ABOUT THE AUTHORS

Professor Kari Fasting is considered to be one of the top experts in the world in issues related to women and sport. She was a ten year member of Norway's national track and field team, which she also coached. She was also a talented ballerina. She was the first president of the Norwegian University for Physical Education and Sports. She is a past president of the International Society for Sport Sociology and of WomenSport International. Her major research interests have been in increasing women's participation in the coaching and in the administration of sport. More recently her research has been in how to increase the number of female coaches and in sexual harassment and abuse in sport. In this area she has been a consultant with the International Olympic Committee in their development of programs to make sport safer for all athletes—female and male.

Christine Wells is a former basketball player and university athletic trainer. Her academic studies in kinesiology bridged the physical and mental aspects of athletic conditioning. She has been a university instructor of anatomy, exercise physiology, kinesiology, strength training and health education. Her writing includes college textbooks on strength training, health education and sports, as well as books on health and fitness for the general population. She is now working in the medical field and is involved with youth and high school sports programs.

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Contents

Preface

Girls and women who move with strength, flexibility, coordination and endurance, whether as dancers or competitive athletes – must rely on science if they are to maximize their physical and mental potentials. Teachers and coaches must keep abreast of the latest scientific and medical knowledge and, if necessary, abandon their traditional beliefs and practices.

What we think we "know" is often either incomplete or wrong. In the sports sciences, a great deal of research has been done during the last few years, but it has not reached the athletes or the coaches. What modern sport science is finding is often counter to what we have traditionally known. For example, there is strong evidence that passive stretching as part of your warm up may set you up for injury. Runners who stretch before competition have more leg injuries. Stretching may reduce your speed and power. Swimmers who stretch reduce their speed. Weight lifters who stretch reduce the load they can lift. Dancers can set themselves up for injuries. We will look into the "whys" later. These examples are certainly counter to what we all thought we knew.

This book is designed for the female athlete and dancer, from high school through the masters level, and for their teachers and coaches. We will reference the research in case you want to read the original sources for the scientific findings, but we have tried to simplify the findings so that you as a female athlete can utilize what is known at this time.

There seems to be a nearly universal interest in the developed countries to become fit. This desire for fitness may be due to a concern for living longer, for becoming more attractive as the media seems to dictate, or to just feel better. Whether the exercise is done in a physical education class, on the field of competition, in a health studio, in a dance class, or on one's own, the activities we do should be understood.

Many of us choose sport or dance as a recreational or a professional activity. The elite fitness needed is more specific than general fitness. In sport we are usually competing. We may compete with ourselves, attempting to lower our 10K times or improving our golf scores, or we may compete against others. But the competitive nature of sport pushes us to go beyond the average and venture into the realm where superiority is required. In dance, too, we compete—to be the best in our class, to perform in London or on Broadway, to be selected for the corps of a major dance troupe, to be a prima ballerina.

While the general fitness advocate can get by with little more knowledge than was gained in school — such as counting one's pulse rate — the competitive nature of the dancer or athlete pushes her toward excellence. She wants to know how to be the best.

There are also psychological and sociological effects of sport. The Women's Sport Foundation has found that young women who are athletes have fewer pregnancies. They feel better about themselves. They feel empowered by their quest and their achievements.

But not all is rosy! As in most forms of endeavor, from school to work, sport and dance are sometimes spheres that offer predators, both male and female, an opportunity for sexual harassment or sexual abuse. While this seems to happen less in sport than in other areas, athletes need to be aware of what can happen and must be prepared to counter any negative advances. Sexual harassment and sexual abuse, no matter where they are encountered, must be stopped for the sake of both the individual and the society.

So fitness for elite performance areas is more encompassing than just running faster, jumping higher or being stronger — it requires a strong mind in a strong body. Properly done, sport or dance are probably our best avenues for developing our physical and psychological selves. And they may well be the most effective and visible method for achieving full equality in our society. But it must be planned for — it doesn't happen automatically.

As the Irish proverb says, "If you don't know where you're going, you'll end up someplace else."

CHAPTER 1
INTRODUCTION

The differences between men and women are not nearly as great as people commonly think. This is particularly true of trained athletes. When comparing trained men with trained women, we find that pound for pound the strength of the lower body and cardio-respiratory endurance are quite similar.

Choosing Your Sport or Sports

You have probably already chosen a sport or two for your competitive nature, but there may be other options for competition. For example many people run 10-kilometer races a couple of times a month, but how many have thought about orienteering? Although practiced around the world, many Americans haven't heard about this sport. In orienteering you walk or run with a compass and map. The goal is to find every marked spot on the map as quickly as possible, so quickness is combined with intelligent map reading. The combination of skills is highly intriguing. Dr. Peter Snell, Olympic 800-meter gold medal winner in the1960s, is now the American age group champion in running orienteering. Orienteering is also done on cross country skis and in canoes.

Swimming is an outstanding conditioner. You can compete from about age 8 to age 90 in age group competitions. Or maybe you would like to play while you swim. Women's water polo has become a worldwide game. Scuba is also an interesting option for the aqua-interested woman.

Maybe you would like to combine your running and swimming with cycling in a triathlon. You can participate in all three events yourself or you can find relay events where three people perform the three different sports as a relay.

