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Running Efficiency Program for the Recreational Runner

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Running Efficiency Program for the Recreational Runner

By

Brennan Noonan

An Honors Thesis Submitted in Partial Fulfillment of the
Requirements for Graduation from the
Western Oregon University Honors Program

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with more assignments and creative thinking projects in a week's time than I thought possible, but it got me to where I am today. I will forever remember Dr. H telling me before winter break of 2018 that he was excited to see me back next year and to tell him about this new "fiancé" of mine that he remembered from previous classes. It was heartbreaking to hear of his passing, but I know that he is in a better place making everyone around him smile and laugh. We miss you Dr. H.

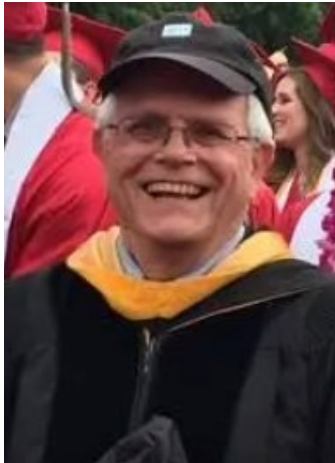


Table of Contents

Abstract	5
Figure 1	7
Figure 2	8
Chapter 1: The Head & Neck	9
Chapter 2: The Shoulders	11
Chapter 3: The Chest	14
Chapter 4: Mid to Low Back	17
Chapter 5: Core	20
Chapter 6: The Hips, Glutes, & Pelvis	22
Figure 3	24
Figure 4	26
Chapter 7: The Knees	29
Chapter 8: Ankles & Feet	32
Chapter 9: Footwear	38
Chapter 10: Putting it all together; Stride	40
Bibliography	42

Abstract

Running. The most natural and physical athletic ability that has been a part of our ancestors' culture for generations upon generations. The sport of running is a mere pastime that seems to be taken up when there is no other exercising option available or appealing. However, for those that have found great joy in the art of running and racing, there is an abundance of knowledge available to the public on every possible aspect of how to improve running performance. The science behind how the body moves oxygen, stores glucose, burns calories, and biomechanically functions while running is immensely vast. Yet, each person is individually different. No two people are the same when it comes to stride, or better yet, running efficiency. Wouldn't it be nice if there was a resource that could compile all the helpful information out there and crunch it down into a manageable and easily understandable template? Improving overall fitness and avoiding injury is as simple as it gets for running basics, but what does the average recreational runner do to prevent injuries before they happen? How can basic training exercises be incorporated into a running routine to help increase longevity? If injury is already present, what can the athlete do to aid in a quick recovery and proper healing, all while staying motivated? The plethora of knowledge is out there and available, all the information needs now is a well-structured and properly designed template.

To best understand and break down the body into manageable chunks, the body has been split into three major sections: 1) The head, neck, and shoulder region; 2) The chest, mid to low back, and core region; 3) The hips, glutes, and everything down to the soles of the feet. These sections were formed because of the unique interactions that

take place in each area and how they can individually be adjusted for better overall running efficiency. Following the introduction of each body section, there will be a breakdown of common injuries in the area, detailed descriptions on how the body interacts to get oneself moving, and finally, the tips and tricks to become more efficient from the modifiable and adaptable regions of the body. The proposed theory is a tool that can be used in the moment for adjusting form inefficiencies. This will be a useful tool in preventative maintenance on the body, strengthening exercises, and training the body to move more efficiently. It will also allow for better ease-of-access in finding the best procedures that work for the individual's specific gait needs. Runners, even those new to the sport, are very aware of how the body is feeling with every step. However, without the proper preventative knowledge or guidance, even slight compromises in the recreational runner's form due to pain or exhaustion, could lead to an imbalance in musculature or other injuries. Efficiency, in terms of running and performance, relates to the precise movement and control it takes to run at a speed using the least amount of energy possible (Figure 1). When targeting the efficiency component of running, individual constraints must be taken into consideration, and pictured demonstrations will be presented throughout the guide to show the individual how to quantifiably put structured exercises into practice. It should be noted that this is *not medical advice* in any sense. Please consult your doctor or physician with any lingering questions, concerns, or injuries. This is simply a compilation of hints and helpful recommendations from one runner to another.

