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# Walking and Jogging for Fitness

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# Chapter 1

## *The Benefits of Walking and Jogging as Exercise*

### The History

The benefits of physical activity and exercise have been recognized for as long as man has been around. Our first ancestors didn't think they were exercising. For them, it was more like chasing their next meal to survive instead of chasing a ball to win a game or going for a leisurely stroll. Regardless, in order to survive, they had to be actively engaged in moderate levels of physical activity either through hunting or gathering foods for their sustenance. In other words: no exercise, no food; no food, death. How's that for a health benefit?

The Greek physician Herodicus in fourth century B.C. recognized the importance of exercise. He practiced gymnastic medicine, a branch of Greek medicine that relied on vigorous exercise as a treatment.<sup>1</sup> Hippocrates also agreed, "if we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health."<sup>1</sup> The Jewish philosopher Rabbi Moses ben Maimon of the 12<sup>th</sup> century, a physician to the Sultan of Egypt, stated, "Anyone who lives a sedentary life and does not exercise...even he eats good and takes care of himself according to proper medical principles-all his days will be painful ones and his strength will wane."<sup>1</sup> Robert Burton, a theologian and scholar also saw the benefits of an active lifestyle and stated in his book *The*

*Anatomy of Melancholy*, "Opposite to exercise is Idleness or want of exercise, the bane of body and minde...one of the seven deadly sinnes, and sole cause of Melancholy."<sup>1</sup> (1632) Heironymus Mercurialis (from the 16<sup>th</sup> century) defined exercise, a definition that has changed little since the 16<sup>th</sup> century, "exercise is the deliberate and planned movement of the human frame, accompanied by breathlessness, and undertaken for the sake of health or fitness..."<sup>1</sup>

Beyond the physical health benefits, there are affective benefits associated with group games and activities. Ancient Mayans organized the first team game called the Ball Game. It consisted of two teams trying to get a ball through a hoop mounted about 23 feet on a wall. The rules were to get the ball through the hoop using certain parts of the body. In some cases the captain of the losing team gave himself as a human sacrifice to the winning team, an act that was believed by the Mayans to be a vital part of prosperity.<sup>2</sup>

American Indians are thought to be the founder of the modern game of lacrosse as well as other stick games. In general, Lacrosse (which received its name from French settlers) was perceived as a cultural event.



George Catlin [Public domain], via Wikimedia Commons , [https://commons.wikimedia.org/wiki/File%3ABall\\_players.jpg](https://commons.wikimedia.org/wiki/File%3ABall_players.jpg)

The game was sometimes used to settle disputes between tribes, victory and choosing teams was thought to be controlled supernaturally, and games and equipment were prepared ritualistically.<sup>3</sup>

### From Ancient History to Modern Times

In retrospect, the perceived benefits of exercise have changed very little since Herodotus or the American Indians. Mounting research continues to support early thoughts that exercise is vital to human quality of life. Culturally, sport plays a huge role in growth and development of youth and adults. Physically, there is indisputable evidence associated with the short and long-term benefits of regular exercise to brain, heart, bone, muscular, and emotional health, and reductions in risk for chronic disease such as cancer, diabetes, and obesity.

**Physical activity** is defined as any movement carried out by skeletal muscle that requires energy and is focused on building health. Health improvements would be seen as improved blood pressure, blood-lipid profile, and heart health. Acceptable physical activity includes

things like yard work, house cleaning, walking the dog, or taking the steps instead of the elevator. Physical activity does not have to be done all at once. It can be accumulated through various activities throughout the day. Although typing on a phone or laptop or playing video games does require skeletal muscle and a minimal amount of energy, the amount required isn't sufficient to improve health.

Despite the common knowledge that physical activity is tremendously beneficial for health, rates of activity continue to be below what is needed. According to the CDC, only 1 in 5 (21%) of American adults meet the recommended physical activity guidelines from the Surgeon General. Less than 3 in 10 high school students get 60 minutes or more of physical activity per day. Non-Hispanic whites (26%) are more active than their Hispanic (16%) and Black counterparts (18%) as is the case for males (54%) and females (46%). Those with more education and those whose household income is higher than poverty level are more likely to be physically active.<sup>4</sup>

Exercise, although often used interchangeably with physical activity, is a sub-category of physical activity. **Exercise** is a planned, structured and repetitive movement pattern intended to improve fitness. As a positive side-effect, it also significantly improves health as well. Fitness improvements would be seen as the heart's ability to pump blood, increased muscle size and flexibility. For the most part, walking and jogging in this text is viewed in the context of exercise.

### The Role of Walking and Jogging

Walking and jogging can play a major role in increasing these activity rates. Why? One of the beauties of walking or jogging comes

from their simplicity. For example, the basic requirements to begin a walking program include: shoes, clothing, and a place to walk. For most, these items are readily available. In other words, the excuse of cost and/or accessibility is simply not a good one.

If you're wanting to be competitive and not a just-for-fun kind of runner, there's no problem with the availability of races. One of the fastest growing race distances, the half-marathon, continues to grow with 1.8 million finishers in 2012 for the 13.1 mile event. The most popular events, 5k's, included 6.2 million finishers. Marathoners dropped slightly from 2011-2012 to 478 thousand finishers of the 26.2 mile events. The number of resources available to runners has also increased with more and more online training programs, many of which are free.<sup>5</sup>



By unknown, from Jackson Mississippi, USA (Blues Race thru Belhaven) [CC BY-SA 2.0 (<http://creativecommons.org/licenses/by-sa/2.0>)], via Wikimedia Commons)

In addition to the growth of half marathons and marathons, 10k's and 5k's have become easy ways for many organizations to raise funds for a particular cause. As a result, these local weekend events can be found by the dozens in many areas of the country. For example, Rungeorgia.com advertises a race calendar for the entire state of Georgia. On any

given weekend, anywhere from 5 to 30 events are posted. Many of which carry low registration costs, short travel, and raise funds for good causes. In addition to the old fashioned 5k and 10k, many "new-age" events have emerged with similar distances but that also include challenging obstacles and other elements of fun such as color-runs or glow-in-the-dark runs. In other words, accessibility to events is rarely an excuse.

Walking generally attracts a less competitive group although many clubs and organizations exist to support competitive race walking, a sport included in the summer Olympic games. Not all finishers of marathons are actually runners. Many are full-distance walkers. Regardless, most walkers are walking for fitness or social enjoyment and not for competition so recommendations in this text primarily adhere to that non-competitive approach.

## Health Benefits

Walking and jogging are considered aerobic exercise—a type of exercise that requires oxygen -- more frequently referred to as simply "cardio." Both walking and jogging not only improve health but also increase fitness levels. The health benefits of aerobic exercise have been well documented since Dr. Kenneth Cooper wrote the book *Aerobics* in the early 60's.

People, in general, exercise for many reasons. Ironically, most reasons lack a specific focus on the health benefits. While that's not a problem, per se, it's still important to remember health as the main objective. Nonetheless, the exact reasons vary between genders and ages but include:

	Females	Males
1.	Weight Control	Muscle tone
2.	Feel good after	Increased energy
3.	Increased energy	Cardiovascular benefits
4.	Muscle tone	Weight control
5.	Cardiovascular benefits	Feel good after
6.	Keep flexibility	Reduce stress
7.	Reduce stress	Build strength
8.	Time for self	Enjoy exercise
9.	Enjoy exercise	Keep flexibility
10.	Improve self esteem	Time for self

Source: Fitness Products Council/IHRSA/American Sports Data, Inc., Reprinted in SGMA's "Tracking the fitness movement" reports.

## Cardiovascular Health Benefits

While the exact details vary for how much exercise is required and at what intensity is most beneficial, little doubt exists as to whether or not exercise will significantly reduce risks of cardiovascular disease. Fit individuals, male or female, are much less likely to die from coronary artery disease as well as cerebrovascular disease (stroke). Current research suggests "more is better," in terms of cumulative energy expenditure, with the most pronounced change in risk seen with moderate levels of activity. Specific adaptations to the cardiovascular system that occur as a result of exercise will be discussed in a later chapter.

## Obesity

Obesity has become an epidemic in the modern world with nearly 70% of all Americans being considered overweight based on body mass index measurements. Unfortunately, only about 21% of adults 18 and older engaged in regular physical activity according to the Center for Disease Control.<sup>6</sup>

Clearly, the more calories you burn during exercise the easier it will be easier to prevent becoming overweight or obese. Walking and jogging, especially at high intensities require significant energy demands and have been shown to reduce body weight if performed consistently over several weeks. Not only do you burn extra calories during the exercise, but metabolic rate remains elevated for up to 24 hours after exercise burning additional calories.

Exercise has not only been used as prevention for CVD and weight management but also as a treatment strategy after diagnosis. In addition to CVD and obesity, regular aerobic exercise may also help prevent:

- Diabetes (Type 2, gestational)
- High cholesterol
- Cancer of the breasts, prostate and colon and rectum
- Arthritis
- Delay the onset of Alzheimer's and Parkinson's disease
- Osteoporosis
- Kidney Disease
- Improves immune system function

In addition to the preventive benefits, it can be used to treat:

- Heart disease
- Asthma
- COPD
- Cystic fibrosis
- Hyperlipidemia
- Multiple sclerosis
- Arthritis
- Depression
- Anxiety disorder



- Improves academic performance

Clearly, Hippocrates was correct in his statement that regular exercise is “the safest way to health.”

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## Chapter 2

# Getting Started With a Walking/Jogging Program

**O**ften, the hardest thing to do in regards to beginning a new routine is simply starting the new routine. Old habits, insufficient motivation, support from others, etc. all play a role in whether or not you successfully begin a new exercise program. Success, in this case, is measured by your ability to consistently participate in the program to reap the fitness benefits associated with the activity.

This chapter will cover the basics of beginning a walking or jogging program in order to give you the best chance of being successful.

### Think Lifestyle

Beginning a walking or jogging program can be a daunting task. To illustrate the concept of lifestyle, take a moment and consider your local gym. You may notice the attendance there in the month of January increases dramatically. Some estimates suggest as many as 80% have stopped coming by the second week of February. However, as February and March approach, attendance steadily declines eventually falling back to pre-January levels. Why does this occur? Why aren't these new customers able to continue the routine for the entire year? One possible explanation: patrons are unsuccessful at viewing their routine as a lifestyle. The new year brings resolutions, goals

and aspirations intended to reach an endpoint in a short period of time. The idea of returning to teen level weight and/or fitness, while alluring and well-intended, are simply unrealistic for most adults. The physical demands and time constraints associated with the adult life stage must be taken in to consideration in order to be successful. If not, goals remain dreams (at least until the next year).

Both walking and jogging are simple activities that promote health and fitness, as previously discussed. Like any other lifestyle habit, optimal health and fitness do not occur over night. Time and more importantly, consistency, drive health and fitness outcomes. So, as you begin your program focus on what will make you consistent. The term lifestyle implies "habits, attitudes,...standards...that together constitute the mode of living" <sup>1</sup>(dictionary) or behavior that is imbedded into your daily and weekly routine. You're not simply trying to change physically, but rather modify your mental perception to promote long term health.

The steps below should guide you through this process. Before getting to the point of beginning your program, you should understand the safety concerns associated with exercise.

### Safety First

The physical challenges of beginning a new exercise program can place you at a greater risk of injury, illness or even death. Results from various studies suggest vigorous activity increases the risk of acute cardiac heart attacks and/or sudden cardiac death (ACSM pg. 10).<sup>2</sup> While that may seem contradictory to the previously suggested benefits of walking and jogging, the long term benefits of exercise

unequivocally outweigh the risks during exercise. In active young adults (younger than 35), incidence of cardiac events are still rare, affecting 1 in 133,000 in men and 1 in 769,000 in women. In older individuals, 1 in 18,000 cardiac events occur. <sup>2</sup>

Of those rare cardiac incidents that do occur, the presence of preexisting heart disease is the common thread, specifically atherosclerosis.

**Atherosclerosis** causes arteries to harden and become clogged with plaque which can break apart, move to other parts of the body, and clog smaller blood vessels. In light of this, it is important to screen individuals for risk factors associated with heart disease before they begin an exercise program.

The American College of Sports Medicine recommends a thorough pre-screening to identify any risk of heart disease. The 7 major risk factors looking to be identified are below. <sup>3</sup>

1. Family history-if a cardiac event has occurred with your father or first-degree male relative before the age of 55, or mother or first-degree female relative before 65, there could be a genetic predisposition to heart disease.
2. Cigarette smoking- currently smoke, or have quit in the past 6 months
3. Hypertension-Blood pressure at or above 140 mm/HG systolic, 90 mm/Hg diastolic
4. Dyslipidemia-cholesterol levels that exceed recommendations (130 mg/dL, HDL below 40 mg/dL, or total cholesterol of greater than 200 mg/dL)

5. Impaired fasting glucose (diabetes)- blood sugar should be within the recommended ranges

*Atherosclerosis-the progressive condition of fatty substances depositing on arterial walls, leading to the development of plaque and hardening of arterial walls*

6. Obesity-Body mass index of >30, waist circumference of >102 cm men, >88 cm women, or waist to hip ratio of >0.95 men, >0.86 women
7. Sedentary lifestyle-persons not meeting physical activity guidelines set by US Surgeon General's Report

In addition to identifying your risk factors, you should also complete a Physical Activity Readiness Questionnaire (PAR-Q). The PAR-Q asks yes or no questions about symptoms associated with heart disease. Based on your risk factors, and your responses in the PAR-Q, you are then placed into a risk category: low, moderate, high.

- Low risk persons are men younger than 45, women younger than 55 who answer no to all of the PAR-Q questions and have one or no risk factors. Although still a good idea, further screening such as getting physician's approval isn't necessary.
- Moderate risk persons are men of or greater than 45, women 55 OR those who have two or more risk factors. Because of the connection between cardiac disease, the seven risk factors, and risk during exercise, it is recommended you get physicians approval before beginning an exercise program.

- High risk persons answer yes to one or more of the questions on the PAR-Q. Physician's approval is required before beginning a program.

Once you have determined your ability to safely perform the demands of walking and jogging, you are now ready to move to the next steps in the process of beginning your program. Other safety concerns, such as where you walk and jog, how to be safe during your workout, and environmental conditions will be addressed at a later time.

As you look at the remaining steps, a simple analogy may help to better conceptualize the process.

Imagine you are looking at a map because you are traveling to a particular location and you'd like to determine the best route for your journey. To get there, you must first determine your current location and then find the roads that will take you to your desired location. You must also consider roads that will present the least amount of resistance, provide a reasonably direct route, and don't present any safety hazards along the way. Of course, planning the trip, while extremely important, isn't the final step. You must now actually drive the route, monitor your car for fuel and/or malfunction, etc, and be prepared to reroute should obstacles arise.

Preparing yourself for a walking and jogging program and ultimately, trying to adapt a lifestyle approach to exercise, requires similar preparation. You will need to:

- Assess your current fitness (where are you on the map?)
- Set goals (what is your destination's location?)

- Create a plan (what route will you choose?)
- Follow Through (start driving!)

### Assess Your Condition

In order to adequately prepare for starting your personal walking and jogging program, you will need to take a hard look at your current level of fitness. With multiple methods of assessing your fitness, you should select the one that best applies to you. Understand, however, that each walking/jogging assessment discussed here is attempting to estimate a key physiological marker, your maximal oxygen consumption. Your **maximal oxygen consumption**, or  $VO_{2max}$ , measures your body's ability to take in and utilize oxygen which directly correlates to your overall health and fitness. Obtaining a good estimate of your  $VO_{2max}$  will provide you a one-time glance at your baseline fitness and health, provide a baseline measurement and help you gauge the efficacy of your fitness program in subsequent reassessments.

Some of the most common walking/jogging assessments used to estimate your  $VO_{2max}$  include the 12 minute Walk, 1.5 mile Run-Walk Test, and 1 mile walk test. Unfortunately, these field assessments, although practical and inexpensive, only provide good estimations. For a more accurate assessment, you would need to perform a lab-based  $VO_{2max}$  test using equipment that measures the volume of oxygen and carbon dioxide being moved in and out of the lungs during exercise. While more accurate, the expense and availability make it impractical for most. Unlike the lab test, the field assessments are basically cost free, user friendly and require very little expertise to conduct or perform. In addition, the key point

*Maximal Oxygen Consumption ( $VO_{2max}$ )-the ability to take in and utilize oxygen*

of the assessment is measuring differences rather than absolute values and the field tests can accurately meet that objective.

You will find information, such as how to safely perform the assessments, at the end of chapter 2. To complete this step, select one or two of those assessments, read and follow the instructions, and record your results.

In addition to walking and jogging assessments, other measurements can be helpful in measuring the success of your activities. Given the top reasons both males and females exercise, weight management and musculature, measuring body fat and weight along with **anthropometric** measurements will help determine if these areas are being affected by your walking and jogging routine.

### Set Goals

Using an analogy of a map, you must determine your current location in order to determine the best route to get to your destination. In the previous step, you essentially figured out “your current location” and now must determine “your destination” by setting up some goals.

In his bestselling book, *7 Habits for Highly Effective People*, the author Stephen Covey suggests you should “begin with the end in mind.”<sup>4</sup> While this may not seem directly applicable to walking and jogging, the greater concept of lifestyle certainly comes in to play here. Setting goals, in any activity, is important because it will lead to a greater chance of

*Anthropometric measurements (anthropometry)-the scientific measurement of the body. Done by using a simple tape measure to determine the circumference of large muscle groups, the waist, and hips.*

success. With goals, you get to determine what success is, you get to determine the end point. Without goals, you have no way to measure whether or not you’ve succeeded or not. In other words, you could easily exceed your goals and actually think you failed.

The art of setting goals includes stating them in a clearly defined and measurable way. You should consider exactly what you would like to accomplish, make sure you can measure it, and establish a time frame in which you will have achieved your goal. These are often termed SMART goals

- S-specific; be as specific as possible.
- M-measurable; if you can’t measure it, you won’t know you’ve completed the goal.
- A-attainable; consider whether or not you will have the resources to obtain your goal (time, cost, support, etc.)
- R-realistic; while your goal should be challenging, it shouldn’t exceed reasonable expectations.
- T-time frame; set a deadline to accomplish your goal.

A well stated goal will contain all of the SMART ingredients. Take a look at the well stated example below:

- I will improve my 12 minute distance by 10% within 2 months of the first assessment.

Note, all the ingredients of a well stated goal are present. It is specific (improve 12-minute distance by 10%), measurable (10% improvement), attainable and realistic (the degree of improvement is reasonable in that time frame), and time frame (a clear deadline of 2 months).