Of course there is volleyball (6 person, mixed, or doubles), basketball, tennis, rugby, ice hockey, field hockey and any number of other traditional sports. If you like combatives you can find wrestling, boxing, kick boxing, judo, karate and the other martial arts. There are some negatives with boxing, kick boxing and full contact karate. Microscopic brain injuries occur just about every time your head is punched. There are several skull bones encircling the brain. Where these bones come together there is often a rough edge. It is at these rough spots that the bouncing brain picks up small "pin point" hemorrhages. Enough of these small injuries and the brain scars. This makes it impossible for the electrical impulses in the nerves of the brain to be transmitted. (Large boxing gloves or head gear do not protect against these injuries.) The

kicking sports are more likely to injure the kidneys. Professional kick boxers in Thailand seldom live to see 40.

Sports Conditioning Needs Are Specific

As we move deeper into the book we will discuss these points in much more detail. But here are some points to ponder:

Doing squats doesn't necessarily help your running - especially distance running.

You want your workouts to be as sport specific as possible. Swimming doesn't help your legs for running and running doesn't help your arms for swimming. Distance running doesn't help your sprinting and sprinting doesn't help your distance running.

If you are working with weights, the posture you use should be as close to your sport posture as possible.

Your sport fitness or dance fitness needs are specific:

How much cardiopulmonary fitness do you need?

How much flexibility do you need?

How much strength or power do you need?

How much strength-endurance or sprint-endurance do you need?

How much sprinting speed do you need for your sport?

How you can achieve these needs will be covered in the opening chapters of the book.

Flexibility

When we are young we tend to be quite flexible. Remember how easy it was to touch your toes when you were ten? Our ligaments, tendons and other connective tissues will tend to shrink as we age. They therefore must be stretched throughout our lives in order to keep our youthful abilities to move painlessly. If you are an athlete, a dancer or someone who needs more flexibility because of leisure time pursuits or work—you may need extra stretching to achieve your desired goals.

If you want to be more flexible, there is a best way to accomplish it.

Other reasons why people do flexibility or stretching exercises are:

to reduce muscle tension;

to obtain low back pain relief;

to promote muscular relaxation;

to develop a better posture;

to find relief from cramps in the muscles

Strength

In our modern world most of us need less and less strength to live our daily lives. We no longer must saddle the horses, beat the rugs or churn the butter. In spite of this, athletes need more strength today because we compete with higher levels of goals than ever before. You may want more strength to serve the tennis ball harder, to ski more aggressively or to kick a soccer ball harder.

A major reason for wanting strength as you grow older is to reduce the chances of developing osteoporosis (weakened bones) which can result in a severely hunched back (a "widow's hump") or easily broken hips.

If you want strength there is a "best" way to gain it.

Developing Aerobic Conditioning

Stamina, endurance or aerobic fitness are just a few of the terms which are used to describe the adjustment of the body's heart, blood circulation system, and lungs when greater demands are placed on the body to work longer and harder. There are a number of ways to achieve this "aerobic" fitness. But whichever you choose, you will be making the best contribution you can to a longer life. Exercising to develop stamina not only reduces body fat while it makes the body more effective, but it reduces stresses, blood pressure and harmful fats in the blood.

Eating Nutritiously for Improved Performance

Effective and adequate nutrition not only helps us to live longer, but it also aids us in developing muscle strength or in gaining more aerobic fitness. After all, we are what we eat! Most people are actually undernourished. It is quite common to take in too few of certain vitamins and minerals. At the same time we often take in too much fat and sugar, and sometimes we take in too much of certain vitamins or minerals.

Injuries and Other Problems from Exercise

Some people train so hard that they injure their health. Overtraining can not only increase your chances for injury and illness, it can actually reduce your performance. Excessive training can increase the likelihood of the female athlete triad occurring — eating disorders, severe menstrual problems and bone loss (osteoporosis We must guard against these problems for both our general health and our sport performance.

Many sport injuries can be prevented or reduced through proper exercise, clothing, shoes, orthotics, braces, taping and conditioning. Women have more knee injuries than men because of both the angle of the thigh bone and the smaller ligaments. Correct strengthening exercises, proper playing techniques, braces or orthotics may reduce the risk. Shin splints can be increased by improper shoes, poor techniques or by ignoring the need for proper orthotics.

Mental Conditioning

Your mental conditioning will determine how effectively you practice. Then when in competition it can give you the edge over your opponent. In many sports the mental edge can be the margin of victory. Your goal setting, your mental practice, your ability to relax under pressure, your ability to peak when it is needed — are all essential elements for a successful athlete.

The Completely Conditioned Athlete or Dancer

All of the above factors (strength, endurance, flexibility, nutrition and mental preparation) are essential for the athlete to function at her highest level. Coaches must be aware of how to work to help the athlete develop to her fullest in each of these areas and in

each sport that she chooses for participation. There are "best" ways to accomplish these tasks. Competitive female athletes are every bit as motivated for success as are male athletes. They seek success just as much. They work just as hard. And they will profit by training using the best information that modern sport science has offered.

CHAPTER 2
COACHING WOMEN AND GIRLS

It is often said that sport is a male world. Until recently sports have been heavily dominated by boys and men, but there have been great changes over the last 20 years. Girls and women participate more often and in a wider range of sporting activities than ever before. In most countries, however, boys and young men are still more active in sports than girls and young women. Why is that, and what are the consequences for the female athletes? Perhaps if both coaches and female athletes better understand the male hegemony in sport and its consequences, more women will participate in and enjoy sports.