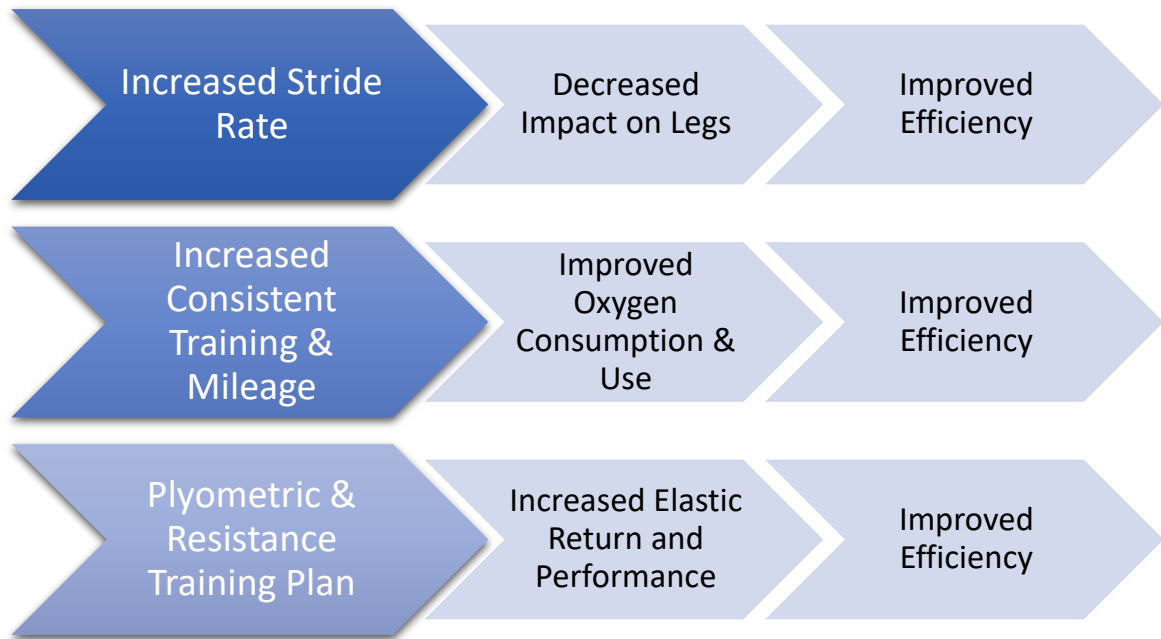
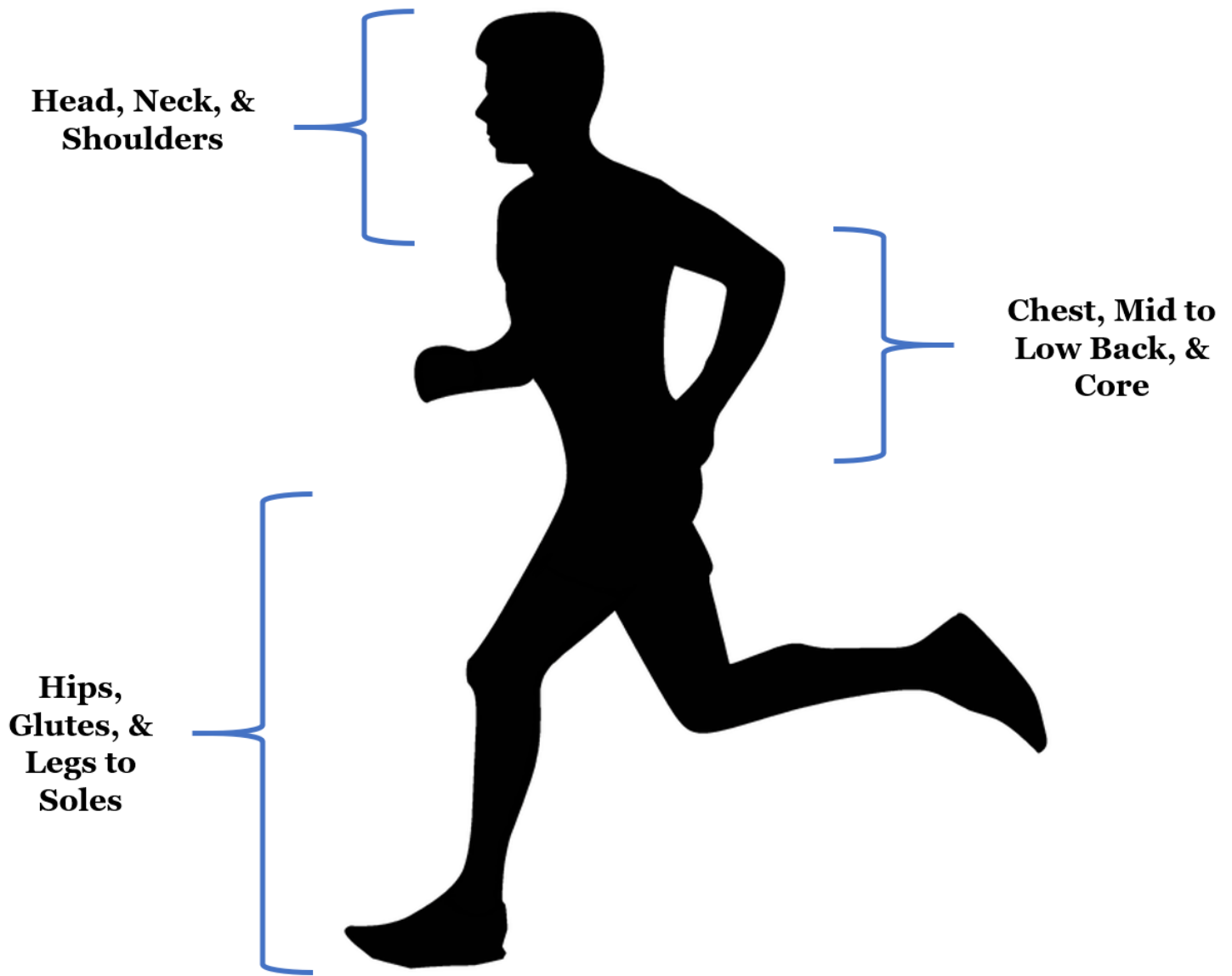


Figure 1

Division of the Body into Sections (Figure 2)



Chapter 1: The Head & Neck

“There’s not one body type that equates to success. Accept the body you have and be the best you can be with it.” – Mary Cullen

The human head weighs about 10 to 11 pounds (4.5 to 5.0 kg). It carries a very intelligent brain inside the skull that helps carry out all actions and thought processes throughout the day. During running, this heavy melon must be carried wisely with a strong and able neck. Extreme tilting of the head too far in any direction can off-balance the whole body. Carry the head wisely for proper, upright form! The natural tendency of the average human is to hold the head vertically in line with the spine, with the eyes looking straight ahead. However, the direction the eyes look can be very telltale of the direction the head will look. Looking down at the ground directly in front of the feet will pull the head forward. Looking up at the clouds rolling by and the birds flying above will roll the head back. Despite this, one of the worst things you could do is to tighten the muscles that hold the head in place in order to keep your head from moving. Instead it is better to relax and avoid tension around the base of the skull while also looking about 10 to 20 feet ahead.

