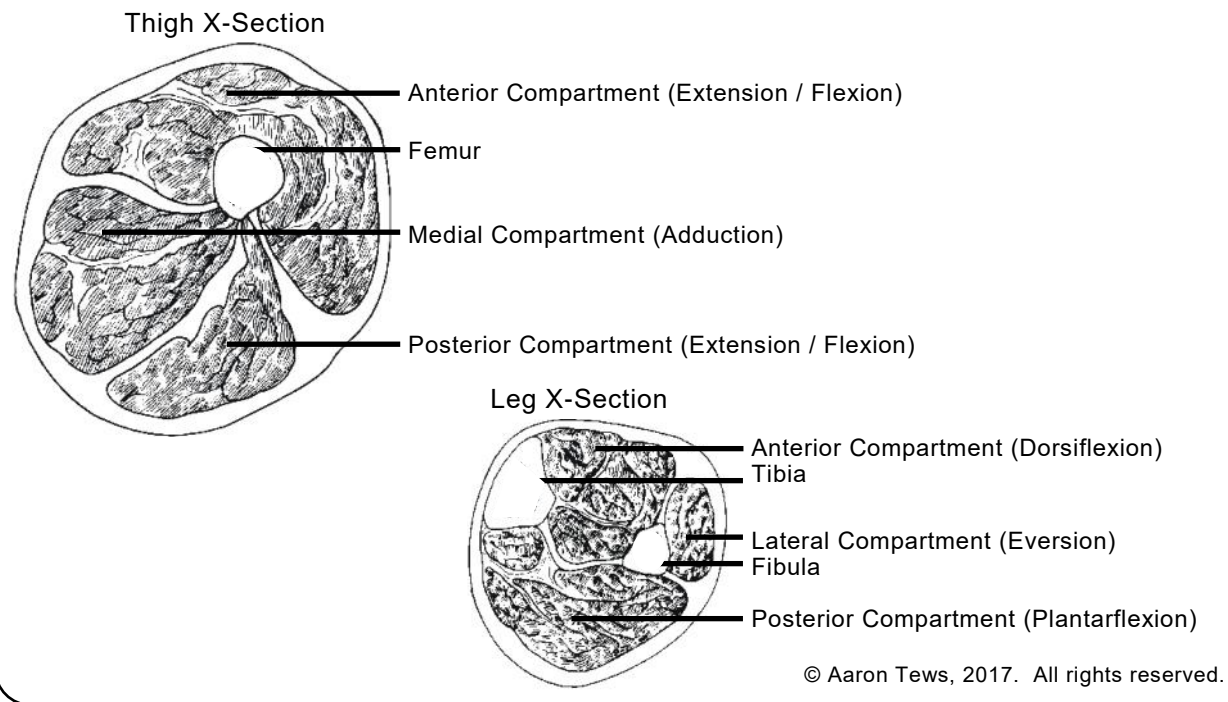


Table 8-1: Muscles of the thigh and leg (below).

Compartment	Composed of	Muscle Function
Medial	Adductor magnus	\
	Adductor longus	>Adducts thigh
	Adductor brevis	/
	Gracilis	Adducts thigh, flexes leg
	Pectineus	Adducts, flexes, rotates thigh
Anterior	Sartorius	Flexes thigh and leg, laterally rotates thigh
	Rectus femoris	Extends leg, flexes thigh
	Vastus medialis	\
Posterior	(Vastus intermedius)	>Extends leg
	Vastus lateralis	/
	Semimembranosus	\
	Semitendinosus	>Flexes leg, extends thigh
Other	Biceps femoris	/
	Gluteus maximus	Extends, laterally rotates thigh
	Gluteus medius	Abducts, medially rotates thigh
	(Gluteus minimus)	Abducts, medially rotates thigh
	Tensor fasciae latae	Assists - flex, abduct, medial rotation thigh
	Iliacus	Flexes the thigh
	Psoas major	Flexes the thigh, medial rotation
Anterior	Tibialis anterior	Dorsi-flexes, inverts foot
	(Extensor hallucis longus)	Dorsi-flexes, inverts foot
Lateral	Peroneus brevis	Plantar flexes, everts foot
	Peroneus longus	Plantar flexes, everts foot
Posterior	Gastrocnemius	Flexes leg, plantar flexes foot
	Soleus	Plantar flexes foot
	(Plantaris)	Flexes leg, plantar flexes foot