Coaching Styles

A study of elite level female soccer players in the USA, Germany, Sweden and Norway found that many of the players preferred female coaches because they liked the female style of communication, which was described as understanding and caring. While many players had positive experiences with male coaches, there was also the belief that many female coaches were better psychologists.

Women may be better coaches of girls and women than many men simply because women and men have different backgrounds and experiences. A man's understanding of the way to coach sport is usually associated with the way it has been coached to boys and men. But girls and women have often been brought up in a different environment. Consequently, a different approach to coaching girls and women may be more successful. This approach, of course, also can be learned by men.

Understanding the Implication of Gender Socialization

Girls and boys are socialized differently. This obvious fact has often been used as an explanation for the lower number of girls interested and involved in sports. The values dominant in most sports are closely connected to a traditional definition of masculinity—toughness, competitiveness and aggressiveness. Boys learn this at an early age. The values that dominate women's lives have not fit into the world of sport very well. For example, women often are better caretakers than men. Many women have a great capacity for empathy, and they are often concerned with the overall aspect of what they do. The values imbedded in this are often contradictory to those central in sport and in a traditional culture of masculinity We therefore agree with the American sport sociologist Jay Coackley when he writes that "The dominant forms of sports in most cultures are played and organized in ways that work to the advantage of most men and to the disadvantage of women."[1] He writes about "the gender logic of sport" and says that if sport had been created by and for women, the Olympic Games motto would have been "balance, flexibility and ultra-endurance," instead of "faster, higher and stronger."

In this connection is it important to know that what we define or look upon as masculine or feminine differs among cultures and also inside a culture depending on the environment. Another way of expressing this is to say that gender, and what is feminine and masculine are social constructions as opposed to sex and primary and secondary sex characteristics which are biological. As will be shown later in the book, these sex differences must be taken into account when coaching women and men. Men have more testosterone, women menstruate and get pregnant, men are relatively stronger in their upper bodies, women have more fat stores which aid in ultra-endurance races, etc. There are sex advantages for each sex. But these biological sex differences are quite different from the psychological, social and cultural factors which form the

gender differences which each society creates. So both male and female coaches must be aware of both the biological (sex) differences and the psycho-social (gender) differences in their athletes. Understanding these will help you to condition them more effectively, both physically and mentally, and to reduce their chances of injuries.

It is important to know that the American College of Sports Medicine stated in 1964 that there are no biological or physiological reasons for women not participating in the same sports as men. There are no reasons based on sex that girls and women cannot box or wrestle, play tackle football, ski jump or run marathons. Obviously effective padding may be required for women, as it is for men, to protect heads, genitals or shins.

Coaching Women and Girls

The major challenge for teachers and coaches is to understand that what we often look upon as "typically feminine" or "typically masculine" behavior or personality traits, can be learned, unlearned and relearned. In practice this may sometimes be difficult first because this learning of what is appropriate behavior for girls and boys starts so early, and we as adults are often strong carriers of these gender stereotypes. How would you, for example, look at 8-year-old boys fighting or boys playing with Barbie dolls. Would your evaluation be the same if they were 8-year-old girls fighting or playing with Barbies? "Infants have a biological sex when they are born, but no 'masculine' or 'feminine' identity."[2]. Girls and boys are socialized differently. They are not treated in the same way at home, by friends, or at school. They learn very early what is appropriate for girls and boys, what it is to be "feminine" or "masculine" in that particular culture in which they live. Girls and boys are exposed to all kinds of influences. One arena is the power of girls' magazines on their behavior. Hargreaves has referred to two popular weekly magazines in the United Kingdom. "Jackie" (average reader is 10-14) and "Just Seventeen" (readers over 15 years). Sport in these magazines is associated with adventure, sweat, and masculinity, and is not a part of the feminine culture. Exercise is synonymous with aerobics and keep-fit activities, presented as part of a "caring for the body" package aimed at making girls attractive to boys.

The society and culture sometimes force different pressures on girls and women — just as they do on boys and men. Canadian Margaret MacNeil said that children, even without being taught or told, learn that certain activities are more appropriate for girls than for boys. The example she uses is the common practice in Canada of sending girls to figure-skating classes while boys play ice-hockey.[3] The Miller Lite Report on Women in Sports in the USA also showed that strong differences in gender-role perceptions emerged early in life and influenced later activity selection and participa-tion.[4] Children learn different skills by participating in different activities. The typical male stereotyped activities are believed to encourage the devel-opment of strength, speed, analytical thinking etc., while the female stereotyped activities like dance and gymnastics are believed to encourage body awareness, fine motor and empathetic skills etc. Girls are disadvantaged here because many of the male stereotyped activities are believed necessary for success in what our society considers high status careers. [5]

Choosing Sports

Both boys and girls may limit their future professional success and life options by limiting their participation to exclusively male or female stereo-typed activities. The Pellett and Harrison study showed that as females got older their perceptions of what was male or female changed and they saw less reason for a line dividing the gender activities, while males' stereotypical perceptions of female-appropriate activities increased as a function of age.' So girls and women look more for equality of opportunity as they matured but boys and men were likely to allow for less equality of opportunity as they grew older. It is also

worth mentioning that girls and women in some countries seem to invade traditional male sport, without the opposite taking place. Girls play soccer, rugby and box and wrestle, but boys are not entering rhythmic gymnastics or synchronized swimming.