Running-related injuries of the head and neck are not as common to the running population and pose minimal threat to overall biomechanics. However, there are a few notable anatomical inefficiencies that can affect running form. Bobbing of the head from side to side, and excessive bending of the neck forward or back, can negatively affect running form. The weight of the head must be held upright and kept in line with

the spine. As we will see later in this essay, the head will need to be in line with the spine as the trunk leans slightly forward. To focus on keeping the head steady, work on standing tall and relaxing the head and neck in an upright position. Before running, experiment with bending your neck and leaning your head to the left, to the right, straight down, and high up. Find that balanced center point in line with the spine, relax the tension in the neck, and look 10 to 20 feet in front of you.

Chapter 2: The Shoulders

“Experience has taught me how important it is to just keep going, focusing on running fast and relaxed. Eventually pain passes and the flow returns. It’s part of racing.” – Frank

Shorter

The shoulders have a key role in defining how the trunk will lean and remain anatomically correct. Do a personal experiment on yourself right now. Stand up and bring your shoulders forward, almost to a point of hunching your back. Now pull your shoulders back and try to squeeze your shoulder blades together. Do you see how one way hunches the back excessively and the other way arches the back? A common form mistake that happens to the best of us is the shoulders find a way to hunch forward and slouch downwards, especially when we are tired. Then the muscles surrounding the shoulder tense up and the body starts compensating by twisting excessively from the upper torso. Tension and soreness around the shoulders and upper back are potential indicators that you are running with improper form in your shoulders.

To find the most efficient center point where the shoulders should relax while running, perform this simple trick.

1. While standing, raise both your arms straight up above like you are raising your hand in class. Now allow your arms to fall straight down as gravity allows.

Feel how your shoulders are positioned currently. Slightly pulled back, chest slightly out, and a small arch in the back. The shoulders are now in line with the trunk and ready to

work *for* you and not *against* you. This can be done before starting a run or even while running if a reminder is needed mentally and physically.

It is also worth noting that increased muscular tension leads to weakened muscles over the course of time. Therefore, if you have found yourself running with too much tension in your shoulders or if you have not kept enough tension in them, you will need to strengthen the muscles to maintain the most efficient posture. Something to look for when carrying the arms while running is tightness and tension. If the arms are immobile, tight, or tense, this can become a problem because energy is being used to keep those arms still when they should be swinging in a natural motion. Imagine holding a leaf or a penny between the index finger and the thumb. Resist squeezing too hard, and do not let go. Focus on staying light and loose to promote lessened tension and non-floppy wrists (Tyson & Binder, 2013).

One of the simplest ways to retrain the shoulders and build up the surrounding muscles to maintain an efficient posture is to do some shoulder rolls.

2. Stand or sit in place and practice rolling the shoulders back in a circular motion.

There is also added benefit to squeezing the shoulder blades together once the shoulders have been rolled back as far as they can.

This will help to engage those upper back muscles that will keep the shoulders in place.

The advanced option involves standing and holding dumbbells while performing the shoulder rolls. There is one other alternative to this exercise that will help to relieve overall tension in the neck, shoulders, and upper back.

3. Start by sitting down and placing your hands palms up on your thighs/knees.

Next roll your shoulders back to the farthest point. Now imagine a string is attached to the crown of your head and it is being pulled straight up. This should cause the chin to tuck into the front of the neck as the back of the neck extends and stretches. Hold this stretch for 10 seconds before relaxing and then beginning again.

On your next run, think about and feel where your shoulders are position in relation to your body. See what happens with little tweaks to how you hold your shoulders. Release the tension and focus on running light, loose, and standing tall.

Chapter 3: The Chest

“Mental will is a muscle that needs exercise, just like the muscles of the body.” – Lynn

Jennings

It was best stated that to run with purpose and to avoid fighting yourself while moving forward, one must take advantage of gravity (Ferber & Macdonald, 2014). Having a forward lean from the hips of 6-10 degrees is one of the most important starting places to help correct posture and form. Angles of lean from the waist greater than 10 degrees can reduce hip flexion and lead to premature foot strike and a shortened stride. Oftentimes people complain about low back pain due to excessive arching of the spine or leaning backwards when running. Another complaint might be overall soreness of the back due to tension and stiffness. Having a backwards lean can limit a powerful extension when pushing off the toes; thus, decreasing forward propulsive trajectory and stride. The chest can also be an important factor in helping to hold the shoulders, and thus the arms, correctly. The arms are like a second engine, aside from the legs, and can be used to help in the fight against gravity and fatigue. They are also crucial for keeping the body in balance as the trunk and hips rotate during running. Relating back to the chest, if the chest is puffed up, then the back potentially arches too much, and then the arms are either tucked at the sides, essentially motionless, or swinging in front of the body recklessly.

Use the following exercise to get a feel for what good forward lean does for your center of gravity.

1. Imagine there is a string attached in the middle of the chest and it is pulling the trunk forward. The idea is to lean forward from the hips, but not bending over and hunching the back. The idea is to work progressively with gravity. Standing flat on your feet with the toes pointing forward, imagine that string pulling you forward, essentially falling forward, feet unmoving. Keep your posture tall as you lean forward into a falling start. Catch yourself before it is too late and go right into a few running steps.

This slight falling forward feeling is what happens when there is enough forward lean during the running motion. Running is like catching yourself from falling, ideally not pulling yourself with the legs, but rather propelling one step forward at a time. Running economy can be improved upon and influenced from plyometrics and strength training exercises (McCann & Higginson, 2008). Implementation of such exercises can lead to better elastic return and plyometric performance. Thus, better overall efficiency and economy.

The chest is an important component of running biomechanics that can be adjusted and trained to stay in the most effective position for good running posture. Try these next two exercises to open-up the front of chest and push back those shoulder blades.

1. This floor exercise is a safe way to stretch the pectoralis minor muscle and because the floor supports the shoulder, whereas the classic doorway or wall stretch can cause shoulder instability. To stretch the left side, lie on your

stomach (prone) and reach the left arm out to the side at 90 degrees from the body. Bend that left arm from the elbow up 45 degrees. Place the right hand under your right shoulder and press up to allow room to bring the knees up to 90 degrees on the right side. Keeping your head on or close to the ground, continue pressing up with the right hand to feel the stretch in the front of the left shoulder. Hold this position for two to three minutes. If you feel tingling or numbness in the side being stretched, drop that elbow down towards the hip for decreased pressure on the area. Repeat on the right side.