Less effective goals would be stated like this:

1. I will run further next time I assess my fitness.
2. I want to jog faster.
3. I will lose weight

And a common one:

4. I will exercise 3 days a week at 60% max heart rate for 45 minutes per session for 2 months.

At a closer glance, none of these examples contain all of the ingredients of a well stated goal. How will you measure “faster?” “Further” is not specific enough nor is “lose weight.” In the last example, this is not a goal at all. It is a plan to achieve a goal that hasn’t been stated.

In the end, setting up well stated goals will give you the best chance to convert good intentions in to a successful lifestyle.

To complete this step, you should write down 2-3 personal goals, stated in the SMART format, and put them in a place you will see them frequently.

## **Create a Plan**

Now that you know exactly what it is you want to achieve, begin generating a strategy that will help you reach your goals. As you strategize, your goal in this step is to determine the frequency, the intensity, and duration of your exercise sessions. While doing this, it is imperative to keep in mind a few key principles.

One obvious, but still key principle, is to use your goals as the foundation for your walking and jogging program. If your goal is related to weight loss, this should drive the frequency, duration, and intensity of your daily workouts as these variables will influence your body’s use

of fat for fuel and the number of calories burned. If you feel more interested in improving your speed, you will need to dedicate more workout time to achieving those results. This idea is associated with the training principle, called specificity, which will be discussed more extensively in a later chapter.

Another key principle to be emphasized is to rely on expert recommendations to safely and effectively design your program. Organizations like the American College of Sports Medicine, Coopers Clinic, the Surgeon General and many more have extensively researched the optimal frequency, intensity and duration for aerobic exercise. As a result, recommendations have been widely distributed to help guide participation in activities such as walking and jogging. Trained professionals such as personal trainers, coaches, and physicians have taken the recommendations and applied them to client’s needs while modifying when necessary. Thousands of books and articles have been published to disseminate their ideas and how they can be applied to the general public.

Because of the volume of information, much of the details of this step, creating a plan, have been entered in chapter 3 and 4. There, we will discuss choosing proper equipment, the adaptation to stress training principles, and the actual physiological adaptations that come from aerobic exercise such as walking and jogging. After reading and understanding the material there, you will want to get your plan in writing. At the end of chapter 3, you will find a form that will help you to complete this step.

## **Follow Through**

Once you’ve assessed your fitness and created your own plan, you’re over half way there to checking your goals off the to do list. Now is

when the rubber hits the road, as the old adage goes. With the investment of a well thought out and designed program comes the returns from good execution. The planning is really the hard part. Now that you know what to do and how to do it, it's a simple matter of doing it.

Unfortunately, the ability to stick with a program has proven difficult for most (cite statistics of starting an exercise program).

In order to prevent getting derailed from your program you should identify barriers that may prevent you from consistently following through. One of the most common challenges cited is time. Work schedules, school, child care, and the activities of daily living can leave you with little time to pursue your walking and jogging goals. Make a list of the items that prevent you from regular exercise and then analyze when you could squeeze in your exercise time. This could be walking or jogging during your child's athletic practice, or extending the daily walking of the dog another 15-20 minutes.

Regardless of how you fit your exercise in, consider how you can do so consistently. Below are a few additional tips on successfully becoming consistent in your routine.

- *Think long term, think lifestyle*-The goal is to make walking and jogging an activity you enjoy and can enjoy throughout your life. This won't occur overnight and will take time to develop your ideal routine. Begin with this in mind and be patient as you work through the challenges of making this a consistent routine.
- *Start out Slowly*-Once again, you're in this for the long haul. No need to overdo it in the first week. Plan for low intensity, 2-3

days per week of activity, and realistic periods of time (20-30 min per session).

- *Low Intensity/low volume*-As fitness improves, you will want to gradually increase your efforts in terms of quantity and quality. You can do this with more time and frequency (called volume) or you can increase your intensity. In beginning a program, don't change both at the same time.
- *Keep Track*-results from a walking and jogging program often occur slowly, subtly, and in a very anti-climatic way. As a result, participants become discouraged when the immediate changes don't seem to be happening. Keeping track of your consistent efforts, body composition, and fitness test results will give you encouragement and motivation to continue as the subtleties of the results will be more obvious.
- *Seek Support*-Look for friends, family members, clubs, or even virtual support using apps and other online forums. Support is imperative as it will provide you with motivation, encouragement and people who share a common interest, all of which are factors in your ability to consistently engage in your fitness program.
- *Vary your activities from time to time*-Your overall goals are to be consistent, build your cardiovascular fitness, and reap the health benefits associated with your routine. From time to time, to avoid boredom, mix up your activities. Instead of walking, play basketball or ride a bike. Go to different locations such as hiking trails, parks or another "new" location to keep things fresh.
- *Have Fun*-You will have to enjoy your activities if they're going to stick as a lifestyle. While you can't expect everyday to be a party, you shouldn't dread doing your



walking and jogging routine. If you do, you should consider varying your activities more, or finding a new routine you find more enjoyable.

- *Eat Right and Exercise*-Nothing can be more frustrating than being consistent in your exercise but not seeing the results on the weight-scale (a major reason for many beginning a walking and jogging routine). Eating a balanced diet will accelerate your results and allow you to feel more successful throughout your activities. More on eating properly can be found in Chapter 5.

## Safety Habits

As activity rates among Americans improve, safety concerns become extremely important. Unfortunately, the physical infrastructure of many American cities is simply not built to accommodate walkers and joggers without going to a local park or trail. Limited financial resources and de-emphasis on health priorities for local and state governments make it tough to build roads with sidewalks, walking trails surrounding parks, bike lanes, etc. In addition, time constraints and inconvenience make it challenging for participants to want to travel to areas where these things are available. As a result, walkers and joggers use roads and isolated trails/pathways inherently increasing the risk of being active.

Whether on the road or off the beaten path, there are a few critical concepts to safe walking and jogging. The first key concept is visibility. You want to be able to see what's coming ahead and you want those approaching to be able to see you. This point can be illustrated by going against traffic, although it may seem counterintuitive, when walking or jogging on the road. This allows the walker to see the on-

coming traffic as opposed to going with the traffic and unaware of the approaching traffic from behind. By wearing bright, reflective material, a walker/jogger is more visible and safer by going against traffic.

A second key principle is to recognize and to avoid the extremes. This can be applied in many ways. For example, areas of heavy traffic versus extremely isolated areas, heavy populated areas versus no one around, early morning versus late at night, or times of extreme cold versus extreme heat. These types of environmental conditions justify not using headphones for better hearing, not walking/jogging alone, preparing for adequate hydration in the heat, and so on. Regardless, extreme conditions require extra vigilance on your part.

A third key principle is to simply use your brain. While this seems obvious, it unfortunately gets ignored too often. Always remember the purpose of your exercise is for enjoyment and the health benefits. If these objectives could be compromised by going for a run at noon in 95-degree heat, or during morning rush hour in low light conditions, you should reconsider your plan. Before exercising in what could be a risky circumstance, you should ask yourself, "Is there a safer option available?"

Last, be aware of the terrain and weather conditions. Walking or jogging on trails is a wonderful way to enjoy mother nature but exposed roots and rocks present a hazard for staying upright. Wet, muddy, or icy conditions also create an additional variable to consider so you can complete your session without accident.

The below table outlines specific safety tips that should help you stay safe in your activities.



From the University of Texas-San Antonio

[https://www.utsa.edu/utsapd/Crime\\_Prevention/Crime\\_prevention%20pdf/Safety%20Tips%20for%20Runners.pdf](https://www.utsa.edu/utsapd/Crime_Prevention/Crime_prevention%20pdf/Safety%20Tips%20for%20Runners.pdf)

### **Environmental Conditions**

When exercising outdoors, you must consider the elements and other factors that could place you at abnormal risk of injury or illness.

### **Heat Related Illness**

Heat related illnesses such as heat cramps, heat exhaustion, and heat stroke contributed to 7233 deaths in the United States between 1999 and 2009. In a 2013 report released by the Center for Disease control, stated that about 658 deaths from heat related illnesses occurred every year which account for more deaths than tornadoes, hurricanes, and lightning combined. Of those deaths, most were male, older adults.<sup>5</sup>

The number one risk factor associated with heat related illness is hydration. It is essentially the starting point of all heat related illness.

Unfortunately, sweat loss can occur at a faster rate than you can replace with fluids during exercise, especially at high intensities. Even when trying to hydrate, ingestion of large amounts of fluids during exercise can lead to stomach discomfort. What does this mean? Hydration must begin before exercise and must become part of your daily routine.

Several practical methods of monitoring your hydration levels exists. One simple method, while not full proof, is to simply monitor the color of your urine. In a hydrated state, urination will occur frequently (every 2-3 hours) and urine will have very little color. In a dehydrated state, urination occurs infrequently

in low volume and will become more yellow in color.

Another simple method involves weighing yourself before and after a workout (see lab). This is a great way to see first hand how much water weight is lost during an exercise session primarily as a result of sweat. Your goal is to maintain your pre and post body weight by drinking fluids during and after the workout to restore what was lost. When combined with urine-monitoring, a fairly accurate level of monitoring hydration can be achieved.

The best fluid for maintaining a hydrated state is simply drinking plenty of water throughout the day. In previous years, recommendations for the amount of water to drink were a one size fits all of about 48-64 oz. per day, per person. In an effort to individualize hydration, experts now recommend fluid intake based on your size, gender, activity levels, and climate. Generally, half an ounce (fluid ounces) to 1 ounce per pound of body weight is recommended.<sup>6</sup> For a 150 lb. individual, this would mean 75-150 oz. of water per day! While there is still considerable debate over the exact amounts, you should continually monitor your hydration through the techniques mentioned previously as insufficient hydration leads to poor performance, poor health and potentially serious illness.

It should be noted that electrolyte “sport” drinks (Gatorade, Powerade, etc.) are often used to maintain hydration. While they can be effective, these types of drinks were designed to replace electrolytes (potassium, sodium, chloride) that are lost in sweat during activity. In addition, they contain carbohydrates to assist in maintaining energy during activities of long duration. If the activity planned is shorter than 60 minutes in duration, water is still the

recommended fluid. For activities beyond 60 minutes, a sports drink should be used.

### **Cold Related Illnesses**

Much like hot environmental conditions, cold weather conditions can be equally as dangerous without taking proper precautions. However, unlike the heat, you are trying to prevent too much heat from being lost. The three major concerns related to cold-related illnesses are: hypothermia, frost-nip, and frost bite.

As in the case with heat related illness, the objective of preventing cold related illnesses is to maintain the proper body temperature of between 98.6 and 99.9 degrees Fahrenheit. If body temperature falls below 98.6 F, multiple symptoms may appear indicating the need to take action. Some of those symptoms include:

- Shivering
- Numbness and stiffness of joints and appendages
- Loss of dexterity and/or poor coordination
- Peeling or blistering of skin, especially to exposed areas
- Discoloration of the skin in the extremities

When walking or jogging in the cold it is important to take the necessary steps to avoid problems that can arise from the environmental conditions.

- Hydration is key-cold air is usually drier air which leads to moisture loss through breathing and evaporation. Staying hydrated is key in maintaining blood flow and regulating temperature.

- Stay dry-Heat loss occurs 25x faster in water than on dry land. As such, keeping shoes/socks dry, shirts from accumulating too much sweat, etc. will allow for more effective body temperature regulation.
- Dress appropriately-Because of the movement involved, the body will produce heat during the exercise session. Therefore, the key point is to direct moisture (sweat) away from the skin. This is controlled most effectively by layering your clothing. A base layer of moisture wicking fabric should be used against the skin while additional layers should be breathable. This will channel moisture away from the skin and additional layers of clothing without becoming saturated in sweat. If exercising on a windy day, use clothing that protects from the wind and is adjustable so you can manage breathability.
- Cover the extremities-Those parts of the body furthest from the heart tend to get coldest first (toes, fingers, ears). Take the appropriate steps to cover those areas by using gloves, good socks and the head.

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# Chapter 3

## *Principles of Stress and Adaptations to Exercise*

**D**eveloping aerobic fitness can be an exciting and invigorating task. If not done properly, however, it can also become very discouraging as your perceived results seemingly don't justify the effort. To really understand if your training plan is working or not, you need to understand what to look for in terms of changes. In other words, you should be able to answer the simple question: How will my body change if I consistently perform a walking/jogging routine?

When referring to change, exercise scientists generally use the term "adaptation." The human body has an amazing capacity to physically adapt when exposed to challenging or stressful activities such as exercise. **Adaptation to stress** can occur as short or long term changes (acute or chronic adaptation, respectively). Most importantly, fitness is the result of chronic adaptations. In this chapter, we will discuss the physical changes that occur as a result of exposure to exercise, specifically walking and jogging, and how to use that knowledge to your advantage when creating a personal fitness plan.

### **Acute Adaptation**

At rest, the human body functions at a minimal level to maintain the necessary functions required to sustain life. When you are exposed to a stressful situation, such as walking at a brisk pace or jogging, your body must respond to meet the increased demands of the activity. Your heart must

speed up to circulate more oxygen-rich blood, your lungs must work harder to bring in more oxygen and get rid of carbon dioxide, the endocrine system must release additional hormones and much more. This is easily detected by the sensation of increased heart rate, faster breathing and maybe even sweating. These physiological changes, in response to exercise, illustrate the concept of acute, or brief, adaptations.

Specific acute adaptations as a result of walking and jogging:

- Increased heart rate
- Increased breathing rate and depth of breathing
- Release of norepinephrine (noradrenaline), epinephrine (adrenaline), cortisol, endorphins, and inhibition of insulin.
- Body temperature increase followed with temperature regulation.
- Blood pressure increase
- Increase in cellular metabolism
- Increase in nervous system and skeletal muscle activity

From the short list above, it's evident that walking and jogging requires significant physiological changes, when compared to the resting state of the body, to manage the energy requirements of an activity. For many, especially those unfamiliar with exercise, this experience can be quite uncomfortable when either starting the exercise session or first beginning a routine. The resulting fatigue and occasional soreness can last for hours to days.

However, it is important to understand that this response is normal. While the acute adaptations occur during every exercise session, your body will adapt over time, altering the degree of these

acute effects. For example, for individuals who haven't participated in vigorous exercise for several months but begin a new routine, they may experience significant soreness after the first few exercise sessions. But, beyond the first few sessions the body will adapt. So long as they remain consistent in their efforts, they will likely not have to deal with soreness again. These adaptations, labeled **chronic adaptation**, don't simply go away when the exercise session ends. They are long-term changes, though not permanent.

### Chronic Adaptations

Before digging into specific adaptations, it is important to understand the physical demands of exercise. By understanding what needs to change, it will be easier to understand what actual changes occur and how to change those areas when you create a training routine.

First, let's take a look at the working parts of the body specific to walking and jogging. The **cardiorespiratory system** consists primarily of the heart and lungs. The purpose of the heart is to pump nutrients and oxygen rich blood to the body's cells and deliver waste product, such as carbon dioxide (CO<sub>2</sub>), to the lungs. The lungs work in tandem with the heart to bring oxygen into the blood so it can then be pumped by the heart, and to get rid of waste such as CO<sub>2</sub> by exhaling into the external environment.

Of course the arteries, veins, and capillaries (along with the heart are collectively part of the cardiovascular system) cannot go without being mentioned. They serve as the highways for delivering blood to the body's cells. As another important part of this puzzle, the muscle cells serve as the endpoint for the

oxygen and nutrients in the blood. They also produce waste products as a result of cellular metabolism which then enters the blood circulation (see figure 3.1).

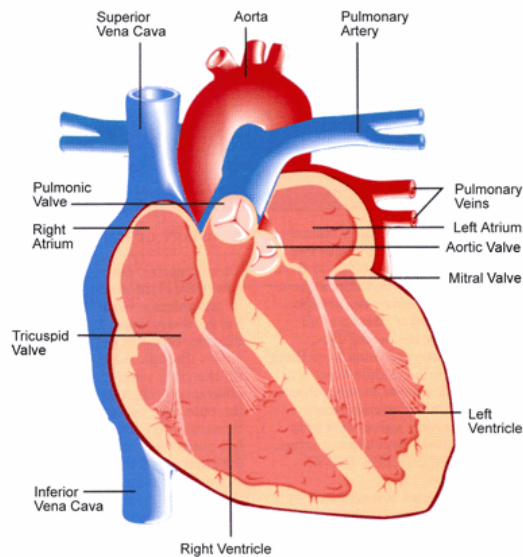
At this point, a series of questions must be answered to make this discussion relevant.

- What is accomplished by the cardio-respiratory system?
- Why do the cells need the oxygen and nutrients delivered in the blood?

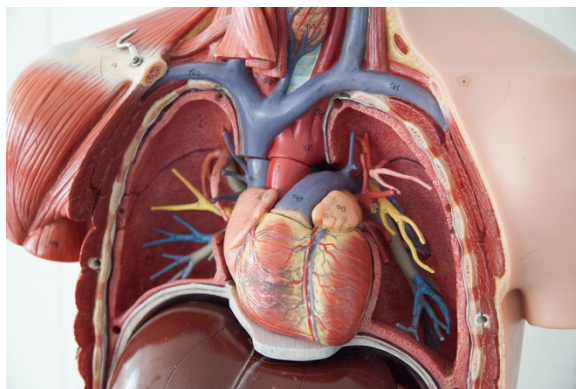
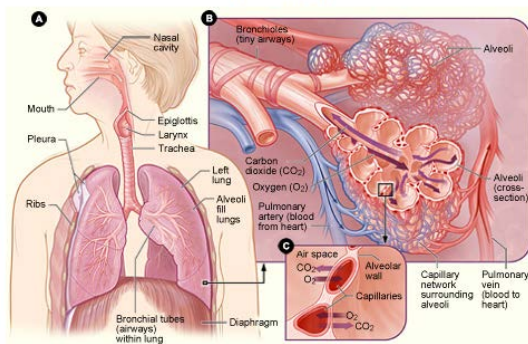
The answer to both questions is simple: energy.

The cardiorespiratory system must work effectively in order to create an environment in the cell in which energy can be produced. Energy, in its basic form of **adenosine triphosphate (ATP)**, is created in the cells and must be available for the body to function. In other words, when you begin walking or jogging, you must increase the production of energy, or ATP, to meet the demands of the activity. Every activity, from rest to jogging a marathon, requires a certain amount of energy. In order to improve your fitness, you must increase your capacity to generate more energy, i.e. adapt. This, of course, is driven by the chronic adaptations which come as a result of consistent training.

As stated previously, in order to produce more energy, you must become more fit. For example, if you would like to increase your mile jogging time from 10 minutes to 9 minutes, you will need to alter the way your body produces energy. Figure 3.1 illustrates a simplified version of the working components of the cardio-respiratory system.