By puberty more girls drop out of sport than do boys. Is this because they really don't like to exercise or they don't enjoy competition or is it because they don't like the way the sport is coached? Or do they experience a so called role -conflict between being an athlete and being a female?

What are Girls Learning from Sport as It Exists Today?

How does the female culture fit the culture of sport? What kinds of experiences do young girls get through sport today? Studies from different industrialized countries show that girls get many messages with a contradictory content. There seems to exist a double standard concerning girls sport participation, and perhaps even a hidden agenda.

While most Western countries are encouraging girls to participate in sports, what do they experience? Do they experience equity, equal worth, do young women for example experience that their sport participation is as valuable as those of young men? Or do girls learn through sport that they are of less worth than boys? Certainly female top level athletes are paid less than men, they get less attention from the media, and it is more difficult for them to get sponsorships. On a lower level, boys often get better coaches and facilities.

But when girls and women first enter the world of sport, what kinds of experiences do they have? What does sport mean for them? George Sage found that winning was more important for boys in sport, while girls thought it was more important to have a good time together socially.[7] They did put weight upon the playing aspect of sport and emphasized more justness (fairness) and fair play. The fact that women put great emphasis on the relational aspect does not necessarily mean that they don't bother about their performance. Diane Gill found that girls were not as competitively oriented as boys, but it was very important for them to perform wel1.[8]

Coaching Can be More "Woman Friendly"

Many athletes believe that sports should be organized in a more "woman friendly" way. Companionship and caring, as well as empowerment, often emerge as major reasons for playing a sport. Carol Gilligan has said that the female experience in gendered culture produces distinctively feminine qualities that are essentially different from those of males.[9] These qualities emphasize caring, social responsibility, democratic problem solving for team problems, and adaptability.

Generally speaking, we may say that social relations seem to be of greater importance for women than for men.

- Qualities that adult women seem to possess are:
- A great capacity for empathy.
- They dare to show caring and humanity
- They gain strength from working together.
- They participate as a team without exaggerated emphasis on their own careers
- They are socially responsible. geared to solving team problems
- as a group
- They have an eye for detail.

This is especially obvious among youth.

In coaching we often use the sport to reinforce the sexual stereotypes rather than trying to change them. Sheila Scraton found that even in coed physical education classes women teachers reinforced the traditional values.' So it is not just male coaches who may be

guilty of expecting less from girls. Sheila's findings were that both women and men were condescending to the girls. A typical teacher's remark might be, "Well it's harder for you because you are a girl."

Perhaps even more than female coaches, male coaches may have to be aware of their male orientation when coaching girls and women. We must remember that "girls and women—can and do." This doesn't mean that every girl on a junior high school softball squad has the motivation of an Olympian but it does mean that girls and women can be serious about developing sports skills — and winning. But it may mean that one's teaching and motivational techniques may have to take the gender into consideration.

Political Ideologies and Coaching Styles

In coaching you must take into account that girls and boys often have developed different values and interests and that these are socially acquired. Female athletes think that coaches who scream at them are using a male-authoritative coaching style. Putting down the athletes may work for men, they say, but it is counterproductive for women and girls. Of course boys and men don't like it either — they have just become more used to being yelled at.

As any sport psychologist or athlete knows, people respond best to praise and poorest to criticism. When that praise is yelled, it may be more positive. But when the criticism, especially a personal insult, is yelled, it becomes embarrassing and can take the athlete's attention from proper performance.

The oldest and easiest method for controlling a group is through autocratic methods. "Do what the king commands." In coaching the coach is the king. Does he or she rule with an iron hand or function as a benevolent dictator? Certainly it is unlikely that a 9-year-old age group swimmer can determine how many yards she should swim in a day for her workout, or a 10-year-old basketball player how she should shoot a jump shot, or a 12-year-old softball player how she should pitch a change-up. On the other hand if coaching an experienced high school, college or other elite athlete perhaps the athlete will have some valuable input into how the workouts can be better conducted.

Eventually at the elite level we might even find that a democratic coaching style will be best. The most successful national approach using a democratic coaching style is that of the Swedish golf program. Former LPGA golfer Pia Nielsen developed an entire golf development program from children through the pros. Her success internationally at the professional level has been astounding. For a country with 8 million people she has consistently had the Swedish women ranked high in the LPGA and the Swedish men are also highly successful.

Probably no sport has been more autocratically controlled than American tackle football. One highly successful and nationally known high school and college coach, the late Jim Brownfield, allowed his players to study the films and develop the best ways to beat opponents in the kicking aspect of the game (punt blocking and kickoff returns). Don't you think that his players were motivated to perform those strategic skills on Friday nights? Effective democratic techniques can be highly motivating for the players involved in the planning. It might also be mentioned that Jim won several California championships in girls track and field while coaching in Pasadena. It should follow from what has been said earlier about gender differences that a democratic coaching style definitely will fit many girls and women. The examples above may also demonstrate that it is probably effective for both women and men.

Coaching is Teaching

Most effective coaches realize that coaching is teaching. An effective coach must understand how the body works and how to make the body perform more efficiently. But more. The coach needs

to understand how to teach the sport and the sport skills as effectively as possible. Poor coaches often yell at their athletes because the coaches haven't done a good job of teaching and motivating. It is hard to imagine that these same coaches like to be yelled at by their bosses, so why would they use this demeaning psychological method to attempt to get their team more motivated?