2. To perform this exercise, you will need a medium-sized TheraBand to hold between your hands and stretch horizontally. Raise your arms straight out in front of you and position your hands shoulder-width apart. This is the position you will be in for the exercise. Now grab the TheraBand so that you are holding it with your palms facing upward. Pulls the band ends in opposite directions until your arms are spread wide, then slowly release back to the starting position. Do at least 20 reps. This movement helps to put the shoulder blades back where they belong.

Chapter 4: Mid to Low Back

“Don’t dream of winning, train for it!” – Mo Farah

To put it simply, the mid back and low back during the running phase can either be excessively arched, slightly arched, neutral, or hunched. The common tendency during the early stages of running is to arch the back too much, or to tense up and keep the back extremely rigid. This is not the most effective positioning of form, yet it seems to be a default setup for most recreational runners. Next time before you go for a run, stand with your side to a mirror that shows your full form, stand tall with good posture, and experiment with different levels of arching in the back. Learn to draw in and engage the abdominals by tilting the pelvis forward and back. We will learn more on engaging the pelvis and positioning of the hips for a center of gravity that *works for you* in upcoming chapters.

Keeping a healthy arch in the back can be found by performing the same exercise that was demonstrated for the shoulders. Stand tall and put the arms straight up overhead, then let your arms drop down quickly as gravity would have them fall. The small amount of arch created in the back by doing this aligning exercise is perfect for keeping the back positioned properly. If the mid to low back is feeling weak during a run, the “Superman” exercise is great for building up a strong foundation.

1. Laying prone (on your stomach) on the ground, simultaneously lift the arms, head, and legs off the ground. Hold this position for about 5-10 seconds before

releasing back to the ground. Repeat this process 10 times for at least one to three sets.

The key is to make sure you are engaging your abdominal muscles throughout the exercise as well. If at any time you feel your low back is compromising and you are dealing with pain, make sure to check on your abdominal engagement. Lack of engagement can lead to added lower back pain.

One way we can modify and improve running biomechanics starting at the mid back is a posture reset. Try these two exercises to help open up the spine and ribs for better running posture (If you have a history of osteoporosis, skip these exercises as it places a lot of pressure on focal points in your spine, and instead try the standing posture reset mentioned in Chapter 2).

1. Find yourself a basketball, soccer ball, or hard medicine ball and sit on the floor, knees bent, feet on the floor. Position the ball on the ground so that when you lean back your middle back will rest on the ball. Then put your hands behind your head, elbows pointing forward, and lean back. Make sure to keep your head and elbows pointed towards your knees, not the ceiling, because we want the fulcrum point to be at the mid back and not the neck. Your butt should be off the ground as you roll up and down along the spine by pushing through your legs and then pulling back the other direction. Just make sure not to curl into a tight crunch. Spend a few minutes rolling up and down the spine from the shoulder blades to the bottom of the rib cage to find sore and stiff spots. Do not go into

the lower back area. Focus on relaxing into the ball with each big exhale as you return to resting position. Another option if you find that a ball is too painful is to use a foam roller to ease your body into it.

2. To perform this exercise, you will need two lacrosse balls, some tape, and light weights (3-5lbs). Tape the two lacrosse balls tightly together in a figure-eight pattern. It should look like a peanut when it is finished. Place your homemade exercise peanut horizontally under your mid back at the bra line or “bro line” area and rest your head on the floor. Next, grab those light weights and hold one in each hand. Hold your hands up to the ceiling and allow your shoulder blades to relax into an open and rested position. Now, with one arm you are lowering the weight until it touches the floor above your head while keeping your arm straight as possible. At the same time lower the opposite arm down the floor alongside your body so that the weight touches the ground near your hip. Now bring both arms back up towards the ceiling over your chest. Repeat this motion moving your arms in an opposite manner so that you have done five repetitions on each side, then move your body down about one inch so that the peanut hits the next vertebra. Repeat the exercise reps and continue moving down until the peanut is a few inches below the bump at the base of the neck.

Chapter 5: Core

“If it doesn’t challenge you, it won’t change you.” – Fred DeVito

Every sturdy foundation needs a strong center. A weak core will prohibit fluid motion of the body and allow for excessive rotation and twisting that can be counterintuitive to running. A strong core aids in anti-rotation that keeps the body aligned in the most efficient position; straight ahead. The goal should be to keep everything in the frontal plane. Excessive twisting from side to side limits efficiency and wastes excess energy. Implementing exercises that train up the core to resist rotation and keep the body centered are efficacious for running.

Side cramps, side stitches, side aches, etc. is the pain felt on either the left or right side of the stomach when running and has been experienced by almost all runners at some point. These symptoms can happen from drinking too much water, eating too closely to the time of running, or your body telling you that something is off with your breathing. Having a strong core and learning to breathe in sync deeply with your stride, can help to alleviate cramping symptoms. Great exercises to implement into a training program and use for preventative maintenance of the core include the following:

1. Russian Twists: Take a seat on the floor and place your feet down in front of you. Now lift your feet off the ground and lean slightly back. Put the hands together and twist from side to side as you touch the ground with your hands next to your side. Keep the legs still and the feet off the floor for the duration of this exercise.

- Touch each side at least 20 times. This move can become advanced by the addition of a medicine ball or light weight (5-15 lbs.).
2. Windshield Wipers: Lay on your back on the floor and raise your legs together so they are perpendicular to your body and pointed directly up at the ceiling. Lay your arms out to the side at 90-degrees from the body. Now, rotating from the core, slowly drop the legs to the left, touch the ground, and then raise back up. Continue moving the legs over to the right side as the motion of a “windshield wiper.” Repeat this back and forth motion 10-20 times.
 3. Lunging Tosses: To perform this exercise, you will need a medicine ball and a solid, flat wall. When getting into the lunge position, place the forwardmost leg parallel to the wall and closest to the wall. The trail leg should be the farthest from the wall. You should be about an arm’s reach away from the wall. Start with the medicine ball down by the dropped leg. Using your core, keep the arms straight and toss the medicine ball at an upwards angle towards the wall. Catch the ball on the rebound and repeat. Switch sides when 10-15 repetitions have been completed.