*The Respiratory System*



By Hikmet Gümüş - Own work, CC BY-SA 3.0,  
<https://commons.wikimedia.org/w/index.php?curid=28813430>

As you look at the illustration, think about how these working components could be altered to enable more ATP production.

## Pulmonary Adaptations

The lungs function to bring oxygen into the cardiorespiratory system. As you inhale, your lungs (right and left sides) fill with oxygen. As a result, the increased pressure inside your lungs drives oxygen into the poorly oxygenated blood circulating past the lungs. While oxygen moves into the blood,  $\text{CO}_2$  simultaneously moves out of the blood into the lungs and is removed when you exhale.

In terms of adaptations, oxygen is key. Much like a manufacturer's supply chain which requires more raw material to produce more product, the lungs must be able to handle more oxygen if more energy is to be produced. Interestingly enough, this is what happens with improved fitness.

As a result of consistent training, two very important adaptations to respiration occur. First, the pulmonary ventilation capacity increases. This means the amount of air inhaled increases from about 100-120 L/min to about 130-150 L/min in previously untrained athletes. In large, well trained endurance athletes, this number can exceed 200 L/min!<sup>1</sup>

Secondly, the air inhaled and its ability to move from the lungs to the bloodstream also changes (called pulmonary diffusion). Although your lungs may fill up with oxygen after a good breath, the total amount of oxygen in your lungs does not go into the blood stream. There is a "residual" amount left over which may linger in the lungs or be exhaled. However, in trained individuals, a greater percentage of oxygen which initially fills the lungs moves into the blood stream.<sup>1</sup>

Both of these adaptations are important because they enable more oxygen to move into the blood, which can

then be delivered to cells for ATP production.

### Cardiovascular Adaptations

More oxygen in the arteries would be meaningless unless this oxygen can then be delivered to the cells. The heart serves as a pump, to generate pressure in the arteries so blood can flow efficiently to the areas of the body in need of what is found in the blood.

As a result of training, the heart's capacity to circulate blood increases. One example of how this might occur can be seen in the size of the heart. Like other muscles of the body, the heart muscle increases with training. Specifically, the left ventricle, one of the four chambers of the heart, increases in mass and thickness, a condition known as **cardiac hypertrophy**. With a larger heart muscle, the heart contracts more forcefully pumping more blood per beat compared to the untrained state.

Another example, which may be related to cardiac hypertrophy, can be seen in the heart rate. It's not uncommon to see resting heart rate decrease as a result of endurance training. On average, the rate of the heart at rest or resting heart rate is around 70-75 beats per minute. While the cause is not entirely known, some estimate declines of 1 beat per minute, per week of training. Highly trained endurance athletes may see their resting heart rate between 30 and 40 beats per minute. Not only does this occur at rest, but also at a given submaximal work load. For example, if an untrained individual were to measure his/her heart rate while jogging at 11 minutes per mile in an initial assessment and found their heart rate to be 150 beats per minute, with 6 weeks of training that

same individual might find that at the same pace, the heart rate is now at 140 beats per minute. This means the heart doesn't have to work as hard to do the same amount of work.

As resting heart rate decreases, the resting time between heart beats is extended. During this resting time is when the four chambers of the heart fill with blood. With more time between beats, more blood can enter the heart's chambers in preparation for the next beat. In combination with the more forceful contractions, the increased filling time contributes to an increase in **stroke volume**, or the amount of blood being ejected from the heart per beat.

As you can see, both heart rate and stroke volume contribute to the efficiency and capacity of the heart to circulate larger amounts of blood. When combined into a formula, the product of stroke volume and heart rate determine **cardiac output** (often labeled Q), a key indicator of cardiac health and fitness.

$$Q = \text{stroke volume} \times \text{heart rate}$$

At rest, in both trained and untrained individuals, Q remains close to the same at about 5-6 L/min. The decreased resting heart rate essentially cancels out the increased stroke volume. However, during exercise, Q is significantly higher in trained individuals, reaching over 30 L/min as opposed to 20 L/min in untrained individuals.<sup>2</sup>

### The Cells

The endpoint for nutrition and oxygen found in the blood is the cells. Cells need oxygen and fuel to generate ATP. In order to produce more ATP, cells must increase

their ability to process oxygen and other nutrients.

The beginning of this, at the level of the cell, is to remove the oxygen from the blood. Just because it's available in the blood, doesn't do us any good unless we can extract it and use it. Scientists can measure the amount of oxygen in arteries/veins before and after it is taken in by the cells, a measurement called the **arteriole-venule difference (a-vO<sub>2</sub> diff)**. The difference indicates the amount taken up by the cell. Trained individuals have a greater a-vO<sub>2</sub> difference than their untrained counterparts, implying cell in trained individuals can remove more oxygen into the cell than those who are untrained.

In addition to the a-vO<sub>2</sub> difference, the working components of the cell must adapt to promote increased ATP production. Using the previous analogy of a manufacturing supply chain, once the raw materials arrive to the manufacturing factory, the factory must then be able to process the new materials. So it is with energy production.

The work horse of aerobic metabolism, and ATP production, occurs in the mitochondria of the cell. In response to aerobic training, cells develop more and larger mitochondria. Clearly, this creates a "bigger factory" for ATP production which in turn equals the ability to do more work.

### **VO<sub>2max</sub>**

So far, we have discussed specific adaptations of the heart, lungs and cells. Collectively, these adaptations can be measured by determining the VO<sub>2max</sub>. If you'll recall, VO<sub>2max</sub>, or maximal oxygen consumption, is a measurement of the body's ability to take in and utilize oxygen.

When thought of in the context of specific adaptations, the heart, lungs and cells all play a significant roll in this measurement. A large VO<sub>2max</sub> would indicate that the lungs are operating at high levels (taking in the O<sub>2</sub>), the heart is pumping efficiently, and the cells are processing the additional oxygen properly.

So, while measuring lung capacity, stroke volume and a-vO<sub>2</sub> difference is important, a better predictor of performance can be seen by measuring the VO<sub>2max</sub>. Presumably, the greater the VO<sub>2max</sub>, the better an athlete can perform. Luckily, VO<sub>2max</sub> is a very adaptable component of aerobic fitness. By some accounts, it can increase by up to 50%, depending on the starting fitness level.

It can also be used as a strong predictor of health when trying to assess cardiorespiratory fitness. The ACSM suggests three important areas can be measured in maximal oxygen consumption measurements: an indication of cardiorespiratory health, an indication of activity levels, and a predictor of all-cause mortality.<sup>3</sup>

VO<sub>2max</sub> is measured most accurately in a laboratory in which the subject exercises until complete exhaustion while using a special mouthpiece attached to a computer to analyze oxygen intake and CO<sub>2</sub> output.

Other measurement techniques use prediction equations to estimate VO<sub>2max</sub>. While less accurate, these prediction equations provide a practical and simple way to assess cardiorespiratory fitness. For the purposes of the general public, the more important measurement is the change between beginning and ending fitness levels which these model can do accurately enough.



The  $VO_{2max}$  measurement can be expressed in multiple ways. Often, it is measured in liters per minute (L/min), indicating an absolute value of how much oxygen has been taken in. Because adult males generally have larger lungs than females, an absolute measurement could be interpreted as males being superior to females in aerobic capacity. However, the measurement more accurately compares men and women when expressed as milliliters per minute per kilogram of body weight (mL/kg/min). When expressed this way, size is incorporated into the measurement giving a much clearer picture of true aerobic capacity. A chart of various sports and average  $VO_{2max}$  ratings can be found below. Also, a chart of ranges of  $VO_{2max}$  can be seen at the end of this chapter.

### Lactate Threshold

Another area that significantly relates to fitness is the body's ability to buffer lactic acid build up in the blood. Lactic acid, often incorrectly associated with muscle soreness, results from cellular metabolism. As cells process fuel (carbohydrates) in order to produce ATP, lactic acid is produced and released into the blood stream. At low levels, the body's natural buffering capacity prevents lactic acid from building up and negatively impacting performance. However, during high intensity endurance exercise, high levels of lactic acid is produced, overwhelming the buffering capacity and fatigue ensues. That tipping point, the point in which the buffering capacity is overwhelmed, is called the **lactate threshold (LT)**.

Considered by most to be the best predictor of performance, the goal in improving fitness is to improve the lactate

threshold. For example, a runner may reach his/her LT when jogging a 7:30 min/mi pace, and when the heart rate is at 156 beats per minute. In order to improve fitness, this runner must adapt so that the new LT occurs at 7:00 min/mi pace and 163 beats per minute. In other words, the runner can now buffer more lactic acid delaying fatigue and improving mile time by 30 seconds per mile. Over the course of a marathon, that's a 13-minute improvement!

This is, in fact, what happens with consistent aerobic training. When charted along with the heart rate, the LT shifts to the right (see figure 3.2) as fitness improves. Well trained athletes may see their LT at 90% or more of their max heart rate! This essentially means an athlete can exercise at near maximum effort without getting fatigued as a result of lactic acid build up.

## Section II

### Principles of Adaptation to Stress

For many readers, the actual adaptations that occur as a result of consistent aerobic training are uninteresting and seemingly irrelevant to learning how to create a walking and jogging plan. However, because these adaptations are key markers of fitness, knowing what adaptations occur should help guide you in how to target them in your plan. This section outlines the principles of adaptation to stress, or the "how" part of organizing an exercise plan.

#### Overload Principle

Consider the old saying, "No pain, no gain." What does this really mean? Is it really

saying that exercise must be painful to get anything from it? Absolutely not. If that were the case, it would make exercise a lot less enjoyable. Maybe a better way to relay the same message would be to say improvements are driven by stress. Physical stress, such as walking at a brisk pace or jogging, places increased stress on the regulatory systems that manage increased heart rate and blood pressure, increased energy production, increased breathing, and even sweating for temperature regulation. The subsequent adaptations that occur, make it so that the same stress previously experienced feels less stressful. As a result, more stress must be applied to the system in order to stimulate improvements, a principle known as the **overload principle**.

For example, a beginning weight lifter performs squats with 10 repetitions at 150 lbs. After 2 weeks of lifting this weight, the lifter notices the 150 lbs. feels easier during the lift and afterward there is less fatigue. So, 20 lbs. are added and the lifter continues with the newly established stress of 170 lbs. The lifter will continue to get stronger until he reaches his maximum capacity or the stress stays the same at which point his strength will simply plateau. This same principle can not only be applied to gaining muscular strength, but also flexibility, muscular endurance and cardiorespiratory endurance.

## **FITT**

In exercise, the amount of stress placed on the body can be controlled by four variables: Frequency, Intensity, time (duration), and type, better known as FITT.

### **Frequency and Time**

Each variable can be used independently or in combination with other variables to impose new stress and stimulate adaptation. Such is the case for frequency and time.

Frequency relates to how often exercises are performed over a period of time. In most cases, the number of walking or jogging sessions would be determined over the course of a week. A beginner, may determine that 2-3 exercise sessions a week are sufficient enough to stimulate improvements in VO<sub>2</sub>max. On the other hand, a seasoned veteran may find that 2-3 days isn't enough to really stress the system. Per overload principle, as fitness improves so must the stress to continue to improve and avoid plateau. Expert recommendations suggest for optimal health and improvement you should plan to walk or jog "most" days of the week (4-5 days a week).

The duration of exercise, or time, also contributes to the amount of stress experienced during a workout. Certainly, a 30-minute brisk walk is less stressful on the body than a 4-hour marathon. Experts recommend 30-90 minutes per exercise session to adequately stimulate adaptation. In the beginning phases of developing a plan, you should aim for the lower range of the recommendations with the intent to gradually increase the duration of your sessions as your fitness progresses.

Although independent, frequency and time are often combined into the blanket term, volume. The idea is that volume more accurately reflects the amount of stress experienced. For example, when attempting to create a walking and jogging plan, you may organize 2 weeks like this:

- Week 1-three days a week at 30 minutes per session

- Week 2-four days a week at 45 minutes per session

At first glance, this might appear to be a good progression of frequency and time. However, when calculated in terms of volume, you see the aggressive nature of the progression. In week 1, three days at 30 minutes per session equals 90 minutes of total exercise. In week two, this amount was doubled with four days at 45 minutes equaling 180 minutes of total exercise. Doing too much, too soon, will almost certainly lead to burn out, severe fatigue, and injury.

Scientists, such as Hunter Allen, have developed many ways to monitor the proper amount of weekly volume by way of stress calculations. The concept takes in to account the time, the intensity of effort, and the distance and creates a training stress score (TSS). The TSS can then be used to estimate possibility of over stressing the body or fine tuning the amount of stress and rest so optimal fitness can be achieved.

## Type

Simply put, the type of exercise you perform should reflect your goals. In walking and jogging, the objective of the exercise is to stimulate the cardiorespiratory system. Other activities that accomplish the same objective include swimming, biking, dancing, cross country skiing, aerobic classes, and much more. So, these activities can be used to build lung capacity and improve cellular and heart function.

However, the more specific the exercise the better. While vigorous ball room dancing will certainly help develop the cardiorespiratory system, it will unlikely improve your 10k time. To improve your

performance in a 10k, you will need to spend most of your training time jogging, as you would do in the actual 10k. In other words, train the way you want to adapt. This concept, called the **principle of specificity**, should be taken in to consideration when creating a training plan.

In this discussion of type and the principle of specificity, a few additional items should be considered. Stress, as it relates to exercise, is very specific. There are multiple types of stress. The three main stressors are: metabolic stress, force stress, and environmental stress. Keep in mind, the body will adapt based on the type of stress being placed on it.

Metabolic stress results from exercise sessions when the energy systems of the body are taxed. For example, sprinting short distances requires near maximum intensity and requires energy (ATP) to be produced primarily through anaerobic pathways (pathways not requiring oxygen to produce ATP). Anaerobic energy production can only be supported for a very limited time (10 seconds to 2 minutes). However, distance running at steady paces require aerobic energy production, which can last for hours. As a result, the training strategy for the distance runner must be different than the training plan of a sprinter so the energy systems will adequately adapt.

Likewise, force stress accounts for the amount of force required during an activity. In weight lifting, significant force production is required to lift heavy loads. The type of muscles being developed, fast-twitch muscle fibers, must be recruited to support the activity. In walking and jogging, the forces being absorbed come from the body weight combined with forward momentum. Slow twitch fibers which are unable to generate as much force as the

fast twitch fibers, are the type of muscle fibers primarily recruited in this activity. Because the force requirements differ, the training strategies must also vary to develop the right kind of musculature.

Environmental stress, such as exercising in the heat, places a tremendous amount of stress on the thermoregulatory to the heat, sweating increases as does plasma volume, making it much easier to keep the body at normal temperatures during exercise. The only way to adapt is through heat exposure which can take days to weeks to properly adapt.

In summary, being specific in your training, or training the way you want to adapt, is paramount. So, when you create your training plan, base your training on your goals.

## Intensity

Intensity, the degree or difficulty at which the exercise is carried out, is the most important variable of FITT. More than any of the others, intensity drives adaptation. Because of its importance, it's imperative to quantify your intensity as opposed to estimating it as hard, easy, etc. Not only will this help you understand your effort level during the exercise session, but it will also help you design your session to accommodate your goals.

How then can intensity be measured? Heart rate is one of the best ways to measure your effort level. As you've undoubtedly noticed, when you begin walking and jogging heart rate increases. Based on the function of the heart, this shouldn't be a surprise. The heart rate directly correlates with the amount of oxygen being taken in by the lungs. As activity increases in intensity,

oxygen demands increase and so does heart rate. See figure 3.3.

Because of this relationship, heart rate can be used to help in the design of your walking and jogging program. This is accomplished by creating heart rate zones. Heart rate zones represent an intensity range, a low end heart rate and a high end, in which you could carry out your walking or jogging session.

The first step in determining your **target heart rate (THR)**, is to determine your **maximum heart rate (MHR)**, both measured in beats per minute (bpm). Generally, MHR is estimated to be your age subtracted from 220 beats per minute. In other words, your heart rate should theoretically stop increasing once it reaches the calculated maximum. While helpful, it's not uncommon to see variances in the laboratory tested maximum heart rate versus the calculated method (*see Max Heart Rate below*). Other studies have also determined that more accurate prediction equations exist that is consistently more accurate such as  $207 - .7 \times \text{age}$ .<sup>3</sup> However, for the sake of what's most commonly used, we will use 220-age.

The next step in calculating THR is to calculate a percentage of your max. This is done using two different methods. Keep in mind, finding the THR is the objective in both methods even though slightly different numbers are used.

The first method, called Max Heart Rate Method, is more commonly used.

### Max Heart Rate Method

1. Calculate MHR;  $\text{MHR} = 220 - \text{age}$ .
2. Calculate high and low THR by plugging in a percentage range. In this example, 60 and 80% are being used.

$$\text{MHR} \times .60 = \text{THR}_{\text{Low}}$$

$$\text{MHR} \times .80 = \text{THR}_{\text{High}}$$

3. The resulting low and high THR numbers represent the range, or target intensity.

The target intensity signifies an optimal training zone for that particular walking or jogging session. By keeping the heart rate within that range, you will drive adaptation specific to that intensity. By using real, but random numbers and plugging them into the above equation this becomes apparent.

Female, age 20

1.  $\text{MHR} = 220 - 20$   
 $\text{MHR} = 200 \text{ bpm}$
2.  $\text{THR}_{\text{low}} = 200 \times .60$   
 $\text{THR}_{\text{low}} = 120 \text{ bpm}$   
  
 $\text{THR}_{\text{high}} = 200 \times .80$   
 $\text{THR}_{\text{high}} = 160 \text{ bpm}$
3.  $\text{THR} = 120 - 160 \text{ bpm}$

As you can see, to achieve her self-established goals, the female in the example above will need to stay within the range of 120 and 160 bpm. If her efforts are intense enough that she begins to exceed 160 bpm during her session, or easy enough that her heart rate falls below 120 bpm, she would need to change her intensity mid-session to get the optimal results.