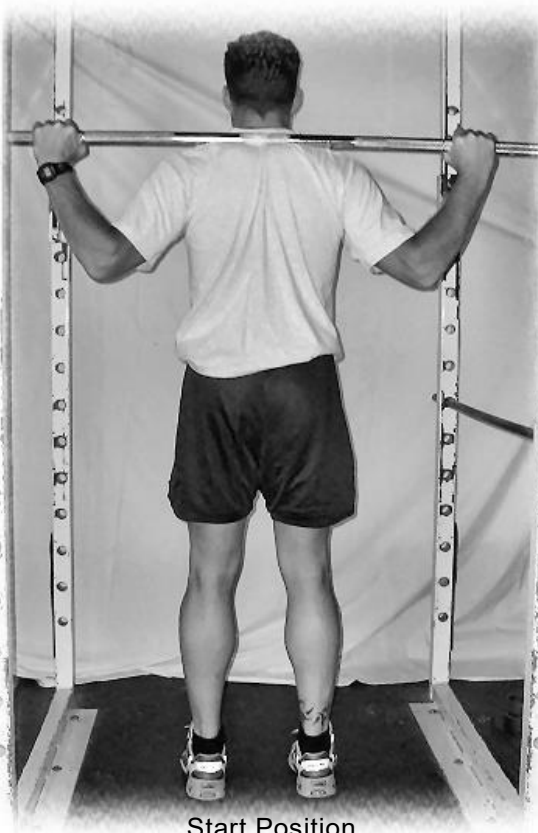
Basic Barbell Squat

Advanced

Description: For many, the squat is considered 'the' exercise for leg development. This exercise is considered highly advanced because of the degree of lifting experience required to perform correctly. This exercise should be attempted by experienced lifters and explained by qualified instructors. Many injuries in the weight room are squat related - very few people perform the squat correctly.



Start Position



Start Position



Finish Position

Muscle Actions Involved

Descending phase (squat position): Ascending phase (standing position)

Flexion at hip joint

Extension at hip joint

Flexion at knee joint

Extension at knee joint

Dorsi-flexion at ankle joint

Plantar flexion at ankle joint

Muscles Involved

Primary Involvement	Moderate Involvement	Stabilizers
Vastus lateralis	Rectus femoris	Erector spinae (isometric)
Vastus intermedius	Adductor magnus	Hamstrings Group
Vastus medialis	Adductor brevis	
Soleus	Adductor longus	
Gluteus maximus	Gluteal group	

* The squat, using a narrower than shoulder width stance, involves the above mentioned muscles of the legs according to MRI studies. The hamstrings muscle group, commonly believed to be involved during the squat is not involved according to MRI studies.

Movement Execution

- Adjust the barbell in the squat rack to approximately mid to upper chest height.
- Rest the barbell behind your neck (comfortably across the upper traps and shoulders).
- The grip on the barbell will vary from person to person, but is usually slightly wider than the shoulders.
- Stance - your feet should be hip width apart with the toes pointed straight forward or slightly outward.
- Your body weight should be equally distributed over both feet.
- Inhale and descend into the squat position - where a 90° angle is formed at your knees (see diagram).
- While descending, concentrate on:
 1. Lowering your hips and buttocks behind your heels.
 2. Keeping your back in its normal, slightly arched position.
 3. Looking straight ahead - into the mirror is the best.
 4. Keeping the barbell directly above your heels (see diagram) but never farther forward than your toes.
 5. The buttocks - should not protrude excessively backwards, but lowered straight down.
 6. Your knee position - should not travel farther forward than the toes during the descent.
 7. Speed of descent - never descend too fast - a 3 second descent is good.
 8. Your heels - must remain in contact with the floor throughout the range of motion.
- Avoid pausing in the finish position - stopping the barbell at the bottom of the range of motion may require excessive forward lean to raise the barbell.
- While exhaling, return to the starting position.
- Maintain the normal lower back arch while ascending.
- No matter how heavy the weight, do not lock out the knees at full extension.