Chapter 6: Hips, Glutes, & Pelvis

“Only the disciplined ones are free in life. If you are undisciplined, you are a slave to your moods. You are a slave to your passions.” – Eliud Kipchoge

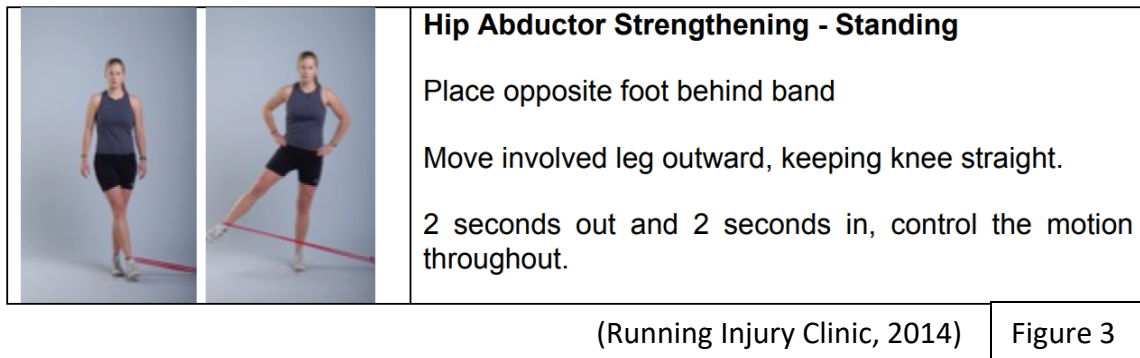
We are a culture that learns, works, and converses in the seated position.

Imagine standing and flexing your leg to 90 degrees in front of your body with the foot hanging down. This stance is activating your hip muscles and engaging them like in the running motion. Now think about what position your legs are in when you are sitting down. The position is the same, except the weight is taken off the hips, and yet the hip flexors are still engaged. Staying in this seated position for long periods of time will slowly wear out the hip flexors' ability to engage and activate properly. Stretching and walking breaks are essential to break up the monotony of sitting for long periods of time. This reminds your hip flexors how to engage and move properly. Stretching and strengthening the hip flexors will allow for a more forceful push off in the extension phase of the running stride, as well as allowing the knees to extend forward and up better for taking that next strong step. The hip muscles can become “deactivated” in a sense due to sitting for long periods of time, day after day. To “reactivate” those hip muscles for better driving force during your run, practice leg swings before the run begins. Additionally, make sure to stretch out those hip flexor muscles with a good lunge stretch positioned against the corner of a wall as described below. Another helpful exercise to perform prior to running is hip abductor strengthening. The gluteus medius is a muscle that runs along the side of the hip and is a major component of

overall stability. Having strong hip abductors and a gluteus medius will help to control balance and control your center of gravity. Strengthening the core and lateral hip muscles to engage and keep the pelvis stable is essential for overall running balance as well. Corrective hip flexor activation stretches must be implemented into a weekly training routine to help fight against long-term fatigue. Try these hip mobility tests.

1. Place your back against the doorframe and slide down until you are able to place one of your knees on the ground(the other should remain at 90 degrees). The side of the doorframe you are on should also be the leg the is up (right side = right leg up, left leg back; left side = left leg up, right leg back). The thigh of the leg you are kneeling on should be vertical, as well as the shin of the leg in front. Now that you are positioned correctly, you might notice there is a small gap between the wall and your low back. Now, try to tuck your tailbone under so that the space between the wall and your low back goes away. To do this, you must picture your pelvis as a bowl that you are trying to tip up towards your belly button. This is more commonly referred to as pelvic tilt. With the low back and mid back now both touching the wall, and the pelvis tucked under, notice what feels tight. If you feel a tightness or pulling sensation in the kneeling leg just above your thigh, then some hip flexor stretching needs to be implemented into your weekly routine. If you feel nothing, then great! Keep up the great work strengthening that hip mobility during your normal routine.

2. To strengthen the hip abductor muscles, review the following figure.



Now, let us dive deep into the powerhouse and pivot point of where running can be adaptable, adjustable, and modifiable for better overall health and efficiency, the glutes. The driving point for power in running should be originating from the glutes, and to make this so, the hips must be flexible and strong, and the pelvis must be properly held in place during natural rotation. If not, there could be excessive pelvic drop due to hip muscle weakness, then the hips and knees will compensate to keep balanced, thus potentially injuring the knees and surrounding ligaments. How often do you think about how your pelvis is tilted while running and what effect it could make on your form? It is more important than you think! The degree to which the pelvis is tilted, whether forward or back, plays an instrumental role in positioning the center of gravity properly, keeping the trunk in the frontal plane, and allowing the back to stay at a healthy amount of arch. Regarding the hips during the foot strike phase of running, powerful extension of the hip, while limiting the amount of knee extension during this phase, is a critical aspect of proper sprint mechanics. “The primary functions of the iliotibial band are to serve as a lateral hip and knee stabilizer and to resist hip adduction and knee internal rotation (Ferber & Macdonald, 2014).”

During the foot strike phase of the running motion, the hip should be extending rapidly to maximize the horizontal velocity of the foot, and hip flexion should be ~25-35 degrees. What this means is that as the foot hits the ground, preferably about 8-10 inches in front of the body's center of gravity, the hip should be quickly pressing backwards to make the most of the speed at which the foot is landing and pulling. During this motion, this pelvis must remain stable to allow optimal rotation and powerful hip flexion. If the hip or core muscles have any sort of muscular imbalance, the pelvis could be unstable and thus dip to one side of the other, causing the subsequent knee to inadvertently drive inwards, and then causing the upper trunk to lean the opposite direction in a counterbalancing act. It is a whole chain reaction that stems from weak hip and core muscles that are undertrained.