#### The Karvonen Formula or Heart Rate Reserve Method

1. Calculate MHR;  $\text{MHR} = 220 - \text{age}$ .
2. Determine your **resting heart rate (RHR)**.
3. Find the **heart rate reserve (HRR)**;  
 $\text{HRR} = \text{MHR} - \text{RHR}$
4. Calculate high and low THR by plugging in a percentage range and then adding in the RHR. In this

example, 60 and 80% are being used.

$$\text{THR}_{\text{low}} = \text{HRR} \times .60 + \text{RHR}$$

$$\text{THR}_{\text{high}} = \text{HRR} \times .80 + \text{RHR}$$

5. The resulting low and high THR numbers represent the range, or target intensity.

As you can see, the Karvonen formula requires a few more steps, specifically, the incorporation of the resting heart rate. Using the same female in the previous example along with a randomly selected RHR, the THR looks like this:

1.  $\text{MHR} = 220 - 20$   
 $\text{MHR} = 200$
2.  $\text{RHR} = 72 \text{ bpm}$  (randomly selected)
3.  $\text{HRR} = \text{MHR} - \text{RHR}$   
 $\text{HRR} = 200 - 72$   
 $\text{HRR} = 128$
4.  $\text{THR}_{\text{low}} = \text{HRR} \times .60 + \text{RHR}$   
 $\text{THR}_{\text{low}} = 128 \times .60 + 72$   
 $\text{THR}_{\text{low}} = 149 \text{ bpm}$   
  
 $\text{THR}_{\text{high}} = \text{HRR} \times .80 + \text{RHR}$   
 $\text{THR}_{\text{high}} = 128 \times .80 + 72$   
 $\text{THR}_{\text{high}} = 174 \text{ bpm}$
5.  $\text{THR} = 149 - 174 \text{ bpm}$

At first glance, you will immediately see that the low and high end of the Karvonen formula is much higher than the Max Heart Rate method, even though the exact same percentages have been used. Certainly, by using the Karvonen Formula you would find yourself at a much higher intensity, especially at the low end of the range (120 vs. 149 bpm). How can this be? Aren't these formulas supposed to have the same objective?

While it is true that both equations are used to estimate a target heart rate range, only the Karvonen Formula takes

into account the RHR, the lowest possible heart rate that can be measured for that individual. The Max Heart Rate method assumes the lowest heart rate possible is "0," a number we would like to stay away from if at all possible! Because of the difference between 0 and the maximum heart rate, the calculated percentages result in a much lower number. In terms of accuracy, the Karvonen method should be used whenever possible. It simply is a better representation of true target ranges.

The optimum ranges to achieve the best results range from >40% to <90% of HRR. Once again, the target HR range selected should be established based on individual goals. For example, walking at a low percentage of HRR results in a greater percentage of calories being burned from fat whereas more intense exercise will result in a greater percentage of calories being burned from carbohydrate. This would be helpful if weight loss were the desired goal. A more in depth look at this phenomenon will be discussed in a later chapter.

### **Measuring Heart Rate**

While exercising, heart rate can be tricky to measure. At rest, the index and middle finger on your wrist or neck can easily be used for an accurate reading. However, the bouncing from ground impact and the dexterity to hold fingers in place required while exercising make it very challenging to avoid over-counting beats, keep track of counting and time, and convert that into target heart rate. Most people have to stop to accomplish this seemingly simple task. To determine if you were in the proper zone, you would have to stop multiple times throughout the session. Of course, each

time you stopped, your heart rate would slow making the measurement inaccurate.

Technology over the last 25 years has developed in a way that products can now track heart rate and zones, keep track of the duration of the session, track your pace and distance, determine your stride rate and stride length, and even alert you if you go outside your preset parameters. For some devices, this data is recorded and available for download via software to analyze and scrutinize.

For most of these products, simply called heart rate monitors, the baseline purchase models include a chest strap that serves as a heart rate detection device and wrist watch that serves as a receiver and data collector. While exercising, your heart rate is detected by the chest strap sensors and displayed on the watch monitor. More sophisticated models may display additional information such as current heart rate zone, pace and distance.

Although generally more expensive, these types of devices prevent you from needing to stop to take your pulse and are able to average your heart rate during the session. As technology has advanced, you may even be able to pair up your device to an app used by your smartphone where you can view a live feed of your distance and heart rate on your phone. In other words, your smartphone becomes the receiver so no wrist watch is needed.

Less expensive models may help you determine heart rate but do so by placing your finger on a button and holding it in place. This method is generally less accurate, requires you to stop your exercise, and does not keep track of an average over the session. Some phone apps use the same concept to give you momentary readings of your heart rather than continuous measurements. One

exception to this can be found in the Garmin fitness watches, FitBit devices, and smart watches which keep continuous measurements without a chest strap by using an infrared sensor.

### Other Ways to Determine Intensity

Since not everyone owns a heart rate monitor, other methods of determining exercise intensity have been developed. One particular method, called the **rating of perceived exertion (RPE)**, uses subjective measurement to determine intensity. The

method is as simple as asking the question: overall, how hard do you feel like you're working? The answer is given based on a scale of 6 to 20 with 6 being almost no effort and 20 being maximum effort. Studies have indicated that when subjects are asked to exercise at a moderate or heavy intensity level, subjects can accurately do so, even without seeing their heart rate. As a result, using the RPE scale can be an effective way of managing intensity.

The original RPE scale or **Borg Scale**, designed by Dr. Gunnar Borg, was

Intensity Scales					
General	Talk Test	Modified Borg	Borg RPE	% HRR	%HR Max
Light	Easy Conversation	0	6	30	57
		1	7		
		2	8	35	60
		3	9		
		4	10	39	63
Moderate	Brief Sentences	5	11		
			12	40	64
		6	13		
Vigorous	A few words		14	59	75
		7	15	60	76
		8	16		
Anaerobic	Unable to speak/one word phrases		17	89	95
		9	18	90	96
			19		
		10	20	100	100

Data are from: American College of Sports Medicine, ACSM's Guidelines for Exercise Testing and Prescription, 9<sup>th</sup> Edition

developed to mimic generalized heart rate patterns. The starting and ending point of the scale are less intuitive than a typical scale of 1-10. By design, the 6 represents a resting heart rate of 60 bpm and the 20 an exercise heart rate of 200 bpm, a beat count someone might experience at maximum effort. Over time, a modified Borg Scale was developed using a simple 1-10 scale with 1 being resting effort and 10 being maximum effort. Even though more intuitive, the traditional scale is still used more frequently.

Walking and jogging not only benefits physical health, but many enjoy the social benefits by exercising with friends. When walking or jogging with friends, intensity can easily be measured by monitoring your ability to carry on a conversation. With the **Talk Test**, if you are only able to say short phrases or give one word responses when attempting to converse during an exercise session, this would suggest you're working at a high enough intensity in which your breathing rate makes conversation difficult. Certainly, if you can speak in full sentences without getting winded, the intensity would be very light. So, just like RPE, the Talk Test is yet another way to subjectively measure your intensity which can then be correlated with heart rates (see figure 3.4).

### Periodization

For hundreds of years, athletes have wondered how to balance their exercise efforts with performance improvements and adequate rest. Over this time frame, exercise scientists and athletes alike have determined that by dividing the training phases into blocks, or periods, optimal fitness can be achieved without

overstressing the athlete. This training principle, called **periodization**, is especially important to serious athletes but can be applied to most walking and jogging plans as well.

Keep in mind, the overlying purpose of developing a walking and jogging program stems from creating a simple way to live an active lifestyle. Up to this point in the discussion, the principle of stressing the body to adapt has been emphasized to the point it could be misunderstood as a non-stop thing. The principle of periodization, however, suggests that training plans incorporate phases of stress followed by phases of rest. Without rest, the body becomes overstressed.

Training phases can be organized on daily, weekly, monthly, and even multi-annual cycles (called micro-, meso-, macrocycles, respectively). An example of this might be:

Week	Frequency	Intensity	Time	Type
1	3 days	40% HRR	25 min	walk
2	4 days	40% HRR	30 min	walk
3	4 days	50% HRR	35 min	walk
4	2 days	30% HRR	30 min	other

As you can see, the volume and intensity changes from week 1 to week 3. But, in week 4, the volume and intensity drops significantly to accommodate a designated rest week. If the chart were continued, weeks 5-7 would be "stress" weeks and week 8 would be another rest week. This pattern could be followed for several months.

Without periodization, the stress from exercise would continue indefinitely eventually leading to fatigue, possible injury, and even a condition known as **overtraining syndrome**. Overtraining syndrome is not well understood but results



from psychological and physiological factors which cause a decline in performance and cannot be fixed by a few days' rest. Instead, weeks, months and even years are sometimes required to overcome the symptoms of overtraining syndrome. Symptoms included are:

- body weight loss
- loss of motivation
- inability to concentrate or stay focused
- feelings of depression
- lack of enjoyment in things that normally are enjoyable
- sleep disturbances
- change in appetite

### Reversibility

Chronic Adaptations are not permanent. As the saying goes, "use it, or lose it." The **principle of reversibility** suggests that activity must continue at the same level to keep the same level of adaptation. As activity declines, called **detraining**, adaptations will recede.

In cardiorespiratory endurance, key areas such as  $VO_{2max}$ , stroke volume, and cardiac output all declined with detraining while submaximal heart rate increases. In one study, trained subjects were given bed rest for 20 days. At the end of the bed rest phase,  $VO_{2max}$  had fallen by 27% and stroke volume and cardiac output had fallen by 25%. For the most well trained subjects in the study, it took them nearly 40 days after bed rest to get back into pre-rest condition. In a study of collegiate swimmers, lactic acid in blood after a 2-minute swim more than doubled after 4 weeks of detraining, showing the ability to buffer lactic acid was dramatically affected.<sup>5</sup>

Not only is endurance training affected, but muscular strength, muscular endurance and flexibility all show similar results.

### Individual Differences

While the principles of adaptation to stress can be applied to everyone, not everyone responds to the stress in the same way. In the HERITAGE Family study, families of 5 (father, mother, and 3 children) participated in a training program for 20 weeks. They exercised 3 times per week, at 75% of their  $VO_{2max}$ , for up to 50 minutes by the end of week 14. By the end of the study, a wide variation in responses to the same exercise regimen were seen by individuals and families. Those who saw the most improvements, saw similar percent improvements across the family and vice versa. Along with other studies, this has led researchers to believe individual differences in exercise response are genetic. Some experts estimate genes to contribute as much as 47% to the outcome of training.

Besides genes, other things can affect the degree of adaptation such as the training status at the start of a program, age, and gender. As you might expect, those with less training background show rapid improvement whereas those who are well trained improve at a slower rate.

Regardless, it is important to understand as you establish your goals that you may not have the same response as your peers. Setting realistic goals and modifying them if necessary are important to avoid frustration and program cessation

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Exercise, Champaign, IL, Human Kinetics

2. American College of Sports Medicine, 5<sup>th</sup> Edition, ACSM's Resource Manual for Guidelines for Exercise Testing and Prescription, Philadelphia, PA, Lippincott Williams & Wilkins
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4. Gellish, RL, Goslin BR, Olson RE, McDonald A, Russi GD, Moudgil VK, May 2007, Longitudinal Modeling of the Relationship Between Age and Maximal Heart Rate, Medicine and Science in Sports and Exercise Vol. 39 (5), p. 822-829
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# Chapter 4

## *Technique: The Art of Jogging and Walking*

**W**alking and jogging is not completely a function of fitness. While significant, fitness reflects only one element of the sport. The objective of improved running and walking extends beyond fitness and in to injury prevention and conserving energy through efficiency. These “secondary” elements can be accomplished by developing proper technique and are the main focus of this chapter.

For some, technique can be a difficult concept to understand. After all, most humans begin walking within the first 1-2 years of life which almost certainly do not involve any type of advanced instruction on the technical aspects of gait patterns or energy conservation. Most parents will simply encourage an infant to simply “take a step.” In contrast, a running coach may instruct a teenager or collegiate athlete how to hold their arms or emphasize proper foot placement. Often, this “new” style requires significant changes from the infant and juvenile technique that happens so naturally.

So, the reader has to ask the question: If I learned to walk or run naturally, why should I learn a new method? Or, another way to put it: Wouldn't my walking/jogging pattern I learned naturally be the best suited for me? The answer to that question is a difficult one but in short, yes and no. It's

entirely possible a change wouldn't be needed for some. However, for those that do, it could help increase pace, conserve energy, and most importantly help prevent injury.

Injury prevention might be the best reason to change. It would be difficult to quantify how many injuries occur to walkers and joggers as a result of poor technique. However, a good argument could be made that 100% of injuries are related to poor form. Why? Unlike contact sports where injuries often result from sudden impact trauma such as American football, jogging or walking injuries generally occur as a cumulative effect of repetition (i.e. overuse injuries). Changes in running technique could be as simple as angling the toe inward slightly, a change of only a few centimeters. However, the accumulation of those centimeters over the course of a half marathon, for example, add up to a significant change.

To apply this concept to injury prevention, consider the load the feet/legs must carry to run a half marathon (13.1 miles). An average runner's feet will strike the ground about 85 times per minute (42-43 per foot) while bearing the load of 2-3 times the body weight with each step. If it takes this 150-pound runner 9 minutes to run a mile, that runner's feet will strike the ground 765 times per mile or roughly 10,000 times during the full race! At impact forces of 2 times the body weight, that's 3 million pounds of weight the feet/legs must absorb! By altering technique, even a small change, big results will occur. In other words, overuse injuries may be less about quantity of use and more an issue of using the joint/muscles improperly through technique flaws.

## Proper Technique

While walking varies less, it may be surprising to know there are multiple styles, or techniques for running. For example, the Chi Method and Pose Method are both popular running styles. Other methods include the Alexander Method, the Yessis “Explosive Running” technique, or more recent trends emphasizing barefoot running. It is not the intention of the author to detail each running style but rather outline some of the common, and important points of each.

As mentioned previously, the main objectives of monitoring and possibly changing your walking technique relates to injury prevention and improved efficiency. However, other positive side-effects such as increased comfort, better muscle conditioning and faster times may occur.

To begin examining your technique, it’s advisable to use a video recorder or photographs to see your current positioning and gait pattern. Do you really know what you look like when you walk or jog? While we may have a mental image of ourselves as Hasselhoff on the beach in a scene from Baywatch, we may actually look more like Napoleon Dynamite. Using these types of media should help you visualize and internalize your positioning. From there, you can begin to make changes where necessary.

In order to properly address technique, it is important to understand some of the terminology associated with a normal gait

pattern. Use the below image to assist in understanding the description.

- **Pull back**-This phase begins from the outward extension of the leg and when the leg starts moving backwards towards the body.
- **Ground Contact**-When the foot hits the ground.
- **Kick**-after ground contact, the leg continues its backwards movement.
- **Recovery**-after the kick, the leg initiates it’s movement to extension out in front of the body.

## Characteristics of Good Walking Technique

Specific photos of walking technique can be viewed here:

<http://racewalk.com/howTo/basicTechnique.php>

### Head and Body Position

Good posture is imperative to walking technique. You should walk like a “peacock.” Head up and eyes forward, chest out (like a peacock) by standing tall. An easy way to envision your posture is to stand with your heels, head, glutes and shoulders against the wall. By doing this, you will notice the chest opens up which promotes airflow and the lower back moves to a neutral position setting the hips up to carry the upper body. This alignment between the shoulders and hips should remain throughout the walking session although the body position may be slightly leaned forward. You should notice however, the lean doesn’t change straight, tall posture because you lean from the hips as opposed to bending at the lower spine.

## **Arm Position and Movement**

Keeping the shoulders and hands relaxed, the elbows should be bent at approximately 80-90 degrees while walking for fitness. The arm swinging motion is initiated at the shoulders and works like a pendulum swinging anywhere between the 3 and 9 o'clock position (relative to the upper arm, elbow-shoulder). As speed increases, the amount of arm swing will also increase.

In relation to the legs, the arms work in opposites. For example, during the recovery phase of the left leg, the right arm will also swing forward. As the arms swing forward and backward, they will ideally not cross the body too much. In other words, they should move as close to straight forward and backward as possible as opposed to side to side movements.

## **Foot Placement and Foot Strike**

During walking, the ground contact phase begins almost exactly when the recovery swing ends. There is very little pull back time. The ground contact phase should occur with the foot slightly out in front of the body, with the ankle flexed at about 45 degrees. The foot contacts the ground with the heel and then rolls forward to the toes as the body passes over foot. Once this occurs, push off with your toes and the kick phase begins.

Occasionally, you will want to look down at your feet to assure proper placement. Doing this too often or continuously should be avoided as it's counter-productive to good posture. When looking down at our feet, make sure your middle toe is pointed straight ahead, and your feet are not

moving too closely to the center line of your body. You want them to land in a way so that they aren't rolling from heel to toe over the side of the foot (outside of heel to little toe, called pronation) or just the opposite (over the inside of the heel to big toe-called supination). In other words, widen your stance so your feet are rolling over the full surface of the foot and finishing with the middle/big toe pushing off. This is easier visualized by thinking of a car tire. Proper alignment makes it so the flat area of the tire makes contact with the ground as opposed to the inner or outer sides of the tire, which would wear quickly and force you to replace. Likewise, you want your foot to roll over the "flat" area. This is achieved by widening your stance slightly.

## **Proper Jogging Technique**

### **Head and Body Position**

Much like the technique for walking, you should stand tall, straight and keep your head up and eyes forward. The primary difference here is there will be more upper body lean as speed increases. An easy way to visualize this can be done by standing up with good running posture and then gently leaning forward. As you lean forward, bend as little as possible at the hip area while bending at the ankles. You will begin to fall forward and will reflexively move one of your legs forward to catch yourself from falling all the way to the ground. To a certain degree, running is simply leaning forward and preventing yourself from hitting the ground. Keep in mind as you lean, you aren't dramatically changing the hip/torso angle, you're simply changing the angle of the shoulders hips relative to the ground by bending at the ankles.

## Arm Position and Movement

Arms should be bent at the elbow to 80-85 degrees. Shoulders and hands remain relaxed as the arms pendulum back and forth. As speed increases, the pendulum motion will lead the elbows closer to 3 and 9 o'clock positions. Arms should move in a straight line back and forth rather than inward and outward towards or away from the body.

## Foot Strike and Foot Placement

The key difference in running is the foot strike. Because of the speed of the leg movement and momentum of the leg during the recovery phase, there is a more pronounced pull back. In addition, the foot should land more underneath the body than the walking stride. By doing this, the ground contact will more likely occur with the foot landing on the flat surface or forefoot rather than the heel.

This aspect of running is imperative in preventing injury. When the foot lands out in front of the body, called over-striding, the impact forces significantly increase and place tremendous stress on the ankles, knees and hips. Over-striding is the equivalent of putting on the brakes with each step leading to inefficiency along with the extra wear and tear. Using another analogy, think of a skateboarder. To move forward and keep the momentum going, the skateboarder must contact the ground with the pushing foot landing underneath the body. Otherwise, if the foot lands behind the body, very little force is generated. If too far in front, the angle of the leg when the foot makes ground contact slows the forward momentum.

Likewise, the runner must keep the foot strike underneath the body and use the momentum of the pull back to maintain momentum.

Foot placement in jogging/running is exactly the same as in walking with the purpose being to make contact with the ground using the large surface of the foot rather than the outside or inside areas.