An international study of elite female soccer players and their perceptions of coaches found that the women involved in the study did not like being yelled at. They thought that yelling worked on men, but not on women.[12] They also often wanted to be pushed harder for success by their coaches. Many also believed that some male coaches didn't take the coaching job seriously enough because they were women.

"We got the feeling that he did not put in 100% for the job and that he did not understand how serious we were, I thought it was irritating. It was just as if we had to tell him, OK we are women, but we can also do our sport seriously. And it was just as if he had not expected it."

Coaching and Motivating Athletes

As a male or female coach of girls and women you should be aware that there is more than one way to coach. There is more than one major outcome possible. And what your athletes want from the sport may be different than what you want from your coaching. In fact your athletes may very well be divided as to what each thinks most important as outcomes of their sport participation.

A coach must first determine what goals should be pursued. At the youth and high school levels the development of the individual's total personality should be primary. This is true also in college. But as the athletes work toward the elite national or Olympic levels the goals may become much more performance oriented.

If you are coaching youth sports you should understand the relationship between a girl's body image, self-esteem, and the development of her own identity. This is very important for girls, because girls often have lower self-esteem than boys, and less favorable body images than males.[13]

Later in the book we will discuss in greater depth how athletes are motivated. Both sexes prefer not to be yelled at. Both sexes expect to be taught how to be better at their sports. And both sexes expect to be taught how to win. Most boys and girls, as well as men and women, want to play within the rules and with a strong concept of fair play.

It has been found that women who were active in sports and recreational activities as girls felt greater confidence, self-esteem and pride in their physical and social selves than those who were sedentary as children. With reference to this Donna A. Lopiano, Executive Director of The Women's Sport Foundation in USA stated that: ". . . Adolescents who feel strong and good about themselves are more likely to be in control of their lives."[14]

A "better sport for girls" should therefore take girls lives, experiences, and wishes more into account.

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CHAPTER 3
CONNECTIVE TISSUES AND MUSCLES

Different types of exercise require varying amounts of flexibility in the joints and varying amounts of muscle stiffness (tension in the individual muscle fibers Flexibility increases the range of motion (ROM) in a joint by stretching the connective tissue around the joint; however, it may also stretch connective tissue around the muscle and the muscle itself. Most of us have taken for granted that being flexible is ~~a~~lways good and that stretching before a practice or a competition is a sacred duty. We may have been wrong! Walking and distance running are more efficient if the muscles are stiffer and if the person's flexibility is not excessive. Gymnastics, on the other hand, requires great flexibility in the joints, while still requiring stiff muscles.

In this chapter we will look at why stretching in sport is being reevaluated. The fact that many north European track and field coaches have stopped stretching their sprinters gives us pause to think that perhaps the traditions with which we have been raised, both in physical education classes and athletic teams, may be in error.

We will begin our exploration of the body's movement potentials by looking at the bones, joints and connective tissues. Then we will look at the effect on the muscle fibers.

Bones, Connective Tissues — Ligaments

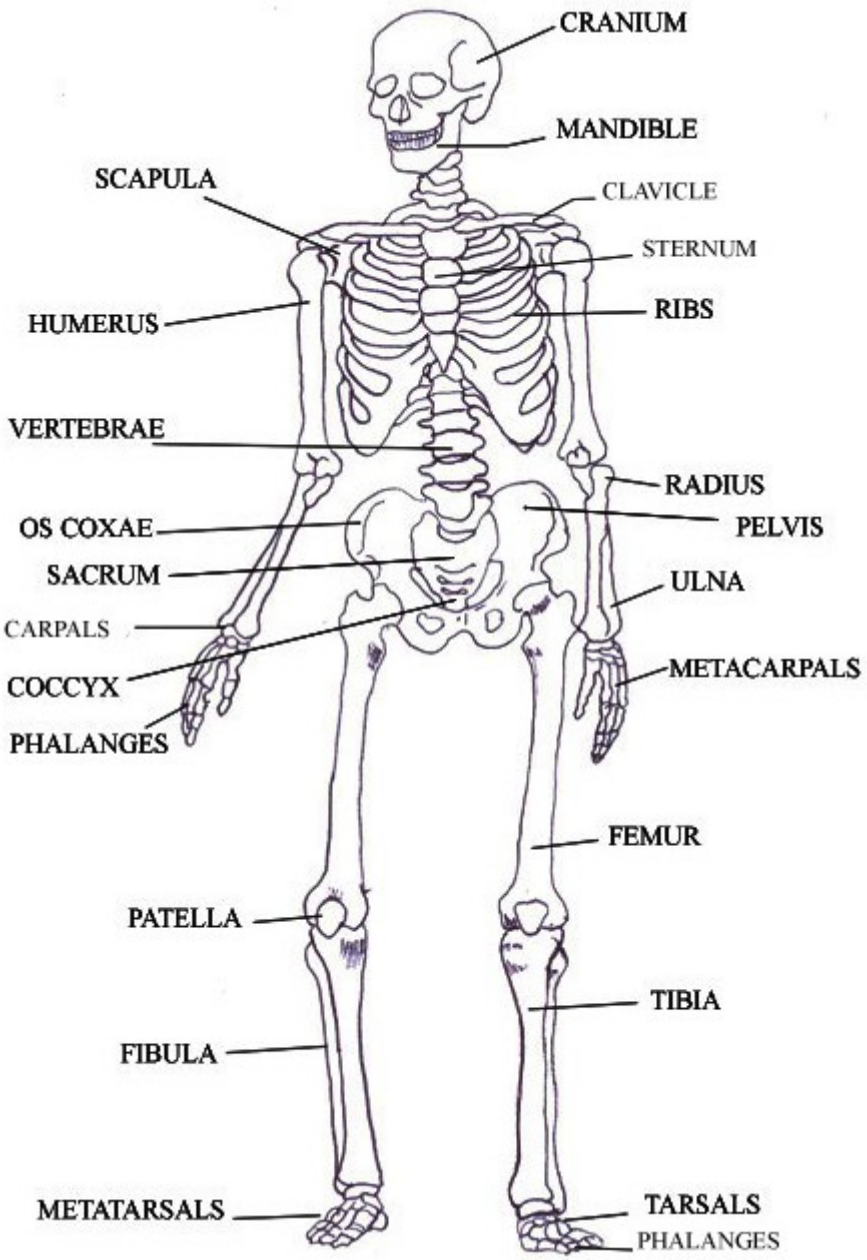
The skeletal system is made up of over 200 bones, each connected to adjacent bones by connective tissue we call ligaments. Nearly all bones are attached to other bones by ligaments. Each joining of bones is a joint. Some joints are very mobile, such as the wrist or shoulder joints which allow many types of motion. Other joints are immobile or nearly immobile, such as the joints of the ribs with the sternum (breastbone) or the joints of the fibula and