The pelvis must be properly engaged to provide the most beneficial effect to the overall running biomechanics. Backward (posterior) pelvic tilt of 7-8 degrees is found to be the most effective positioning. "Keep the hips up" implies that shifting the belly button and pelvis upwards in the front, will then open the hips to have more driving flexion force. This action also keeps the back aligned and engaged, corrected from excessive lordosis. Considering rotation of the pelvis in the forward and backward motion, ~30 degrees of rotation is considered optimal. Excessive, or limited rotation of the pelvis, regarding an optimal 30 degrees of rotation, can often be a telltale sign of poor flexibility and strength of the hips or lower abdominal hip flexor muscles. When running, the pelvis knows, biomechanically speaking, that it is supposed to rotate to some degree when propelling the body along with the legs and hips. However, if the

hips or lower abdominal hip muscles are weak or “deactivated” due to lack of use, the hips, legs, and lower abdominal muscles will over-compensate to make up for the lack of proper rotation. This is where potential injury can be introduced, in addition to poor and ineffective biomechanics. Oftentimes, the relationship seen here is a strength-to-weakness cross on opposing sides of the body from front to back. The low back is tight; thus, the abdominals are weak. Another example is tight hip flexors, which lead to weak glutes. Look at the following exercises to get an idea for what kind of stretches and moves should be incorporated into your normal routine to develop better hip muscles.

1. Single-Leg Bridge

Lie face-up, knees bent then lift your hips.



Figure 4

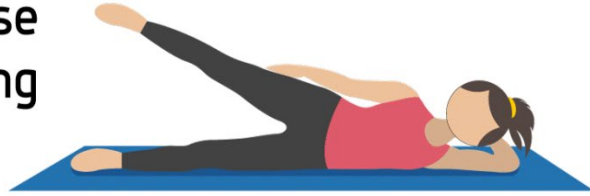
2. Donkey Kicks

From all fours, gradually lift your right leg behind you. Pulsate your flexed leg.

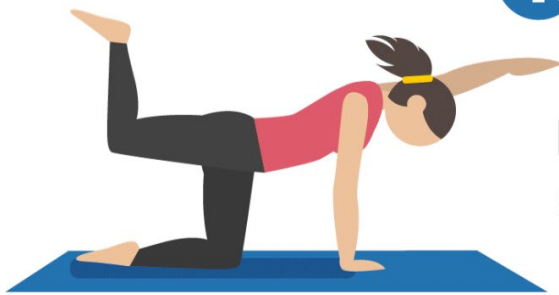


3. Side-Lying Hip Abduction

Lie on your side, raise your top leg while keeping the knee straight.



4. Bird Dog



From all four, extend your left arm in front while straightening your right leg behind you.

5. Single-Leg Deadlift

Stand on one leg then hinge forward at the waist and raise the rear leg behind you.



In a 2016 study, a systematic review and meta-analysis of strength training in runners was performed, and the results showed that specific, targeted strength training and plyometric exercises for the endurance athlete are of great benefit to running economy. Balsalobre-Fernández et al. (2016) conducted a systematic review on these kinds of exercises and the research shows that building up a strong foundation does not hinder

the athlete by adding bulky muscle, but rather providing a balanced all-around musculature.

The final essential exercise is more *brain-training* than hip strengthening stretch. The purpose behind this exercise is to train the body to perform the motion of running in a hip-dominant fashion.

1. Start by placing your left foot out in front of your right foot. Now, keeping your right foot planted, pull your left leg back along the ground until the knee is straightened and on the toes. Repeat this motion and try pulling from the hips.

Notice how your glutes engage as the leg is propelled back. The foot never leaves the ground. Incorporate the arms as in a running motion when the front leg is pulled back. This whole exercise demonstrates the process of landing on your foot slightly in front of the center of gravity, and then engaging the hips to pull the leg back. The next advanced step to this exercise is to incorporate a small hop when pulling the leg back so that the feet switch positions. Finding a line on the ground to stay behind for this exercise is very helpful.

Chapter 7: The Knees

“Persistence can change failure into extraordinary achievement.” – Matt Biondi

“Nearly every study on running injuries ranks patella-femoral pain in the top three injuries ailing runners. Your patella, or kneecap, is basically a pulley for your quad. When you over-stride, the torque or mechanical load on the knee is greater. The quad must work harder, creating more shear across the surface of the patella, which is not the best thing for the long-term health of the cartilage underneath it. Changing your muscle dominance will reduce stress on the knee” (Dicharry, 2017, pg. 90). The knees are one of the most common areas on the body for injury to present itself. From Runner’s Knee to patellofemoral syndrome, to torn ACL’s and MCL’s, the knee is a top-priority joint that takes a large dosage of physical trauma during running. If the knee is compensating for weakness elsewhere in the body, running biomechanics break down quickly. For instance, if there is weakness in the hips, or the hips are “deactivated” due to lack of use or continuous sitting for long periods, the hips will dip inwards to compensate for rotational motion, thus causing the knees to buckle inwards as well. Another way the knees can develop injury is from over-striding and heel striking. However, the degree to which the heel is striking in front of the body’s center of gravity is noteworthy because not all heel striking is bad. “At a running pace of 6 min/mile, initial ground contact is usually made along the posterior 60% of the lateral border of the foot. Usually, contact occurs in the posterior third of the foot (rearfoot or heel strikers)” (Chan and Rudins, 1994, pg. 456). The body is a kinetic chain, and everything is

linked together. If the heel strikes far out in front of the body, the feet are taking almost all of the 2.5 times the body weight worth of force, sending that impact up to the knees, and then up to the hips, where pain might be felt the most.