Instructor Safety Tips

1. How deep is too deep when performing the squat? To work a full range of motion, the glutes would touch the heels, but this places undue stress on the knees. So, for the general public exerciser or the recreational bodyshaper, knees to 90° is deep enough (when performed correctly). Only experienced or professionally supervised weight lifters should perform full squats.
2. If your heels continually lift off the floor while performing the squat, work on your Achilles' tendon and hamstrings flexibility. If you cannot perform this test successfully, you may want to avoid performing the squat until you improve your flexibility. To test Achilles' tendon flexibility:
 1. Stand up straight (without any weight)
 2. Place feet together
 3. Squat until your glutes touch your heels
 4. You should be able to do this without falling over backwards or your heels raising off the floor.
3. Never place a board under your heels to compensate for poor Achilles' tendon flexibility. This only aggravates the problem and increases susceptibility to low back and knee injuries.
4. This exercise requires good lower back and abdominal strength to keep the spine supported properly to prevent the back from buckling.
5. Use a spotter correctly. A spotter should watch for incorrect technique including:
 - A. Hip shift during execution to favor a stronger leg. This generally occurs during the last portion of the descending phase and beginning of the ascending phase. It occurs when a person has a stronger leg and the body tries to compensate for the imbalance. If hip shift is not corrected early, it can become a major problem to correct in the future.



- B. Knees buckling inwards to generate more force (places stress on the knee especially the medial collateral ligaments).
6. Avoid hyperextension of the neck. Focus your vision directly ahead at all times.
 8. Avoid using a weight lifting belt when possible. A belt is only recommended during very heavy lifts. A weight belt compensates for weak abdominal and lower back muscles. A weight belt may actually impair the ability of the lower back muscles to assist during the movement.
 9. When performing heavy lifts (225 pounds or more), use the correct type of barbell. Forged barbells (black in colour) are the best because they are designed to not bend excessively when loaded. Chrome barbells are okay for loads of up to 225 pounds.
 10. Injuries often occur while performing the squat because the barbell is lowered too quickly. Descend slowly - control the weight and do not let the weight control you.
 11. The Vastus medialis is not isolated when the toes are pointed outward according to a MRI study. So, pointing toes outward is more a personal preference than a specific isolator.
 12. Variations:
 - A. **Deep squat:** Descend until your thighs are parallel to the floor or lower. The deep squat works a greater range of motion and should only be performed by advanced lifters because of the stress placed on the knee and hip joints.
 - B. **Classic Wide Stance Back Squat:** Your feet are positioned wider than shoulder width apart and your toes are pointed slightly outward. This method is a substitute for those who have poor Achilles' tendon flexibility, but should not be substituted unless flexibility cannot be improved due to past injury or genetic predisposition.
 - C. **Front Squat:** This exercise is similar to the basic barbell squat except the barbell rests across the upper chest and the deltoids. Your hands should cross over each other and the elbows are kept high so the barbell does not slide forward during the descent. This variation is effective because it ensures an upright posture during execution. This exercise involves all the same muscles as the regular squat. Front squats can be performed with approximately 70% of the load performed with regular squats.
 - D. **Hack Squats:** This exercise is similar to the basic barbell squat except your back is fully supported. This machine can be hard on the knees, so make sure your feet are positioned high on the footplate (not low).
 - E. **Smith Machine Squats:** If you have trouble performing the basic barbell squat because of balance problems, this is an excellent alternative. Be careful when unhooking the bar off the support hooks.
 - F. **Horizontal Machine Squats:** This exercise is similar to the incline leg press. Avoid machines which force the neck into a tightly flexed position (chin forced into the chest).

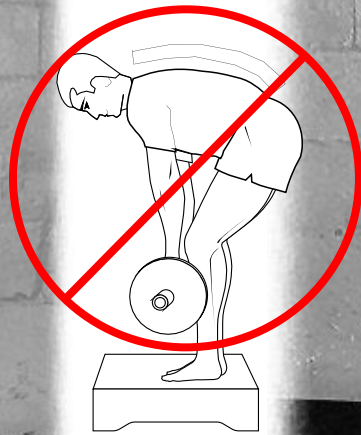
Modified Deadlifts

Advanced

Description: The modified deadlift has the potential to be a high risk exercise. The unmodified version of the deadlift is usually performed by advanced lifters. The modified deadlift version has the potential to develop the hamstrings safely and effectively. It is not an exercise to be performed without professional supervision and instruction. The lower back should be strong and flexible prior to performing this exercise. It is a great free weight exercise and an alternative to prone hamstrings curls.



Start Position



Finish Position

Muscle Actions Involved

Descending phase	Ascending phase
Flexion at hip joint Slight flexion at knee joint Eccentric muscle action	Extension at hip joint Concentric muscle action

Muscles Involved

Primary Involvement	Moderate Involvement	Stabilizers
Biceps femoris Adductor magnus Adductor brevis	Gluteus maximus	Erector spinae (isometric)

* According to MRI studies, the Semimembranosus and Semitendinosus are not involved during this exercise.