	Walking	Jogging
<b>Head/Body Position</b>	Looking straight ahead, tall stance, mostly upright	Looking straight ahead, tall stance, some lean
<b>Arm Position</b>	Elbows bent to about 90 degrees	Elbows bent to about 80 degrees
<b>Foot Placement</b>	In front, heel strike	Underneath, forefoot strike

## Indirect Influencers of Good Running Form

Several factors, beyond what was mentioned above, indirectly influence how running form is carried out. Some of these factors will be discussed in greater detail at a later point in the book. However, they're important enough to go ahead and mention here.

- Flexibility-muscle tension influences the length of muscles, their ability to move through a full range of motion, and general comfort during a running session. Improving flexibility will significantly improve chances at successfully modifying your form and reduce your risk of form related injuries. Stiffness changes range of motion making it more likely to begin

overcompensating (when one leg begins to do more work as a result of disuse of the other).

- Core strength-developing good posture comes from excellent core strength. Core strength relates to those muscles in the hip and abdominal region (front, back and side areas). As fatigue begins to set in, many runners and walkers begin to slouch which places more stress on the spinal column and legs, impedes breathing, and squashes efficiency. Development of a strong core results in a self-perpetuating cycle of good form which drives fitness and vice versa. More about strength training will be discussed later.
- Self-awareness-this applies not only to paying attention to your body in the context of fatigue and aches and pains, but also in the context of special awareness. Developing the ability to “feel” your body position, foot placement, and leg motion will greatly assist you in practicing good form on a consistent basis.

## Equipment

One of the major selling points for walking and jogging is the simple fact that very little equipment is required to participate in this lifetime sport. In its most basic form, you simply need comfortable clothing and shoes and a safe place to perform your exercise. In some locations, even shoes (and clothes) are a luxury! Beyond that, other items fall into the “unnecessary-but-could-help” category.

## Shoes

In an interesting and popular book amongst runners titled “Born to Run,” the author Christopher McDougall goes to the Copper Canyons in Northern Mexico to connect with a people that are believed by some to be the best runners on the planet. One of his most interesting findings were that the meager shoes they wear consist of a dense leather bottom with some Greek style leather laces to secure them to their feet. This indigenous people, the Tarahumara, don’t simply run a few hundred meters, or a few miles, but ultra-marathon-like distances in these shoes. One take home message for many readers (although not the purpose of the book) from McDougall’s book was an increase in interest for “barefoot” running began, a style that was already gaining some notice. Since then, the already-changing styling in shoes progressed rapidly from well cushioned to minimal shoe soles.<sup>1</sup>

This increase in interest for minimal shoes stems from several ideas related to barefoot running:

- Barefoot is the natural, most efficient, and intended method for humans to walk/jog.
- The additional cushioning and support of shoes hinders strength in the feet and actually promotes injury.

Although widely debated, there does seem to be some validity to these claims. For example, as mentioned in the technique section, a feel for foot placement will improve technique. By using shoes with minimal cushioning and support, the nerves of the foot engage more during the run and promote an improved feel for your foot when striking the ground. In addition, the support shoes offer may serve as a “crutch,” by making it so the muscles of the

foot don't have to work as hard (the shoe is doing it for them). The result is weakness in the foot and eventual injury. Once again, while many of these ideas seem plausible and may very well be true, each walker and jogger should examine their own needs when selecting footwear.

Here are specific items you should look for when purchasing footwear (in no particular order):

1. Cost-of all of your walking and jogging gear, your shoes are the most important. Do not skimp on this item, especially if you plan to increase mileage over time. There's no need to go and break-the-bank, but you generally get what you pay for when it comes to shoe purchases.
2. Heel-to-toe drop-all shoes are offset, or designed to have an offset height at the heel and forefoot. The greater the offset or difference, the more cushioning you'll find in the heel. The less the offset, the more "barefoot" the shoe will feel. When considering this element before purchasing, think about what your intended use of the shoe will be. A greater offset can be found more often in the walking shoe, which promotes heel strike. A smaller offset tends to promote forefoot and front-foot ground strike. Because of the differences in shoe offset, the smaller heel-to-toe drop will stretch the calves more with each foot strike resulting in fatigue and possibly soreness after the first use, especially if you're not used to the small offset. So, if you're used to larger heel-to-toe difference, a

gradual change over the course of 2-3 shoe life-spans is recommended to avoid injury.

3. Cushioning-cushioning in a shoe is most often associated with comfort. However, it should also be considered in the light of efficiency. Finding that balance, especially for shoe makers, can be tough to do. A well cushioned shoe will fit your specific needs. Walkers need more cushioning in the heel because of the heel foot strike pattern. Runners need more cushion in the forefoot area. However, too much cushioning can lead to inefficiency. A thick, soft shoe sole will absorb the downward forces from the foot strike. However, when the foot pushes off, forward propulsion will be lost in the "give" of the cushion resulting in more energy needed to move at a faster pace. Shoe makers are now trying to make good cushion with more "springy" materials to avoid this dilemma.
4. Durability/comfort-Look for a shoe that is durable and comfortable. Many durable materials are stiff and inflexible. While resistant to wear and tear, the lack of flexibility and weight aren't very comfortable. Shoes that are lightweight, breathable, flexible, made from materials like mesh and soft leathers make for good comfort and usually good durability.
5. Purpose (trail/track/road)-the days of the Taylor Berry Converse all-purpose shoes are long gone. Shoes have become remarkably specific to terrain and purpose. You will find shoes designed specifically for trails, pavement, and cross training shoes.



In addition, racing flats, long distance running, triathlon, and walking shoes are all designed specifically to meet the demands of the event. Determine your purpose of use and look for shoes that meet that need.

6. Support-with the increasing interest in barefoot, support has almost become a bad word! Support in shoes is based on the needs of the foot and incorporated into the design of the shoe. For example, if you land on the outside of your foot at ground strike, you may need a shoe designed for pronators. An over-pronation shoe will generally have a thicker arch and support plate in the shoe sole to keep the ankle from rolling inward and prevent the arch from collapsing too much on foot impact. Shoes for mild-pronators are often labeled “stability” shoes. Most people have this gait pattern. For those walkers/joggers with serious over-pronation challenges, they will find more success with shoes labeled “motion control” and/or “stability.” “Neutral” shoes work great for those non-pronators. Many shoe stores now offer a free gait analysis before purchasing their shoes to help you purchase the correct shoes. You can also easily determine your gait pattern by looking at the tread wear on the bottom of your shoe. Pronators generally have the most tread loss on the outside heel of the shoe and on the inner front (near the location of the big toe).

## Other Equipment

While shoes would be considered the most important piece of walking or jogging equipment, there are other items that may help you be comfortable and enjoy your exercise experience.

## Clothing

It goes without saying that comfortable clothing is necessary to enjoy your walking or jogging experience. Like shoes, endless styles exist which have been designed specifically for various environmental conditions and even some with claims to promote blood flow and recovery. Regardless, the key objectives are two fold: comfort and functionality.

Clothing options begin with the under-garments, specifically briefs and bras. Briefs should be breathable fabric and help manage too much rubbing which would cause chafing. Much of this goes to personal preference in regards to the level of support needed. Many shorts have briefs built into the shorts making it possible to avoid an additional article of clothing. In addition, many manufactures claim their under-garments, or built in briefs, have anti-microbial properties. The validity of these claims have yet to be determined but the concept is ideal to avoid bacterial contact and smelly underpants.

Females should consider sport specific bras using the same basic criteria as briefs: moisture wicking, breathable, and supportive. Special attention should be given to the location and feel of the straps

as they can rub under the arms, neck and back.

Shorts and shirts should be loose enough to allow for ease of movement but tight enough in the right areas to prevent chaffing. Areas of specific concern include the inner thighs, under the arms and sometimes the nipples. Socks should be moisture wicking fabric (cotton/polyester blends) and should fit snug to the foot so the shoe doesn't rub creating foot blisters.

Depending on when and where you run, your clothing should provide reasonable protection from the elements. In both hotter and colder climates, wear clothing that wicks moisture away from the skin. Hats can be used to protect your face from sun exposure and help keep sweat from dripping into your eyes. Sun sleeves reflect radiating heat away from the arms which may help to maintain a good body temperature.

## **Work Rate Monitors**

For decades, experts and amateurs have found ways to measure the amount of work they are doing when performing cardiorespiratory-type exercises. As mentioned in chapter 3, the amount of work that can be done while exercising ultimately determines the level of performance and fitness. These measurement tools have included cycling ergometers, heart rate monitors, step counters, pacing charts, and more recently through power meters. The objectives of measuring work rate are to measure calories burned, distance traveled, performance, and progression over time. With the advancement of technology in recent years, many of these once expensive

and impractical measurement devices can now be downloaded to the palm of your hand through smart phones.

## **Heart Rate Monitors**

One of the most common and most widely used tools is the heart rate monitor (HRM). Because the heart rate monitor has been covered extensively in chapter 3, details will be limited here. HRM's are what could be termed, "effort based" devices simply because your heart rate will reflect your effort level.

Of course, heart rate can change as fitness improves. For example, a beginning runner may run at a pace of 8 min/mi with an 80% effort level (reflected by heart rate) of 167 bpm. However, after months of training, this same athlete may actually do the same pace at 160 bpm. This would of course reflect an improvement in fitness and would change the effort level since the max heart rate would stay the same.

In summary, heart rate monitors create an excellent way to measure intensity, or work rate, during the exercise session and track progress over time.

## **Step Counters**

Step counters have been used for decades now and still come as a feature in many smart phone apps. Because they're inexpensive (often free) and easily accessible, they often are used for large group contests and other challenges. Their primary function, to count steps throughout the day or during exercise, can then be used to estimate a distance traveled. The American College of Sports Medicine estimates 2000 steps to be one mile for the average adult, making the

average stride length approximately 31 inches. Using the recommended daily step count of 10,000 steps and this would accumulate to about 5 miles per day.<sup>2</sup>

It's important to note that these are approximations. In many cases, a change in the direction of the accelerometer, inside the step counter, is what signals the step to be counted. So, simple movements that shake the accelerometer could be interpreted as steps. Also, stride length varies widely throughout the day as climbing stairs makes for short stride lengths and stepping over objects, such as a puddle of water, make for longer strides.

### Pacing Charts

Pacing charts are generally more performance oriented tools designed to improve fitness. The pace is the rate at which the walking and jogging is taking place and is generally expressed as minutes per mile. For example, if a one mile assessment is completed in 9 minutes and 36 seconds, the pace is 9:36 min/mi. Pace based training varies from effort based training because pace doesn't include heart rate as a marker.

To generate a pacing chart, it's important to establish a "personal best" pace on a given course such as a 1-mile assessment or 5k. Once the personal best pace is established, the time can then be used to calculate other training or race paces for various distances. For example, a jogger who measures a 9:36 min/mi could use this pace to calculate how fast they should try and jog at a 10k, half marathon, and marathon as well as use that pace to establish training paces for various kinds of training sessions. These training sessions could include 400

meter intervals which would be done at a faster pace than the 1 mile pace. Or, stamina type running session designed to simply build endurance rather than speed which would be done at a slower pace. A great place to see an example, and one of the more accurate pace calculators, can be seen at [www.mcmillanrunning.com](http://www.mcmillanrunning.com).

As noted, this type of tool is primarily used for those interested in improving performance rather than those interested in improving only health or weight loss. However, it is better in improving performance than by using the heart rate monitor to achieve the same objective.

A criticism of this tool stems from it's application to a single course. If the above mentioned jogger ran a personal best on a track, flat terrain, it would be unlikely to see that same pace on course with rolling hills. Therefore, a pacing chart would need to be created for each course with different terrain. Additionally, environmental conditions such as head-winds and sun may make it very difficult to hold a particular pace although effort could be quite high. As a result, this could lead to overtraining and frustration.

### Power Meters

Recent technology has taken a tool that was once primarily associated with the sport of cycling and made it available to runners. While the validity and usefulness of the product is still being evaluated, like a cycling power meter, it attempts to determine the amount of wattage (power), that is being used during a jogging session. As a result of having this information available, a much more precise means of gauging effort can be used. This would help a jogger improving

pacing, determine a more precise amount of calories burned, and predict the impact of the exercise session on the body for recovery purposes. As with the pacing charts, this tool is all about improving performance.

### Smartphone Apps

Smartphone apps can be very helpful in tracking many or all of the above information either as a stand alone tool or when paired with other devices. For example, many apps use the GPS tool in smartphones to track distance over the course of a day's activities which could be used to track distance as opposed to using a step counter. Or, a heart rate strap could be purchased and paired with a phone app using the Bluetooth in the smartphone. By doing this, a detailed history of activities can be kept, improvements tracked, and activities shared with others. A few smartphone apps are:

- MapMyRun
- Strava
- GarminConnect (needs to be paired with Garmin product)

### Hydration Systems

As mentioned in chapter 3, staying hydrated is key to preventing both heat related and cold related illnesses. However, many walkers and joggers find it difficult stay hydrated during their workouts without excessive stopping. The importance of this concept, and impracticality of frequent stops, has lead to the development of multiple hydration systems.

If and when you consider a means of staying hydrated, i.e. hydration system, you

need to make sure it will fulfill it's purpose: make fluids easily accessible to you with as little discomfort as possible. Ultimately, your choice will come down to personal preference but there are several options available.

- The hydration backpack uses a backpack with a bladder inserted into the satchel portion of the pack. A long straw-tube leading from the bladder is then used to access the water.
- Hydration belts use a belt around the waist with various compartments to hold small flasks for easy access to fluids.
- Hand held water bottle covers allow for a water bottle to be inserted in the casing carried in the hand by using a strap that goes around the palm of the hand.

### Summary

In summary, improving technique should be viewed as important, if not paramount, in preventing injury and improving performance. Likewise, equipment can do much of the same, help you from overtraining by monitoring your work rate and helping you improve your performance.

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# Chapter 5

## Nutrition and Energy Requirements

Regardless of the goals or tools used to monitor effort, both walkers and joggers must fuel their body to do the work needed to perform the exercises. As you might imagine, exercising on an “empty tank” would be very uncomfortable if not impossible. This chapter will cover the basics on nutrition, how much energy is required for walking and jogging, energy sources, and ways to apply these concepts.

### Nutritional Basics

While eating for energy is essential to our survival and good health, it’s not the only reason we eat. Eating also gives us access to other essential nutrients that help to promote cellular activity, repair damaged tissue, produce chemicals such as hormones and neurotransmitters, and countless other functions. Experts have identified 45 essential nutrients that we must get from food because we don’t produce them at all or quickly enough.

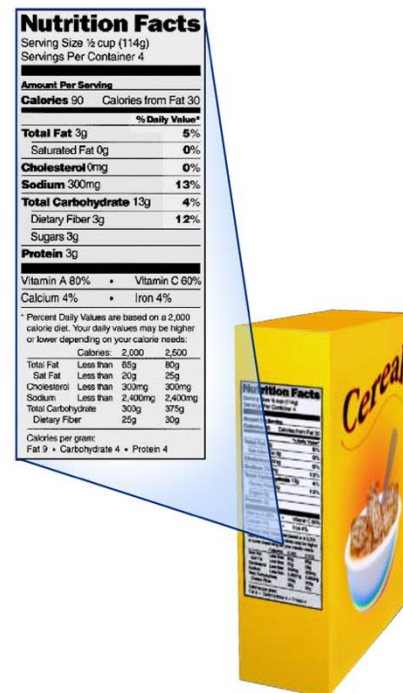
These 45 nutrients can be broken down into two major classifications: macronutrients and micronutrients. Within each of the two classifications, 3 subcategories can be formed.

- Macronutrients-nutrients we need in large amounts and that contain energy (calories).
  - Carbohydrate
  - Protein
  - Fats

- Micronutrients-nutrients we need in small amounts and do not contain energy (calories).
  - Vitamins
  - Minerals
  - Water

### Macronutrients

Macronutrients are needed in relatively large quantities for good health. Generally, these nutrients are measured in grams. Reading food labels on food packaging will help to understand the makeup of the food. As you can see in the food label below, macronutrients are organized in grams and account for the caloric make up of each serving.



## Food Label

By BruceBlaus (Own work) [CC BY-SA 4.0  
(<http://creativecommons.org/licenses/by-sa/4.0/>)], via Wikimedia Commons  
[https://commons.wikimedia.org/wiki/File%3AFood\\_Label.png](https://commons.wikimedia.org/wiki/File%3AFood_Label.png)

**Proteins** are the building blocks and major structural components of nearly all cells and function to aid in bone repair, muscle, skin and blood cells. A protein is made up of a series of building blocks called **amino acids**. There are 20 amino acids necessary for optimal functioning for humans but the body only manufactures 11 of those. The remaining 9 amino acids are termed essential amino acids and must be obtained from our foods. The foods that contain all of the essential amino acids we need come from complete protein sources, primarily animal sources such as red meat, poultry, fish, eggs, and milk products. Incomplete sources come from plant sources such as nuts, beans, seeds and leafy green vegetables.

**Fats**, or lipids, are also important for our diet. Fats are important for flavor in foods, energy, thermoregulation, cushioning of organs, and cellular function. There are 3 different types of fats, all are named based on their molecular structure (specifically, the number of carbon bonds taken by hydrogen).

Saturated fats have all bonds filled by hydrogen and can be found in animal products such as red meats and dairy products. Saturated fats should be consumed in limited amounts.

Unsaturated fats have bonds available and may be monounsaturated (single bond available) or polyunsaturated (multiple bonds available). These fats usually consist of oils such as olive or vegetable oil and can be found in fish oils (omega 3 and omega 6). Unsaturated fats are the healthiest of the fats.

Food manufacturers often alter the properties of unsaturated fats to create a hybrid fat known as trans fats. These fats may be solid at room temperature but liquid when used to cook. Shortenings, margarines, and other hybrid fats should be avoided because of the negative impact they can have on health.

In order to deliver fats to the body's cells, fats are packaged together with cholesterol in units called lipoproteins. These lipoproteins are collectively called cholesterol (Low-density lipoproteins (LDL) and high-density lipoproteins (HDL)). Cholesterol is important for cellular health but when LDL's are in excess, they can invade damaged cells and cause arteries to harden and become blocked. HDL's, on the other hand, help remove excess cholesterol. While aerobic exercise will help manage cholesterol levels by increasing HDL's, bad food choices can negatively impact cardiovascular functioning by increasing LDL's. Over consumption of saturated fats and trans fats leads to excess LDL production so these foods should be consumed in limited quantities.