tibia in the lower leg

Ligament tightness is a major factor determining your range of motion. If your elbow joint is too loose or if there is an unusual shape at the end of the bones, the arm may be able to be bent

backward past the normal straight position. If you have normally tight ligaments in the hip joint, but you wanted to be a ballet dancer who could lift your leg forward at a 120-degree angle, you would need to stretch the ligaments in the back of the joint capsule to allow for such a movement. The same would be true if you wanted to do the splits for dancing, cheerleading, or gymnastics. You would need stretched ligaments in both the front and the rear of your hip joint.

Increases in flexibility, however, do not always aid an athlete's performance. In one of the earliest studies in this area, Herb DeVries found that great increases in flexibility did not improve 100 yard running time.[1] Also, tighter subjects are more efficient in walking than the looser subjects.[2]



Connective Tissues — Tendons

Tendons are another type of connective tissues. Tendons connect muscle to bone. It is the function of a tendon to transfer all of the force generated by a muscle to the bone into which it connects. Obviously, if the tendon stretched, it would not be able to transfer the force

effectively. It would be like trying to tow a car with a rubber band rather than with a chain. If a tendon is stretched over 4%, it is likely to be injured.

A lack of flexibility commonly appears when the connective tissues in the muscles or the tendons shorten, as happens when we age or are inactive. In the "olden days" of weight lifting and body building, it was common. It was described as being *muscle bound*. Now we know that it was not the muscles that were bound but that inflexibility came from not having the connective tissue stretched. The problem with the old-time body builders was that they did not do their exercises through a full range of motion. Consequently, the connective tissue in their bicep muscles was shortened by bicep curls in which they did not fully extend their arms. The connective tissues in their chests were shortened from bench presses in which they did not allow the bar to drop to the chest.

Connective Tissue — Fascia

Fascia is a term applied to connective tissue that is not otherwise identifiable as ligaments, tendons, or other common types of collagen. A few examples would be: fascia that binds the muscle fibers and that encases the muscle belly, fascia that binds our organs and holds them in place, and fascia under the skin.

When we contract a muscle in order to move something, some of the muscle's power is used to overcome internal friction and tension. The fascia between and around the muscle fibers provide over 40% of the internal resistance that the muscle encounters in developing its force. The joint capsule (the friction of one bone moving against another plus the tightness of the connective tissue in and around the joint) provides about 47% of the internal resistance. The muscle's tendon accounts for about 10% of the internal resistance, and the skin adds another 2% to the total resistance.

With these resistance factors in mind, if you are interested in efficiency of movement, stretching the connective tissues in the areas in which you need extra efficiency should be of value. Such stretching can not only increase your range of motion but can also reduce your chances of injury due to making a movement which could overly stretch the connective tissue.

The Effect of Heat and Cold on Stretching

Most studies indicate that connective tissues can be more effectively stretched if they are heated, so a warm up or warm water may allow for greater stretching. Laboratories often use ultrasound waves to warm the tissues. Additionally, cooling the muscles in cool water after stretching can help to set the stretched condition. This cooling must be done before the stretch is relaxed.[3] But because the muscle should be heated deeply, the effect of applying warm compresses to the muscle may not always help, and the results may be similar to stretching a muscle which has not been warmed.[4] However, a study at Baylor University indicated that the amount of flexibility gained was about the same whether the muscles were heated, cooled or not treated.[5]

Types of Joint Movements

There are commonly used terms that identify the various types of joint movement. Each of these could be an objective for a stretching program. The terms are also used to describe many strength development movements. We will use these terms in many of the upcoming chapters.