Common inefficient tendencies for movement of the knee during running include diving inwards, diving outwards, or not being lifted high enough. Ideally, we want the knee to travel solely front-to-back so that energy is conserved, and excessive side-to-side motion does not waste energy and compensate form. Additionally, if the knee is not lifted to an adequate height, then the leg cannot complete a full rotation. A better stride is built on good rotation of the legs, and landing under the center of gravity. If you want to see how your knees typically bend upon landing, try this simple exercise.

1. Perform a standing broad jump and notice directional how your knees move upon landing. This action can also be done in front of a mirror or video recorded straight-on.

There are many exercises to help train the knees to behave properly, avoid injury, and move correctly. Some of these beneficial exercises include single-leg deadlifts, single-leg squats, single-leg hops, and intervals of running uphill. Isolating a single leg and performing *dynamic* exercises are best for building up the complementary muscles that aide in stability and balance. Running uphill can be extremely beneficial to remind the body to stand tall, drive the knees, and stay on the front half of the foot for the most effective push-off (Barnes, 2013). Knees that dive in or out can most likely be related

back to a hip muscle imbalance or gluteus medius weakness upon landing. During foot strike, if the shins are pointed outward, then the hips might also be pointed outwards, causing your knee to do the same. If the shins are neutral and pointing forward, and the hips are neutral as well, then the knee will track neutrally too. If the shins are pointed in, and the hips are in as well, then the knee will track inward. From these examples, it must be understood that if the hips are pointed in any direction besides neutral, the knees will track that direction, as well.

Chapter 8: Ankles & Feet

“Run often. Run long. But never outrun your joy of running.” – Julie Isphording, former

Olympic runner

Foot strike and proper landing must be supported by flexible feet and ankles. Ankles are one of the more common areas for injury to occur and are at even greater risk of reinjury for those that have previously hurt the joint. In addition to the ankle, the feet must be cared for even more so. As a population, the majority of runners land on their rearfoot naturally, while some land on their midfoot, and others land on their forefoot or toes. “The feet are generally neutral or slightly internally rotated and land under the knee below the center of gravity. At a running pace of 6 min/mile, initial ground contact is usually made along the posterior 60% of the lateral border of the foot. Usually, contact occurs in the posterior third of the foot (rearfoot or heel strikers)” (Chan & Rudins, 1994, pg. 456). No one way is correct as the most efficient strike depends on the person. Every stride is unique to the individual, and science does not say that one way of foot-striking is more efficient than the other. However, studies have shown that in regards to metabolic cost, or the amount of energy used to perform an action, rearfoot striking is the most efficient given that the big toe is designed to take the brunt of the load during toe-off. This contrasts the ideology that forefoot striking is the most effective due to the theory of elasticity and keeping ground-contact time as minimal as possible. As true as this is, everyone should not go trying to change their foot strike pattern instantaneously. Changing the way you *naturally* land during running can be detrimental and lead to more injuries. If you naturally rearfoot strike, focus on where

in relation to your center of gravity the strike is happening. It can never truly be directly under your center of gravity, but rather it should be slightly out in front. Landing too far out in front of the center of gravity, also known as over-striding, can lead to ankle, knee, and hip problems. Aside from the increased impact on the feet, this is a braking action, slowing down your forward momentum significantly. Drastically changing the natural foot-strike of one's stride could lead to overcompensation or further injury because the body is not structurally strong enough or adaptable enough yet. Make small changes at a time and be cognizant of how the body physically reacts and modifies the impact.

Going back to the ankle, the factor to look for when identifying natural weaknesses or imbalances is the direction the ankle causes the foot to turn. When you walk in a straight line, does the ankle bend inwards, outwards, or not at all? For the most part, a common tendency of all runners is to see some minor levels of internal rotation of the ankle. This is completely natural but can become an issue if the degree to which the ankle is caving inwards becomes excessive. If you have ever stepped wrong while running on a trail, or side of the road, causing your ankle to twist oddly, you might know the feeling of going a little too far past normal range of motion. To build up strength in the ankle and prevent against future twisted ankles, implement a stability and mobility routine into your weekly training. Try this exercise.

1. Place your hands on your hips and bring one foot off the ground. Position the ankle near the knee of the leg on the ground. Stand in this stable position for a few seconds and be aware of how your ankle flexes and relaxes to keep you balanced. Now, to add to the exercise, keep that foot planted and try twisting

side-to-side, rotating from the ankle. This will help in balance and stability of the ankle.

Other injuries to do preventative maintenance for are Achilles tendonitis, plantar fasciitis, and stress fractures. The Achilles muscle is one giant spring that aids in rebound and elasticity. Stretching the Achilles can be done by extending the leg straight back behind you and pressing the heel down. This will help to provide greater overall flexibility throughout the back of your leg. Maintaining foot and toe flexibility is also crucial for preventing against plantar fasciitis. Searing, shooting pain along the arches of the feet whenever walking or running can be prevented against. Practicing “Toe Yoga” by flexing the toes up and down, while also taking recovery steps by rolling out the soles with a tennis ball or lacrosse ball is a good general practice. Stress fractures can occur in the small bones of the feet due to overuse. Neglecting care and recovery of the feet, as well as wearing the proper footwear, can lead to season-ending stress fracture injuries.

If you would like to determine how much mobility your ankle really has, perform this simple test.

1. In just your bare feet, stand facing a wall and place your big toe against the base of the wall (place your other leg back behind you to support you). Attempt to bend from your ankle and touch your kneecap to the wall without your heel coming off the ground. If you can do this, then you have plenty of mobility needed in the ankle for running. The test may also be performed one to two inches back from the base of the wall. If this version of the test can be

performed, then there is sufficient mobility of the ankle to perform squat workouts (Dicharry, 2017).

However, in either of the tests, if you feel tightness in the front of the ankle, perform exercise 1. If you feel tightness in the back of the ankle, try exercise 2. If you can touch the wall with your kneecap, but your calves are stiff, do exercise 3.