**Carbohydrate** are chains of sugar molecules and their primary function is energy. There are two types of carbohydrate, simple and complex. Like proteins, they're labeled based on their molecular structure. Simple carbohydrates have 1-2 sugar chains and can be found in fruits, sugar cane, and some vegetables. Complex carbohydrates have 3 or more sugar chains and can be found in grains, rice, potatoes and vegetables. While carbohydrate consumption often gets a bad name, carbohydrates are important for energy and should not be overlooked. Complex carbohydrates should be the staple of carbohydrate consumption as they

not only contain energy, but also carry multiple other nutrients important for energy production. They also contain fiber, a non-digestible carbohydrate that improves benefits the digestive tract as well as several other benefits.

### **Micronutrients**

Micronutrients are needed in relatively small quantities and are generally stated in milligrams. However, don't mistake their importance because of the small amount needed for good health. As you see in the food label above, they are measured in milligrams (for example, sodium, 300 mg).

### **Vitamins**

Vitamins can be broken down into two primary types, each having similar functions which promote all the chemical reactions needed for cellular health. These two types are: water-soluble and fat-soluble vitamins.

Water-soluble vitamins are easily absorbed with water and consist of vitamins C and the B-vitamins. These vitamins assist in immune system health and the breakdown of fats and carbohydrates so they can be processed by the cells for energy production.

Fat-soluble vitamins require fat to be available to be absorbed and consist of vitamins A, D, E and K. These vitamins assist in healthy blood cells, bone and eye health, digestive health and growth and repair of tissues.

### **Minerals**

Minerals have very similar functions as vitamins in that they assist in regulating

chemical reactions in the cells and body. They can be broken down into two categories: major and trace minerals.

Major minerals consist of minerals such as calcium, sodium, potassium, and chloride. Each of these minerals plays specific roles in nervous system function, bone health, muscular contraction, cardiovascular functioning and fluid balance.

Trace minerals consist of several minerals such as selenium, iron, chromium, magnesium, zinc, iodine, phosphorous, copper and fluoride. Those of special interest include iron which is important for blood and fluoride which is important for teeth.

### **Water**

Unlike the other micronutrients, water is needed in large amounts. However, water doesn't have any calories associated with it making it a perfect fit for the micronutrient category. About 60% of the body is made up of water making it an absolutely critical nutrient. While you could live for weeks on energy storage you could only live for days without adequate water. Water is the solution where all the chemical reactions must occur. Changes in fluid volumes can result in an inability to properly transport substances from one area of the body to another, improper pH balance, and improper balance of salt solutions within the cells.

The average adult needs approximately 48-64 ounces of water every day to maintain this delicate balance. In addition to getting water from the tap or bottled sources, water can be obtained from foods we eat,

especially water rich foods like fruits and vegetables.

## Eating for Health and Fitness

### Eating Energy Dense Foods

As you may have noticed, much of the food we should be eating evolves around fruits, vegetables, and whole grains. One major reason for this comes from the fact that these foods can not only provide energy, but they can also deliver the nutrients needed. This concept is termed eating nutrient dense foods.

As an example, consider eating a snack such as a candy bar of 250 calories. While the candy bar would have plenty of caloric value, very few additional nutrients tag along for the ride. By contrast, eating a Greek yogurt and some strawberries would provide plenty of protein and be packed with vitamin B and vitamin C, all around the same 250 calorie range. Not only that, but you would likely be more filling than the candy bar meaning you would eat less over the course of the day.

### Energy Balance, Eating the Right Amounts

Just as important as knowing your target heart rate is knowing how many calories you need on a daily basis. This will provide the foundation of planning your fuel consumption for the day. Calories, give us a way to measure how much fuel we are putting into our bodies. As previously noted, the basic unit of energy the body must produce and use is ATP. In order to produce ATP, we must eat! The primary substances in our foods that are converted

to ATP are fats and carbohydrates. Four calories can be found in 1 gram of carbohydrate. One gram of carbohydrate can then be broken down into individual glucose molecules and broken down and processed in the body's cells to produce ATP. Similarly, fats are broken down by the body and processed by cells to generate ATP. However, 9 calories can be found in one gram of fat. While protein does contain 4 calories per gram, protein is used sparingly if at all for energy during physical activity.

The balance of food, or energy balance equation, suggests that in order to maintain weight the same amount of energy consumed must be burned. In other words, if you eat 2500 calories you must burn 2500 calories to maintain your current weight. In simpler terms, energy in must equal energy out. By consuming more calories than needed, weight gain would result. By consuming fewer calories than needed, weight loss would be the result. Regardless of the goal, the foundation of this equation is understanding how many calories are needed on a daily basis.

To find your total daily energy expenditure, you need to calculate the components of your energy expenditure. The 3 ways you burn calories are: Basal metabolic rate (BMR), food digestion, and physical activity.

BMR accounts for the greatest amount of energy out so it's a great place to begin the calculations. The most widely used equation is known as the Mifflin-St. Jeor equation, named for its founders. Here is the equation:

- **For men:**  $BMR = 10 \times \text{weight (kg)} + 6.25 \times \text{height (cm)} - 5 \times \text{age (years)} + 5$



- **For women:**  $BMR = 10 \times \text{weight (kg)} + 6.25 \times \text{height (cm)} - 5 \times \text{age (years)} - 161$

Once the BMR is calculated, the addition of the food digestion and physical activity can be added in. To do this, simply multiply the BMR by 1.2-1.9 based on your estimated daily activity levels. For mostly sedentary behavior, use 1.2 and for very active behavior use 1.9.

Generally, these numbers are an estimate of what you do on a daily basis and may exclude specific exercise sessions. Of course this means the additional exercise sessions would need to be included in the final calculations. For example, the BMR and activities may account for daily functions such as work, housework, childcare, etc. but will not account for a 30-minute evening jog. So, the evening jog would be totaled and added to the BMR and activities.

### Macronutrient Distribution

Another way of examining and analyzing eating patterns is to determine what's best in regards to adequate macronutrient distribution. Remember, macronutrients consist of proteins, fats and carbs. The recommendations for how much to consume of each category are wide open giving freedom to adapt to your personal circumstance and needs.

The distribution ranges are expressed as percentages of the total diet. The recommended amount of protein, fat and carbohydrate for an adult range from 10-30%, 20-35%, and 45-65%, respectively. For example, food labels are based on the daily values assuming 2000 calories to be the magic number for everyone (not the

case). That same food label may indicate the amount of protein consumed, for that particular food, accounts for 10% of the total recommended amount out of 2000 calories. In other words, the protein content of that food product equals 200 calories which is being suggested as 10 percent of what is recommended.

However, the recommendations were created as ranges, not set amounts. An elite endurance athlete may need close to 65% of his/her total daily calories to come from carbohydrate to support the energy requirements of the daily training and frequent competitions. While someone needing to lose weight may elect to stick closer to the 45% range of carbohydrate and 30% range of protein. Unfortunately, no magic number exists for everyone so finding the right distribution range can be a process.

### Nutritional Tracking

Keeping track of the number of calories, the quality of foods being eaten, and the distribution of calories can be an arduous task. Fortunately, technology has enabled this task to be done quite easily. Multiple food logs exist online and as applications on smart phones. Both Fitday.com and myplate.gov fit into this category.

Regardless, the good ones have foods loaded into a database allowing users to look up specific foods eaten and select them as part of their food consumption for the day. Once the food is selected and serving size indicated, the total calories from the food are generated along with a distribution and micronutrient profile. Additionally, by entering a user profile, BMR and activity rates can be calculated in terms

of calories and then compared with total food consumption. As a result, an easy visual of energy in versus energy out can be done.

Some of these applications also offer suggestions for improving nutrition based on life stage, eating trends and activity habits. They also allow you to set goals and provide information and tracking on how many calories would be needed to be restricted in order to reach those goals.

### Application to Walking and Jogging

To understand the energy requirements of walkers and joggers, it is important to understand two terms that are often used in correlation with how much energy is being used: economy and efficiency.

**Efficiency**, in the context of human movement, is the amount of energy being converted from the foods consumed (calories) to work stated as a ratio or percentage. An automobile may take 17 gallons of gasoline, but only a certain percentage of that gasoline can be utilized to produce forward motion while the remaining amount is given off as heat and waste product. Likewise, an athlete may consume 2500 calories throughout the day but only about 23-28% of that “fuel” can be converted into actual work. The remaining amount is given off as heat and waste product. In other words, human movement is not very efficient.

**Economy** is a term very similar to efficiency and often used interchangeably. However, they are very different terms. While efficiency describes the percentage of energy converted into work, economy describes how much energy is consumed

over time or distance. For example, a sedan automobile may be able to go 35 miles in using only 1 gallon of gas, or a large truck may only be able to go 15 miles in using one gallon of gas. In walking or jogging, you may use 100 calories to travel one mile.

What do these terms have to do with walking and jogging? The amount of energy needed is directly affected by efficiency and economy. So, this can be tied back to the eating habits of the individual. A walker who walks with poor technique will be very inefficient and economy will be low, requiring more calories for the exercise session. From a performance perspective, this wouldn't be a good thing.

From a weight loss perspective, burning more calories, i.e. having a low economy, would be precisely what is needed. So, the question in this context would be: how do I burn more calories?

*Chart 4.1* helps explain how walking and running speeds correlate with energy expenditure.

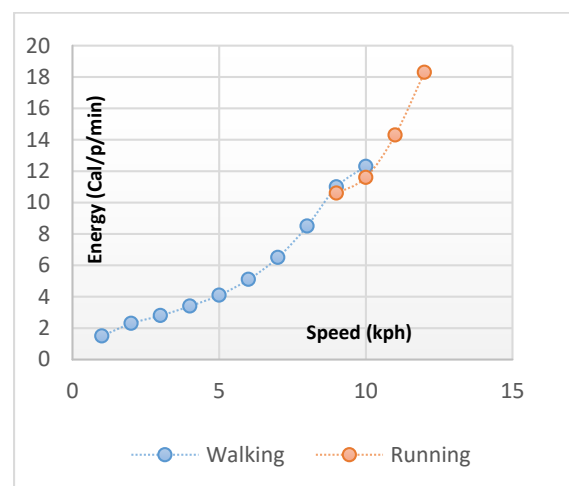


Chart 4.1

From *chart 4.1*, walking at 4 kph (about 2.5 mph) leads to burning about 3.3 calories

per minute or 198 calories over the course of 4 kilometers (2.5 mi). However, as walking speeds increase, the economy changes. At 10 kph (about 6.2 mph), calories are being burned at over 11 calories per minute! Compare that to the 4 kph pace who burns 198 calories, and the faster walker would burn 271.

This phenomenon is related to the mechanics of walking. Consider what was previously discussed in chapter 4 with walking technique. As the speed of walking increases, stride length will increase and so will the arm movements. This leads to inefficient walking in the context of energy expenditure, but progress in the context of speed and weight management.

An additional note from *chart 4.1* comes from the overlapping energy cost in running and walking. You have undoubtedly walked fast enough at some point that it's no longer comfortable to walk so you begin a light jog. Based on energy cost, this is a natural response since jogging at 9 and 10 kph is more economical than walking at those same speeds.

While this might seem unimportant, it once again goes back to the basic idea of energy expenditure and consumption. If the goal of a walker is weight loss, understanding this concept of economy will assist in food selection and consumption amounts based on the activity's energy cost. Or, for a jogger, this same understanding may present the right tools to fuel their body through a marathon race.

### **Walking or Jogging?**

The question of whether to walk or to jog is a hotly debated topic. Joggers may criticize

the effectiveness of walking for fitness and weight management while walkers may argue that walking poses less risk of injury and burns as many calories as jogging the same distance. For purposes of this chapter, that question can be examined through the eyes of energy expenditure.

*Chart 4.1* illustrates a general idea of the amount of calories being burned for both walking and jogging. As you can see, jogging results in a greater absolute amount of calories burned (with the exception of faster walking speeds). However, there is more to be considered.

During exercise, fats and carbohydrates from foods consumed are broken down and utilized to help produce ATP. The intensity of exercise governs the ratio of fats to carbohydrates used for that session. For example, participating in a 10k (6.2 miles) at a lower intensity walking will lead to more fat being used for energy than would high intensity running. In other words, walking at 20% of your maximal capacity would result in close to 60% of your energy coming from fat, 40% coming from carbohydrate. If intensity increased to 70% of maximal capacity, only about 30% of energy would come from fat.

In terms of absolute calories, let's compare a walker to a jogger of the same size who participates in the same 10k. The walker that walks at 7 kph (about 4.5 mph), corresponding to 50% of the max capacity would be able to complete the 10k in 1 hour and 22 min. Based on *chart 4.1*, this would equate to 6.5 cal/min for 82 minutes, or 533 calories. Of those 533 calories, 40% of them would be derived from fat (so, 213 calories from fat, 320 from carbohydrate).

A jogger who jogs at 12 kmh (about 7.5 mph), corresponding to 70% of max capacity would be able to complete the 10k in about 50 minutes. Based on the chart 4.1, this would equate to 14.3 calories per min, or 715 calories. Of those 715 calories, 25% of them would be derived from fat (so, 179 calories from fat, 536 from carbohydrate).

In short, jogging would have the greater energy cost burning almost as many calories from fat as total calories by the walker and significantly more from carbohydrate.

### **Other Ways to Burn More Calories**

It may appear contradicting at this point to say “be inefficient” if you want to burn more calories but that rings true in this context. As has been illustrated, walking at faster speeds results disproportionately in more arm movement, longer strides and will burn more calories as a result of this inefficient walking pattern.

One additional element that hasn’t been mentioned in the energy expenditure conversation is body weight. As you might imagine, a walker who weighs 115 lbs. will require fewer calories than a walker who weighs 180 lbs. This can easily be monitored by using a heart rate monitor. The 115 lb walker may be working at 50% of his/her max while the 180 lb walker may be working at 65% of his/hers on the same course and pace. There are two key take-away points to this concept that have been lightly touched on in chapter 4: exercise prescription in cases like this should be customized for each individual (by using effort based methods), and weight significantly influences caloric expenditure. This last point can be used for anyone. For example, if the 115 lb walker wanted to

burn more calories, weight could be added by using a weight vest, backpack, or other objects.

Another way to increase energy expenditure is to change the grade of terrain. Walking up hills requires more effort and consequently burns more calories than downhill or flat surfaces. So, if the goal is to burn more calories, hills are a great way to do that.

It should also be noted that inefficient is not the same as poor technique. Technique should always be monitored so that injury risk can be minimized. Adding weight and terrain changes can alter good form and result in injury.

### **Nutrient Timing**

In recent years, attention has not only looked at what is being consumed at meal time but also the timing of the meals. Weight lifters have long used protein before and after workouts to help produce more muscle and aid in recovery in between workouts. As a result, questions have come up about how soon should meals be eaten before a workout and when to eat after the workout. This question not only stems from a desire to improve performance but also to avoid gastrointestinal discomfort and speed up recovery.

Most experts suggest eating 2-3 hours before a workout allowing ample time for digestion so as to avoid stomach and/or gastrointestinal (GI) discomfort. Eating a meal with ample carbohydrate is suggested to provide adequate energy that can be used during the activity. If hungry before the workout, try and consume a small amount of carbohydrate to get through the

workout. Something like a granola bar, a few pretzels and peanut butter, or some fruit could be used. Keep in mind, walking and jogging consists of up and down and some side-to-side movements making it easy for foods to be sloshed around in the stomach. Foods that are greasy and fatty, like potato chips and fried foods are not recommended as they take longer to digest, sit heavy in the stomach, and can cause GI distress.

Each time you eat a meal, the carbohydrates you've consumed are broken down and, in part, stored in the muscles as glycogen. This glycogen is then readily available for use during the next activity. Once the workout is complete, muscles may be depleted of glucose/glycogen stores so consumption of carbohydrate within an hour after the workout is recommended. Because exercise can lead to muscle breakdown, protein post-workout can help speed up recovery by making needed amino acids available to muscle tissue in need of repair. A ratio of 4 grams of carbohydrate to 1 gram of protein will give optimal results. Foods like Greek yogurt, chocolate milk, and specially formulated protein shakes are excellent post-workout products.

The amount of post-workout calories should be determined by the length and intensity of the workout. Of course the energy balance concept applies. Shorter workouts of less than 30 minutes and/or low intensity workouts will require little to no post-workout food while activities beyond 30 minutes are more and/or very intense workouts likely justify post-workout calories.

### **Eating for Weight Loss**

Ultimately, weight loss can be achieved by eating fewer calories than calories burned. This negative energy balance must be accrued over long periods of time. In general, it is believed that 3500 calories equal 1 pound of fat. In the context of daily eating, a safe amount of calorie restriction would be 500 calories. By continuing that for 7 days, a negative energy balance of 3500 calories could be achieved and a pound of fat lost.

It is important to remember that energy out is not only achieved through calorie restriction. Energy out consists of BMR, food digestion, and physical activity. The healthiest way to lose weight comes from restricting calories and maintaining a consistent exercise program. For example, not drinking a soda, a daily habit for many, would mean 250 calories have been restricted each day. A daily ,2.5 mile, brisk, walk roughly burns 250 calories which goes on to the energy out side of the scale. Together, subtracting the 250 calories from the soda and adding the 250 calories from the walk would generate a negative energy balance of 500 calories. This is a simple lifestyle change for most which could yield large results!

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# Chapter 6

## *Injuries and Care*

**U**nfortunately for some walkers and joggers, beginning a new program or even maintaining a program doesn't always go as smoothly as planned. As mentioned previously, the physical challenges of beginning a new exercise program can place you at a greater risk of injury, illness or even death. Results from various studies suggest vigorous activity increases the risk of acute heart attacks and/or sudden cardiac death.<sup>1</sup>

In addition to the increased risk of cardiovascular events, muscle strains, joint sprains and pains, broken bones and soft tissue damage can occur as a result of walking and jogging. In a large study at the Cooper Clinic in Dallas, Texas, regular walkers and joggers were tracked for 8 years to determine how many of them required physician visits as a result of musculoskeletal injury. Of the nearly 3,000 participants, walkers were less likely to be injured compared with young and old male runners. In addition, the researchers found that running for greater than 30 min posed more risk than walking for a similar or greater time frame.<sup>2</sup> Regardless of the differences in risk, when considering walking for fitness or jogging, one should consider all of the costs and benefits.

### **Basic Treatment of Injuries**

Most injuries occurring with walkers and joggers would be classified as soft-tissue injuries. This simply implies that fractures

and other bone related problems occur less frequently. Of course, this is a good thing because many soft tissue injuries can be treated at home and don't require the time or expense of visiting a physician. However, it is imperative that as you begin a program you become familiar with your body's response to exercise so you're able to differentiate between minor tweaks and strains and significant injuries that would require medical attention. If in doubt, see a physician.

### **PRICE**

The acronym PRICE describes the proper approach to soft tissue treatment.