Flexion is generally considered to be the action of a joint which decreases the angle of the joint. Bending the arm at the elbow, bringing your lower leg backward, or bending your neck forward would all be examples of flexing the joint. Bringing your arm forward from the

shoulder joint is also flexion but does not fit the general definition of the term. If you are doing a biceps curl or lifting a package to your chest, you are flexing your elbows.

Extension is generally the action which increases the angle of the joint. Straightening your arm or knee or moving your head from a forward position to a straight up position would be examples of extension. Bringing the arm back to the side from a flexed position would also be extension — even though the angle of the joint is actually being reduced. If you are getting up from a chair, your knees and hips are extending.

Hyperextension is bringing the joint past what would be the normally extended position. The elbow and knee will not normally hyperextend, but if the head is moved past the vertical so that you are looking upward, your neck has been hyperextended. Similarly, if your arm is brought backward at the shoulder joint so that it is now past the point where it was hanging at the side, it is hyperextended. If you are swimming the crawl stroke and are pulling your arm out of the water in its recovery, your shoulder is hyperextended. If you bend your back past the vertical, as in an advanced high jumping technique, your spine is hyperextended.

Abduction is taking away your arm or leg from the mid-line of your body. Raising your arm out to the side or lifting your leg to the side would be examples of abduction. In doing a jumping jack both your arms and legs are abducted at the beginning of the movement.

Adduction is the returning of your arm or leg to the midline of the body from an abducted position. So in your jumping jack exercise, when your arms come back to your sides and your legs are together, they have been adducted.

Rotation is the pivoting of a body part around its own axis. Twisting your head to the side (as in nodding "no"), twisting your torso, or rotating your arm or leg would be rotation.

Circumduction occurs when the end of your arm, leg or head describes a circle. Swimming the butterfly stroke would be an example of the arms circumducting. If you were to draw circles in the sand with your toes, your leg would be circumducting.

Other Specific Movements

For the forearm and hands, supination is an outward rotation of the forearm. If your arm was flexed at the elbow and you had a bowl of soup in your hand, your hands would be supinated. If your hand is then turned back inward and downward it would be pronated.

For the ankles, if you turn the sole of your foot inward, it is called inversion; if you turn them outward, it is called eversion.

For the shoulders, protraction occurs when your shoulders are pushed forward, such as when doing a pushup or reaching forward with an oar while rowing. Retraction occurs when you pull your shoulder girdle backward such as when standing at attention or pulling backward on an oar while rowing.

Range of Motion

Your range of motion is the measure of flexibility for each joint or combination of joints. That range of motion is determined by the ligaments and tendons and by the tension in the muscle fibers. When the muscle tension is very high, the muscle is said to be in a state of contracture. The contactures can generally be reduced by effective stretching exercises within a few weeks. Movement restriction caused by tight ligaments will generally take much longer.

Some people are highly concerned with increasing their range of motion. Many athletes need flexibility that is beyond what is normally needed for day to day living. Hurdlers, divers, dancers, cheerleaders, high jumpers, soccer kickers, swimmers and gymnasts are just a few of those who may need to increase their range of motion in order to be more effective in their chosen activities.

The Effects of Aging on Connective Tissues

Our connective tissues are 60 to 70% water when we are young. As we age our connective tissues become more brittle. By age 70 we have lost about 20% of the water content that was in the connective tissues when we were born. In addition, our collagen becomes thicker so we become stiffer and less flexible.

An effective stretching program can reduce the aging of connective tissues. Even those who have not been careful to stay flexible can undo much of the damage of inactivity by beginning to stretch in the ways described in Chapter 13.

Should All Athletes or Dancers Stretch?

Recent research is making us question our previously unquestioned reliance on stretching for warm up, to reduce delayed onset muscle soreness (DOMS), and to reduce injuries. While we have always thought that stretching was good and more stretching was better, there are now a number of questions. Is stretching as a warm up good for some people and not good for others? Is it good for the treatment of some injuries but not for others?

Certainly when you need a greater range of motion, stretching is essential. The question is, how much range of motion do you need for your sport or style of dance? If you are a cyclist, you may not need much. If you swim the backstroke you may not need as much shoulder flexibility as a butterfly swimmer, yet both may need some extra flexibility for their sprint turns. A jogger or marathon runner probably doesn't need extra hip flexibility, but a sprinter might. Certainly a gymnast needs great flexibility, as do participants in the martial arts. How much flexibility do you really need to perform your exercise or to compete in your competitive event?

Static stretching during a warm up increases injuries for at least some people. A couple of studies of 10K runners have found that those who stretched had more injuries than those who did not. The question is, is it the stretching itself or just poor stretching technique that is the culprit?

Relative to injury, one study found that when one joint had at least a 15% greater flexibility than the corresponding joint, the more flexible joint was 2.6 times more likely to be injured.[6] A hypothesis for this might be that the stretching exercises lengthen the connective tissue surrounding the muscle fibers which then requires the fibers to absorb all of the force of the eccentric contractions — contractions in which the muscle lengthens while it is being contracted, such as returning the barbell to the starting position after it has been lifted or landing on the ball of the foot when running—the calf muscle is contracted but it lengthens while landing on the foot. The theory is that too much force was placed on the fibers, and they overstretched and were injured.