1. Find a TheraBand and loop it around something sturdy near the ground, at ankle-height. Position your ankle in the loop, just above the ankle joint, and turn so the attachment point is behind you. Make sure the loop is taut against your ankle so there is no slack. Place the opposite foot slightly in front of the looped foot. Keep the back foot planted and move the shin forward, then back slowly. Hold for a few seconds before releasing.
2. Grab a handy towel and roll it into a sizable burrito. Place the big toe on the edge of the towel roll so that your little toes hang off the edge. Bend your knee forward and keep your heel flat. Hold this stretch for at least two to three minutes. You should feel this across the back of the calf.
3. You will need a foam roller to perform this exercise. While sitting, position the foam roller under one of your calves and cross the other leg on top. Place your hands behind your butt and lift so that you are supported by your hands and the calf on the foam roller only. Roll up and down along the calf for a few minutes each day to work out the tension and stiffness in the calf muscles.

When it comes to foot mobility, it is crucial to have a *sure-footed* foundation. The feet are our solid base that we must take good care of for lifelong support. To test if the foot muscles are firing and activating correctly, try this simple test.

1. Stand on one foot and close your eyes. Pay attention to how the foot reacts and adapts to keep you balanced. Notice if the foot tends to drift to the outside, not at all, or wobbles quite a bit. Now stand on the opposite foot and repeat the process.

If you happen to notice a tendency for the foot to drift outwards, there might be some tightness on the underside of your foot causing the big toe to be pulled up. To get that big toe down on the ground for a stable foot, try putting a lacrosse ball just behind the ball of your foot, closer to your last, outside toes. Take a stance that is slightly wider than shoulder-width. Twist your pelvis and trunk left and right for about 90 seconds. The ball should not move. This exercise will feel strange and probably cause some soreness in the foot, but it is extremely effective at retraining how the big toe should be sturdy and in solid contact with ground.

Another great exercise for improving foot control and stability is the single-leg shoulder press. This exercise can be done with a dumbbell, kettlebell, or even a milk jug.

2. Stand on one leg and raise the other leg off the ground (however is most comfortable for you). Hold your light weight (5-10 lbs.) in the arm opposite the leg on the ground. Press the weight upward and focus on keeping your spine as

neutral as possible. If the low back starts to arch, try dropping the ribs down in front to keep the spine neutral.

Chapter 9: Footwear

“Runs end. Running doesn’t.” – Quote from Nike

For this section, I will try not to go into too much detail, as there is a whole market for running shoes of all kinds, and explaining which shoe is right for every type of runner would become too lengthy and might come across as biased. In brief, I fully support local running stores, as well as larger chain running stores that sell running shoes. When figuring out what pair of running shoes is right for you, go into a store and have one of the employees perform a gait analysis or general exam of how you move when you walk and run. This should be standard practice now as the number of shoes targeted for specific foot movement patterns has skyrocketed. Simply put, if your foot has little to no arch, you will probably want something with arch support, or maybe you haven’t ever had foot problems and enjoy more of the natural ride of minimalist shoes. If your ankle dives inward when you walk or run, it would be recommended to find a supportive shoe that keeps your foot from collapsing, bending, or twisting excessively. If you notice your foot sliding around in the shoe when you are running, find a shoe that has a smaller toe box. The shoe should also be suitable for the type of running you are going to be doing, and the terrain you will be running on as well. If you are looking for a shoe that will help on race day, find a lighter shoe. The lighter the weight at the end your pendulum leg will use less energy. If you primarily run on rugged trails, find a sturdy shoe with good traction and grip. Many shoe companies have a tool online that you can use for free to determine which shoe is best for you. These online survey-type

tools can help determine which shoe fits your desired running goals and can properly support you along the way. Now, once you have your properly fitted and stylish shoe, find a way to keep track of the total mileage accumulated in the shoes. When a shoe accumulates anywhere from 350-500 miles (depending on the type of shoe) it is about time to get a replacement. This is the recommended mileage to replace at because shoes typically start to structurally break down around this time. If running is continued in well-worn, broken-down shoes, injury could arise. It has also been found that if you suffer from injuries or weakness to the Achilles tendon, run in a shoe that has a higher heel-to-toe drop. Less impact on the tendon and a smaller angle of dorsiflexion of the foot stretching the Achilles. As a good podiatrist would say, the feet are the foundation of the body. If they are not supported, the whole body can become structurally unsound.

Chapter 10: Putting it all together; Stride

“Keep listening to your body. It’ll tell you when something’s not okay.” – Emily Infeld

In conclusion, attempt to take in all the information previously touched upon. Glean from it what you wish and learn from the rest. Focus on one step at a time when running. Focus on a single modifiable attribute during each run. Eventually it will all come together into a cohesive running form. To avoid digressing and to best summarize all the available information, consider the following points:

1. Always keep the head relaxed and looking about 10-20 feet ahead.
2. Consider your posture and avoiding hunching. Roll those shoulders back.
3. Stick the chest out and lean from the waist.
4. Tuck the hips and pelvis up. Maintain a neutral spine.
5. Lift the knees enough for a full rotation, but also considering #6.
6. Attempt to land under the body, yet slightly in front of the center of gravity.
7. Stay light on your feet and act tall.
8. Run happy!

In a study done by Bailey and Messier (1991), it was found that by changing the stride length of an individual, drastic changes can take place on how the body adapts to handling impact and using metabolic energy. Shortening the stride so that the feet are landing under the body is efficacious to building better biomechanics.

Considering all that has been said, one must remember that there is no *perfect* running form. Every individual is unique and what makes one person the most economical and efficient is different for the next person. All biomechanical tendencies must be taken into consideration when aiming to improve performance and running form (Dugan & Bhat, 2005). Focus on staying loose, relaxed, and calm while running. The best thing you can do to improve your form is stay positive, take consistent steps to balance out musculature, and be cognizant of how the whole body is feeling. Improved economy and efficiency will come with time and patience.

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