P-Prevention  
R-Rest  
I-Ice  
C-Compression  
E-Elevation

Because prevention is so important, a larger section of text has been devoted to prevention at a later point.

### **Rest**

Once injury has occurred, treatment should begin as soon as possible. The first step in soft-tissue treatment comes from resting the injured area. Resting, or discontinuing use of the injured area helps prevent additional damage and allow for the natural healing processes to occur. The amount of resting or time off depends on the severity of the injury. In some cases, time off may not be required. In other cases, not resting, or just dealing with the pain, may lead to additional damage to the injured area and overuse to areas of the body that now must

compensate for the damaged area's inability to function properly. Post injury, rest should last for 24-48 followed by modified activity when possible.

### **Ice**

Ice, or cryotherapy, serves two purposes. First, it helps reduce inflammation by reducing blood flow to the injured area. Second, it helps with pain. Ice should be administered as soon as possible and continue for 48 hours in the pattern of 15-20 minutes per hour or several times per day. Continuing use in this fashion beyond 48 hours may delay healing. However, a single treatment of ice may be needed after modified exercises have been performed.

### **Compression**

Edema, or swelling may result from injury leading to pain, stiffness, and low blood flow. In order to attempt to manage the swelling, compressing the area may be necessary. This can effectively be done with an elastic bandage (such as an Ace bandage). Caution should be taken to avoid wrapping any bandage too tightly which will stop or significantly reduce blood flow to extremities beyond the injured area. Symptoms of a bandage that is too tight include skin discoloration, loss of feeling, and/or a tingling sensation in the area below the wrapped area.

### **Elevation**

When muscles contract, the contraction actions also serve as a pump, pumping blood in the veins back towards the heart. While resting an injured area, muscular contractions will be at a minimum making it

easier for an accumulation of blood to occur, i.e. swelling. By elevating the injured area above the level of the heart, gravity helps push blood back to the heart and reduce swelling and removal of accumulating metabolites in the injured area.<sup>3</sup>

## **Additional Treatments**

There are many methods athletes treat injuries. It is not within the scope of this class to explore them all. In many cases, those that require advanced treatments are elite or competitive endurance athletes rather than walkers and joggers who are simply trying to improve fitness and maintain good health.

### **Anti-inflammatory Medications**

Injuries often result in inflammation which causes pain, interferes with blood flow and delays healing time. Medications that reduce inflammation, anti-inflammatory medications, can be used in conjunction with other treatments to alleviate pain and obviously, reduce inflammation.

Over-the-counter anti-inflammatory medications are used most commonly. This includes drugs such as ibuprofen, aspirin and naproxen which are also grouped into a category of drugs known as Non-steroidal Anti-inflammatory Drugs (NSAID's). These can be a very effective means of treating soft-tissue injuries when used properly (consult a pharmacist, physician, or the packaging for proper dosage amounts).

Steroidal medications differ from NSAID's in their chemistry and the way the body processes them. These medications are



administered under a physician's supervision as shots or in oral form. Shots, like cortisone shots, are injected into the local area of the injury and linger over a long period of time to alleviate pain and inflammation.

## **Surgery**

While every attempt should be made to avoid it, surgery may be the only way to deal with some injuries. Fortunately, surgery isn't a frequent treatment for walking and jogging related injuries. Most injuries can be treated at home, with physical therapy, and common sense. The key point is to not allow injuries to go untreated so that they get to the point where surgery might be needed.

## **P for Prevention**

The old adage, "An ounce of prevention is worth a pound of cure" holds true in walking and jogging. There is no better way to avoid treatment of injury than to prevent it from happening altogether. In a 2010 researchers published a meta-analysis of runners identifying multiple factors that could be implicated as possible causes of injury. Of those factors identified, only one strong correlation between injury prevention and weekly mileage was determined. Of the other factors cited such as strength, pre-exercise stretching, and shoes, the researchers found that more research was needed to connect these factors with injury occurrence.

However, in their findings of pre-routine stretching, it was noted that 95% of coaches still believed it helped prevent injuries and 73% believed there were no drawbacks.<sup>4</sup>

This raises the question of whether or not the science supports the anecdotal opinions of professional coaches. In other words, while significant scientific evidence may not exist supporting the claims of stretching or several other factors, there may still be a benefit to paying attention to areas like stretching which have long been believed to contribute to injury prevention. Of course, that goes for each factor.

Regardless, while not implicated specifically, walkers and joggers will almost certainly benefit from identifying these factors and taking action to minimize the associated risks.

## **Factors Related to Prevention of Injury**

Later in this chapter, the most common injuries associated with walking and jogging will be examined more closely. However, at this point the focus is turned to what is believed to generally be the most common causes of injury. It should be noted that identifying the causes also identifies the treatment strategy.

As these causes are outlined, it may be easier to understand by considering the muscles and bones in the legs as being a part of a chain, beginning in the feet and ending where the gluteal muscles end (buttocks) attach to the hips in the lower back. Each muscle, or chain link, serves a specific purpose to aid in the running or walking movement. This chain, is often referred to as the kinetic chain.

### *Muscle Weakness*

Muscle weakness has been identified as a problem for many runners with injuries in the hip, thigh and knees. Of course this

seems logical when you consider the movement pattern of walking and jogging. Once again, in thinking of the leg as a chain of connected muscles, beginning at the feet and ending in the lower back where the buttocks muscles attach to the hips, it's easy to visualize how one weak link would cause the other links to have to "pick up the slack." As a result, the additional load leads to overuse which leads to pain, inflammation and ultimately injury. Therefore, attempting to strengthen each "link" through strength training, an area of fitness often avoided by cardio-lovers, has long been recommended by coaches and other experts.

#### **Muscles to Be Strengthened:**

- Gluteus Maximus
- Gluteus Minimus
- Hamstrings
- Calf muscles
- Quadriceps (vastus lateralis, vastus medialis, rectus femoris, bicep femoris)
- Core muscles (abdominal muscles and those surrounding the hips).

Muscle weakness in the feet and ankles is one of the primary arguments by proponents of barefoot running. Proponents believe that cushioned and motion control shoes serve as a "crutch" to muscles in the feet. This weakness leads to unnatural movement of the ankles and over-stress in the foot which causes the muscles in other areas of the body compensate. For example, inward rotation of the ankle requires additional rotation at the knee. The additional work of the illiotibial band (IT band), used to stabilize the knee, can lead to inflammation of the IT band. By walking and jogging without that support and cushion, or performing specific

exercises, muscles are strengthened and injuries avoided.

#### *Anatomical Factors, Orthotics, Shoes*

Unfortunately, some factors are genetic and can't be modified very easily. For example, the degree of arch in the feet appear to be connected to injuries of the knee. High arches (cavus) can alter the way the foot contacts the ground, making it so the foot rolls from the outside to inward rotation. As a result (consider the kinetic chain), the ankle bends inward as does the knee making the muscles in the thigh and hip engage to stabilize the inward forces. Other genetic factors may be the width of the hips and differing leg lengths. Of course, little can be done to anatomically change these factors.<sup>4,6</sup>

However, physicians and shoe manufacturers attempt to minimize the effects of these genetic differences by using orthotics and shoes specifically designed for certain gait patterns (as mentioned in previous chapters). Conflicting evidence implies that either of these methods significantly reduce the risk of injuries in runners.<sup>6</sup> Nonetheless, patients and consumers abundantly support the use of orthotics and motion control shoes showing they believe they are helpful.

#### *Training Errors*

Not only do weak muscles and anatomical factors pose a risk to joggers and walkers, but the type, frequency and volume of training also increase the risk of injury. Of all the factors listed, the one with the strongest correlation to injury is weekly mileage. In general, the greater mileage

(40+ miles per week), the greater the chance of being injured. However, in some studies more mileage may have actually prevented knee injury although injury to the thighs and hamstrings were more frequent.

In addition to weekly mileage, the frequency and time also affected the occurrence rates of injury. Studies comparing runners of 1, 3 and 5 days a week for 20 weeks, and 15, 30, and 45 min for 20 weeks found that the rate of injury increased in both control groups, i.e. as volume and frequency increased, so did injury rates.

Changes in running schedules have also been linked to injury. For example, sudden increases in volume of training or modifying a running program to include more difficult types of workouts (hill training, interval training) may be too much for the body to absorb without a gradual build up. This was observed by researchers who examined injury rates of military recruits. Those recruits that entered basic training with a running background had fewer injuries than those who did not.<sup>8</sup>

As outlined in chapter 2, starting out slowly and gradually increasing the volume and intensity are very important to staying healthy.

### *Stretching*

Stretching has long been used before the warm-up phase of an exercise session with the intent of loosening up (reducing muscle tension), improving performance, and preventing injury (overtension may lead to pulling or straining a muscle). Research over the years has not been able to confirm this

idea and in some cases may actually show that stretching before exercise may actually have the opposite effect.<sup>9</sup>

More recently, studies have been designed to include stretching after the workout has been finished. The authors of one such study assessing hamstring injuries and stretching post-workout, followed a single team for four playing seasons and found that hamstring injuries decreased from 11 to 4 injuries and the number of days missed from injury went from 38 to 16. While more evidence is needed, injury prevention through stretching may be optimized by simply changing the timing of when it is performed.<sup>10</sup>

### *Warm up*

Much like stretching, the warm up, a phase of the exercise session used to gradually increase body temperature through low-intensity movements, has been used under the pretense that it would help prevent injury, improve performance and help relieve muscle tension. In the context of injury prevention, a meta-analysis by Fradkin et al. concluded there was a small reduction of risk from using a warm up.<sup>11</sup> Furthermore, another study used two intervention groups, one who just did the warm up and another that did the warm up and stretched. The warm-up plus stretching group had fewer injuries than the warm-up alone group. Once again, this seems to imply that much of the anecdotal evidence from those coaches and athletes may be more useful than the current scientific literature.

### *Terrain and Running Surfaces*

Combined or in isolation, the type of terrain (hilly vs. flat) and the actual running surfaces (pavement vs. rocky vs. dirt path) are often linked to injuries. While there may not be large amounts of scientific evidence to support this idea, runners and walkers alike feel strongly that these factors strongly contribute to injuries.

For example, paved roads are not only unforgivingly hard surfaces but are also constructed so that they can easily drain water. To accomplish this, the middle of the road sits higher than the outer edges. When walking or jogging on roads, the inside leg/foot makes contact with the pavement at a different height than the outside leg/foot altering the “natural” gait pattern. Repeatedly running on these types of roads could lead to injuries such as iliotibial band syndrome (ITBS), knee pain, or ankle pain.

Or, running down hill frequently may place additional stress on the quads and knee leading to knee pain and other problems. Much like volume and intensity, terrain and running surfaces should vary often to avoid potential injuries and boredom.

### *Weight*

Elite endurance athletes pay close attention to achieving their “ideal” race weight. Not only is this good for performance but also to avoid injuries. During walking and jogging, tremendous stress is placed on the involved bones and muscles. Each step means the legs must absorb 2-3 times the body weight. It seems only logical that the greater the weight, the greater the chance of injury. This should be taken in to consideration when planning the volume and intensity of a training session. When excessive weight is present, resistance

training should be included and volume and intensity should be kept low to gradually build muscles so they are prepared to absorb the impact forces of walking and jogging.

## **Common Injuries**

### **Medial tibia stress syndrome (MTSS)**

Medial tibia stress syndrome (MTSS), better known as shin splints, is one of the most common lower leg injuries accounting for about 15% of all running injuries. Shin splints are small tears in the connective tissue where the soleus muscle connects to the anterior and medial area of the tibia (the large bone of the lower leg).

**Symptoms** Shin splints are easily identified by pain or discomfort that runs along the shin bone (tibia). Pain may go away during activities, once muscles are loosened up, and return during rest but may also be present before, during, and after the activity in more severe cases.

**Causes** The exact cause of shin splints is unknown but is believed to be related to fatigue of the soleus muscle. As the soleus fatigues, the impact forces are absorbed more by the tibia itself. The additional stress causes the tibia to bend or bow, leading to connective tissue tearing. Those at greatest risk of developing MTSS are those with flat feet or high arches, inflexible muscles, running on uneven terrain such as frequently running downhill, running on pavement/hard surfaces, and improper or worn out shoes. However, those who try to do too much, too soon (mileage, intensity) are probably most likely to develop shin splints.<sup>13</sup>

**Treatment** Fortunately, shin splints are very treatable at home. Rest from high impact activities is needed along with anti-inflammatory medications and ice. Exercises to strengthen the lower leg muscles should also be performed. In addition, shoes should be examined and replaced with a more suitable pair if needed. Finding alternate walking/jogging trails or paths could also be used to alleviate the volume of training that occurs on hard surfaces.

### **Plantar fasciitis**

Plantar fasciitis is the inflammation of the thick band of tissue (called fasciae) that connects your heel to your toes. This band supports the arch of your foot. If it is stressed too much, small tears in the fasciae develop leading to foot pain and inflammation.

**Symptoms** Plantar Fasciitis can be recognized by stiffness and pain in the bottom of the foot, usually closer to the heel. This will likely be felt in the mornings or after a period of sitting, when the foot isn't in use.

**Causes** Overuse of the area in a fatigued state. For example, standing for long periods of time. Of course, the "too much to soon" concept also applies here. Flat or high arches and overpronation also are linked to plantar fasciitis along with shoe type. More often, individuals with really tight calves develop this condition.

**Treatment** according to the American Orthopedic Foot and Ankle Society, stretching your calves is the best treatment for plantar fasciitis.<sup>7</sup> You can also apply ice to the foot/feet affected 2-4 times a day for about 20 minutes to reduce the inflammation.<sup>14</sup>

### **Muscle Soreness**

Many believe the idea that if your muscles aren't sore after a workout you haven't done enough. While a good workout may cause muscle soreness, it is certainly not what defines the quality of a workout. On the contrary, you should not be sore after every workout. **Delayed Onset Muscle Soreness (DOMS)**, is a condition that occurs when microscopic tears form in the muscle tissue leading to stiffness and general soreness in the muscles. This is a result of stress placed on the muscles during activity. You've undoubtedly experienced this immediately following your first workout after a long period of inactivity. This soreness, DOMS, may continue for days while your muscles are naturally repairing themselves. You might even feel this way after the first two or three workouts. However, if you are continuously sore after your walking/jogging sessions, you need to reconsider what you're doing as it is likely too much stress for your body to handle.

DOMS, when experienced occasionally, should not be a cause for major alarm. Unfortunately, there isn't much that can be done to treat it. Rest and anti-inflammatory medication may provide some relief.

### **Patellofemoral Pain Syndrome (Runner's Knee)**

Patellofemoral Pain Syndrome is a general term that describes pain in the part of the knee where the femur (thigh bone) and patella (kneecap) come together. Often called Runner's Knee, this pain can result from several scenarios such as Chondromalacia Patella or patellar misalignment. In Chondromalacia Patella, the cartilage underneath the patella

becomes worn and breaks down, leading to pain and inflammation in the surrounding area. With patellar misalignment, the kneecap doesn't track in its normal pattern. Normally, the patella sits in a groove and tracks along the groove when the knee is bending. When misaligned, the kneecap tracks to one side causing irritation and pain.

**Symptoms** According to the Academy of Orthopedic Surgeons, the most common symptom is a dull, aching pain in the front of the knee. This pain can increase during repetitive activity where the knee is bending or after long periods of sitting.

**Causes** Weak and inflexible quadriceps muscles play a significant role in this injury since these muscles are the primary stabilizers of the kneecap. Simple overuse is also connected to this condition.

**Treatment** RICE is the suggested method to treat this condition at home. A change to lower impact activity may be required while healing to improve the response to treatments. Strengthening exercises combined with flexibility should also be used.<sup>15</sup>

### **Iliotibial Band Syndrome (ITBS)**

The iliotibial band is located on the outer part of the thigh and connects the pelvis to the tibia (bone in the lower leg) just below the knee. This band of tissue, supports and stabilizes the knee during activities like walking and jogging. As the IT band passes over the outside portion of the knee, it can often rub against a bony protrusion on the femur. When this occurs frequently, the area of the knee being rubbed can become inflamed, leading to ITBS.

**Symptoms** Most often, ITBS can be detected by pain and possibly swelling in the outside portion of the knee especially

when the heel impacts the ground when walking. This can also occur near the hip but more often occurs in the knee area. A clicking, or popping sensation may also occur each time the knee is bent then flexed with ITBS.

**Causes** There can be several causes to ITBS making it very difficult to pinpoint. Improper technique during walking or jogging, weak glute and thigh muscles, low arches, and simple overuse all contribute to development of this condition.

**Treatment** Like other walking and jogging conditions, stretching, anti-inflammatory medications, strengthening and rest can be good short-term solutions. Long-term solutions should focus on technique, possible shoe changes, and a continued stretching and strengthening program.<sup>16</sup>

### **Achilles injuries (tendonitis)**

The Achilles tendon connects the muscles of the calf to the heel. This thick tendon can become irritated during activity causing pain and discomfort in the heel. This irritation of the tendon is called tendonitis (inflammation of the Achilles tendon).

**Symptoms** Pain in the heel(s), sometimes going away during the activity but present before and after is the primary symptom of tendonitis.

**Causes** The inflammation usually stems as a result from overuse, inflexible and weak calf muscles. Changes in shoes, such as those with a lower drop, might also contribute to tendonitis because the calves are now stretching more with each step.

**Treatment** RICE is the best method of treatment to prevent making the condition worse. Anti-inflammatory medications, strengthening of the calves and stretching the calf muscles should also be used to prevent and treat this condition.<sup>13</sup>

## Stress fractures

Unlike blunt-force fractures, stress fractures develop in the bones over time as a result of excessive use. Stress fractures of the foot and heel are most common in runners but can occur in areas such as the shins. Additionally, fractures in the bones cannot be treated as easily as other soft-tissue injuries.

**Symptoms** Sharp pain in the specific area of the fracture develops and is sensitive to the touch and when walking and jogging.

**Causes** Overuse is the primary cause of stress fractures.

**Treatment** While many of the soft-tissue injuries can easily be diagnosed and treated at home, stress fractures require proper medical attention. Discontinuation of activity is necessary to give the bone time to heal.<sup>13</sup>

## Muscle Strains, Hamstring Strains

Muscle strains are injuries of the muscle tissue caused by overstretching or overstraining the muscle. Strains can be detected by a pain, sometimes sharp in nature, to a particular area of a muscle. Hamstring strains are a common running injury along with calf muscle strains. All strains, especially in the hamstring, can be very frustrating to deal with because they can occur spontaneously and seemingly without warning, rhyme or reason. Pain may not be present during everyday activities but when attempting to jog or walk may surface making it a challenge to understand when resuming activity would be safe. Depending on the severity, activities can be put on hold for weeks.