Stretching may decrease injuries, at least for some people. In a study of military recruits, the group that had 3 hamstring stretching exercises added to its physical fitness regime both increased their hamstring flexibility and reduced the rate of overuse injuries to the legs from 29.1% in the control group to 16.7% in the group that stretched.[7]

How we measure flexibility affects what we find. At the present time we have no way of knowing just how much we are stretching the muscle fibers and how much we are stretching the various connective tissues involved. When the research relates to injuries, the studies have not reported whether the injuries were to the muscle fibers, the tendons or the ligaments. They also don't report on whether the injury was acute (an injury from a single specific movement) or a chronic overuse injury due to repeating the same movement patterns thousands of times, perhaps on a surface that contributes to the injury, such as running on concrete versus running on grass or in the sand.

Are muscular injuries such as strains or pulls increased or decreased by stretching? Does stretching before the exercise increase the susceptibility of the muscle fibers to injury during the activity when the muscle's job is to shorten?

The muscles are stretched more than the connective tissue. This can set the muscle up for more injury and reduce the muscle stiffness by relaxing the muscles.'

To understand a bit better, we must remember that while tendons may be stretched to 4% before injury and muscles can usually be stretched to 20% to 30% before they are injured, each of us, and each muscle and tendon, differ somewhat. We therefore don't know exactly how far any of our own muscle groups can be stretched before some injury either occurs or becomes more probable with our ensuing exercise.

At the Duke University Medical Center an interesting study was performed with leg muscles in the front of the lower leg of rabbits. It was found that when the muscles were stretched by 20%, they didn't seem to have their potential contracting force reduced. Muscles stretched 30%, however, were not able to exert maximum force. Additionally, the fibers near the tendons at the end of the muscle belly showed ruptures of some of the fibers and bleeding. Certainly the 30% stretch injured some fibers. Is this what causes more injuries in 10K runners who stretch? The study also concluded that when the fibers lost their ability to contract to the fullest, they also increased their chance for injury.[9]

Naturally, much of the work on stretching muscles or tendons to the breaking point has to be done with animals or excised muscles from dead animals. Do these studies hold true for human tissue? If a rabbit's front leg muscle fibers can withstand a 20% stretch without ill effect, does that mean that a human leg muscle fiber can only withstand 20%? What about a human neck muscle? What about another rabbit's leg or neck? What about your leg muscle fibers compared to those of your sister, your neighbor, the Olympic sprint champion? Lots of questions! But realistically, studying the muscle fibers of a rabbit's leg or a bird's wing will give us some indication as to how muscles react. And certainly, at this stage of the game, all we are seeing are indications — but indications strong enough that we should take them into account in our training.

The stretch of the muscle can make it less able to contract efficiently. This reduces its "stiffness." A study at the Centinella Hospital Biomechanics Laboratory, a major southern California sports medicine center, may indicate why. The study found that the electrical activity in muscles was generally reduced by stretching, whether the stretching was before or after a warm up. This was particularly true for the calf muscles (soleus and gastrocnenius[1]°

Muscle Stiffness

Muscle stiffness may be mechanical, due to the properties in the muscle fibers, or neural, due to increased electrical activity in the nerves which then stimulate the muscle fibers and make them more tense. While the aforementioned "contractures" are excessive stiffness and will reduce one's performance, a certain amount of stiffness is valuable for most athletic movements because power is increased with the right amount of stiffness.

Mechanical Properties of Muscles

Extensibility or stiffness of muscle fibers is related to how easily or difficult it is to lengthen the muscle fibers when a lengthening force is applied to them. We measure the stiffness of muscle by seeing how much it lengthens when it is affected by a force which should stretch it. Muscles which lengthen rather easily are called compliant, those that don't stretch readily are called stiff. More technically, stiffness is defined as the ratio of change in force to the change in the length of the muscle. This stiffness is dependent, to a large degree, on the tension within the muscle fibers. That tension can come from the activation by the nerves or from factors within the muscle.

The myosin and actin proteins, which move across each other when the muscle fiber contracts, thereby shortening the muscle fiber, are attached by what is termed a "myosin cross bridge." The strength of that attachment by the cross bridge is what sustains a muscular contraction and what causes the stiffness of a muscle. The stronger the tension of the cross bridge, the more the muscle resists stretching, so the more it is considered to be stiff. (More on this in the next chapter.)

Some of those factors can be hereditary. Environmental factors may also be present. For example, when a stretch-shortening (plyometric) stress occurs, such as when you jump down from a chair and immediately jump upwards, there is much greater tension developed in the muscle fibers than if you are merely standing on the chair. The tension required in the muscles to absorb the force of jumping from 18 inches above the floor is significant. (In Chapter 10 we will discuss this "stretch-shortening cycle" and plyometric exercises as a method of developing power for your sport.)

Stretching a muscle (as during eccentric or lengthening action) increases the firing rate of the muscle spindles which increases the stiffness of the muscle. The spindles sense the amount of stretch in muscle fibers and signal the information to the spinal column. The stiffness of the muscle will therefore be influenced also by the level of muscle activation.

Continued activity such as running or other exercises in which the muscle lengthens under pressure then immediately contracts (called the stretch-shortening cycle) obviously causes fatigue in the muscles. Part of that fatigue is due to normal fatiguing factors such as increased waste products from the energy generating system, but fatigue also comes from the reduced muscle stiffness caused by exercise that requires more energy to contract the muscles.[12] So muscle stiffness also slows the fatigue factor, especially in strength-speed activities such as running 100 to 400 meters.

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