Causes are related to overtension which could occur for multiple reasons such as poor flexibility or poor strength. Treatment strategies include RICE, strengthening and gentle stretching of the injured muscle.

## Illness

While not exactly considered an injury, walking and jogging and illness should also be addressed. Many avid endurance athletes live by the adage, "above the neck, you're okay to exercise, below is a no go." This simply implies that if the illness is isolated to an area above the neck, you are probably okay to exercise without making the condition worse. Above the neck illnesses, much of the time are things like allergies, congestion, headache, etc. In other words, illnesses that likely won't worsen if you exercise. Below the neck illnesses might include upset stomach, chest congestion, and body aches signaling more of a widespread infection. Exercise in this state may make the condition even worse, prolonging recovery. In this case, you should wait until 24 hours after the symptoms are gone to resume your exercise routine. Regardless of the location of the illness, caution and good old fashioned common sense should be used. If you're unsure, don't exercise.

Stomach or gastrointestinal distress may pose an additional risk since they are usually associated with vomiting and/or diarrhea, i.e. fluid loss. To avoid dehydration, exercising during or after a illness with fluid loss should be avoided.

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# ***FLEXIBILITY***

One of the five health related components of fitness is flexibility. Flexibility relates to the ability to move a joint through it's full range of motion (ROM). To develop a complete fitness program, you should take time to emphasize this component in your routine by stretching. Unfortunately, "...most people neglect flexibility training, limiting freedom of movement, physical and mental relaxation, release of muscle tension and soreness, and injury prevention." (American Council on Exercise)

Flexibility is classified into two types: static and dynamic. **Static flexibility** is a measure of the limits of a joints overall range of motion. It's measured by stretching and holding a joint in the position of it's maximum range while using a measuring instrument to quantify that range. To achieve the maximum range, passive forces are required (force generated from an external source). **Dynamic flexibility** is a measure of overall joint stiffness during movement. Unlike static flexibility, dynamic flexibility requires active force production (your own muscles contracting). Because it's difficult to quantify "stiffness," dynamic flexibility is measured more subjectively. For example, how easy is it to swing a tennis racket, climb steps, or get in and out of a car? The target of any good stretching program is to improve static and dynamic flexibility so

that normal ROM can be achieved. The term "normal" relates to population studies that have measured various areas of the body and established an average degree of movement for a particular joint.

## **THE BENEFITS OF FLEXIBILITY AND STRETCHING**

There are many benefits to regular stretching with the most important of those being simple: being flexible will help you move freely and complete activities with greater ease.

### **HEALTHY JOINTS AND PAIN MANAGEMENT**

As many as 28 percent of all adults report pain and stiffness in joints. That number increases dramatically with age and women are more likely to develop joint symptoms. For adults, arthritis is one of the most common conditions with 54% of people 75 years and older having been diagnosed with arthritis. Regular exercise, including regular stretching, is essential for people with arthritis to maintain function and manage joint pain. Even for those not affected by joint conditions, stretching increases joint mobility and function, and decreases joint stiffness and pain.

Pain can also be related to imbalances in the muscles. For example, if the front of your thighs and hips get too tight from a lack of flexibility, the tension will pull on the hips (where the muscles are attached). The result is the pelvis may be pulled forward and cause greater sway in your lower back. This

affects your posture and can eventually lead to pain and stiffness in the neck, shoulders and lower back. Stretching regularly, for all major muscle groups/joint areas, promotes good alignment and balance.

## **MUSCLE RELAXATION AND STRESS RELIEF**

Staying in one position for long periods of time, repetitive movements, and other everyday stressors can result in stiff muscles and knots (also called trigger points). Regular stretching decreases anxiety, blood pressure, and breathing rate which help to relax muscles and aches and pains related to neuromuscular tension (stress). Flexibility has also been prescribed successfully to treat dysmenorrhea (painful menstruation) and to relieve muscle cramps during participation of exercise/sports.

## **OTHER BENEFITS**

In addition to the benefits listed above, several other benefits have been researched and characterized as good reasons maintain a regular routine of stretching:

- Increased blood flow- Blood carries vital nutrients and oxygen to muscles and tissues. Stretching increases blood flow to the muscles being stretched which may help them recover from exercise faster.
- Reduction of Future Lower Back Pain-Most experts agree (while research is still inconclusive) that counteracting the natural loss in muscle and connective tissue

elasticity that occurs with aging with muscle fitness and stretching exercises can reduce your risk of developing lower-back pain.

## **FLEXIBILITY AND AGING**

For many young adults, the thought of long term flexibility can be taken for granted. For example, how hard is it to bend over and tie your shoes? How difficult is it to walk around campus with a backpack? As young adults, most of those activities are likely encountered with little pain or resistance. However, ROM declines with age. Simple things like rotating the head and neck to glance over the shoulders, getting in and out of a vehicle, or carrying groceries can be painful. Therefore, flexibility is critical to maintaining a high quality of life in older years.

## **THE INACTIVITY-MOBILITY CYCLE**

If you have ever been injured to the point that required immobilization of a joint, you realize how important mobility is in relation to your overall health. Unfortunately, as joints ROM is restricted from arthritis or other injuries, activity declines. As activity declines, the ROM likely continues to suffer as a result of inactivity and the vicious cycle ensues. A simple stretching program can help alleviate this problem and help break out of the cycle.

## **IMPROVING RANGE OF MOTION**

Joint ROM results from a combination of factors which could be classified as internal or external. Internal structures relate to the physical structures of body materials and tissue. External factors are non-structural and include environmental temperature, gender, age, excess fat mass, muscle mass, and restrictions in clothing or equipment.

Internal factors include joint structure/joint mechanics and the connective and soft tissue surrounding the joint. Because muscular actions such as muscular contractions and stretching are controlled by the nervous system, another internal factor can be attributed to the neuromuscular system and how the stretching and tension is managed.

## **JOINT STRUCTURE**

A joint is a location on the body in which two or more bones intersect and interact. For example, the humerus (upper arm) intersects with the radius and ulna (lower arm) at the point of the elbow. The bony formation of each joint structurally limits the ROM. For example, the shoulder joint which is structurally a ball-in-socket joint, can rotate in multiple directions. In other words, it has a wide range of motion. However, the knee joint is a modified hinge joint which is limited to essentially a forward-backward direction of movement. Additionally, excessive fat mass surrounding a joint or even large muscle mass may limit the ROM for a particular joint. Although weight loss could affect amounts of fat mass surrounding a joint, or loss of muscle, joint

structure cannot be altered. As a result, little can be done in this area to improve flexibility.

Not only is range of motion related to the joint structure, but flexibility exercises are joint-specific. In other words, you can't stretch your hamstring and expect your shoulders to improve. Likewise, you can be flexible in your shoulder but very "stiff" in your fingers or ankles. So, a complete stretching program must include multiple stretches for various joints.

## **CONNECTIVE AND MUSCLE TISSUE**

Joints are surrounded and connected by muscles, tendons, ligaments, and skin. For example, the head of the humerus fits into a small cavity to create the shoulder joint. However, those bones can only remain in place as a result of the muscles, tendons, and ligaments that keep the joint tight and in place. In addition, muscle tissue is surrounded with connective tissue, primarily collagen and elastin. As a joint moves through its normal range of motion, all of this soft tissue must stretch to accommodate the movement. Therefore, static and dynamic flexibility is probably most limited by the flexibility of the surrounding soft tissue, specifically the connective tissue.

While the exact biomechanics of how flexibility is changed isn't well understood, it does appear to be related to the elastic and plastic properties of the connective tissue. Elasticity is defined as the ability to return to resting length after **passive stretching** (i.e.

elastic recoil). Like a spring, soft tissues stretch and then recoil to their resting position. Plasticity is the tendency to assume a greater length after passive stretching (i.e. plastic deformation). In other words, taking that stretchy spring and changing the resting position to a new longer length. The goal of a flexibility program, is to repeatedly overload the elastic properties of the muscle to elicit plastic deformation over time. Several studies have suggested that a slow, sustained stretch of 30-90 seconds is necessary to produce chronic plastic deformation.

## **NEUROMUSCULAR SYSTEM**

Modern cars come equipped with a central computer and sensors throughout to troubleshoot problems with the vehicle. Sensors in the engine determine temperature. Sensors on the wheels determine tire pressure while sensors in the gas tank tell you when the gas tank is low in fuel. Much like car, our bodies are equipped with sensors, called proprioceptors, that help us manage movement and prevent injury.

Muscles have two specific types of proprioceptors that determine the length and tension of the muscle. These proprioceptors are called muscle spindles and Golgi tendon organs (GTO's).

Muscles spindles, lie parallel to the regular muscle and help determine the length of muscles when they are being stretched. When a muscle is stretched, they send signals to the central nervous system

causing the stretched muscle to contract. In other words, there is some resistance to the stretch generated by the nervous system's reflexive stimulus sent to the stretching muscle. This is called the myotatic or stretch reflex. Additionally, that same signal also causes the antagonist (the opposing) muscle to relax, called reciprocal inhibition. So, when you stretch your upper thigh (quadriceps) your hamstrings (antagonist to the quadriceps) are relaxed.

The GTO's are located near the musculo-tendon junction (the end points of the muscle) and relay messages to the central nervous system regarding muscle lengthening and tension of the muscle. When activated, its signal will override the stretch reflex causing a sudden relaxation of the stretching muscle. This is called autogenic inhibition or the inverse myotatic reflex. This inhibitory reflex can only occur after the muscle has been stretched for 5 seconds or longer. This is why, in order effectively stretch, it must be done in long, slow increments of time. Otherwise, the resistance encountered from the stretch reflex will prevent the muscle from being over

In both cases, the neuromuscular system manipulates the stretched muscle by either facilitates or inhibits presumably as a protective mechanism.

## **WAYS TO IMPROVE FLEXIBILITY**

### **STRETCHING TECHNIQUES**

Multiple stretching techniques have been researched with results showing they can be beneficial in improving ROM. Regardless of the specific technique or specific mode used, each technique can be performed using two basic modes: active or passive. **Active stretching**, also called unassisted stretching, suggests that the actual stretch is done individually without an external stimulus. **Passive stretching**, or assisted stretching is when a partner or trainer is used as the stimulus in the stretching exercise. Both modes are effective and can be applied to each of the techniques mentioned below.

#### STATIC STRETCHING

The most commonly prescribed and most commonly used technique for improving flexibility is the static stretch. A static stretch involves slow, gradual and controlled movements. The muscle group is stretched toward the end of the joint ROM until the point of mild discomfort is reached. Once that point is reached, the stretch is held in a “static” position for 30 to 90 seconds. After the prescribed time, the stretch can be repeated. Common ways in which static stretching is applied would be in Yoga routines or stretching after a workout or athletic event.

Some of the major advantages for static stretching is that it is generally considered safe (see Stretches to Avoid), it is simple to perform and effective at increasing ROM. The only major disadvantage comes from when it is done too much which can reduce strength and may make joints unstable. Of

course this could apply to any of the techniques.

#### BALLISTIC STRETCHING

Ballistic stretching involves forceful bouncing or ball-like movements that quickly exaggerate the joint ROM without holding the position for any particular duration. This type of stretching involves dynamic movements like those done by athletes during sports events. In that regard, ballistic stretching is seen as being very specific to and beneficial for athletes. However, one criticism of ballistic stretching is that because of the short duration of the stretch, and ballistic movements that can be forceful, the muscular contraction from the stretch reflex may cause muscle soreness or even injury. For that reason, many athletic coaches feel ballistic stretching is unsafe. Also, many researchers feel it is less effective at improving ROM. Nonetheless, the ACSM still recommends ballistic as one method to effectively increase flexibility.

#### DYNAMIC STRETCHING

Ballistic stretching is a form of dynamic stretching. However, when referring to dynamic stretching routines, most fitness professionals are referring to dynamic movements that don't involve forceful bouncing motions. Instead, dynamic stretching, in this context, suggests performing exaggerated sports movements in a slower, more controlled manner. For example, a sprinter may use several exaggerated stride lengths before a race to improve hip ROM.

An advantage of dynamic stretching is that it will target and improve dynamic flexibility which in turn may improve performance. A disadvantage comes from the type of movements which often require good balance and coordination. So, learning correct form and being able to perform dynamic stretches may take a little time to learn or may not be applicable to certain populations.

#### **PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION (PNF) STRETCHING**

This type of exercise usually involves a partner. The partner will passively stretch the muscle, immediately followed by an isometric muscle contraction against resistance. This contraction is then followed by another passive stretch. This type of stretch is also named contract-relax stretch because of the sequence of movements involved. Other types of PNF stretching involve contract-relax-antagonist contraction, also describing the sequence of movements involved but adding an additional step.

As the name of the technique implies, PNF stretching emphasizes the natural interaction of the proprioceptors with the muscles to increase the ROM during the stretch. Remember that during the stretch, the muscle spindles cause two things to happen, the stretch reflex and reciprocal inhibition (the antagonist muscle to relax). After 5 seconds, the GTO's then override the muscle spindle's signals causing autogenic inhibition. Because the muscle is relaxed, it can more easily be stretched. In other words,

the stretch either uses the activity of the antagonist muscle to get the target muscle to relax or the target muscle itself to relax as a result of the contraction.

While many experts feel that PNF stretching is the most effective technique, studies that compare static and PNF stretching are inconclusive. Regardless, it does appear to be very effective at increasing static flexibility. Some disadvantages to PNF is that it generally requires a knowledgeable partner, it's somewhat complicated, and can cause some soreness from the contractions.

## **CREATING AN EFFECTIVE STRETCHING PROGRAM**

The ACSM has made specific recommendations on how to design a flexibility program. However, before getting into the design, you should know your current flexibility status by assessing various joint's ROM. Specifically, performing the sit-and-reach test will assess your hamstring and lower back flexibility while using a goniometer can be used to assess your ankles, knees, hips, neck and shoulders. Instructions on how to perform these assessments will follow later.

### **SET GOALS**

Once you learn where you are most and least flexible, you should make some realistic goals to improve or maintain your ROM. Be specific when you set goals. Instead of just saying, "I want to increase my flexibility,"

you will want to state the specific area of the body you intend to improve. You will also want to make sure your goal can be measured. A better way to state your goal may be, "I will improve my sit-and-reach score by 4 cm by the end of the semester." Notice this goal, as stated, includes a specific area, is measurable, and includes a deadline. By stating your goal properly, you will increase the likelihood of actually achieving it.

### APPLY THE FITT PRINCIPLE

As mentioned previously, the ACSM has made recommendations for carrying out a flexibility program based on the FITT Principle (Frequency, Intensity, Time and Type). As you select the areas you want to stretch, keep in mind it is recommended that multiple stretching exercises should be performed to target all major joints including the neck, shoulders, elbows, wrists, trunk, hips, knees, and ankles. (insert link to specific exercise here). After selecting your exercises, follow the below recommendations when performing your routine. :

- **Frequency**-Stretch a minimum of 2-3 days per week, ideally 5-7 days per week.
- **Intensity**-Stretch to the point of tightness or mild discomfort.
- **Time (or duration of each stretch)**-a minimum of 10 seconds for very tight muscles with an emphasis to progress to 30-90

seconds. Two to four repetitions of each stretch should be done.

- **Type (mode)**-Select from either of the above techniques mentions that best suit your circumstances (Static, Dynamic, Ballistic, or Proprioceptive Neuromuscular Facilitation).

### WHEN TO STRETCH

Although stretching can be done at any time of the day, the ACSM has traditionally recommended that flexibility training be incorporated into the warm up or cool down phase of an exercise session. Recent studies have provided evidence against stretching before exercise session suggesting that stretching will compromise the force-producing capabilities of muscles. Therefore, it is recommended that stretching take place only after the body temperature and of the muscles has increased, i.e. after the warm up or after the workout. Additional confirming evidence of this concept has shown that applying heat packs for 20 minutes to increase muscle temperature can increase hamstring flexibility more so than 30 seconds of static stretching. As you can see, temperature also plays a significant role in muscle ROM.

[HTTP://WWW.ACSM.ORG/PUBLIC-  
INFORMATION/ARTICLES/2016/10/07/IMPROVING-  
YOUR-FLEXIBILITY-AND-BALANCE](http://www.acsm.org/public-information/articles/2016/10/07/improving-your-flexibility-and-balance)

### STRETCHING SAFELY

In addition to warming the muscle before performing stretching exercises, there are other things that can be done to make your



flexibility routine safe. When muscles are stretched quickly and forcefully, the stretch reflex can be activated. This creates significant tension because the muscle fibers will not only be stretching but also attempting to contract. As mentioned, this is one of the reasons ballistic stretching may not be suitable for everyone. To avoid this, stretch slowly and in a controlled fashion while holding the stretch for 10 seconds or more.

In addition, some stretches are not recommended, or contraindicated. Researchers have determined that some stretching exercises may not be beneficial at all or may cause injury. A list of contraindicated stretches and alternative stretches can be found by clicking on the link below. However, this is not a comprehensive list of potentially risky stretches. It is important to understand personal limitations before or during a stretch exercise to avoid injury.

#### CONTRAINDICATED STRETCHES

[HTTP://WWW.MHHE.COM/SOCSCIENCE/HHP/OTW/FIT W  
ELL/WEB12/WEB12 IPT BAD EXERCISES FLEX.HTM](http://www.mhhe.com/socscience/hhp/otw/fitt_well/web12/web12_ipt_bad_exercises_flex.htm)

## **ASSESSING YOUR FLEXIBILITY, LABORATORY EXERCISES**

The first step in creating a successful flexibility program is to assess your own flexibility. Follow the link below to understand how you can perform these assessments. Those that may be most helpful include sections 5.1, 5.2, and 5.3.

[http://wps.aw.com/bc\\_hopson\\_health\\_2/214/54825/14035385.cw/index.html](http://wps.aw.com/bc_hopson_health_2/214/54825/14035385.cw/index.html)

#### References

##### BIOMECHANICS OF STRETCHING

<http://medind.nic.in/jau/t06/jaut06p3.pdf>

##### PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION (PNF): ITS MECHANISMS AND EFFECTS ON RANGE OF MOTION AND MUSCULAR FUNCTION

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3588663/>

##### IMPROVING FLEXIBILITY AND BALANCE

[HTTP://WWW.ACSM.ORG/PUBLIC-  
INFORMATION/ARTICLES/2016/10/07/IMPROVING-  
YOUR-FLEXIBILITY-AND-BALANCE](http://www.acsm.org/public-information/articles/2016/10/07/improving-your-flexibility-and-balance)

##### VIDEO FLEXIBILITY

[HTTPS://YOUTU.BE/XeEI0GMLDYC](https://youtu.be/XeEI0GMLDYC)